Total Questions : 1053

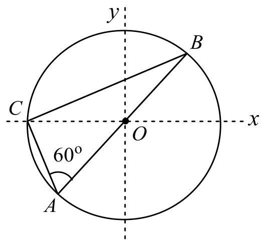
PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

Single Correct Answer Type

1. Charge $q_1 = +6.0$ nC is on Y- axis at y=+3 cm and charge q_2 =-6.0 nC is on Y- axis at y=-3 cm calculate force on a test charge $q_0 = 2$nC placed on X-axis at x=4 cm.
   a) $-51.8\,\hat{j}\mu$N b) $+51.8\,\hat{j}\mu$N c) $-5.18\,\hat{j}\mu$N d) $5.18\,\hat{j}\mu$N
2. The electric intensity outside a charged sphere of radius R at a distance $r(r > R)$ is
   a) $\frac{\sigma R^2}{\varepsilon_0 r^2}$ b) $\frac{\sigma r^2}{\varepsilon_0 R^2}$ c) $\frac{\sigma r}{\varepsilon_0 R}$ d) $\frac{\sigma R}{\varepsilon_0 r}$
3. An uniform electric field E exists along positive x-axis. The work done in moving a charge 0.5 C through a distance 2 m along a direction making an angle 60^o with x-axis is 10 J. Then the magnitude of electric field is
   a) 5 Vm^{-1} b) 2 Vm^{-1} c) $\sqrt{5}Vm^{-1}$ d) 20 Vm^{-1}
4. 64 small drops of mercury, each of radius r and charge q coalesce to form a big drop. The ratio of the surface density of charge of each small drop with that of the big drop is
   a) 1 : 64 b) 64 : 1 c) 4 : 1 d) 1 : 4
5. Two point charges 100 μC and 5 μC are placed at points A and B respectively with $AB = 40\ cm$. The work done by external force in displacing the charge 5 μC from B to C, where $BC = 30cm$, angle $ABC = \frac{\pi}{2}$ and $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2/C^2$
   a) 9 J
   b) $\frac{81}{20}J$
   c) $\frac{9}{25}J$
   d) $-\frac{9}{4}J$
6. An electric dipole is placed at an angle of 60^0 with an electric field of intensity 10^5 NC^{-1}. It experiences a torque equal to $8\sqrt{3}$ Nm. Calculate the charge on the dipole, if the dipole length is 2 cm.
   a) -8×10^3 C b) 8.54×10^{-4} C c) 8×10^{-3} C d) 0.85×10^{-6} C
7. A sphere of 4 cm radius is suspended within a hollow sphere of 6 cm radius. The inner sphere is charged to potential 3 $e.s.u.$ and the outer sphere is earthed. The charge on the inner sphere is
   a) 54$e.s.u.$
   b) 1/4$e.s.u.$
   c) 30$e.s.u.$
   d) 36$e.s.u.$
8. The angle subtended by a circular disk of diameter 2 cm at a distance 1000 cm from your eye is
   a) 0.2^o b) 0.002^o c) 0.11^o d) 0.22^o
9. Given that $q_1 + q_2 = q$. For what ratio q_1/q will the force between q_1 and q_2 be maximum?
   a) 0.25 b) 0.5 c) 1 d) 2
10. Two plates are at potentials $-10\ V$ and $+30\ V$. If the separation between the plates be 2 cm. The electric field between them is
   a) 2000 V/m b) 1000 V/m c) 500 V/m d) 3000 V/m

11. Consider a system of three charges $\frac{q}{3}, \frac{q}{3}$ and $-\frac{2q}{3}$ placed at points A, B and C, respectively, as shown in the figure. Take O to be the centre of the circle of radius R and angle CAB $= 60^o$



a) The electric field at point O is $\frac{q}{8\pi\varepsilon_0 R^2}$ directed along the negative x −axis
b) The Potential energy of the system is zero
c) The magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\varepsilon_0 R^2}$
d) The potential at point O is $\frac{q}{12\pi\varepsilon_0 R}$

12. There is a uniform electric field of strength $10^3 V/m$ along y-axis. A body of mass $1g$ and charge $10^{-6} C$ is projected into the field from origin along the positive x-axis with a velocity $10 m/s$. Its speed in m/s after $10s$ is (Neglect gravitation)
a) 10 b) $5\sqrt{2}$ c) $10\sqrt{2}$ d) 20

13. A cylindrical capacitor has charge Q and length L. If both the charge and length of the capacitor are doubled, by keeping other parameters fixed, the energy stored in the capacitor
a) Remains same b) Increases two times c) Decreases two times d) Increases four times

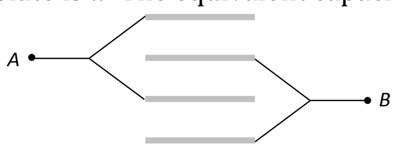
14. The electrostatic potential inside a charged spherical ball is given by $\phi = ar^2 + b$ where r is the distance from the centre a, b are constants. Then the charge density inside the ball is
a) $-6a\varepsilon_0 r$ b) $-24\pi a\varepsilon_0$ c) $-6a\varepsilon_0$ d) $-24\pi a\varepsilon_0 r$

15. Can a metal be used as a medium for dielectric
a) Yes b) No
c) Depends on its shape d) Depends on dielectric

16. The electric potential V is given as a function of distance x(metre) by $V = (5x^2 + 10x - 9) volt$. Value of electric field at $x = 1$ is
a) $-20 V/m$ b) $6 V/m$ c) $11 V/m$ d) $-23 V/m$

17. The work done in carrying a charge of $5\mu C$ from a point A to a point B in an electric field is $10 mJ$. The potential difference $(V_B - V_A)$ is then
a) $+2kV$ b) $-2 kV$ c) $+200 V$ d) $-200 V$

18. Four plates of the same area of cross-section are joined as shown in the figure. The distance between each plate is d. The equivalent capacity across A and B will be



a) $\frac{2\varepsilon_0 A}{d}$ b) $\frac{3\varepsilon_0 A}{d}$ c) $\frac{3\varepsilon_0 A}{2d}$ d) $\frac{\varepsilon_0 A}{d}$

19. A hollow conducting sphere of radius R has a charge $(+Q)$ on its surface. What is the electric potential within the sphere at a distance $r = R/3$ from its centre
a) Zero b) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$ c) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$ d) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$

20. The capacity of a spherical conductor in MKS system is
a) $\frac{R}{4\pi\varepsilon_0}$ b) $\frac{4\pi\varepsilon_0}{R}$ c) $4\pi\varepsilon_0 R$ d) $4\pi\varepsilon_0 R^2$

21. Two charged spheres of radii R_1 and R_2 having equal surface charge density. The ratio of their potential is

a) R_1/R_2 b) R_2/R_1 c) $(R_1/R_2)^2$ d) $(R_2/R_1)^2$

22. The magnitude of electric field E in the annular region of a charged cylindrical capacitor
a) Is same throughout
b) Is higher near the outer cylinder than near the inner cylinder
c) Varies as $1/r$, where r is the distance from the axis
d) Varies as $1/r^2$, where r is the distance from the axis

23. A charge of Q *coulomb* is placed on a solid piece of metal irregular shape. The charge will distribute itself
a) Uniformly in the metal object
b) Uniformly on the surface of the object
c) Such that potential energy of the system is minimised
d) Such that the total heat loss is minimised

24. Charge on α-particle is
a) $4.8 \times 10^{-19} C$ b) $1.6 \times 10^{-19} C$ c) $3.2 \times 10^{-19} C$ d) $6.4 \times 10^{-19} C$

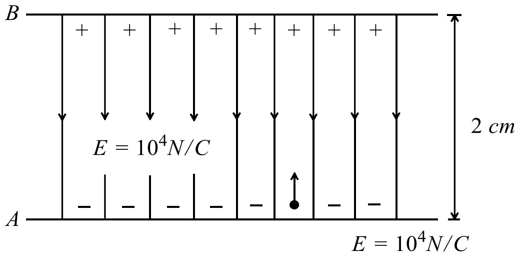
25. Two equal charges are separated by a distance d. A third charge placed on a perpendicular bisector at x distance will experience maximum coulomb force when
a) $x = \frac{d}{\sqrt{2}}$ b) $x = \frac{d}{2}$ c) $x = \frac{d}{2\sqrt{2}}$ d) $x = \frac{d}{2\sqrt{3}}$

26. Two unit negative charges are placed on straight line. A positive charge q is placed exactly at the mid-point between these unit charges. If the system of these three charges is in equilibrium, the value of q (in C) is
a) 1.0 b) 0.75 c) 0.5 d) 0.25

27. A capacitor of capacitance value $1\mu F$ is charged to 30 V and the battery is then disconnected. If it is connected across a $2\mu F$ capacitor, the energy lost by the system is
a) 300 μJ b) 450 μJ c) 225 μJ d) 150 μJ

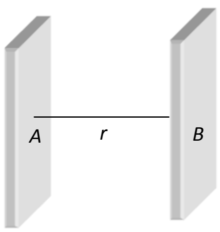
28. If the electric flux entering and leaving an enclosed surface respectively are ϕ_1 and ϕ_2, the electric charge inside the surface will be
a) $(\phi_2 - \phi_1)\varepsilon_0$ b) $\frac{\phi_1 + \phi_2}{\varepsilon_0}$ c) $\frac{\phi_1 - \phi_2}{\varepsilon_0}$ d) $\varepsilon_0(\phi_1 - \phi_2)$

29. An electron is released from the bottom plate A as shown in the figure ($E = 10^4 N/C$). The velocity of the electron when it reaches plate B will be nearly equal to



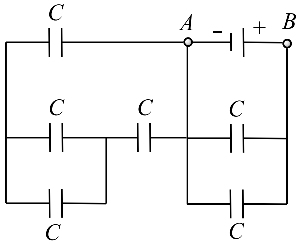
a) $0.85 \times 10^7\ m/s$ b) $1.0 \times 10^7\ m/s$ c) $1.25 \times 10^7\ m/s$ d) $1.65 \times 10^7\ m/s$

30. There are two equipotential surfaces as shown in figure. The distance between them is r. The charge of $-q$ coulomb taken from the surface A to B, the resultant work done will be



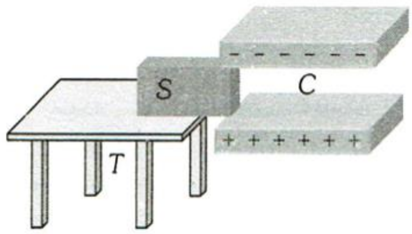
a) $W = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ b) $W = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ c) $W = -\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ d) $W =$ zero

31. Find equivalent capacitance between A and B



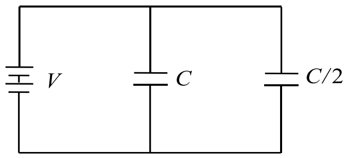
a) $6C$ b) $5C$ c) $3C$ d) $2C$

32. A frictionless dielectric plate S is kept on a frictionless table T. A charged parallel plate capacitance C (of which the plates are frictionless) is kept near it. The plate S is in between the plates. When the plate S is left between the plates



a) It will remain stationary on the table
b) It is pulled by the capacitor and will pass on the other end
c) It is pulled between the plates and will remain there
d) All the above statements are false

33. Two condensers, one of capacity C and the other of capacity $C/2$, are connected to a V-volt battery, as shown



The work done in charging fully both the condensers is

a) $2CV^2$ b) $\frac{1}{4}CV^2$ c) $\frac{3}{4}CV^2$ d) $\frac{1}{2}CV^2$

34. A parallel plate capacitor is connected to a battery. The plates are pulled apart with a uniform speed. If x is the separation between the plates, the time rate of change of electrostatic energy of capacitor is proportional to

a) x^{-2} b) x c) x^{-1} d) x^2

35. Two conducting sphere of radii r_1 and r_2 are charged to the same surface charge density. The ratio of electric field near their surface is

a) r_1^2 / r_2^2 b) r_2^2 / r_1^2 c) r_1 / r_2 d) 1 : 1

36. A capacitor 4 μF charged to 50 V is connected to another capacitor of 2μF charged to 100 V with plates of like charges connected together. The total energy before and after connection in multiples of $(10^{-2} J)$ is

a) 1.5 and 1.33 b) 1.33 and 1.5 c) 3.0 and 2.67 d) 2.67 and 3.0

37. Capacitors are used in electrical circuits where appliances need more

a) Current b) Voltage c) Watt d) Resistance

38. A hollow charged metal sphere has a radius r. If the potential difference between its surface and a point at a distance $3r$ from the centre is V, then electrical intensity at distance $3r$ from the centre is

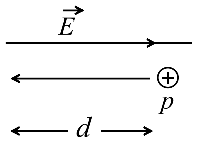
a) $\frac{V}{2r}$ b) $\frac{V}{3r}$ c) $\frac{V}{4r}$ d) $\frac{V}{6r}$

39. In a charged capacitor, the energy resides

a) The positive charges
b) Both the positive and negative charges
c) The field between the plates
d) Around the edge of the capacitor plates

40. An infinite number of electric charges each equal to 5 $nano - coulomb$ (magnitude) are placed along X-axis at $x = 1\ cm,\ x = 2\ cm,\ x = 4\ cm\ \ x = 8\ cm$ … … … and so on. In the setup if the consecutive charges have opposite sign, then the electric field in $Newton/Coulomb$ at $X = 0$ is
$\left[\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 N - m^2/c^2\right]$
a) 12×10^4 b) 24×10^4 c) 36×10^4 d) 48×10^4

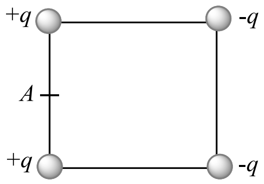
41. In the figure, a proton moves a distance d in a uniform electric field $\vec{E}$ as shown in the figure. Does the electric field do a positive or negative work on the proton? Does the electric potential energy of the proton increase or decrease



a) Negative, increase b) Positive, decrease c) Negative, decrease d) Positive, increase

42. When one electron is taken towards the other electron, then the electric potential energy of the system
a) Decreases b) Increases c) Remains unchanged d) Becomes zero

43. Four electric charges $+q, +q, -q$ and $-q$ are placed at the corners of a square of side $2L$ (see figure). The electric potential at point A, midway between the two charges $+q$



a) Zero b) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}(1+\sqrt{5})$ c) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$ d) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

44. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches$Q$ upto a closest distance r and then returns. If q is shot with speed$2v$, the closest distance of approach would be
a) $\frac{r}{4}$ b) $\frac{r}{2}$ c) $2r$ d) r

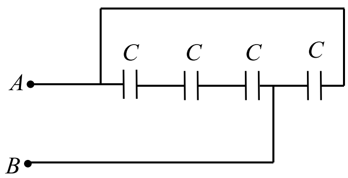
45. When the distance between the charged particles is halved, the force between them becomes
a) One-fourth b) Half c) Double d) Four times

46. Two identify long parallel conducting plates having surface charge densities $+\sigma$ and $-\sigma$ respectively, are separated by a small distance. The medium between the plates is vacuum. If ε_0 is the dielectric permittivity of vacuum, then the electric field in the region between the plates is
a) $0\ volts/meter$ b) $\frac{\sigma}{2\varepsilon_0}\ volts/meter$ c) $\frac{\sigma}{\varepsilon_0}\ volts/meter$ d) $\frac{2\sigma}{\varepsilon_0}\ volts/meter$

47. The capacity of the conductor does not depend upon
a) Charge b) Voltage
c) Nature of the material d) All of these

48. The electric intensity due to an infinite cylinder of radius R and having charge q per unit length at a distance $r(r > R)$ from its axis is
a) Directly proportional to r^2 b) Directly proportional to r^3
c) Inversely proportional to r d) Inversely proportional to r^2

49. The equivalent capacitance between A and B is



a) $C/4$ b) $3C/4$ c) $C/3$ d) $4C/3$

50. The force between two charges $0.06m$ apart is $5N$. If each charge is moved towards the other by $0.01m$, then the force between them will become

a) $7.20N$ b) $11.25N$ c) $22.50N$ d) $45.00N$

51. Identify the WRONG statement

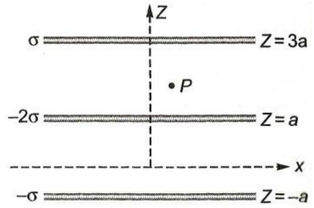
a) In an electric field two equipotential surface can never intersect

b) A charged particle free to move in an electric field shall always move in the direction of $\vec{E}$

c) Electric field at the surface of a charged conductor is always normal to the surface

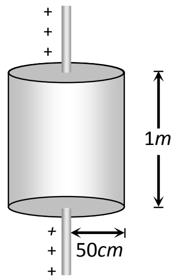
d) The electric potential decrease along a line of force in an electric field

52. Three infinitely long charge sheets are placed as shown in figure. The electric field at point P is



a) $\frac{2\sigma}{\varepsilon_0}\hat{\boldsymbol{k}}$ b) $-\frac{2\sigma}{\varepsilon_0}\hat{\boldsymbol{k}}$ c) $\frac{4\sigma}{\varepsilon_0}\hat{\boldsymbol{k}}$ d) $-\frac{4\sigma}{\varepsilon_0}\hat{\boldsymbol{k}}$

53. Electric charge is uniformly distributed along a long straight wire of radius $1\ mm$. The charge per cm length of the wire is $Q\ coulomb$. Another cylindrical surface of radius $50\ cm$ and length $1\ m$ symmetrically encloses the wire as shown in the figure. The total electric flux passing through the cylindrical surface is



a) $\frac{Q}{\varepsilon_0}$ b) $\frac{100Q}{\varepsilon_0}$ c) $\frac{10Q}{(\pi\varepsilon_0)}$ d) $\frac{100Q}{(\pi\varepsilon_0)}$

54. A particle of $'m'$ and charge $'q'$ is accelerated through a potential difference of $V\ volt$, its energy will be

a) qV b) mqV c) $\left(\frac{q}{m}\right)V$ d) $\frac{q}{mV}$

55. Two charges q_1 and q_2 are placed in vacuum at a distance d and the force acting between them is F. If a medium of dielectric constant 4 is introduced between them, the force now will be

a) $4F$ b) $2F$ c) $\frac{F}{2}$ d) $\frac{F}{4}$

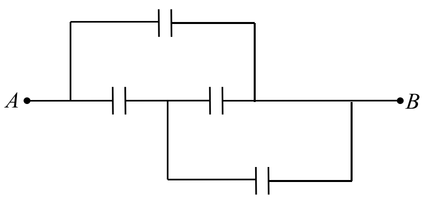
56. Charges $+2q, +q$ and $+q$ are placed at the corners A, B and C of an equilateral triangle ABC. If E is the electric field at the circumcentre O of the triangle, due to the charge $+q$, then the magnitude and direction of the resultant electric field at O is

a) E along AO b) $2E$ along AO c) E along BO d) E along CO

57. The value of electric potential at any point due to any electric dipole is

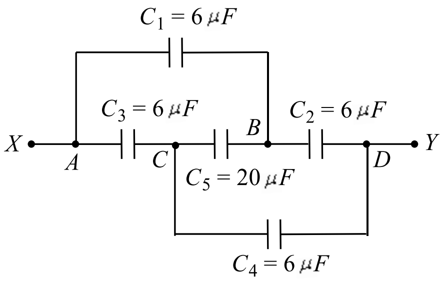
a) $k.\frac{\vec{p}\times\vec{r}}{r^2}$ b) $k.\frac{\vec{p}\times\vec{r}}{r^3}$ c) $k.\frac{\vec{p}.\vec{r}}{r^2}$ d) $k.\frac{\vec{p}.\vec{r}}{r^3}$

58. In the circuit shown in figure, each capacitor has a capacity of $3\mu F$. The equivalent capacity between A and B is



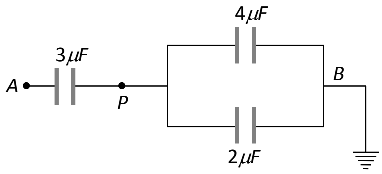
a) $\frac{3}{4}\mu F$ b) $3\mu F$ c) $6\mu F$ d) $5\mu F$

59. What is the effective capacitance between points X and Y



a) $24\mu F$ b) $18\mu F$ c) $12\mu F$ d) $6\mu F$

60. In the figure a potential of $+\ 1200\ V$ is given to point A and point B is earthed, what is the potential at the point P

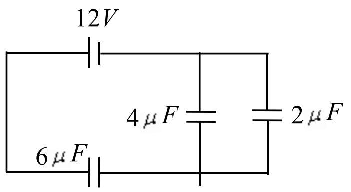


a) $100\ V$ b) $200\ V$ c) $400\ V$ d) $600\ V$

61. Conduction electrons are almost uniformly distributed within a conducting plate. When placed in an electrostatic field $\vec{E}$, the electric field within the plate

a) Is zero
b) Depends upon E
c) Depends upon $\vec{E}$
d) Depends upon the atomic number of the conducting element

62. The charge deposited on $4\mu F$ capacitor in the circuit is



a) $6 \times 10^{-6}C$ b) $12 \times 10^{-6}C$ c) $24 \times 10^{-6}C$ d) $36 \times 10^{-6}C$

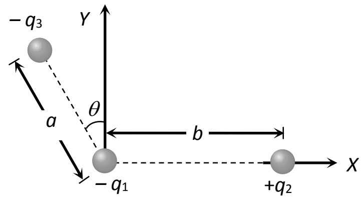
63. The magnitude of electric field intensity E is such that, an electron placed in it would experience an electrical force equal to its weight is given by

a) mge b) $\frac{mg}{e}$ c) $\frac{e}{mg}$ d) $\frac{e^2}{m^2}g$

64. While a capacitor remains connected to a battery and dielectric slab is applied between the plates, then

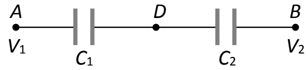
a) Potential difference between the plates is changed
b) Charge flows from the battery to the capacitor
c) Electric field between the plates increases
d) Energy store in the capacitor decreases

65. Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The x-component of the force on $-q_1$ is proportional to



a) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$ b) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\cos\theta$ c) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$ d) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\cos\theta$

66. Two condensers C_1 and C_2 in a circuit are joined as shown in figure. The potential of point A is V_1 and that of B is V_2. The potentials of point D will be

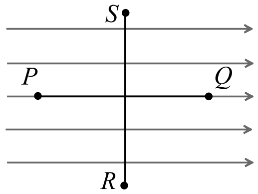


a) $\frac{1}{2}(V_1+V_2)$ b) $\frac{C_2V_1+C_1V_2}{C_1+C_2}$ c) $\frac{C_1V_1+C_2V_2}{C_1+C_2}$ d) $\frac{C_2V_1-C_1V_2}{C_1+C_2}$

67. A parallel plate air capacitor has a capacitance of $100\mu\mu F$. The plates are at a distance d apart. If a slab of thickness $t(t \leq d)$ and dielectric constant 5 is introduced between the parallel plates, then the capacitance will be

a) 50 $\mu\mu F$ b) 100 $\mu\mu F$ c) 200 $\mu\mu F$ d) 500 $\mu\mu F$

68. The points resembling equal potentials are



a) P and Q b) S and Q c) S and R d) P and R

69. What is angle between electric field and equipotential surface?

a) 90°always b) 0° always c) 0° to 90° d) 0° to 180°

70. Two equal charges q are placed at a distance of $2a$ and a third charge $-2q$ is placed at the midpoint. The potential energy of the system is

a) $\frac{q^2}{8\pi\varepsilon_0 a}$ b) $\frac{6q^2}{8\pi\varepsilon_0 a}$ c) $-\frac{7q^2}{8\pi\varepsilon_0 a}$ d) $\frac{9q^2}{8\pi\varepsilon_0 a}$

71. An electric dipole is put in north-south direction in a sphere filled with water. Which statement is correct

a) Electric flux is coming towards sphere

b) Electric flux is coming out of sphere

c) Electric flux entering into sphere and leaving the sphere are same

d) Water does not permit electric flux to enter into sphere

72. If 3 charges are placed at the vertices of equilateral triangle of charge $'q'$ each. What is the net potential energy, if the side of equilateral Δ is $l\ cm$

a) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{l}$ b) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2}{l}$ c) $\frac{1}{4\pi\varepsilon_0}\frac{3q^2}{l}$ d) $\frac{1}{4\pi\varepsilon_0}\frac{4q^2}{l}$

73. An electric dipole of moment p is placed at the origin along the x-axis. The electric field at a point P, whose position vector makes an angle θ with the x-axis, will make an angle .... With the x-axis, where $\tan\theta = \frac{1}{2}\tan\theta$

a) α b) θ c) $\theta+\alpha$ d) $\theta+2\alpha$

74. A long, hollow conducting cylinder is kept coaxially inside another long, hollow conducting cylinder of larger radius. Both the cylinders are initially electrically neutral.

a) A potential difference appears between the two cylinders when a charge density is given to the inner cylinder

b) A potential difference appears between the two cylinders when a charge density is given to the outer cylinder

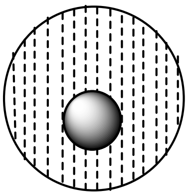
c) No potential difference appears between the two cylinders when a uniform line charge is kept along the axis of the cylinders

d) No potential difference appears between the two cylinders when same charge density is given to both the cylinders

75. The bob of simple pendulum is hanging vertically down from a fixed identical bob by means of string of length l. If both bobs are charged with a charge with a charge q each, time period of the pendulum is (ignore the radii of the bobs)

a) $2\pi\sqrt{\frac{l}{g+\left(\frac{q^2}{l^2m}\right)}}$ b) $2\pi\sqrt{\frac{l}{g-\left(\frac{q^2}{l^2m}\right)}}$ c) $2\pi\sqrt{\frac{l}{g}}$ d) $2\pi\sqrt{\frac{l}{g-\left(\frac{q2}{l}\right)}}$

76. A spherical portion has been removed from a solid sphere having a charge distributed uniformly in its volume as shown in the figure. The electric field inside the emptied space is

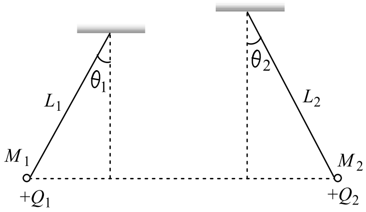


a) Zero everywhere
b) Non-zero and uniform
c) Non-uniform
d) Zero only at its centre

77. Four metal conductors having different shapes
I. A sphere
II. Cylinder
III. Pear
IV. Lightning conductor
are mounted on insulating stands and charged. The one which is best suited to retain the charges for a longer time is
a) 1
b) 2
c) 3
d) 4

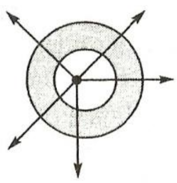
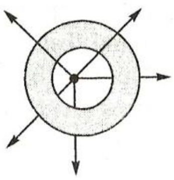
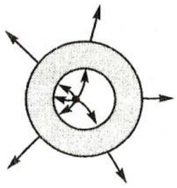
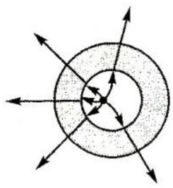
78. Two identical charges repel each other with a force equal to 10 mg wt when they are 0.6 m apart in air ($g = 10ms^{-2}$). The value of each charge is
a) 2mC
b) 2×10^{-7} C
c) 2 nC
d) 2μ C

79. Two small spheres of masses M_1 and M_2 are suspended by weightless insulating threads of lengths L_1 and L_2. The spheres carry charges Q_1 and Q_2 respectively. The spheres are suspended such that they are in level with one another and the threads are inclined to the vertical at angles of θ_1 and θ_2 as shown. Which one of the following conditions is essential, if $\theta_1 = \theta_2$



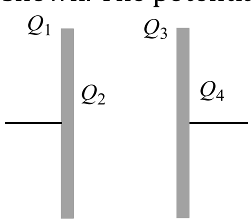
a) $M_1 \neq M_2$ but $Q_1 = Q_2$
b) $M_1 = M_2$
c) $Q_1 = Q_2$
d) $L_1 = L_2$

80. A metallic shell has a point charge q kept inside its cavity. Which one of the following diagrams correctly represents the electric lines or forces?

a) 
b) 
c) 
d) 

81. The electric field inside a spherical shell of uniform surface charge density is
a) Zero
b) Constant, less than zero
c) Directly proportional to the distance from the centre
d) None of the above

82. In an isolated parallel plate capacitor of capacitance C, the four surface have charges Q_1, Q_2, Q_3 and Q_4 as shown. The potential difference between the plates is



a) $\frac{Q_1+Q_2+Q_3+Q_4}{2C}$ b) $\frac{Q_2+Q_3}{2C}$ c) $\frac{Q_2-Q_3}{2C}$ d) $\frac{Q_1+Q_4}{2C}$

83. A pendulum bob carries a negative charge $-q$ .A positive charge $+q$ is held at the point of support. Then, the time period of the bob is
a) Greater than $2\pi\sqrt{\frac{L}{g}}$ b) Less than $2\pi\sqrt{\frac{L}{g}}$ c) equal to $2\pi\sqrt{\frac{L}{g}}$ d) Equal to $2\pi\sqrt{\frac{2L}{g}}$

84. $0.2F$ capacitor is charged to $600\ V$ by a battery. On removing the battery, it is connected with another parallel plate condenser of $1F$. The potential decreases to
a) $100\ volts$ b) $120\ volts$ c) $300\ volts$ d) $600\ volts$

85. Identify the wrong statement in the following. Coulomb's law correctly describes the electric force that
a) Binds the electrons of an atom to its nucleus
b) Binds the protons and neutrons in the nucleus of an atom
c) Binds atoms together to form molecules
d) Binds atoms and molecules together to form solids

86. An electric dipole is placed in an electric field generated by a point charge
a) The net electric force on the dipole must be zero
b) The net electric force on the dipole may be zero
c) The torque on the dipole due to the field must be zero
d) The torque on the dipole due to the field may be zero

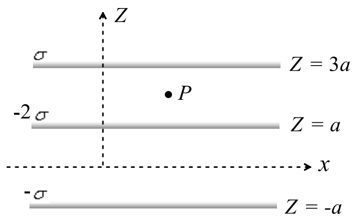
87. A cube of side b has a charge q at each of its vertices. The electric field due to this charge distribution at the centre of this cube will be
a) q/b^2 b) $q/2b^2$ c) $32q/b^2$ d) Zero

88. Two capacitors of capacitance $3\mu\ F$ and $6\mu\ F$ are charged to a potential of $12\ V$ each. They are now connected to each other, with the positive plate of each joined to the negative plate of the other. The potential difference across each will be
a) $6\ volt$ b) $4\ volt$ c) $3\ volt$ d) Zero

89. There are two metallic spheres of same radii but one is solid and the other is hollow, then
a) Solid sphere can be given more charge b) Hollow sphere can be given more charge
c) They can be charged equally (maximum) d) None of the above

90. An infinite line charge produce a field of $7.182 \times 10^8\ N/C$ at a distance of $2\ cm$. The linear charge density is
a) $7.27 \times 10^{-4}\ C/m$ b) $7.98 \times 10^{-4}\ C/m$ c) $7.11 \times 10^{-4}\ C/m$ d) $7.04 \times 10^{-4}\ C/m$

91. Three infinitely long charge sheets are placed as shown in figure. The electric field at point P is



a) $\frac{2\sigma}{\varepsilon_0}\hat{k}$ b) $-\frac{2\sigma}{\varepsilon_0}\hat{k}$ c) $\frac{4\sigma}{\varepsilon_0}\hat{k}$ d) $-\frac{4\sigma}{\varepsilon_0}\hat{k}$

92. A given charge is situated at a certain distance from an electric dipole in the end-on position experiences a force F. If the distance of the charge is doubled, the force acting on the charge will be
a) $2F$ b) $F/2$ c) $F/4$ d) $F/8$

93. A slab of material of dielectric constant K has the same area as the plates of a parallel plate capacitor but has a thickness $\left(\frac{3}{4}\right)d$, where d is the separation of the plates. The ratio of the capacitance C (in the presence of the dielectric) to the capacitance C_0 (in the absence of the dielectric) is
a) $\frac{3K}{K+4}$ b) $\frac{3}{4}K$ c) $\frac{4K}{K+3}$ d) $\frac{4}{3}K$

94. The magnitude of electric field at distance r from an infinitely thin rod having a linear charge density λ is(use Gauss's law)

a) $E = \frac{\lambda}{2\pi\varepsilon_0 r}$ b) $E = \frac{2\lambda}{\pi\varepsilon_0 r}$ c) $E = \frac{\lambda}{4\pi\varepsilon_0 r}$ d) $E = \frac{4\lambda}{\pi\varepsilon_0 r}$

95. When two identical capacitors are in series have $3\mu F$ capacitance and when parallel $12\mu F$. What is the capacitance of each

a) $6\mu\ F$ b) $3\mu\ F$ c) $12\mu\ F$ d) $9\mu\ F$

96. The ratio of the forces between two small spheres with constant charge (a) in air (b) in a medium of dielectric constant K is

a) $1 : K$ b) $K : 1$ c) $1 : K^2$ d) $K^2 : 1$

97. An electric dipole has a pair of equal and opposite point charges q and $-q$ separated by a distance $2x$. The axis of the dipole is defined as

a) Direction from positive charge to negative charge
b) Direction from negative charge to positive charge
c) Perpendicular to the line joining the two charges drawn at the centre and pointing upward direction
d) Perpendicular to the line joining the two charges drawn at the centre and pointing downward direction

98. If $4 \times 10^2\ eV$ energy is required to moves a charge of 0.25 *coulomb* between two points. Then what will be the potential difference between them

a) 178 V b) 256 V c) 356 V d) None of these

99. Condenser A has a capacity of $15\mu F$ when it is filled with a medium of dielectric constant 15. Another condenser B has a capacity of $1\pi F$ with air between the plates. Both are charged separately by a battery of 100 V. After charging, both are connected in parallel without the battery and the dielectric medium being removed. The common potential now is

a) 400 V b) 800 V c) 1200 V d) 1600 V

100. A capacitor is charged by a battery and the energy stored is U. The battery is now removed and the separation distance between the plates is doubled. The energy stored now is

a) $\frac{U}{2}$ b) U c) $2U$ d) $4U$

101. Three condensers each of capacitance $2F$ are put in series. The resultant capacitance is

a) $6F$ b) $\frac{3}{2}F$ c) $\frac{2}{3}F$ d) $5F$

102. A ball of mass 1 g and charge $10^{-8}C$ moves from a point A. where potential is 600 *volt* to the point B where potential is zero. Velocity of the ball at the point B is 20 cm/s. The velocity of the ball at the point A will be

a) 22.8 cm/s b) 228 cm/s c) 16.8 m/s d) 168 m/s

103. An electric dipole of moment p is placed in the position of stable equilibrium in uniform electric field of intensity E. It is rotated through an angle θ from the initial position. The potential energy of electric dipole in the final position is

a) $pE\cos\theta$ b) $pE\sin\theta$ c) $pE(1-\cos\theta)$ d) $-pE\cos\theta$

104. The electric field intensity **E**, due to an electric dipole of moment **p**, at a point on the equatorial line is

a) Parallel to the axis of the dipole and opposite to the direction of the dipole moment **p**
b) Perpendicular to the axis of the dipole and is directed away from it
c) Parallel to the dipole moment
d) Perpendicular to the axis of the dipole and is directed towards it

105. When a piece of polythene is rubbed with wool, a charge of -2$\times 10^{-7}$ C is developed on polythene. What mass, is transferred to polythene?

a) 5.69$\times 10^{-19}$ kg b) 2.25$\times 10^{-19}$ kg c) 9.63$\times 10^{-19}$ kg d) 11.38$\times 10^{-19}$ kg

106. An electron moving with the speed $5 \times 10^6\ m$ per sec is shooted parallel to the electric field of intensity $1 \times 10^3 N/C$. Field is responsible for the retardation of motion of electron. Now evaluate the distance

travelled by the electron before coming to rest for an instant (mass of $e = 9 \times 10^{-31}\ Kg$. charge $= 1.6 \times 10^{-19}C$)

a) $7\ m$ b) $0.7\ mm$ c) $7\ cm$ d) $0.7\ cm$

107. The capacitance of a parallel plate capacitor with air as medium is $3\mu F$. With the introduction of a dielectric medium between the plates, the capacitance becomes $15\mu F$. The permittivity of the medium is

a) 5 b) 15

c) $0.44 \times 10^{-10} C^2N^{-1}m^{-2}$ d) $8.854 \times 10^{-11} C^2N^{-1}m^{-2}$

108. Two similar spheres having $+q$ and $-q$ charge are kept at a certain distance. F force acts between the two. If in the middle of two spheres, another similar sphere having $+q$ charge is kept, then it experience a force in magnitude and direction as

a) Zero having no direction b) $8F$ towards $+q$ charge

c) $8F$ towards $-q$ charge d) $4F$ towards $+q$ charge

109. A spherical conductor of radius $2m$ is charged to a potential of $120\ V$. It is now placed inside another hollow spherical conductor of radius $6m$. Calculate the potential to which the bigger sphere would be raised

a) $20\ V$ b) $60\ V$ c) $80\ V$ d) $40\ V$

110. In a parallel plate capacitor of capacitance C, a metal sheet is inserted between the plates, parallel to them. If the thickness of the sheet is half of the separation between the plates. The capacitance will be

a) $C/2$ b) $3C/4$ c) $4C$ d) $2C$

111. A parallel plate condenser with oil between the plates (dielectric constant of oil $K = 2$) has a capacitance C. If the oil is removed, then capacitance of the capacitor becomes

a) $\sqrt{2}C$ b) $2C$ c) $\frac{C}{\sqrt{2}}$ d) $\frac{C}{2}$

112. A solid sphere of radius R has a charge Q distributed in its volume with a charge density$\rho = kr^a$, where k and a are constants and $r$is the distance from its centre. If the electric field at $r = \frac{R}{2}$ is$\frac{1}{8}$ times that at $r = R$, find the value of a.

a) 2 b) 3 c) 2.5 d) 0.2

113. Two spherical conductors A and B of radius a and $b(b > a)$ are placed in air concentrically B is given charge $+\ Q\ coulomb$ and A is grounded. The equivalent capacitance of these is

a) $4\pi\varepsilon_0 \frac{ab}{b-a}$ b) $4\pi\varepsilon_0(a+b)$ c) $4\pi\varepsilon_0 b$ d) $4\pi\varepsilon_0 \frac{b^2}{b-a}$

114. A neutral water molecule (H_2O) in it's vapor state has an electric dipole moment of magnitude $6.4 \times 10^{-30}\ C - m$. How far apart are the molecules centres of positive and negative charge

a) $4\ m$ b) $4\ mm$ c) $4\ \mu m$ d) $4\ pm$

115. A point charge q is placed at a distance $a/2$ directly above the centre of a square of side a. The electric flux through the square is

a) q/ε_0 b) $q/\pi\varepsilon_0$ c) $q/4\varepsilon_0$ d) $q/6\varepsilon_0$

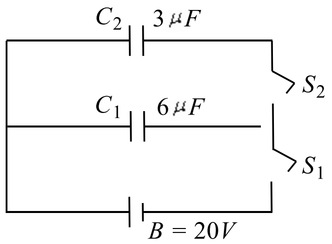
116. C, V, U and Q are capacitance, potential difference, energy stored and charge of parallel plate capacitor respectively. The quantities that increases when a dielectric slab is introduced between the plates without disconnecting the battery are

a) V and C b) V and U c) U and Q d) V and Q

117. The potentials of the two plates of capacitor are $+10V$ and $-10\ V$. The charge on one of the plates is $40\ C$. The capacitance of the capacitor is

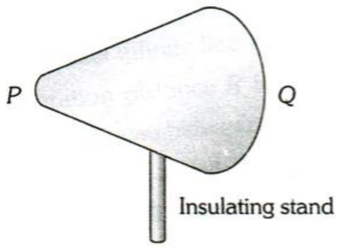
a) $2\ F$ b) $4\ F$ c) $0.5\ F$ d) $0.25\ F$

118. In the circuit shown here $C_1 = 6\mu F, C_2 = 3\mu F$ and battery $B = 20V$. The switch S_1 is first closed. It is then opened and afterwards S_2 is closed. What is the charge finally on C_2



a) $120\mu C$ b) $80\mu C$ c) $40\mu C$ d) $20\mu C$

119. Figure shows a charged conductor resting on an insulating stand. If at the point P the charge density is σ, the potential is V and the electric field strength is E, what are the values of these quantities at point Q



Charge Density	Potential	Electric intensity
a) $> \sigma$	$> V$	$> E$
b) $> \sigma$	V	$> E$
c) $< \sigma$	V	E
d) $< \sigma$	V	$< E$

120. If q is the charge per unit area on the surface of a conductor, then the electric field intensity at a point on the surface is

a) $\left(\frac{q}{\varepsilon_0}\right)$ normal to surface b) $\left(\frac{q}{2\varepsilon_0}\right)$ normal to surface
c) $\left(\frac{q}{\varepsilon_0}\right)$ tangential to surface d) $\left(\frac{q}{2\varepsilon_0}\right)$ tangential to surface

121. Two metal spheres of capacitance C_1 and C_2 carry some charges. They are put in contact and then separated. The final charges Q_1 and Q_2 on them will satisfy

a) $\frac{Q_1}{Q_2} < \frac{C_1}{C_2}$ b) $\frac{Q_1}{Q_2} = \frac{C_1}{C_2}$ c) $\frac{Q_1}{Q_2} > \frac{C_1}{C_2}$ d) $\frac{Q_1}{Q_2} < \frac{C_2}{C_1}$

122. A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is r (much larger than the size of the dipole), then electric field at Q is proportional to

a) p^{-1} and r^{-2} b) p and r^{-2} c) p^2 and r^{-3} d) p and r^{-3}

123. Let C be the capacitance of a capacitor discharging through a resistor R. Suppose t_1 is the time taken for the energy stored in the capacitor to reduce to half its initial value and t_2 is the time taken for the charge to reduce to one-fourth its initial value. Then the ratio t_1/t_2 will be

a) 2 b) 1 c) $\frac{1}{2}$ d) $\frac{1}{4}$

124. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density 0.8 gcm^{-3}, then angle remains the same. If density of the material of the sphere is 16g cm^{-3}, the dielectric constant of the liquid is

a) 4 b) 3 c) 2 d) 1

125. When a slab of dielectric material is introduced between the parallel plates of a capacitor which remains connected to a battery, then charge on plates relative to earlier charge

a) Is less b) Is same
c) Is more d) May be less or more depending on the nature of the material introduced

126. A charged particle of mass m and charge q is released from rest in a uniform electric field E. Neglecting the effect of gravity, the kinetic energy of the charged particle after $'t'$ second is

a) $\frac{Eq^2m}{2t^2}$ b) $\frac{2E^2t^2}{mq}$ c) $\frac{E^2q^2t^2}{2m}$ d) $\frac{Eqm}{t}$

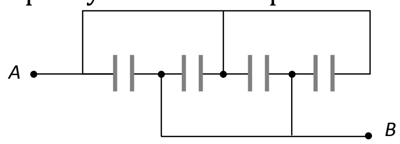
127. On rotating a point charge having a charge q around a charge Q in a circle of radius r. The work done will be

a) $Q \times 2\pi r$ b) $\frac{q \times 2\pi Q}{r}$ c) Zero d) $\frac{Q}{2\varepsilon_0 r}$

128. A body can be negatively charged by

a) Giving excess of electrons to it b) Removing some electrons from it
c) Giving some protons to it d) Removing some neutrons from it

129. Four condensers are joined are shown in the adjoining figure. The capacity of each is $8\mu F$. The equivalent capacity between the points A and B will be

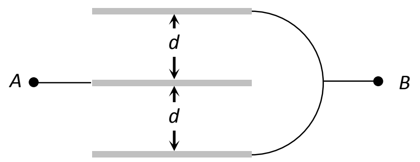


a) $32\mu F$ b) $2\mu F$ c) $8\mu F$ d) $16\mu F$

130. Under the action of a given coulombic force the acceleration of an electron is $2.5 \times 10^{22} m/s^2$. Then the magnitude of the acceleration of a proton under the action of same force is nearly

a) $1.6 \times 10^{-19} m/s^2$ b) $9.1 \times 10^{31} m/s^2$ c) $1.5 \times 10^{19} m/s^2$ d) $1.6 \times 10^{27} m/s^2$

131. Three plates of common surface area A are connected as shown. The effective capacitance will be



a) $\frac{\varepsilon_0 A}{d}$ b) $\frac{3\varepsilon_0 A}{d}$ c) $\frac{3}{2}\frac{\varepsilon_0 A}{d}$ d) $\frac{2\varepsilon_0 A}{d}$

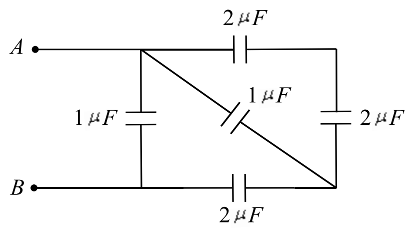
132. Two metal pieces having a potential difference of $800V$ are $0.02m$ apart horizontally. A particle of mass $1.96 \times 10^{-15} kg$ is suspended in equilibrium between the plates. If e is the elementary charge, then charge on the particle is

a) e b) $3e$ c) $6e$ d) $8e$

133. A capacitor of capacity C_1 is charged upto V volt and then connected to an uncharged capacitor of capacity C_2. Then final potential difference across each will be

a) $\frac{C_2 V}{C_1 + C_2}$ b) $\left(1 + \frac{C_2}{C_1}\right) V$ c) $\frac{C_1 V}{C_1 + C_2}$ d) $\left(1 - \frac{C_2}{C_1}\right) V$

134. The total capacity of the system of capacitors shown in the adjoining figure between the points A and B is

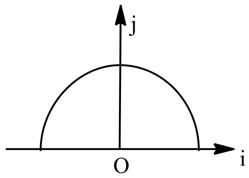


a) $1\mu F$
b) $2\mu F$
c) $3\mu F$
d) $4\mu F$

135. There is 10 units of charge at the centre of a circle of radius $10m$. The work done in moving 1 unit of charge around the circle once is

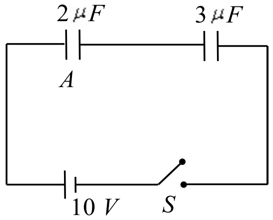
a) Zero b) 10 units c) 100 units d) 1 unit

136. A thin semi-circular ring of radius r has a positive charge q distributed uniformly over it. The net field $\mathbf{E}$ at the centre O is



a) $\frac{q}{4\pi^2\varepsilon_0 r^2}\,\hat{\mathbf{i}}$ b) $-\frac{q}{4\pi^2\varepsilon_0 r^2}\,\hat{\mathbf{j}}$ c) $-\frac{q}{2\pi^2\varepsilon_0 r^2}\,\hat{\mathbf{i}}$ d) $\frac{q}{2\pi^2\varepsilon_0 r^2}\,\hat{\mathbf{j}}$

137. Two capacitor A and B are connected in series with a battery as shown in the figure. When the switch S is closed and the two capacitors get charged fully, then



a) The potential difference across the plates of A is $4V$ and across the plates of B is $6V$
b) The potential difference across the plates of A is $6V$ and across the plates of B is $4V$
c) The ratio of electrical energies stored in A and B is $2 : 3$
d) The ratio of charges on A and B is $3 : 2$

138. There are two charged identical metal spheres A and B repel each other with a force 3×10^{-5} N. Another identical uncharged sphere C is touched with A and then placed at the mid-point between A and B. net force on C is
a) 1×10^{-5} N b) 2×10^{-5} N c) 1.5×10^{-5} N d) 3×10^{-5} N

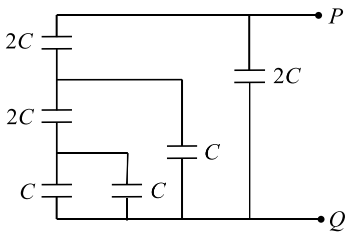
139. A resistor $'R'$ and $2\mu F$ capacitor in series is connected through a switch to 200 V direct supply. Across the capacitor is a neon bulb that lights up at 120 V. Calculate the value of R to make the bulb light up $5s$ after the switch has been closed. ($\log_{10} 2.5 = 0.4$)
a) $1.3 \times 10^4\Omega$ b) $1.7 \times 10^5\Omega$ c) $2.7 \times 10^6\Omega$ d) $3.3 \times 10^7\Omega$

140. The force of interaction between two charges $q_1 = 6\mu$ C and $q_2 = 2\mu$C is 12 N. If charge $q = -2\mu$C is added to each of the charges, then the new force of interaction is
a) 2×10^{-7} N b) Zero c) 30 N d) 2×10^{-3} N

141. Two spherical conductors A and B of radii 1 mm and 2 mm are separated by a distance of 5 cm and are uniformly charged. If the spheres are connected by a conducting wire then in equilibrium condition, the ratio of the magnitude of the electric fields at the surfaces of spheres A and B is
a) 1:2 b) 2:1 c) 1:4 d) 4:1

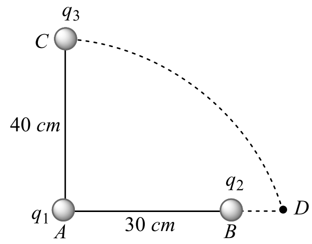
142. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then
a) Negative and distributed uniformly over the surface of the sphere
b) Negative and appears only at the point on the sphere closest to the point charge
c) Negative and distributed non-uniformly over the entire surface of the sphere
d) Zero

143. The resultant capacitance of given circuit is



a) $3C$ b) $2C$ c) C d) $\frac{C}{3}$

144. Two charges q_1 and q_2 are placed 30 cm apart, as shown in the figure. A third charge q_3 is moved along the arc of a circle of radius 40 cm from C to D. The change in the potential energy of the system is $\frac{q_3}{4\pi\varepsilon_0}k$, where k is



a) $8\ q_2$ b) $8\ q_1$ c) $6q_2$ d) $6q_1$

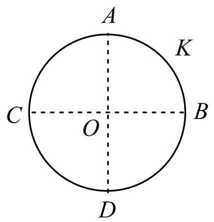
145. A thin metal plate P is inserted half way between the plates of a parallel plate capacitor of capacitance C in such a way that it is parallel to the two plates. The capacitance now becomes

a) C b) $C/2$ c) $4C$ d) None of these

146. Two protons are a distance of $1 \times 10^{-10} cm$ from each other. The forces acting on them are

a) Nuclear force and coulomb force
b) Nuclear force and gravitational force
c) Coulomb force and gravitational force
d) Nuclear, coulomb and gravitational force

147.



A thin conducting ring of radius R is given a charge $+Q$. The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part $ACDB$ of the ring is

a) E along KO b) 3 E along OK c) 3 E along KO d) E along OK

148. Which of the following statement is correct?

a) Electric field is zero on the surface of current carrying wire.
b) Electric field is non-zero on the axis of hollow current carrying wire
c) Surface integral of magnetic field for any closed surface is equal to μ_0 times of total algebraic sum of current which are crossing through the closed surface
d) None of the above

149. The charge given to any conductor resides on its outer surface, because

a) The free charge tends to be in its minimum potential energy state
b) The free charge tends to be in its minimum kinetic energy state
c) The free charge tends to be in its maximum potential energy state
d) The free charge tends to be in its maximum kinetic energy state

150. A 10 μF capacitor is charged to a potential difference of 1000 V. The terminals of the charged capacitor are disconnected from the power supply and connected to the terminals of an uncharged $6\mu F$ capacitor. What is the final potential difference across each capacitor

a) 167 V b) 100 V c) 625 V d) 250 V

151. The plates of a parallel plate condenser are pulled apart with a velocity v. If at any instant their mutual distance of separation is d, then the magnitude of the time of rate of change of capacity depends on d as follows

a) $1/d$ b) $1/d^2$ c) d^2 d) d

152. If a dielectric substance is introduced between the plates of a charged air-gap capacitor. The energy of the capacitor will

a) Increase
b) Decrease
c) Remain unchanged
d) First decrease and then increase

153. Two capacitors each of capacity $2\mu F$ are connected in parallel. This system is connected in series with a third capacitor of $12\mu F$ capacity. The equivalent capacity of the system will be

a) $16\mu F$ b) $13\mu F$ c) $4\mu F$ d) $3\mu F$

154. The top of the atmosphere is at about 400 kV with respect to the surface of the earth, corresponding to an electric field that decreases with attitude. Near the surface of the earth, the field is about 100 Vm^{-1}. Still, we do not get an electric shock as we step out of our house into the open house because (assume the house to be a steel cage so that there is no field inside)

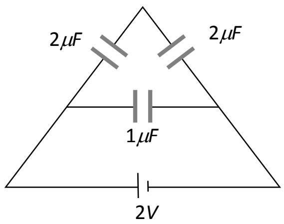
a) There is a potential difference between our body and the ground

b) 100 Vm^{-1} is not a high electric field so that we do not feel the shock

c) Our body and the ground forms and Equipotential surface

d) The atmosphere is not a conductor

155. The charge on any one of the 2μ F capacitors and 1μ F capacitor will be given respectively (in μ C) as



a) 1,2 b) 2,1 c) 1,1 d) 2,2

156. A 4 μF capacitor, a resistance of 2.5 $M\Omega$ is in series with 12 V battery. Find the time after which the potential difference across the capacitor is 3 times the potential difference across the resistor. [Given $\ln(2) = 0.693$]

a) 13.86 s b) 6.93 s c) 7 s d) 14 s

157. A cube of metal is given a positive charge Q. For the above system, which of the following statements is true

a) Electric potential at the surface of the cube is zero b) Electric potential within the cube is zero

c) Electric field is normal to the surface of the cube d) Electric field varies within the cube

158. 100 capacitors each having a capacity of $10\mu F$ are connected in parallel and are charged by a potential difference of 100 kV. The energy stored in the capacitors and the cost of charging them, if electrical energy costs 108 $paise\ per\ kWh$, will be

a) 10^7 $joule$ and 300 $paise$ b) 5×10^6 joule and 300 $paise$

c) 5×10^6 joule and 150 $paise$ d) 10^7 $joule$ and 150 $paise$

159. Four metal conductors having different shapes

1. A sphere 2. Cylindrical

3. Pear 4. Lightning conductor

Are mounted on insulating stands and charged. The one which is best suited to retain the charges for a longer time is

a) 1 b) 2 c) 3 d) 4

160. Two identical conducting spheres carrying different charges attract each other with a force F when placed in air medium at a distance $'d'$ apart. The spheres are brought into contact and then taken to their original positions. Now the two spheres repel each other with a force whose magnitude is equal to that of the initial attractive force. The ratio between initial charges on the spheres is

a) $-(3+\sqrt{8})$ only b) $-3+\sqrt{8}$ only

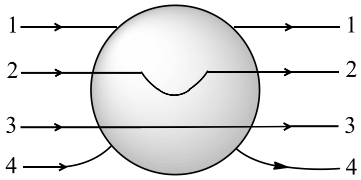
c) $-(3+\sqrt{8})$ or $(-3+\sqrt{8})$ d) $+\sqrt{3}$

161. A sample of HCl gas is placed in an electric field of 3×10^4 NC^{-1}. The dipole moment of each HCl molecule is $6 \times 10^{-30} c \times m$. The maximum torque that can act on a molecule is

a) $2 \times 10^{-34} C^2 N^{-1} m$ b) $2 \times 10^{-34} Nm$

c) 18×10^{-26} Nm d) $0.5 \times 10^{34} C^{-2} N^{-1} m^{-1}$

162. A metallic solid sphere is placed in a uniform electric field. The lines of force follow the path(s) shown in figure as



a) 1 b) 2 c) 3 d) 4

163. Dimensions of ε_0 are

a) $M^{-1}L^{-3}T^4A^2$ b) $M^0L^{-3}T^3A^3$ c) $M^{-1}L^{-3}T^3A$ d) $M^{-1}L^{-3}T\,A^2$

164. Two parallel metal plates having charges $+Q$ and $-Q$ face each other at a certain distance between them. If the plates are now dipped in kerosene oil tank, the electric field between the plates will

a) Become zero b) Increase c) Decrease d) Remain same

165. What is not true for equipotential surface for uniform electric field?

a) Equipotential surface is flat
b) Equipotential surface is spherical
c) Electric lines are perpendicular to equipotential surface
d) Work done is zero

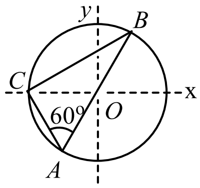
166. Two infinite plane parallel sheets separated by a distance d have equal and opposite uniform charge densities σ. Electric field at a point between the sheets is

a) Zero b) $\frac{\sigma}{\varepsilon_0}$
c) $\frac{\sigma}{2\varepsilon_0}$ d) Depends upon the location of the point

167. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

a) Be doubled b) Increase four times c) Be reduced to half d) Remain the same

168. Consider a system of three charges $\frac{q}{3}, \frac{q}{3}$ and $-\frac{2q}{3}$ placed at point A, B and C, respectively, as shown in the figure. Take O to be the centre of the circle of radius R and angle CAB=60°.



a) The electric field at point O is $\frac{q}{8\pi\varepsilon_0 R^2}$ directed along the negative x-axis
b) The potential energy of the system is zero
c) The magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\varepsilon_0 R^2}$
d) The potential at point O is $\frac{q}{12\pi\varepsilon_0 R}$

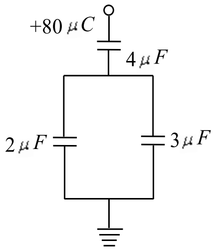
169. Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium the value of q is

a) $-\frac{Q}{4}(1+2\sqrt{2})$ b) $\frac{Q}{4}(1+2\sqrt{2})$ c) $-\frac{Q}{2}(1+2\sqrt{2})$ d) $\frac{Q}{2}(1+2\sqrt{2})$

170. Two conducting spheres of radii 5 cm and 10 cm are given a charge of 15μC each. After the two spheres are joined by a conducting wire, the charge on the smaller sphere is

a) 5μC b) 10μC c) 15μC d) 20μC

171. In the given circuit, a charge of +80 μC is given to the upper plate of the 4 μF capacitor. Then in the steady state, the charge on the upper plate of the 3 μF capacitor is

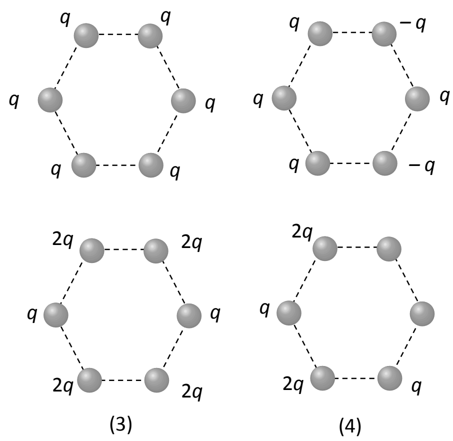


a) $+32\ \mu C$ b) $+40\ \mu C$ c) $+48\ \mu C$ d) $+80\ \mu C$

172. A hollow sphere of charge does not produce an electric field at any
a) Point beyond 2 metres
b) Point beyond 10 metres
c) Interior point
d) Outer point

173. A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is r (much larger than the size of the dipole), then the electric intensity E at Q is proportional to
a) r^{-2} b) r^{-4} c) r^{-1} d) r^{-3}

174. Figures below show regular hexagons, which charges at the vertices. In which of the following cases the electric field at the centre is not zero



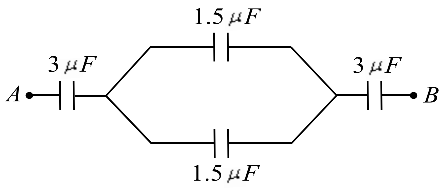
a) 1 b) 2 c) 3 d) 4

175. If an insulated non-conducting sphere of radius R has charge density ρ. The electric field at a distance r from the centre of sphere $(r < R)$ will be
a) $\frac{\rho R}{3\varepsilon_0}$ b) $\frac{\rho r}{\varepsilon_0}$ c) $\frac{\rho r}{3\varepsilon_0}$ d) $\frac{3\rho R}{\varepsilon_0}$

176. A soap bubble is given a negative charge, then its radius
a) Decreases
b) Increases
c) Remains unchanged
d) Nothing can be predicted as information is insufficient

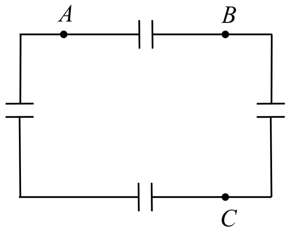
177. Charge Q is placed on each of $(n-1)$ corners of a polygon of n sides. The distance of centre of the polygon from each corners is $'r'$, then electric field at centre is
a) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ b) $\frac{(n-1)}{4\pi\varepsilon_0}\frac{Q}{r^2}$ c) $\frac{n}{(n-1)}\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ d) Zero

178. The capacitance between the points A and B in the given circuit will be



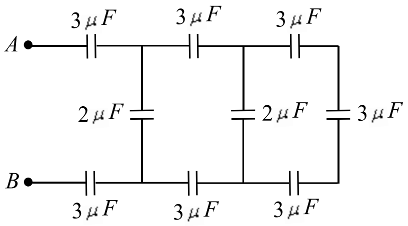
a) $1\ \mu F$ b) $2\ \mu F$ c) $3\ \mu F$ d) $4\ \mu F$

179. Four capacitors of each of capacity $3\mu F$ are connected as shown in the adjoining figure. The ratio of equivalent capacitance between A and B and between A and C will be



a) 4 : 3 b) 3 : 4 c) 2 : 3 d) 3 : 2

180. The equivalent capacitance between A and B is (in μF)

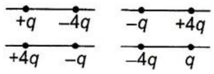


a) 25 b) $\frac{84}{25}$ c) 9 d) 1

181. For a dipole $q = 2 \times 10^{-6} C$ and $d = 0.01\ m$. Calculate the maximum torque for this dipole if $E = 5 \times 10^5\ N/C$

a) $1 \times 10^{-3} Nm^{-1}$ b) $10 \times 10^{-3} Nm^{-1}$ c) $10 \times 10^{-3} Nm$ d) $1 \times 10^{2} Nm^{2}$

182. The figure shows four situations in which charges as indicated (q >0) are fixed on an axis .In which situation is there a point to the left of the charges where an electron would be in equilibrium?



a) 1 and 2 b) 2 and 4 c) 3 and 4 d) 1 and 3

183. If the electric field given by $\left(5\hat{\mathbf{i}} + 4\hat{\mathbf{j}} + 9\hat{\mathbf{k}}\right)$, the electric flux through a surface of area 20 unit lying in the Y-Zplane will be

a) 100 unit b) 80unit c) 180 unit d) 20 unit

184. The electric potential at a point (x, y) in the $x - y$ plane is given by $V = -kxy$. The field intensity at a distance r from the origin varies as

a) r^2 b) r c) $\frac{1}{r}$ d) $\frac{1}{r^2}$

185. An electron falls through a small distance in a uniform electric field of magnitude $2 \times 10^4 NC^{-1}$. The direction of the field is reversed keeping the magnitude unchanged and a proton falls through the same distance. The time of fall will be

a) Same in both cases b) More in the case of an electron
c) More in the case of proton d) Independent of charge

186. An electron of mass m_e initially at rest moves through a certain distance in a uniform electric field in time t_1. A proton of mass m_p also initially at rest takes time t_2 to move through and equal distance in this uniform electric field. Neglecting the effect of gravity, the ratio of t_2/t_1 is nearly equal to

a) 1 b) $\left(m_p/m_e\right)^{1/2}$ c) $\left(m_e/m_p\right)^{1/2}$ d) 1836

187. Two unlike charges of the same magnitude Q are placed at a distance d. The intensity of the electric field at the middle point in the line joining the two charges.

a) Zero b) $\frac{3Q}{4\pi\varepsilon_0 d^2}$ c) $\frac{6Q}{2\pi\varepsilon_0 d^2}$ d) $\frac{4Q}{4\pi\varepsilon_0 d^2}$

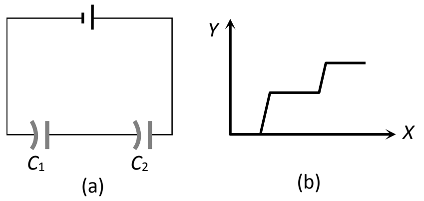
188. A solid conducting sphere of radius R_1 is surrounded by another concentric hollow conducting sphere of radius R_2. The capacitance of this assembly is proportional to

a) $\frac{R_2 - R_1}{R_1 R_2}$ b) $\frac{R_2 + R_1}{R_1 R_2}$ c) $\frac{R_1 R_2}{R_1 + R_2}$ d) $\frac{R_1 R_2}{R_2 - R_1}$

189. A $10\mu F$ capacitor is charged to a potential difference of $50\ V$ and is connected to another uncharged capacitor in parallel. Now the common potential difference becomes $20\ volt$. The capacitance of second capacitor is

a) $10\mu F$ b) $20\mu F$ c) $30\mu F$ d) $15\mu F$

190. Figure (a) shows two capacitors connected in series and joined to a battery. The graph in figure (b) shows the variation in potential as one moves from left to right on the branch containing the capacitors, if



a) $C_1 > C_2$ b) $C_1 = C_2$

c) $C_1 < C_2$ d) The information is not sufficient to decide the relation between $C1$ and C_2

191. Three identical capacitors are combined differently. For the same voltage to each combination, the one that stores the greatest energy is

a) Two in parallel and the third in series with it b) Three in series

c) Three in parallel d) Two in series and third in parallel with it

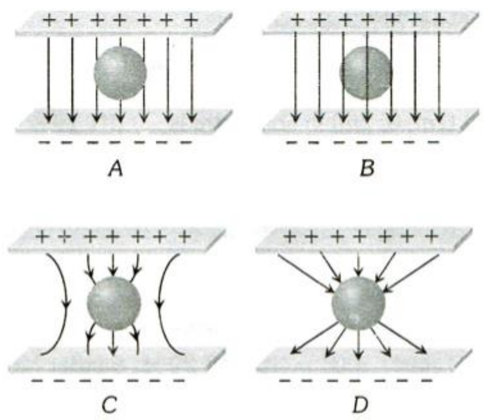
192. Three capacitors of $2\mu F, 3\mu F$ and $6\mu F$ are joined in series and the combination is charged by means of a $24\ volt$ battery. The potential difference between the plates of the $6\mu F$ capacitor is

a) $4\ volt$ b) $6\ volt$ c) $8\ volt$ d) $10\ volt$

193. Equal charges q are placed at the vertices A and B of an equilateral triangle ABC of side a. The magnitude of electric field at the point C is

a) $\frac{q}{4\pi\varepsilon_0 a^2}$ b) $\frac{\sqrt{2}q}{4\pi\varepsilon_0 a^2}$ c) $\frac{\sqrt{3}q}{4\pi\varepsilon_0 a^2}$ d) $\frac{q}{2\pi\varepsilon_0 a^2}$

194. An uncharged sphere of metal is placed in between two charged plates as shown.
The lines of force look like

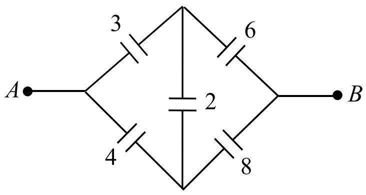


a) A b) B c) C d) D

195. The capacity and the energy stored in a parallel plate condenser with air between its plates are respectively C_0 and W_0. If the air is replaced by glass (dielectric constant = 5) between the plates, the capacity of the plates and the energy stored in it will respectively be

a) $5C_0, 5W_0$ b) $5C_0, \frac{W_0}{5}$ c) $\frac{C_0}{5}, 5W_0$ d) $\frac{C_0}{5}, \frac{W_0}{5}$

196. Effective capacitance between A and B in the figure shown is (all capacitance are in μF)



a) $21\ \mu F$ b) $23\ \mu F$ c) $\frac{3}{14}\mu F$ d) $\frac{14}{3}\mu F$

197. Two charged spheres of radii 10 cm and 15 cm are connected by a thin wire. No charge will flow, if they have

a) The same charge on each
b) The same potential
c) The same energy
d) The same field on their surface

198. Point charges $q_1 = 2\mu C$ and $q_2 = -1\mu C$ are kept at points $x = 0$ and $x = 6$ respectively. Electrical potential will be zero at points

a) $x = 2$ and $x = 9$
b) $x = 1$ and $x = 5$
c) $x = 4$ and $x = 12$
d) $x = -2$ and $x = 2$

199. The electric field due to an electric dipole at a distance r from its centre in axial position is E. If the dipole is rotated through an angle of 90° about its perpendicular axis, the electric field at the same point will be

a) E
b) $\frac{E}{4}$
c) $\frac{E}{2}$
d) 2E

200. A total charge Q is broken in two parts Q_1 and Q_2 and they are placed at a distance R from each other. The maximum force of repulsion between them will occur, when

a) $Q_2 = \frac{Q}{R}, Q_1 = Q - \frac{Q}{R}$ b) $Q_2 = \frac{Q}{4}, Q_1 = Q - \frac{2Q}{3}$ c) $Q_2 = \frac{Q}{4}, Q_1 = \frac{3Q}{4}$ d) $Q_1 = \frac{Q}{2}, Q_2 = \frac{Q}{2}$

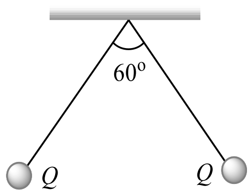
201. Two pint charges + 8q and -2q are located at $x = 0$ and $x = L$ respectively. The location of a point on the x- axis at which the net electric field due to these two point charges is zero is

a) 2L b) L/4 c) 8L d) 4L

202. Two long conductors, separated by a distance d carry currents I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to $3d$. The new value of the force between them is

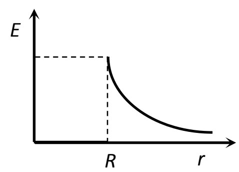
a) $-2F$ b) $F/3$ c) $-2F/3$ d) $-F/3$

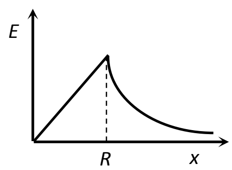
203. Two small spherical balls each carrying a charge $Q = 10\mu C$ ($10\ micro - coulomb$) are suspended by two insulating threads of equal lengths $1m$ each, from a point fixed in the ceiling. It is found that in equilibrium threads are separated by an angle 60^o between them, as shown in the figure. What is the tension in the threads (Given : $\frac{1}{(4\pi\varepsilon_0)} = 9 \times 10^9 Nm/C^2$)

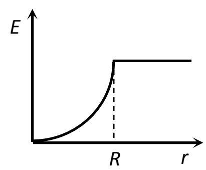


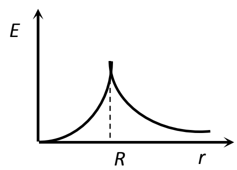
a) 18 N b) 1.8 N c) 0.18 N d) None of the above

204. Which of the following graphs shows the variation of electric field E due to a hollow spherical conductor of radius R as a function of distance from the centre of the sphere

a) 

b) 

c) 

d) 

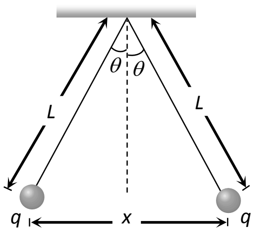
205. In infinite parallel plane sheet of a metal is charged to charge density σ coulomb per square metre in a medium of dielectric constant$K$. Intensity of electric field near the metallic surface will be

a) $E=\frac{\sigma}{\varepsilon_0 K}$ b) $E=\frac{K}{3\varepsilon_0}$ c) $E=\frac{\sigma}{2\varepsilon_0 K}$ d) $E=\frac{K}{2\varepsilon_0}$

206. A negatively charged plate has charge density of $2\times10^{-6} C/m^2$. The initial distance of an electron which is moving towards the plate, cannot strike the plate, if it is having energy of $200 eV$

a) 1.77 mm b) 3.51 mm c) 1.77 cm d) 3.51 cm

207. In the given figure two tiny conducting balls of identical mass m and identical charge q hang from non-conducting threads of equal length L. Assume that θ is so small that $\tan\theta \approx \sin\theta$, then for equilibrium x is equal to



a) $\left(\frac{q^2L}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$ b) $\left(\frac{qL^2}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$ c) $\left(\frac{q^2L^2}{4\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$ d) $\left(\frac{q^2L}{4\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$

208. An electric dipole in a uniform electric field experiences (When it is placed at an angle θ with the field)

a) Force and torque both b) Force but no torque

c) Torque but no force d) No force and no torque

209. In a parallel plate capacitor the separation between the plates is 3 mm with air between them. Now a 1mm thick layer of a material of dielectric constant 2 is introduced between the plates due to which the capacity increases. In order to bring its capacity to the original value the separation between the plates must be made

a) 1.5 mm b) 2.5 mm c) 3.5 mm d) 4.5 mm

210. Two point charges $+9e$ and $+e$ are at 16 cm away from each other. Where should another charge q be placed between them so that the system remains in equilibrium

a) 24 cm from $+9e$

b) 12 cm from $+9e$

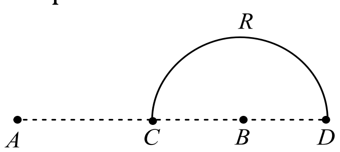
c) 24 cm from $+e$

d) 12 cm from $+e$

211. A cylinder of radius r and length l is placed in an uniform electric field E parallel to the axis of the cylinder. The total flux for the surface of the cylinder is given by

a) Zero b) $2\pi r^2 E$ c) $\pi r^2 E$ d) $(\pi r^2+\pi l^2)E$

212. Charges $+q$ and $-q$ are placed at point A and B respectively which are a distance $2L$ apart, C is the midpoint between A and B. The work done in moving a charge $+Q$ along the semicircle CRD is



a) $\frac{qQ}{4\pi\in_0 L}$ b) $\frac{qQ}{2\pi\in_0 L}$ c) $\frac{qQ}{6\pi\in_0 L}$ d) $-\frac{qQ}{6\pi\in_0 L}$

213. The energy required to charge a parallel plate condenser of plate separation d and plate area of cross-section A such that the uniform electric field between the plates is E, is

a) $\in_0 E^2Ad$ b) $\frac{1}{2}\in_0 E^2Ad$ c) $\frac{1}{2}\in_0 E^2/A.d$ d) $\in_0 E^2/Ad$

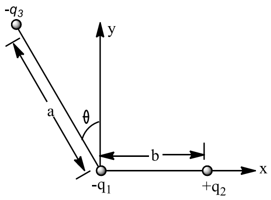
214. Two capacitors each of $1\mu F$ capacitance are connected in parallel and are then charged by 200 $volts\ d.c.$ supply. The total energy of their charges (in joules) is

a) 0.01 b) 0.02 c) 0.04 d) 0.06

215. The electric field near a conducting surface having a uniform surface charge density σ is given by

a) $\frac{\sigma}{\varepsilon_0}$ and is parallel to the surface
b) $\frac{2\sigma}{\varepsilon_0}$ and is parallel to the surface
c) $\frac{\sigma}{\varepsilon_0}$ and is normal to the surface
d) $\frac{2\sigma}{\varepsilon_0}$ and is normal to the surface

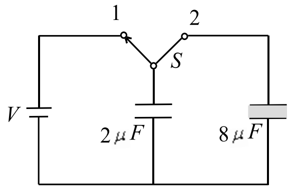
216. Three charges $-q_1 + q_2$ and $-q_3$ are placed as shown in the figure. The x −component of the force on $-q_1$ is proportional to



a) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\cos\theta$
b) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$
c) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\cos\theta$
d) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$

217. Top of the stratosphere has an electric field E (in units of V/m) nearly equal to
a) 0
b) 10
c) 100
d) 1000

218. A $2\mu F$ capacitor is charged as shown in figure. The percentage of its stored energy dissipated after the switch S is turned to position 2 is



a) 0%
b) 20%
c) 75%
d) 80%

219. Electric field strength due to a point charge of 5 μC at a distance of 80 cm from the charge is
a) $8 \times 10^4 N/C$
b) $7 \times 10^4 N/C$
c) $5 \times 10^4 N/C$
d) $4 \times 10^4 N/C$

220. A given charge situated at a certain distance from an electric dipole in the end on opposition, experiences a force F. If the distance of charge is doubled, the force acting on the charge will be
a) 2 F
b) $F/2$
c) $F/4$
d) $F/8$

221. A spherical drop of mercury having a potential of 2.5 V is obtained as a result of merging 125 droplets. The potential of constituent droplets would be
a) 1.0 V
b) 0.5 V
c) 0.2 V
d) 0.1 V

222. A region surrounding a stationary electric dipoles has
a) Magnetic field only
b) Electric field only
c) Both electric and magnetic fields
d) No electric and magnetic fields

223. The plates of a capacitor are charged to a potential difference of 320 *volts* and are then connected across a resistor. The potential difference across the capacitor decays exponentially with time. After 1 *second* the potential difference between the plates of the capacitor is 240 *volts*, then after 2 and 3 *seconds* the potential difference between the plates will be
a) 200 and 180 V
b) 180 and 135 V
c) 160 and 80 V
d) 140 and 20 V

224. The distance between two point charges is increased by 10%. The force of interaction between them
a) Increased by 10%
b) decreased by 10%
c) decreased by 17%
d) decreased by 21%

225. If 10^{10} electrons are acquired by a body every second, the time required for the body to get a total charge of 1 C will be
a) Two hours
b) Two days
c) Two years
d) 20 years

226. Electric charge is uniformly distributed along a long straight wire of radius 1mm. The charge per cm length of the wire is Q coulomb. Another cylindrical surface of radius 50 cm and length 1m symmetrically encloses the wire. The total electric flux passing through the cylindrical surface is
a) $\frac{Q}{\varepsilon_0}$
b) $\frac{100Q}{\varepsilon_0}$
c) $\frac{10Q}{\pi\varepsilon_0}$
d) $\frac{100Q}{\pi\varepsilon_0}$

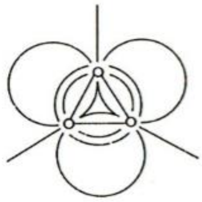
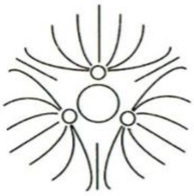
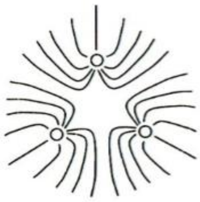
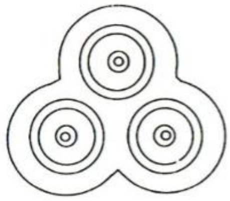
227. A non-conducting ring of radius $0.5m$ carries a total charge of $1.11 \times 10^{-10} C$ distributed non-uniformly on its circumference producing an electric field $\vec{E}$ everywhere in space. The value of the line integral $\int_{l=\infty}^{l=0} -\vec{E}.\vec{dl}$ ($l = 0$ being centre of the ring) in volt is

a) +2 b) −1 c) −2 d) Zero

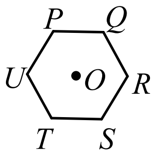
228. The potential of the electric field produced by point charge at any point (x, y, z) is given by $V = 3x^2 + 5$, where x, y are in metres and V is in volts. The intensity of the electric field at (-2,1,0) is

a) $+17\ \mathrm{Vm^{-1}}$ b) $-17\ \mathrm{Vm^{-1}}$ c) $+12\ \mathrm{Vm^{-1}}$ d) $-12\ \mathrm{Vm^{-1}}$

229. Three positive charges of equal value q are placed at the vertices of an equilateral triangle. The resulting lines of force should be sketched as in

a) 
b) 
c) 
d) 

230. Six charges, three positive and three negative of equal magnitude are to be placed at the vertices of a regular hexagon such that the electric field at O is double the electric field when only one positive charge of same magnitude is placed at R. Which of the following arrangements of charges is possible for P, Q, R, S, T and U respectively?



a) $+,-,+,-,-,+$ b) $+,-,+,-,+,-$ c) $+,+,-,+,-,-$ d) $-,+,+,-,+,-$

231. 4 point charges each $+q$ is placed on the circumference of a circle of diameter $2d$ in such a way that they form a square. The potential at the centre is

a) 0 b) $\frac{4q}{d}$ c) $\frac{4d}{q}$ d) $\frac{q}{4d}$

232. N identical spherical drops charged to the same potential V are combined to form a big drop. The potential of the new drop will be

a) V b) V/N c) $V \times N$ d) $V \times N^{2/3}$

233. An arc of radius r carries charge. The linear density of charge is λ and the arc subtends a angle $\frac{\pi}{3}$ at the centre. What is electric potential at the centre

a) $\frac{\lambda}{4\varepsilon_0}$ b) $\frac{\lambda}{8\varepsilon_0}$ c) $\frac{\lambda}{12\varepsilon_0}$ d) $\frac{\lambda}{16\varepsilon_0}$

234. The work done in bringing a unit positive charge from infinite distance to a point at distance x from a positive charge Q is W. Then the potential ϕ at that point is

a) $\frac{WQ}{x}$ b) W c) $\frac{W}{x}$ d) WQ

235. A parallel plate capacitor is made by stacking n equally spaced plates connected alternately. If the capacitance between any two plates is C then the resultant capacitance is

a) C b) nC c) $(n-1)C$ d) $(n+1)C$

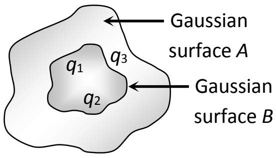
236. Electric field strength due to a dipole at a point on the axial line of dipole is

a) From positive charge to negative charge
b) From negative charge to positive charge
c) Along the equatorial line
d) At an angle to axial line

237. Charges 5μC and 10μC are placed 1 m apart. Work done to bring these charges at a distance 0.5 m from each other is

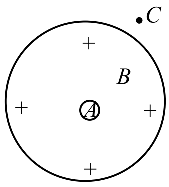
a) 9×10^4 J b) 18×10^4 J c) 45×10^{-2} J d) 9×10^{-1} J

238. The electric flux for Gaussian surface A that enclose the charged particles in free space is (given $q_1 = -14\ nC, q_2 = 78.85\ nC, q_3 = -56\ nC$)



a) $10^3 Nm^2C^{-1}$
b) $10^3 CN^{-1}m^{-2}$
c) $6.32 \times 10^3 Nm^2C^{-1}$
d) $6.32 \times 10^3 CN^{-1}m^{-2}$

239. Two equal metal balls are charged to 10 and -20 units of electricity. Then they are brought in contact with each other and then again separated to the original distance. The ratio of magnitudes of the force between the two balls before and after contact is

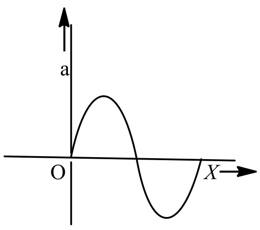


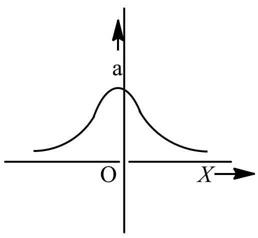
a) 8:1 b) 1:8 c) 2:1 d) 1:2

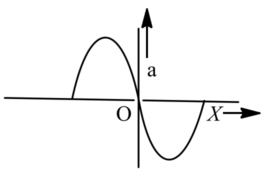
240. Two charges are at a distance $'d'$ apart. If a copper plate (conducting medium) of thickness $\frac{d}{2}$ is placed between them, the effective force will be

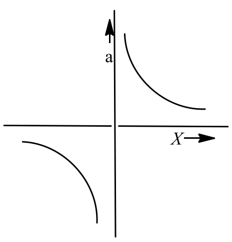
a) $2F$ b) $F/2$ c) 0 d) $\sqrt{2}F$

241. Two identical positive charges are fixed on the y-axis at equal distances from the origin O. A negatively charged particle starts on the x-axis, at a large distance from$O$, moves along the x-axis, passes through O and moves far away from O. Its acceleration a is taken as positive along its direction of motion. The best graph between the particle's acceleration and its x-coordinate is represented by

a) 

b) 

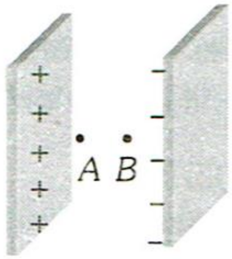
c) 

d) 

242. The electric dipole moment of an electron and a proton 4.3 nm apart is

a) $6.88 \times 10^{-28} cm$ b) $2.56 \times 10^{-29} c^2/m$ c) $3.72 \times 10^{-14} c/m$ d) $11 \times 10^{-46} c^2/m$

243. Two protons A and B are placed in space between plates of a parallel plate capacitor charged upto $V\ volts$ (see fig.)
Force on protons are F_A and F_B then



a) $F_A > F_B$ b) $F_A < F_B$ c) $F_A = F_B$ d) Nothing can be said

244. Which of the following statement(s) is/are correct
a) If the electric field due to a point charge varies as $r^{-2.5}$ instead of r^{-2}, then the Gauss law will still be valid
b) The Gauss law can be used to calculate the field distribution around an electric dipole
c) If the electric field between two point charges is zero somewhere, then the sign of the two charges is the same
d) The work done by the external force in moving a unit positive charge from point A at potential V_A is $(V_B - V_A)$

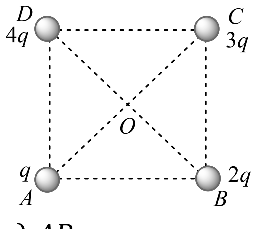
245. The condensers of capacity C_1 and C_2 are connected in parallel, then the equivalent capacitance is
a) $C_1 + C_2$ b) $\frac{C_1 C_2}{C_1 + C_2}$ c) $\frac{C_1}{C_2}$ d) $\frac{C_2}{C_1}$

246. A parallel plate condenser has a capacitance $50 \mu F$ in air and $110 \mu F$ when immersed in an oil. The dielectric constant $'k'$ of the oil is
a) 0.45 b) 0.55 c) 1.10 d) 2.20

247. Torque acting on an electric dipole in a uniform electric field is maximum if the angle between **p** and **E** is
a) 180° b) 0° c) 90° d) 45°

248. Let three be a spherically symmetric charge distribution with charge density varying as $\rho(r) = \rho_0 \left(\frac{5}{4} - \frac{r}{R}\right)$ upto $r = R$, and $\rho(r) = 0$ for $r > R$, where r is the distance from the origin. The electric field at a distance $r (r < R)$ from the origin is given by
a) $\frac{4\pi\rho_0 r}{3\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$ b) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$ c) $\frac{4\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4} - \frac{r}{R}\right)$ d) $\frac{\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4} - \frac{r}{R}\right)$

249. Charges $q, 2q, 3q$ and $4q$ are placed at the corners A, B, C and D of a square as shown in the following figure. The direction of electric field at the centre of the square is along



a) AB b) CB c) BD d) AC

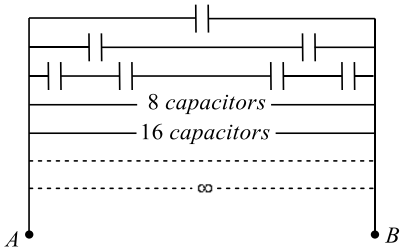
250. A spherical condenser has inner and outer spheres of radii a and b respectively. The space between the two is filled with air. The difference between the capacities of two condensers formed when outer sphere is earthed and when inner sphere is earthed will be
a) Zero b) $4\pi\varepsilon_0 a$ c) $4\pi\varepsilon_0 b$ d) $4\pi\varepsilon_0 a \left(\frac{b}{b-a}\right)$

251. A dipole of electric dipole moment p is placed in a uniform electric field of strength E. If θ is the angle between positive directions of p and E, then the potential energy of the electric dipole is largest when θ is
a) $\frac{\pi}{4}$ b) $\frac{\pi}{2}$ c) π d) Zero

252. Which of the following will represent coulomb's law

a) $\oint \vec{E}.d\vec{S} = \frac{q}{\epsilon_0}$ b) $\oint \vec{E}.d\vec{l} = 0$ c) $\oint \vec{H}.d\vec{S} = 0$ d) $\oint \vec{H}.d\vec{l} = \mu_0 I$

253. An infinite number of identical capacitors each of capacitance $1\mu F$ are connected as in adjoining figure. Then the equivalent capacitance between A and B is



a) $1\mu F$ b) $2\mu F$ c) $\frac{1}{2}\mu F$ d) ∞

254. In Millikan's oil drop experiment an oil drop carrying a charge Q is held stationary by a potential difference 2400 V between the plates. To keep a drop of half the radius stationary the potential difference had to be made 600 V. What is the charge on the second drop

a) $\frac{Q}{4}$ b) $\frac{Q}{2}$ c) Q d) $\frac{3Q}{2}$

255. A square of side $'a'$ has charge Q at its centre and charge $'q'$ at one of the corners. The work required in moving the charge $'q'$ from one corner to the diagonally opposite corner is

a) Zero b) $\frac{Qq}{4\pi \epsilon_0 a}$ c) $\frac{Qq\sqrt{2}}{4\pi \epsilon_0 a}$ d) $\frac{Qq}{2\pi \epsilon_0 a}$

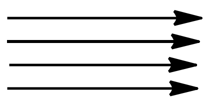
256. A charge of 1 μC is divided into two parts such that their charges are in the ratio of 2:3. These two charges are kept at a distance 1 m apart in vacuum. Then, the electric force between them (in N) is

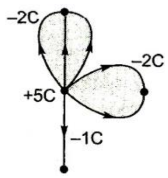
a) 0.216 b) 0.00216 c) 0.0216 d) 2.16

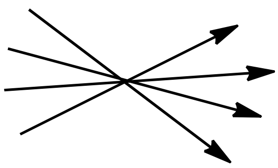
257. A charge $(-q)$ and another charge $(+Q)$ are kept at two points A and B respectively. Keeping the charge $(+Q)$ fixed at B, the charge $(-q)$ at A is moved to another point C such that ABC forms an equilateral triangle of side l. The net work done in moving the charge $(-q)$ is

a) $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{l}$ b) $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{l^2}$ c) $\frac{1}{4\pi\varepsilon_0}Qql$ d) Zero

258. Which of the following configurations of electric lines of force is not possible?

a) 

b) 

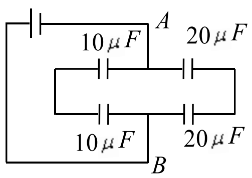
c) 

d) Both (b) and (c)

259. An electric dipole when placed in a uniform electric field E will have minimum potential energy, if the positive direction of dipole moment makes the following angle with E

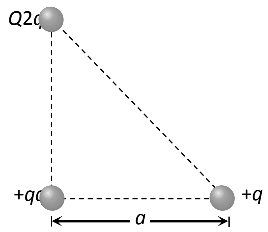
a) π b) $\pi/2$ c) Zero d) $3\pi/2$

260. The equivalent capacitance between A and B as shown in the figure is



a) $\frac{85}{3}\mu F$ b) $30\mu F$ c) $15\mu F$ d) $75\mu F$

261. The charges $Q, +q$ and $+q$ are placed at the vertices of a right-angled isosceles triangle as shown. The net electrostatic energy of the configuration is zero if Q is equal to



a) $\frac{-q}{1+\sqrt{2}}$ b) $\frac{-2q}{2+\sqrt{2}}$ c) $-2q$ d) $+q$

262. Two small spheres each having the charge $+Q$ are suspended by insulating threads of length L from a hook. This arrangement is taken in space where there is no gravitational effect, then the angle between the two suspensions and the tension in each will be

a) $180^0, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$ b) $90^0, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$ c) $180^0. \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2L^2}$ d) $180^o, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

263. A force F acts between sodium and chlorine ions of salt (sodium chloride) when put $1cm$ apart in air. The permittivity of air and dielectric constant of water are ε_0 and K respectively. When a piece of salt is put in water electrical force acting between sodium and chlorine ions $1cm$ apart is

a) $\frac{F}{K}$ b) $\frac{FK}{\varepsilon_0}$ c) $\frac{F}{K\varepsilon_0}$ d) $\frac{F\varepsilon_0}{K}$

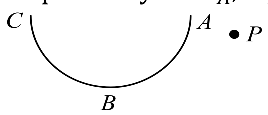
264. A condenser having a capacity of $6\mu F$ is charged to $100\ V$ and is then joined to an uncharged condenser of $14\mu F$ and then removed. The ratio of the charges on $6\mu F$ and $14\mu F$ and the potential of $6\mu F$ will be

a) $\frac{6}{14}$ and 50 $volt$ b) $\frac{14}{6}$ and 30 $volt$ c) $\frac{6}{14}$ and 30 $volt$ d) $\frac{14}{6}$ and 0 $volt$

265. Capacitance of a capacitor made by a thin metal foil is $2\mu F$. If the foil is filled with paper of thickness $0.15mm$, dielectric constant of paper is 2.5 and width of paper is $400mm$, then length of foil will be

a) 0.34 m b) 1.33 m c) 13.4 m d) 33.9 m

266. In the following diagram the work done in moving a point charge from point P to point A, B and C is respectively as W_A, W_B and W_C, then



a) $W_A = W_B = W_C$ b) $W_A = W_B = W_C = 0$ c) $W_A > W_B > W_C$ d) $W_A < W_B < W_C$

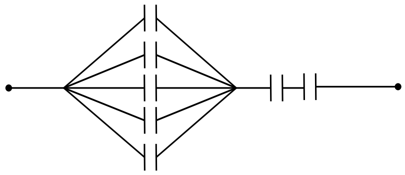
267. Two small conducting spheres of equal radius have charges $+10\ \mu C$ and $-20\mu C$ respectively and placed at a distance R from each other experience force F_1. If they are brought in contact and separated to the same distance, they experience force F_2. The ratio of F_1 to F_2 is

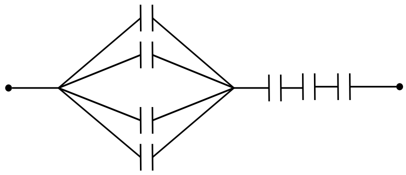
a) 1 : 8 b) −8: 1 c) 1 : 2 d) −2: 1

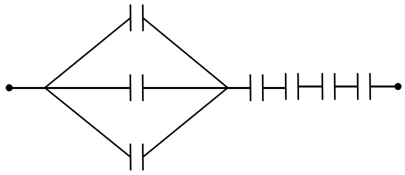
268. A small conducting sphere of radius r is lying concentrically inside a bigger hollow conducting sphere of radius R. The bigger and smaller spheres are charged with Q and $q(Q > q)$ and are insulated from each other. The potential difference between the spheres will be

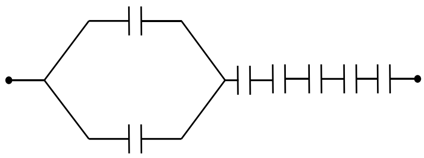
a) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}-\frac{Q}{R}\right)$ b) $\frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R}+\frac{q}{r}\right)$ c) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}-\frac{q}{R}\right)$ d) $\frac{1}{4\pi\varepsilon r_0}\left(\frac{q}{R}-\frac{Q}{r}\right)$

269. Seven capacitors each of capacity $2\mu F$ are to be so connected to have a equivalent capacity $\frac{10}{11}\mu F$. Which will be the necessary figure as shown

a) 

b) 

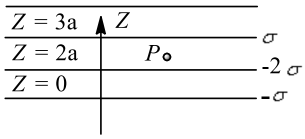
c) 

d) 

270. The combined capacity of the parallel combination of two capacitors is four times their combined capacity when connected in series. This means that

a) Their capacities are equal
b) Their capacities are $1\mu F$ and $2\mu F$
c) Their capacities are $0.5\mu F$ and $1\mu F$
d) Their capacities are infinite

271. Three infinitely charged sheets are kept parallel to $x - y$ plane having charge densities as shown in figure. Then the value of electric field at point P is



a) $-\frac{2\sigma}{\varepsilon_0}\hat{k}$
b) $\frac{2\sigma}{\varepsilon_0}\hat{k}$
c) $-\frac{4\sigma}{\varepsilon_0}\hat{k}$
d) $\frac{4\sigma}{\varepsilon_0}\hat{k}$

272. Infinite charges of magnitude q each are lying at $x = 1,2,4,8 \ldots meter$ on X-axis. The value of intensity of electric field at point $x = 0$ due to these charges will be

a) $12 \times 10^9 q\ N/C$
b) Zero
c) $6 \times 10^9 q\ N/C$
d) $4 \times 10^9 q\ N/C$

273. Electric potential is given by
$V = 6x - 8xy^2 - 8y + 6yz - 4z^2$
Then electric force acting on $2C$ point charge placed on origin will be

a) $2N$
b) $6N$
c) $8N$
d) $20N$

274. Ten electrons are equally spaced and fixed around a circle of radius R. Relative to $V = 0$ at infinity, the electrostatic potential V and the electric field E at the centre C are

a) $V \neq 0$ and $\vec{E} \neq 0$
b) $V \neq 0$ and $\vec{E} = 0$
c) $V = 0$ and $\vec{E} = 0$
d) $V = 0$ and $\vec{E} \neq 0$

275. Three capacitors of capacitances $3\mu F$, $9\mu F$ and $18\mu F$ are connected once in series and another time in parallel. The ratio of equivalent capacitance in the two cases $\left(\frac{C_s}{C_p}\right)$ will be

a) 1 : 15
b) 15 : 1
c) 1 : 1
d) 1 : 3

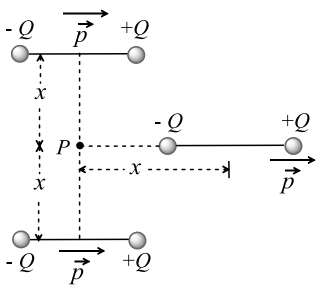
276. Two charges of equal magnitudes and at a distance r exert a force F on each other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is

a) $F/8$
b) $F/4$
c) $4F$
d) $F/16$

277. n identical droplets are charged to V volt each. If they coalesce to form a single drop, then its potential will be

a) $n^{2/3}V$
b) $n^{1/3}V$
c) nV
d) V/n

278. Three identical dipoles are arranged as shown below. What will be the net electric field at P $\left(k = \frac{1}{4\pi\varepsilon_0}\right)$



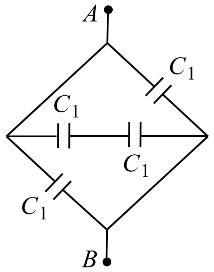
a) $\frac{k.p}{x^3}$ b) $\frac{2kp}{x^3}$ c) Zero d) $\frac{\sqrt{2}kp}{x^3}$

279. The diameter of each plate of an air capacitor is $4cm$. To make the capacity of this plate capacitor equal to that of $20cm$ diameter sphere, the distance between the plates will be
a) $4 \times 10^{-3}m$ b) $1 \times 10^{-3}m$ c) $1cm$ d) $1 \times 10^{-3}cm$

280. The capacitance of a parallel plate condenser does not depend on
a) Area of the plates b) Medium between the plates
c) Distance between the plates d) Metal of the plates

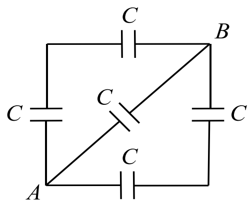
281. A sphere of radius R has a uniform distribution of electric charge in its volume. At a distance x from its centre, for $x < R$, the electric field is directly proportional to
a) $\frac{1}{x^2}$
b) $\frac{1}{x}$
c) x
d) x^2

282. Four identical capacitors are connected as shown in diagram. When a battery of 6 V is connected between A and B, the charge stored is found to be 1.5 μC. The value of C_1 is



a) 2.5 μF b) 15 μF c) 1.5 μF d) 0.1 μF

283. In the figure shown, the effective capacitance between the points A and B, if each has capacitance C, is



a) $2C$ b) $\frac{C}{5}$ c) $5C$ d) $\frac{C}{2}$

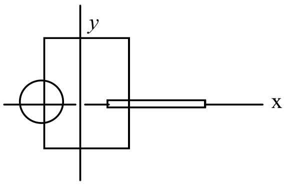
284. A parallel plate capacitor of a capacitance of 1 farad would have the plate area of about
a) 100 m^2 b) 1 km^2 c) 100 km^2 d) 1000 km^2

285. Point charges $+4q, -q$ and $+4q$ are kept on the x –axis at points $x = 0, x = a$ and $x = 2a$ respectively, then
a) Only q is in stable equilibrium b) None of the charges are in equilibrium
c) All the charges are in unstable equilibrium d) All the charges are in stable equilibrium

286. Two electrons are separated by a distance of 1Å. What is the coulomb force between them
a) $2.3 \times 10^{-8}N$ b) $4.6 \times 10^{-8}N$ c) $1.5 \times 10^{-8}N$ d) None of these

287. A disc of radius $\frac{a}{4}$ having a uniformly distributed charge 6C is placed in the $x - y$ plane with its centre at $\left(\frac{-a}{2}, 0,0\right)$. A rod of length a carrying a uniformly distributed charge 8 C is placed on the x-axis form $x = \frac{a}{4}$ to $x = \frac{5a}{4}$. Two point charges -7C and 3C are placed at $\left(\frac{a}{4}, \frac{-a}{4}, 0\right)$ and $\left(\frac{-3a}{4}, \frac{3a}{4}, 0\right)$ respectively. Consider

a cubical surface formed by six surfaces $x = \pm\frac{a}{2}, y = \pm\frac{a}{2}, z = \pm\frac{a}{2}$. The electric flux through this cubical



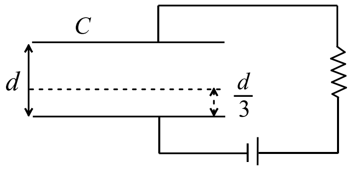
surface is

a) $\frac{-2C}{\varepsilon_0}$ b) $\frac{2C}{\varepsilon_0}$ c) $\frac{10C}{\varepsilon_0}$ d) $\frac{12C}{\varepsilon_0}$

288. The acceleration of an electron in an electric field of magnitude 50 V/cm, if e/m value of the electron is $1.76 \times 10^{11}\ C/kg$, is

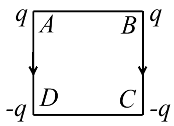
a) $8.8 \times 10^{14}\ m/sec^2$ b) $6.2 \times 10^{13}\ m/sec^2$ c) $5.4 \times 10^{12} m/sec^2$ d) Zero

289. A parallel plate capacitor C with plates of unit area and separation d is filled with a liquid of dielectric constant $K = 2$. The level of liquid is $\frac{d}{3}$ initially. Suppose the liquid level decreases at a constant speed V, the time constant as a function of time t is



a) $\frac{6\varepsilon_0 R}{5d + 3Vt}$ b) $\frac{(15d + 9Vt)\varepsilon_0 R}{2d^2 - 3dVt - 9V^2t^2}$ c) $\frac{6\varepsilon_0 R}{5d - 3Vt}$ d) $\frac{(15d - 9Vt)\varepsilon_0 R}{2d^2 + 3dVt - 9V^2t^2}$

290. Charges are placed on the vertices of a square as shown. Let E be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then



a) $\vec{E}$ remains unchanged, V changes b) Both $\vec{E}$ and V change
c) $\vec{E}$ and V remains unchanged d) $\vec{E}$ changes, V remains unchanged

291. Two point charges of 1μC and −1μC are separated by a distance of 100 Å. A point P is at a distance of 10 cm from the mid-point and on the perpendicular bisector of the line joining the two charges. The electric field at P will be

a) 9 NC^{-1} b) 0.9 Vm^{-1} c) 90 Vm^{-1} d) 0.09 NC^{-1}

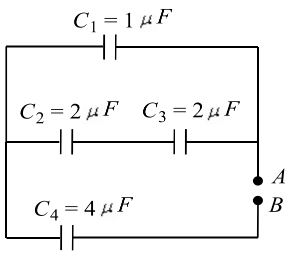
292. Three charges 1 μC, 1μC and 2 μC are kept at vertices of A, B and C of an equilateral triangle ABC of 10cm side respectively. The resultant force on the charge at C is

a) 0.9 N b) 1.8 N c) 2.72 N d) 3.12 N

293. The equivalent capacitance of three capacitors of capacitance C_1, C_2 and C_3 are connected in parallel is 12 units and product $C_1.C_2.C_3 = 48$ unit. When the capacitors C_1 and C_2 are connected in parallel, the equivalent capacitance is 6 units. Then the capacitances are

a) 2, 3, 7 b) 1, 5, 2, 5, 8 c) 1, 5, 6 d) 4, 2, 6

294. Four capacitors are connected in a circuit as shown in the following figure. Calculate the effective capacitance between the points A and B

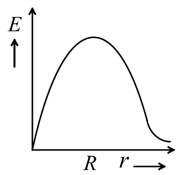


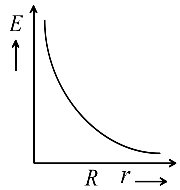
a) $\frac{4}{3}\mu F$ b) $\frac{24}{5}\mu F$ c) $9\mu F$ d) $5\mu F$

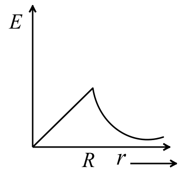
295. Let V be the electric potential at a given point. Then the electric field E_x along x direction at that point is given by

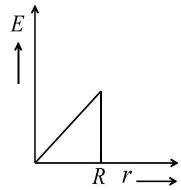
a) $\int_0^{\infty} V dx$ b) $\frac{dV}{dx}$ c) $-\frac{dV}{dx}$ d) $-V\frac{dV}{dx}$

296. In a uniformly charged sphere of total charge Q and radius R, the electric field E is plotted as function of distance from the centre. The graph which would correspond to the above will be

a) 

b) 

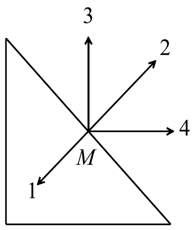
c) 

d) 

297. If E_a be the electric field strength of a short dipole at a point on its axial line and E_e that on equatorial line at the same distance, then

a) $E_e = 2E_a$ b) $E_a = 2E_e$ c) $E_a = E_e$ d) None of these

298. Three identical point charges, as shown are placed at the vertices of an isosceles right angled triangle. Which of the numbered vectors coincides in direction with the electric field at the mid-point M of the hypotenuse



a) 1
b) 2
c) 3
d) 4

299. Two identical metal spheres charged with + 12μF and -8μF are kept at certain distance in air. They are brought into contact and then kept at the same distance. The ratio of the magnitudes of electrostatic forces between them before them and after contact is

a) 12:1 b) 8:1 c) 24:1 d) 4:1

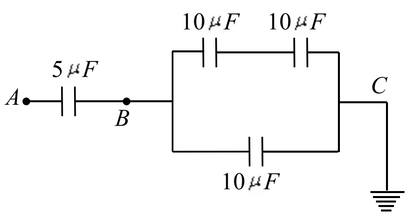
300. A solid sphere of radius R_1 and volume charge density $\rho = \frac{\rho_0}{r}$ is enclosed by a hollow sphere of radius R_2 with negative surface charge density σ, such that the total charge in the system is zero, ρ_0 is a positive constant and r is the distance from the centre of sphere. The ratio $\frac{R_2}{R_2}$ is

a) $\frac{\sigma}{\rho_0}$ b) $\sqrt{2\sigma}/\rho_0$ c) $\sqrt{\rho_0}/2\sigma$ d) $\frac{\rho_0}{\sigma}$

301. A spherical shell of radius R has a charge $+q$ units. The electric field due to the shell at a point

a) Inside is zero and varies as r^{-1} outside it
b) Inside the constant and varies as r^{-2} outside it
c) Inside is zero and varies as r^{-2} outside it
d) Inside is constant and varies as r^{-1} outside it

302. In the given circuit if point C is connected to the earth and a potential of $+2000\ V$ is given to the point A, the potential at B is



a) 1500 V b) 1000 V c) 500 V d) 400 V

303. A negatively charged oil drop is prevented from falling under gravity by applying a vertical electric field $100V\ m^{-1}$. If the mass of the drop is $1.6 \times 10^{-3} g$, the number of electrons carried by the drop is ($g = 10 ms^{-2}$)

a) 10^{18} b) 10^{15} c) 10^{6} d) 10^{12}

304. Identify the false statement

a) Inside a charged or neutral conductor electrostatic field is zero

b) The electrostatic field at the surface of the charged conductor must be tangential to the surface at any point

c) There is no net charge at any point inside the conductor

d) Electric field at the surface of a charged conductor is proportional to the surface charge density

305. Two large metal plates are placed parallel to each other. The inner surfaces of plates are charged by $+\sigma$ and $-\sigma(\text{cm}^{-2})$. The outer surfaces are neutral. The electric field in the region between the plates and outside the plates is

a) $\frac{2\sigma}{\varepsilon_0}, \frac{\sigma}{\varepsilon_0}$ b) $\frac{\sigma}{\varepsilon_0}$, zero c) $\frac{2\sigma}{\varepsilon_0}$, zero d) zero, $\frac{2\sigma}{\varepsilon_0}$

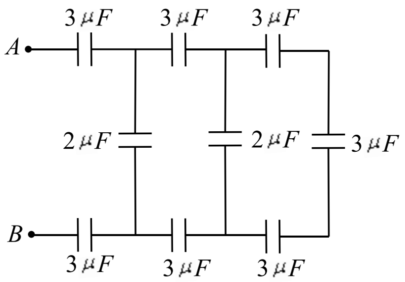
306. Two identical balls having like charges and placed at a certain distance apart repel each other with a certain force. They are brought in contact and then moved apart to a distance equal to half their initial separation. The force of repulsion between them increases 4.5 times in comparison with the initial value. The ratio of the initial charges of the balls is

a) 2 b) 3 c) 4 d) 6

307. Two charges each equal to $\eta q(\eta^{-1} < \sqrt{3})$ are placed at corners of an equilateral triangle of side a. The electric field at the third corner is E_3 then (where $E_0 = q/4\pi\varepsilon_0 a^2$)

a) $E_3 = E_0$ b) $E_3 < E_0$ c) $E_3 > E_0$ d) $E_3 \geq E_0$

308. The resultant capacitance between A and B in the following figure is equal to



a) $1\mu F$ b) $3\mu F$ c) $2\mu F$ d) $1.5\mu F$

309. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then

a) negative and distributed uniformly over the surface of the sphere

b) negative and appears only at the point on the sphere closest to the point charge

c) Negative and distributed non-uniformly over the entire surface of the sphere

d) Zero

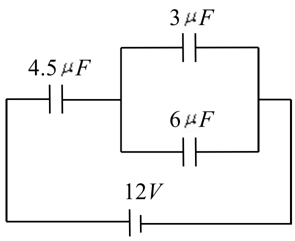
310. If the magnitude of intensity of electric field at a distance x on axial line and at a distance y on equatorial line on a given dipole are equal, then $x: y$ is

a) $1:1$ b) $1:\sqrt{2}$ c) $1:2$ d) $\sqrt[3]{2}:1$

311. Consider a parallel plate capacitor with plates 20 cm by 20 cm and separated by 2 mm. The dielectric constant of the material between the plates is 5. The plates are connected to a voltage sources of 500 V. The energy density of the field between the plates will be close to

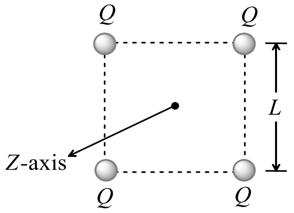
a) 2.65 J/m^3 b) 1.95 J/m^3 c) 1.38 J/m^3 d) 0.69 J/m^3

312. In the circuit shown in the figure, the potential difference across the $4.5\mu F$ capacitor is



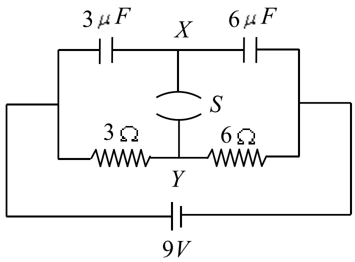
a) $\frac{8}{3}\,volts$ b) $4\ volts$ c) $6\ volts$ d) $8\ volts$

313. Four point $+ve$ charges of same magnitude (Q) are placed at four corners of a rigid square frame as shown in figure. The plane of the frame is perpendicular to Z –axis. If a $-ve$ point charge is placed at a distance z away from the above frame ($z << L$) then



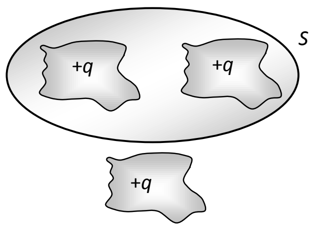
a) $-ve$ charge oscillates along the Z – axis
b) It moves away from the frame
c) It moves slowly towards the frame and stays in the plane of the frame
d) It passes through the frame only once

314. A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge that flows from Y to X is



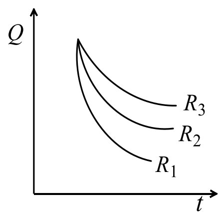
a) 0 b) $54\ \mu C$ c) $27\ \mu C$ d) $81\ \mu C$

315. Shown below is a distribution of charges. The flux of electric field due to these charges through the surface S is



a) $3q/\varepsilon_0$ b) $2q/\varepsilon_0$ c) q/ε_0 d) Zero

316. Three identical capacitors are given a charge Q each and they are then allowed to discharge through resistance R_1, R_2 and R_3. Their charges, as a function of time shown in the graph below. The smallest of the three resistance is

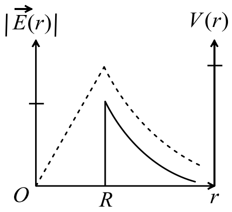


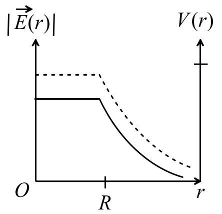
a) R_3 b) R_2 c) R_1 d) Cannot be predicted

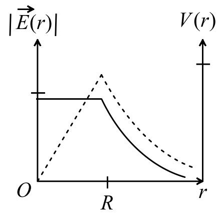
317. Three capacitors each of capacitance C and of breakdown voltage V are joined in series. The capacitance and breakdown voltage of the combination will be

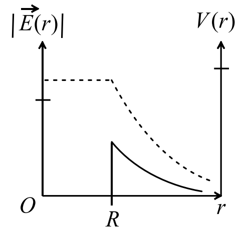
a) $\frac{C}{3}, \frac{V}{3}$ b) $3C, \frac{V}{3}$ c) $\frac{C}{3}, 3V$ d) $3C, 3V$

318. Consider a thin spherical shell of radius R with its centre at the origin, carrying uniform positive surface charge density. The variation of the magnitude of the electric field $|\vec{E}(r)|$ and the electric potential $V(r)$ with the distance r from the centre, is best represented by which graph

a) 

b) 

c) 

d) 

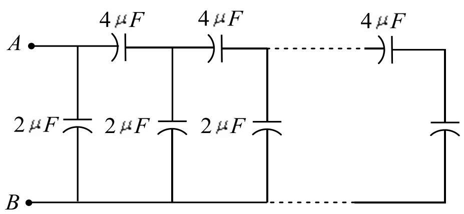
319. The charge on 500 cc of water due to protons will be

a) $6.0 \times 10^{27} C$ b) $2.67 \times 10^{7} C$ c) $6 \times 10^{23} C$ d) $1.67 \times 10^{23} C$

320. A capacitor of capacitance C is charged to potential V. The flux of the electric field through a closed surface enclosing the capacitor is

a) $\frac{CV}{\epsilon_0}$ b) $\frac{2CV}{\epsilon_0}$ c) $\frac{CV}{2\epsilon_0}$ d) Zero

321. A finite ladder is constructed by connecting several sections, of $2\mu F$, $4\mu F$ capacitor combinations as shown in the figure. It is terminated by a capacitor of capacitance C. What value should be chosen for C such that the equivalent capacitance of the ladder between the points A and B becomes independent of the number of sections in between



a) $4\mu F$ b) $2\mu F$ c) $18\mu F$ d) $6\mu F$

322. Dielectric constant for metal is

a) Zero b) Infinite c) 1 d) Greater than 1

323. The electric field due to a charge at a distance of 3 m from it is 500 N/coulomb. The magnitude of the charge is $\left[\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \frac{N-m^2}{coulomb^2}\right]$

a) 2.5 $micro-coulomb$ b) 2.0 $micro-coulomb$ c) 1.0 $micro-coulomb$ d) 0.5 $micro-coulomb$

324. A capacitor is charged by using a battery which is then disconnected. A dielectric slab is then slipped between the plates, which results in

a) Reduction of charge on the plates and increase of potential difference across the plates

b) Increase in the potential difference across the plate, reduction in stored energy, but no change in the charge on the plates

c) Decrease in the potential difference across the plates, reduction in the stored energy, but no change in the charge on the plates

d) None of the above

325. The distance between the circular plates a parallel plate condenser 40 mm in diameter, in order to have same capacity as a sphere of radius 1 $metre$ is

a) $0.01mm$ b) $0.1mm$ c) $1.0mm$ d) $10mm$

326. A proton is about 1840 times heavier than an electron. When it is accelerated by a potential difference of 1 kV, its kinetic energy will be

a) 1840 keV b) 1/1840 keV c) 1 keV d) 920 keV

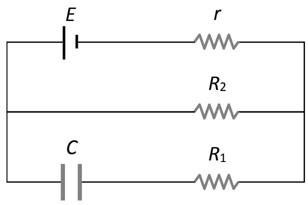
327. Consider $\overrightarrow{E_1} = x\hat{\imath} + J$ and $\overrightarrow{E_2} = xy^2\hat{\imath} + x^2y\,\hat{\jmath}$; then

a) Only E_1 is electrostatic
b) Only E_2 is electrostatic
c) Both are electrostatic
d) None of these

328. When the 10^{19} electrons are removed from a neutral metal plate, the electric charge on it is

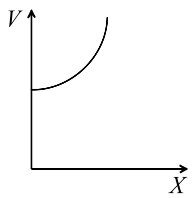
a) $-1.6\ C$
b) $+\ 1.6\ C$
c) $10^{+19}\ C$
d) $10^{-19}C$

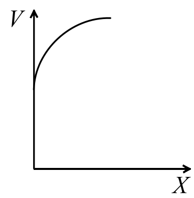
329. In the given figure each plate of capacitance C has partial value of charge

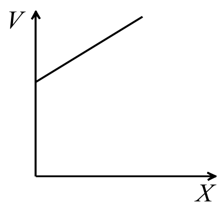


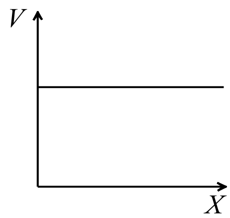
a) CE
b) $\frac{CER_1}{R_2 - r}$
c) $\frac{CER_2}{R_2 + r}$
d) $\frac{CER_1}{R_1 - r}$

330. Between the plates of a parallel plate capacitor a dielectric plate is introduced just to fill the space between the plates. The capacitor is charged and later disconnected from the battery. The dielectric plate is slowly drawn out of the capacitor parallel to the plates. The plot of the potential difference across the plates and the length of the dielectric plate drawn out is

a) 

b) 

c) 

d) 

331. The dimension of $(1/2)\ \varepsilon_0 E^2$ (ε_0 : permittivity of free space; E: electric field) is

a) MLT^{-1}
b) ML^2T^{-2}
c) $ML^{-1}T^{-2}$
d) ML^2T^{-1}

332. Two conducting spheres of radii 3 cm and 1 cm are separated by a distance of 10 cm in free space. If the spheres are charged to same potential of 10 V each, the force of repulsion between them is

a) $\frac{1}{3} \times 10^{-9}$ N
b) $\frac{2}{9} \times 10^{-9}$N
c) $\frac{1}{9} \times 10^{-9}$ N
d) $\frac{4}{3} \times 10^{-9}$ N

333. The capacity of parallel plate condenser depends on

a) The type of metal used
b) The thickness of plates
c) The potential applied across the plates
d) The separation between the plates

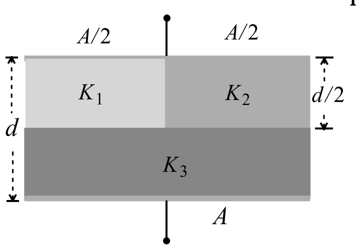
334. A capacitor is kept connected to the battery and a dielectric slab is inserted between the plates. During this process

a) No work is done
b) Work is done at the cost of the energy already stored in the capacitor before the slab is inserted
c) Work is done at the cost of the battery
d) Work is done at the cost of both the capacitor and the battery

335. Total electric flux coming out of a unit positive charge put in air is

a) ε_0
b) ε_0^{-1}
c) $(4p\varepsilon_0)^{-1}$
d) $4\pi\varepsilon_0$

336. A parallel plate capacitor of area A, plate separation d and capacitance C is filled with three different dielectric materials having dielectric constants k_1, k_2 and k_3 as shown. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant k is given by



A = Area of plates

a) $\frac{1}{k}=\frac{1}{k_1}+\frac{1}{k_2}+\frac{1}{2k_3}$ b) $\frac{1}{k}=\frac{1}{k_1+k_2}+\frac{1}{2k_3}$ c) $k=\frac{k_1k_2}{k_1+k_2}+2k_3$ d) $k=k_1+k_2+2k_3$

337. Below figure (1) and (2) represent lines of force. Which is correct statement

(1)

(2)

a) Figure (1) represents magnetic lines of force
b) Figure (2) represents magnetic lines of force
c) Figure (1) represents electric lines of force
d) Both figure (1) and figure (2) represent magnetic lines of force

338. The capacity of a parallel plate condenser is $10\mu F$ without dielectric. Dielectric of constant 2 is used to fill half the distance between the plates, the new capacitance in μF is
a) 10 b) 20 c) 15 d) 13.33

339. A sphere of radius 1 cm has potential of 8000 V, then energy density near its surface will be
a) $64\times10^5\ J/m^3$ b) $8\times10^3\ J/m^3$ c) $32\ J/m^3$ d) $2.83\ J/m^3$

340. Two insulates metallic spheres of $3\mu F$ and $5\mu F$ capacitances are charged to $300V$ and $500V$ respectively. The energy loss, when they are connected by a wire is
a) 0.012 J b) 0.0218 J c) 0.0375 J d) 3.75 J

341. The electric flux through a closed surface area S enclosing charge Q is ϕ. If the surface area is doubled, then the flux is
a) 2ϕ b) ϕ/2 c) ϕ/4 d) ϕ

342. An infinite line charge produce a field of $7.182\times10^8\text{NC}^{-1}$at a distance of 2 cm. The linear charge density is
a) $7.27\times10^{-4}\text{Cm}^{-1}$ b) $7.98\times10^{-4}\text{Cm}^{-1}$ c) $7.11\times10^{-4}\text{Cm}^{-1}$ d) $7.04\times10^{-4}\text{Cm}^{-1}$

343. A point charge$q$ produces an electric field of magnitude 2 NC^{-1} at a point distance 0.25 m from it. What is the value of charge?
a) 1.39×10^{-11} C b) 1.39×10^{11} C c) 13.9×10^{-11} C d) 13.9×10^{11} C

344. A particle A has charge $+q$ and a particle B has charge $+4q$ with each of them having the same mass m. When allowed to fall from rest through the same electric potential difference, the ratio of their speed $\frac{v_A}{v_B}$ will become
a) 2:1 b) 1:2 c) 1:4 d) 4:1

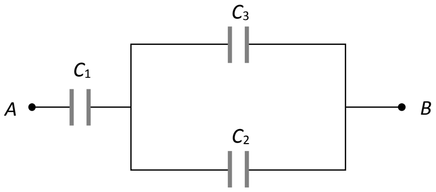
345. The ratio of electrostatic and gravitational forces acting between electron and proton separated by a distance $5\times10^{-11}m$, will be (Charge on electron $=1.6\times10^{-19}C$, mass of electron $=9.1\times10^{-31}kg$, mass of proton $=1.6\times10^{-27}kg, G=6.7\times10^{-11}Nm^2/kg^2$)
a) 2.36×10^{39} b) 2.36×10^{40} c) 2.34×10^{41} d) 2.34×10^{42}

346. If the circumference of a sphere is 2m, then capacitance of sphere in water would be
a) 2700 pF b) 2760 pF c) 2780 pF d) 2800 pF

347. Charges of $+\frac{10}{3}\times10^{-9}\ C$ are placed at each of the four corners of a square of side $8cm$. The potential at the intersection of the diagonals is
a) $150\sqrt{2}\ volt$
b) $1500\sqrt{2}\ volt$
c) $900\sqrt{2}\ volt$
d) $900\ volt$

348. The energy stored in the condenser is
a) QV b) $\frac{1}{2}QV$ c) $\frac{1}{2}C$ d) $\frac{1}{2}\frac{Q}{C}$

349. The combination of capacitors with $C_1 = 3\mu\,F, C_2 = 4\mu\,F$ and $C_3 = 2\mu\,F$ is charged by connecting AB to a battery
Consider the following statements
I. Energy stored in $C_1 =$ Energy stored in $C_2 +$ Energy stored in C_3
II. Charge on $C_1 =$ Charge on $C_2 +$ Charge on C_2
III. Potential drop across $C_1 =$ Potential drop across $C_2 =$ Potential drop across C_3
Which of these is/are correct

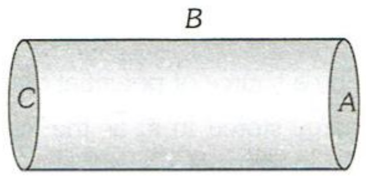


a) I and II b) II only c) I and III d) III only

350. Two equal point charges are fixed at $x = -a$ and $x = +a$ on the x-axis. Another point charge Q is placed at the origin. The change in the electrical potential energy of Q, when it is displaced by a small distance x along the x-axis, is approximately proportional to
a) x b) x^2 c) x^3 d) $1/x$

351. It is not convenient to use a spherical Gaussian surface to find the electric field due to an electric dipole using Gauss's theorem because
a) Gauss's law fails in this case
b) This problem does not have spherical symmetry
c) Coulomb's law is more fundamental than Gauss's law
d) Spherical Gaussian surface will alter the dipole moment

352. A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of $volt - meter$ associated with the curved surface B, the flux linked with the plane surface A in units of $volt - meter$ will be

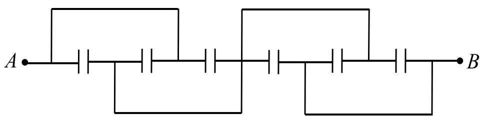


a) $\frac{1}{2}\left(\frac{q}{\epsilon_0} - \phi\right)$ b) $\frac{q}{2\,\epsilon_0}$ c) $\frac{\phi}{3}$ d) $\frac{q}{\epsilon_0} - \phi$

353. A neutral water molecule (H_2O) in its vapour state has an electric dipole moment of 6×10^{-30} Cm. If the molecule is placed in an electric field of 1.5×10^4 NC^{-1}, the maximum torque that the field can exert on it is nearly
a) 4.5×10^{-26} N-m b) 4×10^{-34} N-m c) 9×10^{-26} N-m d) 6×10^{-26} N-m

354. The electric field at a point due to an electric dipole, on an axis inclined at an angle $\theta (< 90°)$to the dipole axis, is perpendicular to the dipole axis, if the angle θ is
a) $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$ b) $\tan^{-1}(\sqrt{2})$ c) $\tan^{-1}\left(\frac{1}{2}\right)$ d) $\tan^{-1}(2)$

355. All capacitors used in the diagram are identical and each is of capacitance C. Then the effective capacitance between the points A and B is

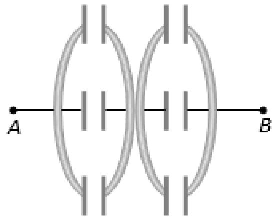


a) $1.5C$ b) $6C$ c) C d) $3C$

356. The electric field at a point on equatorial line of a dipole and direction of the dipole moment

a) Will be parallel
b) Will be in opposite direction
c) Will be perpendicular
d) Are not related

357. All six capacitor shown are identical, Each can withstand maximum 200 $volts$ between its terminals. The maximum voltage that can be safely applied between A and B is



a) 1200 V
b) 400 V
c) 800 V
d) 200 V

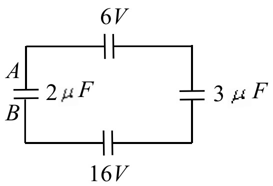
358. Two identical charged spherical drops each of capacitance C merge to form a single drop. The resultant capacitance is

a) Equal to $2C$
b) Greater than $2C$
c) Less than $2C$ but greater than C
d) Less than C

359. A capacitor of capacity C has charge Q and stored energy is W. If the charge is increased to $2Q$, the stored energy will be

a) $2W$
b) $W/2$
c) $4W$
d) $W/4$

360. The potential difference between A and B is



a) $13.2V$
b) $-13.2V$
c) $-6V$
d) $6V$

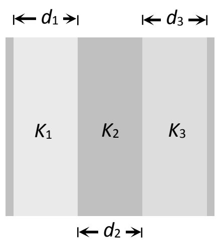
361. A conductor having a cavity is given a positive charge. Then field strengths E_A, E_B and E_C at point A (within cavity), at B (within conductor but outside cavity) and C (near conductor) respectively will be

a) $E_A = 0, E_B = 0, E_c = 0$
b) $E_A = 0, E_B = 0, E_c \neq 0$
c) $E_A \neq 0, E_B = 0, E_C \neq 0$
d) $E_A \neq 0, E_B \neq 0, E_C \neq 0$

362. The capacity of a parallel plate capacitor with no dielectric substance but with a separation of 0.4 cm is $2\mu F$. The separation is reduced to half and it is filled with a dielectric substance of value 2.8. The final capacity of the capacitor is

a) $11.2\mu F$
b) $15.6\mu F$
c) $19.2\mu F$
d) $22.4\mu F$

363. The expression for the capacity of the capacitor formed by compound dielectric placed between the plates of a parallel plate capacitor as shown in figure, will be (area of plate $= A$)



a) $\frac{\varepsilon_0 A}{\left(\frac{d_1}{K_1}+\frac{d_2}{K_2}+\frac{d_3}{K_3}\right)}$
b) $\frac{\varepsilon_0 A}{\left(\frac{d_1+d_2+d_3}{K_1+K_2+K_3}\right)}$
c) $\frac{\varepsilon_0 A(K_1 K_2 K_3)}{d_1 d_2 d_3}$
d) $\varepsilon_0\left(\frac{AK_1}{d_1}+\frac{AK_2}{d_2}+\frac{AK_3}{d_3}\right)$

364. Two charges of equal magnitudes and at a distance r exert a force F on each other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is

a) $F/8$
b) $F/4$
c) $4F$
d) $F/16$

365. An infinitely long thin straight wire has uniform linear charge density of $\frac{1}{3} cm^{-1}$. Then, the magnitude of the electric intensity at a point 18 cm away is
(Given $\varepsilon_0 = 8.8 \times 10^{-12} C^2 Nm^{-2}$)
a) $0.33 \times 10^{11} NC^{-1}$
b) $3 \times 10^{11}\ NC^{-1}$
c) $0.66 \times 10^{11} NC^{-1}$
d) $1.32 \times 10^{11} NC^{-1}$

366. Eight dipoles of charges of magnitude e are placed inside a cube. The total electric flux coming out of the cube will be
a) $\frac{8e}{\varepsilon_0}$
b) $\frac{16e}{\varepsilon_0}$
c) $\frac{e}{\varepsilon_0}$
d) Zero

367. A $20F$ capacitor is charged to $5V$ and isolated. It is then connected in parallel with an uncharged $30F$ capacitor. The decrease in the energy of the system will be
a) $25\,J$
b) $200\,J$
c) $125\,J$
d) $150\,J$

368. Consider a thin spherical shell of radius R consisting of uniform surface charge density σ. The electric field at a point of distance x from its centre and outside the shell is
a) Inversely proportional to σ
b) Directly proportional to x^2
c) Directly proportional to R
d) Inversely proportional to x^2

369. Two insulated charged conducting spheres of radii $20cm$ and $15cm$ respectively and having an equal charge of $10C$ are connected by a copper wire and then they are separated. Then
a) Both the spheres will have the same charge of 10 C
b) Surface charge density on the $20cm$ sphere will be greater than that on the $15cm$ sphere
c) Surface charge density on the $15cm$ sphere will be greater than that on the $20cm$ sphere
d) Surface charge density on the two spheres will be equal

370. The electrostatic potential energy between proton and electron separated by a distance 1Å is
a) $13.6eV$
b) $27.2eV$
c) $14.4eV$
d) $1.44eV$

371. Two charges $+q$ and $-q$ are situated at a certain distance. At the point exactly midway between them
a) Electric field and potential both are zero
b) Electric field is zero but potential is not zero
c) Electric field is not zero but potential is zero
d) Neither electric field nor potential is zero

372. Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium the value of q is
a) $-\frac{Q}{4}(1 + 2\sqrt{2})$
b) $\frac{Q}{4}(1 + 2\sqrt{2})$
c) $-\frac{Q}{2}(1 + 2\sqrt{2})$
d) $\frac{Q}{2}(1 + 2\sqrt{2})$

373. A thin spherical conducting shell of radius R has a charge q. Another charge Q is placed at the centre of the shell. The electrostatic potential at a point p a distance $R/2$ from the centre of the shell is
a) $\frac{(q+Q)}{4\pi\varepsilon_0}\frac{2}{R}$
b) $\frac{2Q}{4\pi\varepsilon_0 R}$
c) $\frac{2Q}{4\pi\varepsilon_0 R} - \frac{2q}{4\pi\varepsilon_0 R}$
d) $\frac{2Q}{4\pi\varepsilon_0 R} + \frac{2q}{4\pi\varepsilon_0 R}$

374. Two large vertical and parallel metal plates having a separation of 1 cm are connected to a DC voltage source of potential difference X. A proton is released at rest midway between the two plates. It is found to move at 45^o to the vertical JUST after release. Then X is nearly
a) $1 \times 10^{-5}V$
b) $1 \times 10^{-7}V$
c) $1 \times 10^{-9}V$
d) $1 \times 10^{-10}V$

375. A capacitor with air as the dielectric is charged to a potential of 100 $volts$. If the space between the plates is now filled with a dielectric of dielectric constant 10, the potential difference between the plates will be
a) 1000 $volts$
b) 100 $volts$
c) 10 $volts$
d) Zero

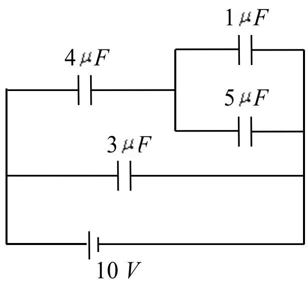
376. Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre .If the system is in equilibrium, the value of q is
a) $-\frac{Q}{4}(1 + 2\sqrt{2})$
b) $\frac{Q}{4}(1 + 2\sqrt{2})$
c) $-\frac{Q}{2}(1 + 2\sqrt{2})$
d) $\frac{Q}{2}(1 + 2\sqrt{2})$

377. An electric dipole of length 1 cm is placed with the axis making an angle of 30^o to an electric field of strength $10^4\ NC^{-1}$. If it experiences a torque of $10\sqrt{2}\ Nm$, the potential energy of the dipole is
a) $0.245\,J$
b) $2.45\,J$
c) $0.0245\,J$
d) $24.5\,J$

378. An electric dipole of moment $\vec{p}$ placed in a uniform electric field $\vec{E}$ has minimum potential energy when the angle between $\vec{p}$ and $\vec{E}$ is

a) Zero b) $\frac{\pi}{2}$ c) π d) $\frac{3\pi}{2}$

379. The charge on 4 μF capacitor in the given circuit is .... in μC



a) 12 b) 24 c) 36 d) 32

380. A 2μF capacitor is charged to 100 *volt* and then its plates are connected by a conducting wire. The heat produced is

a) 1 J b) 0.1 J c) 0.01 J d) 0.001 J

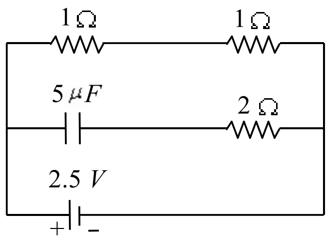
381. The capacitance of a metallic sphere will be 1μF, if its radius is nearly

a) 9km b) 10m c) 1.11 m d) 1.11 cm

382. The capacity of a condenser in which a dielectric of dielectric constant 5 has been used, is C. If the dielectric is replaced by another with dielectric constant 20, the capacity will become

a) $\frac{C}{4}$ b) 4C c) $\frac{C}{2}$ d) 2C

383. A capacitor of capacitance 5μF is connected as shown in the figure. The internal resistance of the cell is 0.5Ω. The amount of charge on the capacitor plate is



a) 0μC b) 5μC c) 10μC d) 25μC

384. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches Q upto a closest distance r and then returns. If q is shot with speed 2v, the closest distance of approach would be

a) $\frac{r}{4}$ b) $\frac{r}{2}$ c) 2r d) r

385. The ratio of electric fields on the axis and at equator of an electric dipole will be

a) 1:1 b) 2:1 c) 4:1 d) 1:4

386. A cube of side l is placed in a uniform field $\boldsymbol{E}$, where $\boldsymbol{E} = E\hat{\boldsymbol{\imath}}$. The net electric flux through the cube is

a) Zero b) l^2E c) $4l^2E$ d) $6l^2E$

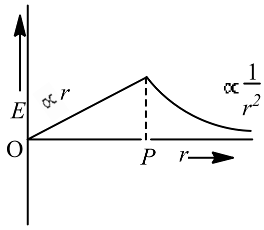
387. Three concentric spherical shells have radii a, b and $c(a < b < c)$ and have surface charge densities $\sigma, -\sigma$ and σ respectively. If V_A, V_B and V_C denote the potentials of the three shells, then, for $c = a + b$, we have

a) $V_C = V_A \neq V_B$ b) $V_C = V_B \neq V_A$ c) $V_C \neq V_B \neq V_A$ d) $V_C = V_B = V_A$

388. Three point charges are placed at the corners of an equilateral triangle. Assuming only electrostatic forces are acting

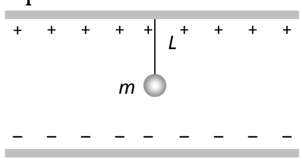
a) The system can never be in equilibrium
b) The system will be in equilibrium if the charges rotate about the centre of the triangle
c) The system will be in equilibrium if the charges have different magnitudes and different signs
d) The system will be in equilibrium if the charges have the same magnitudes but different signs

389. The figure shows electric field E at a distance r in any direction from the origin$O$. The electric field E is due to



a) A charged hollow metallic sphere of radius OP with centre at O
b) A charged solid metallic sphere of radius OP with centre at$O$
c) A uniformly charged non-conducting sphere of radius $OP$with centre at O
d) A uniformly charged non-conducting hollow sphere of radius $OP$with centre at O

390. A small sphere carrying a charge $'q'$ is hanging in between two parallel plates by a string of length L. Time period of pendulum is T_0. When parallel plates are charged, the time period charges to T. The ratio T/T_0 is equal to

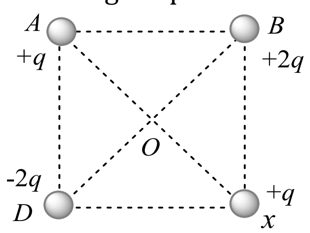


a) $\left(\frac{g+\frac{qE}{m}}{g}\right)^{1/2}$ b) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{3/2}$ c) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{1/2}$ d) None of these

391. The electric field created by a point charge falls with distance r from the point charge as

a) $\frac{1}{r}$ b) $\frac{1}{r^2}$ c) $\frac{1}{r^3}$ d) $\frac{1}{r^4}$

392. Four charges arranged the at the corners of a square $ABCD$, as shown in the adjoining figure. The force on the charge kept at the centre O is

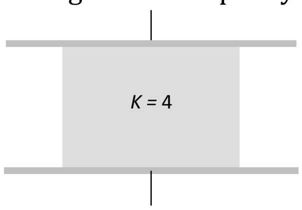


a) Zero
b) Along the diagonal AC
c) Along the diagonal BD
d) Perpendicular to side AB

393. Electric potential at any point is $V=-5x+3y+\sqrt{15z}$, then the magnitude of the electric field is

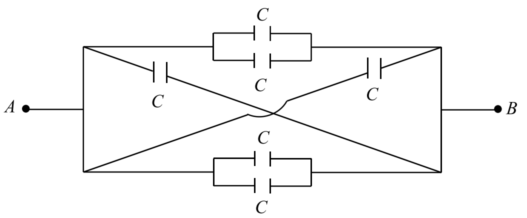
a) $3\sqrt{2}$ b) $4\sqrt{2}$ c) $5\sqrt{2}$ d) 7

394. Consider a parallel plate capacitor of $10\mu F$ $(micro-farad)$ with air filled in the gap between the plates. Now one half of the space between the plates is filled with a dielectric of dielectric constant 4, as shown in the figure. The capacity of the capacitor changes to



a) 25 μF b) 20 μF c) 40 μF d) 5 μF

395. Six capacitors each of capacitance of $2\mu F$ are connected as shown in the figure. The effective capacitance between A and B is



a) $12\mu F$ b) $8/3\mu F$ c) $3\mu F$ d) $6\mu F$

396. Two point charges+3μC and +8μC repel each other with a force of 40 N. If a charge of +5μC is added to each of them, then the force between them will become

a) −10 N b) +10 N c) +20 N d) −20 N

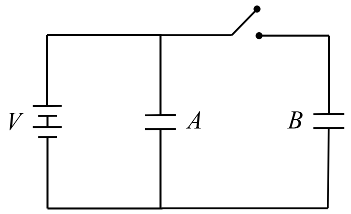
397. A charge q is placed at the centre of the line joining two equal point charges each equal to$Q$. The system of three charges will be in equilibrium if $q$is equal to

a) $+Q/4$ b) $-Q/2$ c) $+Q/2$ d) $-Q/4$

398. The mean free path of electrons in a metal is $4 \times 10^{-8}m$. The electric field which can give on an average $2\ eV$ energy to an electron in the metal will be in units of V/m

a) 8×10^{7} b) 5×10^{-11} c) 8×10^{-11} d) 5×10^{7}

399. Figure given below shows two identical parallel plate capacitors connected to a battery with switch S closed. The switch is now opened and the free space between the plate of capacitors is filled with a dielectric of dielectric constant 3. What will be the ratio of total electrostatic energy stored in both capacitors before and after the introduction of the dielectric



a) 3 : 1 b) 5 : 1 c) 3 : 5 d) 5 : 3

400. The magnetic potential at a point on the axial line of a bar magnet of dipole moment $M$is V. What is the magnetic potential due to a bar magnet of dipole moment $\frac{M}{4}$ at the same point?

a) $4V$ b) $2V$ c) $\frac{V}{2}$ d) $\frac{V}{4}$

401. Potential and field strength at a certain distance from a point charge are 600V and 200 NC^{-1}. Distance of the point from the charge is

a) 2m b) 4m c) 8m d) 3m

402. Cathode rays travelling from east to west enter into region of electric field directed towards north to south in the plane of paper. The deflection of cathode rays is towards

a) East b) South c) West d) North

403. The capacity of a parallel plate capacitor increases with the

a) Decreases of its area b) Increase of its distance
c) Increase of its area d) None of the above

404. An electric dipole consists of two opposite charges of magnitude $q = 1 \times 10^{-6}$ C separated by 2.0 cm. the dipole is placed in an external field of 1×10^{5} NC^{-1}. What maximum torque does the field exert on the dipole? How much work must an external agent do to turn the dipole end for end, starting from position of alignment $(\theta = 0^{0})$

a) 4.4×10^{6} N − m, 3.2×10^{-4} J b) -2×10^{3} N − m, -4×10^{3} J
c) 4×10^{3} N − m, 2×10^{-3} J d) 2×10^{-3} N − m, 4×10^{-3} J

405. An electric dipole is situated in an electric field of uniform intensity E whose dipole moment is p and moment of inertia is I. If the dipole is displaced slightly from the equilibrium position, then the angular frequency of its oscillations is

a) $\left(\frac{pE}{I}\right)^{1/2}$ b) $\left(\frac{pE}{I}\right)^{3/2}$ c) $\left(\frac{I}{pE}\right)^{1/2}$ d) $\left(\frac{p}{IE}\right)^{1/2}$

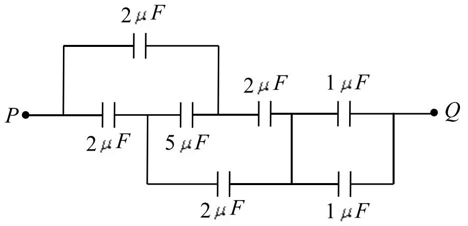
406. A infinite number of charges, each of charge 1μ C, are placed on the x-axis with co-ordinates x =1, 2, 4, 8, … ∞. If a charge of 1 C is kept at the origin, then what is the net force acting on 1C charge?

a) 9000 N b) 12000 N c) 24000 N d) 36000 N

407. The force between the plates of a parallel plate capacitor of capacitance C and distance of separation of the plates d with a potential difference V between the plates, is

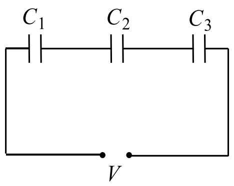
a) $\frac{CV^2}{2d}$ b) $\frac{C^2V^2}{2d^2}$ c) $\frac{C^2V^2}{d^2}$ d) $\frac{V^2d}{C}$

408. The effective capacitance between the points P and Q of the arrangement shown in the figure is



a) $\frac{1}{2}\mu F$ b) $1\mu F$ c) $2\mu F$ d) $1.33\mu F$

409. In the figure, three capacitors each of capacitance 6 pF are connected in series. The total capacitance of the combination will be



a) $9 \times 10^{-12}F$ b) $6 \times 10^{-12}F$ c) $3 \times 10^{-12}F$ d) $2 \times 10^{-12}F$

410. Two charges is equal to $2\mu C$ are $0.5m$ apart. If both of them exist inside vacuum, then the force between them is

a) 1.89 N b) 2.44 N c) 0.144 N d) 3.144 N

411. The energy required to charge a capacitor of $5\mu F$ by connecting a $d.c.$ source of $20kV$ is

a) 10 kJ b) 5 kJ c) 2 kJ d) 1 kJ

412. A polythene piece, rubbed with wool, is found to have negative charge of 4×10^{-7}C. the number of electrons transferred from wool to polythene is

a) 1.5×10^{12} b) 2.5×10^{12} c) 2.5×10^{13} d) 3.5×10^{13}

413. Two conducting spheres of radii 3 cm and 1 cm are separated by a distance of 10 cm in free space. If the spheres are charged to same potential of 10 V each, the force of repulsion between them is

a) $\left(\frac{1}{3}\right) \times 10^{-9}N$ b) $\left(\frac{2}{9}\right) \times 10^{-9}N$ c) $\left(\frac{1}{9}\right) \times 10^{-9}N$ d) $\left(\frac{4}{3}\right) \times 10^{-9}N$

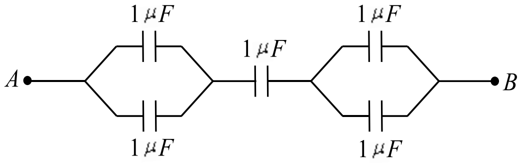
414. What is the flux through a cube of side $'a'$ if a point charge of q is at one of its corner

a) $\frac{2q}{\varepsilon_0}$ b) $\frac{q}{8\varepsilon_0}$ c) $\frac{q}{\varepsilon_0}$ d) $\frac{q}{2\varepsilon_0}6a^2$

415. Let there be a spherically symmetric charge distribution with charge density varying as $\rho(r) = \rho_0\left(\frac{5}{4} - \frac{r}{R}\right)$ upto $r = R$, and $\rho(r) = 0$ for $r > R$, where r is the distance from the origin. The electric field at a distance $r(r < R)$ from the origin is given by

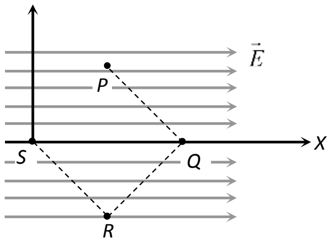
a) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{4} - \frac{r}{R}\right)$ b) $\frac{4\pi\rho_0 r}{3\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$ c) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$ d) $\frac{4\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4} - \frac{r}{R}\right)$

416. The equivalent capacitance between A and B is



a) 2 μF b) 3 μF c) 5 μF d) 0.5 μF

417. Point charge q moves from point P to point S along the path $PQRS$ (figure shown) in a uniform electric field E pointing coparallel to the positive direction of the X-axis. The coordinates of the points P, Q, R and S are $(a, b, 0)(2a, 0,0)(a, -b, 0)$ and $(0,0,0)$ respectively. The work done by the field in the above process is given by the expression



a) qEa b) $-qEa$ c) $qEa\sqrt{2}$ d) $qE\sqrt{[(2a)^2 + b^2]}$

418. Two charges placed in air repel each other by a force of $10^{-4} N$. When oil is introduced between the charges, the force becomes $2.5 \times 10^{-5} N$. The dielectric constant of oil is

a) 2.5 b) 0.25 c) 2.0 d) 4.0

419. The electric charges are distributed in a small volume. The flux of the electric field through a spherical surface of radius 10 cm surrounding the total charge is 20 Vm. The flux over a concentric sphere of radius 20 cm will be

a) 20Vm b) 25Vm c) 40Vm d) 200Vm

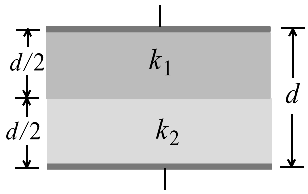
420. n identical condensers are joined in parallel and are charged to potential V. Now they are separated and joined in series. Then the total energy and potential difference of the combination will be

a) Energy and potential difference remain same
b) Energy remains same and potential difference is nV
c) Energy increases n times and potential difference is nV
d) Energy increases n times and potential difference remains same

421. Electric field of an isolated metallic sphere at any interior point is

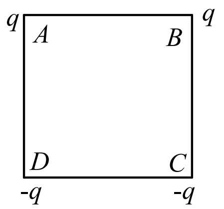
a) Zero b) One
c) Proportional to field d) None of these

422. Two dielectric slabs of constant K_1 and K_2 have been filled in between the plates of a capacitor as shown below. What will be the capacitance of the capacitor



a) $\frac{2\varepsilon_0 A}{d}(K_1 + K_2)$ b) $\frac{2\varepsilon_0 A}{d}\left(\frac{K_1 + K_2}{K_1 \times K_2}\right)$ c) $\frac{2\varepsilon_0 A}{2}\left(\frac{K_1 \times K_2}{K_1 + K_2}\right)$ d) $\frac{2\varepsilon_0 A}{d}\left(\frac{K_1 \times K_2}{K_1 + K_2}\right)$

423. Charges are placed on the vertices of a square as shown. Let **E** be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then



a) **E** remains unchanged, V changes
b) Both **E** and V change
c) **E** and V remain unchanged
d) **E** changes, V remains unchanged

424. A glass rod rubbed with silk is used to charge a gold leaf electroscope and the leaves are observed to diverge. The electroscope thus charged is exposed to X-rays for a short period. Then
a) The divergence of leaves will not be affected
b) The leaves will diverge further
c) The leaves will collapse
d) The leaves will melt

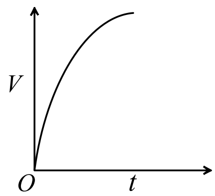
425. Two point charges of $20\mu C$ and $80\mu C$ are $10cm$ apart. Where will the electric field strength be zero on the line joining the charges form $20\mu C$ charge
a) $0.1\ m$
b) $0.04\ m$
c) $0.033\ m$
d) $0.33\ m$

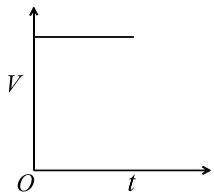
426. An object A has a charge of -2μ C and the object B has a charge of $+6\ \mu\ C$. Which statement is true?
a) $F_{AB} = -3F_{BA}$
b) $F_{AB} = -F_{BA}$
c) $3F_{AB} = -F_{BA}$
d) $F_{AB} = 4F_{BA}$

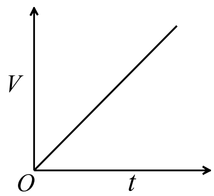
427. The electric potential at a point (x, y, z) is given by $V = -x^2y - xz^3 + 4$
The electric field $\vec{E}$ at that point is
a) $\vec{E} = \hat{\imath}(2xy + z^3) + \hat{\jmath}x^2 + \hat{k}3xz^2$
b) $\vec{E} = \hat{\imath}\,2xy + \hat{\jmath}(x^2 + y^2) + \hat{k}(3xz - y^2)$
c) $\vec{E} = \hat{\imath}\,z^3 + \hat{\jmath}\,xyz + \hat{k}\,z^2$
d) $\vec{E} = \hat{\imath}(2xy - z^3) + \hat{\jmath}\,xy^2 + \hat{k}3z^2x$

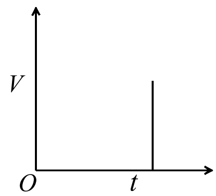
428. The capacitance of a spherical condenser is $1\mu F$. If the spacing between the two spheres is $1\ mm$, then the radius of the outer sphere is
a) $30cm$
b) $6m$
c) $5cm$
d) $3m$

429. During charging a capacitor variation of potential V of the capacitor with time t is shown as

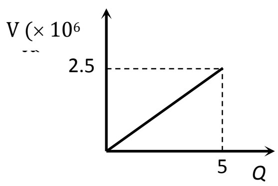
a) 

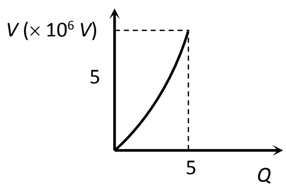
b) 

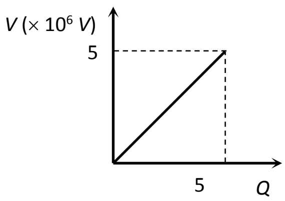
c) 

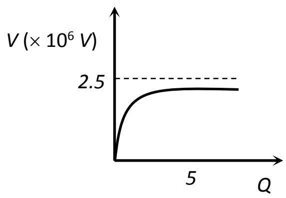
d) 

430. A condenser of $2\mu F$ capacitance is charged steadily from 0 to 5 *coulomb*. Which of the following graphs correctly represents the variation of potential difference across its plates with respect to the charge on the condenser

a) 

b) 

c) 

d) 

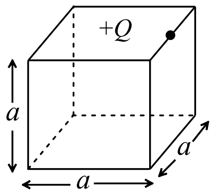
431. Let V be the electric potential at a given point. Then the electric field E_x along x-direction at that point is given by
a) $\int_0^\infty V\,dx$
b) $\frac{dV}{dx}$
c) $-\frac{dV}{dx}$
d) $-V\frac{dV}{dx}$

432. Charge motion within the Gaussian surface gives changing physical quantity
a) Electric field
b) Electric flux
c) Charge
d) Gaussian surface area

433. Energy stored in capacitor and dissipated during charging a capacitor bear a ratio

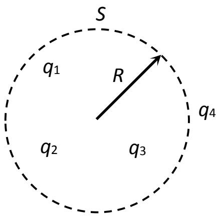
a) 1 : 1 b) 1 : 2 c) 1 : 1/2 d) 2 : 1

434. In figure $+Q$ charge is located at one of the edge of the cube, then electric flux through cube due to $+Q$ charge is



a) $\frac{+Q}{\epsilon_0}$ b) $\frac{+Q}{2\,\epsilon_0}$ c) $\frac{+Q}{4\,\epsilon_0}$ d) $\frac{+Q}{8\,\epsilon_0}$

435. q_1, q_2, q_3 and q_4 are point charges located at points as shown in the figure and S is a spherical Gaussian surface of radius R. Which of the following is true according to the Gauss's law



a) $\oint_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3).d\vec{A} = \frac{q_1 + q_2 + q_3}{2\varepsilon_0}$

b) $\oint_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3).d\vec{A} = \frac{(q_1 + q_2 + q_3)}{\varepsilon_0}$

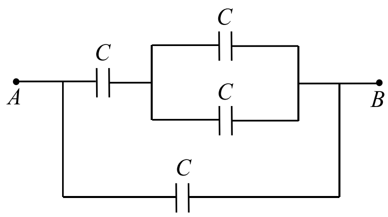
c) $\oint_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3).d\vec{A} = \frac{(q_1 + q_2 + q_3 + q_4)}{\varepsilon_0}$

d) None of the above

436. Two spheres of radii a and b respectively are charged and joined by a wire. The ratio of electric field of the spheres is

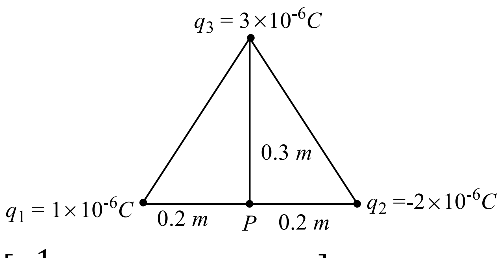
a) a/b b) b/a c) a^2/b^2 d) b^2/a^2

437. Four equal capacitors, each of capacity C, are arranged as shown. The effective capacitance between A and B is



a) $\frac{5}{8}C$ b) $\frac{3}{5}C$ c) $\frac{5}{3}C$ d) C

438. Figure shows a triangular array of three point charges. The electric potential V of these source charges at the midpoint P of the base of the triangle is



$\left[\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 Nm^2C^{-2}\right]$

a) 55 kV b) 45 kV c) 63 kV d) 49 kV

439. Two parallel infinite line charges $+\lambda$ and $-\lambda$ are placed with a separation distance R in free space. The net electric field exactly mid-way between the two line charges is

a) Zero b) $\frac{2\lambda}{\pi\varepsilon_0 R}$ c) $\frac{\lambda}{\pi\varepsilon_0 R}$ d) $\frac{\lambda}{2\pi\varepsilon_0 R}$

440. A capacitor of $20\mu F$ is charged to 500 $volts$ and connected in parallel with another capacitor of $10\mu F$ and charged to 200 $volts$. The common potential is

a) 200 $volts$ b) 300 $volts$ c) 400 $volts$ d) 500 $volts$

441. A pendulum bob of mass $30.7 \times 10^{-6} kg$ and carrying a charge $2 \times 10^{-8} C$ is at rest in a horizontal uniform electric field of 20000 V/m. The tension in the thread of the pendulum is ($g = 9.8 m/s^2$)

a) $3 \times 10^{-4} N$ b) $4 \times 10^{-4} N$ c) $5 \times 10^{-4} N$ d) $6 \times 10^{-4} N$

442. There is an air filled $1pF$ parallel plate capacitor. When the plate separation is doubled and the space is filled with wax, the capacitance increases to $2pF$. The dielectric constant of wax is

a) 2 b) 4 c) 6 d) 8

443. If E_a be the electric field strength of a short dipole at a point on its axial line and E_e that on the equatorial line at the same distance, then

a) $E_e = 2E_a$ b) $E_a = 2E_e$ c) $E_a = E_e$ d) None of the above

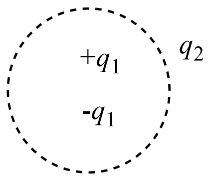
444. One metallic sphere A is given positive charge whereas another identical sphere B of exactly same mass as of A is given equal amount of negative charge. Then

a) Mass of A and mass of B still remain equal b) Mass of A increases
c) Mass of B decreases d) Mass of B increases

445. The electric field due to a dipole at a distance r on its axis is

a) Directly proportional to r^3 b) Inversely proportional to r^3
c) Directly proportional to r^2 d) Inversely proportional to r^2

446. Consider the charge configuration and spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface the electric field will be due to

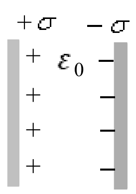


a) q_2
b) Only the positive charges
c) All the charges
d) $+q_1$ and $-q_1$

447. A water molecule has an electric dipole moment 6.4×10^{-30} cm when it is in vapour state. The distance in metre between the centre of positive and negative charge of the molecule is

a) 4×10^{-10} b) 4×10^{-11} c) 4×10^{-12} d) 4×10^{-13}

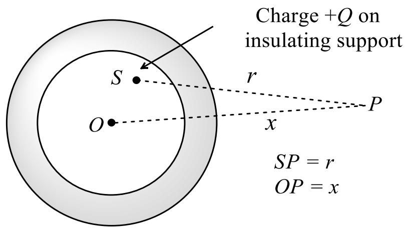
448. Two large metal plates are placed parallel to each other. The inner surfaces of plates are charged by $+\sigma$ and$-\sigma$ (Coulomb/m^2). The outer surfaces are neutral. The electric field is …… in the region between the plates and …… outside the plates



a) $\frac{2\sigma}{\epsilon_0}, \frac{\sigma}{\epsilon_0}$ b) $\frac{\sigma}{\epsilon_0}$, zero c) $\frac{2\sigma}{\epsilon_0}$, zero d) zero, $\frac{2\sigma}{\epsilon_0}$

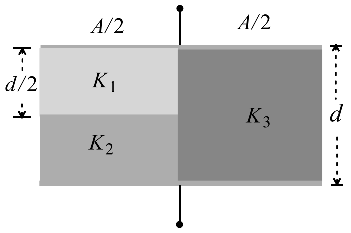
449. The adjacent diagram shows a charge $+Q$ held on an insulating support S and enclosed by a hollow spherical conductor. O represents the centre of the spherical conductor and P is a point such that $OP = x$ and $SP = r$

The electric field at point P will be



a) $\frac{Q}{4\pi\varepsilon_0 x^2}$ b) $\frac{Q}{4\pi\varepsilon_0 r^2}$ c) 0 d) None of the above

450. In the figure a capacitor is filled with dielectrics. The resultant capacitance is

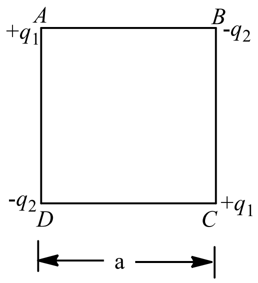


a) $\frac{2\varepsilon_0 A}{d}\left[\frac{1}{k_1}+\frac{1}{k_2}+\frac{1}{k_3}\right]$ b) $\frac{\varepsilon_0 A}{d}\left[\frac{1}{k_1}+\frac{1}{k_2}+\frac{1}{k_3}\right]$ c) $\frac{2\varepsilon_0 A}{d}[k_1+k_2+k_3]$ d) None of these

451. Two capacitors of $3pF$ and $6pF$ are connected in series and a potential difference of $5000\ V$ is applied across the combination. They are then disconnected and reconnected in parallel. The potential between the plates is

a) $2250V$ b) $2222V$ c) $2.25 \times 10^6 V$ d) $1.1 \times 10^6 V$

452. Charges are placed at corner of square of side a as shown in following figure. The charge A is in equilibrium. The ratio $\frac{q_1}{q_2}$ is



a) 1 b) $\sqrt{2}$ c) $\frac{1}{\sqrt{2}}$ d) $\frac{2}{\sqrt{2}}$

453. Consider the following statements about electric dipole and select the correct ones

S1 : Electric dipole moment vector $\vec{p}$ is directed from the negative charge to the positive charge

S2 : The electric field of a dipole at a point with position vector $\vec{r}$ depends on $|\vec{r}|$ as well as the angle between $\vec{r}$ and $\vec{p}$

S3 : The electric dipole potential falls off as $\frac{1}{r^2}$ and not as $\frac{1}{r}$

S4 : In a uniform electric field, the electric dipole experiences no net forces but a torque $\vec{\tau} = \vec{p} \times \vec{E}$

a) S2, S3 and S4 b) S3 and S4 c) S2 and S3 d) All four

454. The capacitance C of a capacitor is

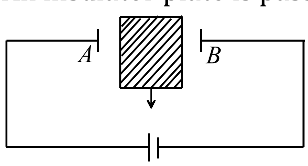
a) Independent of the charge and potential of the capacitor

b) Dependent on the charge and independent of potential

c) Independent of the geometrical configuration of the capacitor

d) Independent of the dielectric medium between the two conducting surfaces of the capacitor

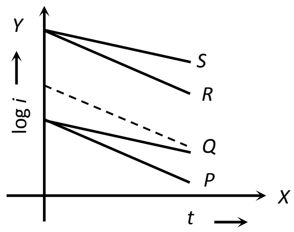
455. An insulator plate is passed between the plates of a capacitor. Then the displacement current



a) First flows from A to B and then from B to A
b) First flows from B to A then from A to B
c) Always flows from B to A
d) Always flows from A to B

456. In a medium of dielectric constant K, the electric field is $\vec{E}$. If ε_0 is permittivity of the free space, the electric displacement vector is
a) $\frac{K\vec{E}}{\varepsilon_0}$
b) $\frac{\vec{E}}{K\varepsilon_0}$
c) $\frac{\varepsilon_0\vec{E}}{K}$
d) $K\varepsilon_0\vec{E}$

457. In an RC circuit while charging, the graph of $\ln i$ versus time is as shown by the dotted line in the diagram figure, where i is the current. When the value of the resistance is doubled, which of the solid curve best represents the variation of $\ln i$ versus time

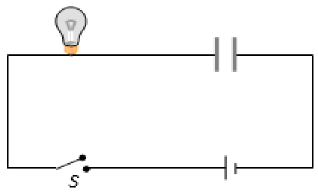


a) P
b) Q
c) R
d) S

458. Four charges $+Q, -Q, +Q, -Q$ are placed at the corners of a square taken in order. At the centre of the square
a) $E = 0, V = 0$
b) $E = 0, V \neq 0$
c) $E \neq 0, V = 0$
d) $E \neq 0, V \neq 0$

459. A parallel plate capacitor has an electric field of $10^5 V/m$ between the plates. If the charge on the capacitor plate is $1\mu\ C$, the force on each capacitor plate is
a) 0.5 N
b) 0.05 N
c) 0.005 N
d) None of these

460. A light bulb, a capacitor and a battery are connected together as shown here, with switch S initially open. When the switch S is closed, which one of the following is true



a) The bulb will light up for an instant when the capacitor starts charging
b) The bulb will light up when the capacitor is fully charged
c) The bulb will not light up at all
d) The bulb will light up and go off at regular intervals

461. The electric field due to an extremely short dipole at distance r from it is proportional to
a) $\frac{1}{r}$
b) $\frac{1}{r^2}$
c) $\frac{1}{r^3}$
d) $\frac{1}{r^4}$

462. A piece of cloud having area $25 \times 10^6 m^2$ and electric potential of 10^5 volts. If the height of cloud is 0.75 km, then energy of electric field between earth and cloud will be
a) 250 J
b) 750 J
c) 1225 J
d) 1475 J

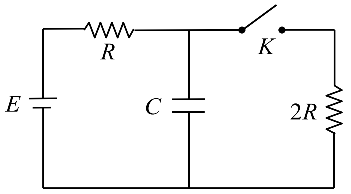
463. Two thin wire rings each having radius R are placed at a distance d apart with their axes coinciding. The charges on the two rings are $+q$ and $-q$. The potential difference between the centres of the two rings is
a) Zero
b) $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}}\right]$
c) $QR/4\pi\varepsilon_0 d^2$
d) $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}}\right]$

464. An electron having charge $'e'$ and mass $'m'$ is moving in a uniform electric field E. Its acceleration will be
a) $\frac{e^2}{m}$
b) $\frac{E^2 e}{m}$
c) $\frac{eE}{m}$
d) $\frac{mE}{e}$

465. 64 drops of mercury each charged to a potential of $10V$. They are combined to form one bigger drop. The potential of this drop will be (Assume all the drops to be spherical)

a) 160 V b) 80 V c) 10 V d) 640 V

466. In the circuit, shown in fig. $''K''$ is open. The charge on capacitor C in steady state is q_1. Now key is closed and at steady state, the charge on C is q_2. The ratio of charges $\left(\frac{q_1}{q_2}\right)$ is



a) $\frac{3}{2}$ b) $\frac{2}{3}$ c) 1 d) $\frac{1}{2}$

467. If the capacity of a spherical conductor is 1 $picofarad$, then its diameter, would be

a) $1.8 \times 10^{-3}m$ b) $18 \times 10^{-3}m$ c) $1.8 \times 10^{-5}m$ d) $18 \times 10^{-7}m$

468. The electric potential at a point on the axis of an electric dipole depends on the distance r of the point from the dipole as

a) $\propto \frac{1}{r}$ b) $\propto \frac{1}{r^2}$ c) $\propto r$ d) $\propto \frac{1}{r^3}$

469. A variable condenser is permanently connected to a 100 V battery. If the capacity is changed from $2\mu F$ to $10 \mu F$, then change in energy is equal to

a) $2 \times 10^{-2} J$ b) $2.5 \times 10^{-2} J$ c) $3.5 \times 10^{-2} J$ d) $4 \times 10^{-2} J$

470. A particle of mass $2 \times 10^{-5} Kg$ and charge $4 \times 10^{-3} C$ moves from rest in a uniform electric field of magnitude 5 V/m. its kinetic energy after 10 seconds is

a) $2 \times 10^3 J$ b) $10^3 J$ c) $2 \times 10^{-3} J$ d) $10^2 J$

471. Two parallel plates separated by a distance of $5mm$ are kept at a potential difference of $50V$ A particle of mass $10^{-15} kg$ and charge $10^{-11} C$ enters in it with a velocity $10^7 m/s$. The acceleration of the particle will be

a) $10^8 m/s^2$ b) $5 \times 10^5 m/s^2$ c) $10^5 m/s^2$ d) $2 \times 10^3 m/s^2$

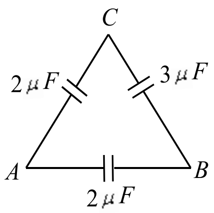
472. An electron initially at rest falls a distance of 1.5 cm in a uniform electric field of magnitude 2×10^4 N/C. The time taken by electron to fall this distance is

a) 1.3×10^2 s b) 2.1×10^{-12} s c) 1.6×10^{-10} s d) 2.9×10^{-9} s

473. Two charges $+q$ and $-q$ are kept apart. Then at any point on the right bisector of line joining the two charges

a) The electric field strength is zero
b) The electric potential is zero
c) Both electric potential and electric field strength are zero
d) Both electric potential and electric field strength are non- zero

474. Three capacitors are connected in the arms of a triangle ABC as shown in figure 5 V is applied between A and B. The voltage between B and C is



a) 2 V b) 1 V c) 3 V d) 1.5 V

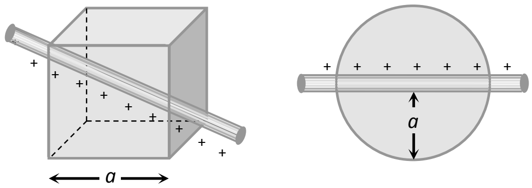
475. Two identical conductors of copper and aluminium are placed in an identical electric fields. The magnitude of induced charge in the aluminium will be

a) Zero
b) Greater than in copper
c) Equal to that in copper
d) Less than in copper

476. If charge q is placed at the centre of the line joining two equal charges Q, the system of these charges will be the same distance would be

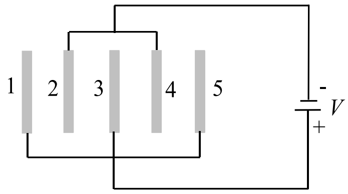
a) $-4Q$ b) $-Q/4$ c) $-Q/2$ d) $+Q/2$

477. A linear charge having linear charge density λ, penetrates a cube diagonally and then it penetrate a sphere diametrically as shown. What will be the ratio of flux coming cut of cube and sphere



a) $\frac{1}{2}$ b) $\frac{2}{\sqrt{3}}$ c) $\frac{\sqrt{3}}{2}$ d) $\frac{1}{1}$

478. Five identical plates each of area A are joined as shown in the figure. The distance between the plates is d. The plates are connected to a potential difference of V $volts$. The charge on plates 1 and 4 will be



a) $\frac{\varepsilon_0 AV}{d}, \frac{2\varepsilon_0 AV}{d}$ b) $\frac{-\varepsilon_0 AV}{d}, \frac{2\varepsilon_0 AV}{d}$ c) $\frac{\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$ d) $\frac{-\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$

479. Positive and negative point charges of equal magnitude are kept at $\left(0,0,\frac{a}{2}\right)$ and $\left(0,0,\frac{-a}{2}\right)$, respectively. The work done by the electric field when another positive point charge is moved from $(-a,0,0)$ to $(0,a,0)$ is

a) Positive
b) Negative
c) Zero
d) Depends on the path connecting the initial and final positions

480. What is called electrical energy tank

a) Resistor b) Inductance c) Capacitor d) Motor

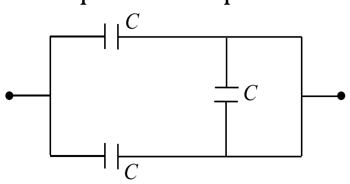
481. A body has -80 $micro$ $coulomb$ of charge. Number of additional electrons in it will be

a) 8×10^{-5} b) 80×10^{-17} c) 5×10^{14} d) 1.28×10^{-17}

482. An electric dipole is placed at an angle of 30° to a non-uniform electric field. The dipole will experience

a) A translational force only in the direction of the field
b) A translational force only in a direction normal to the direction of the field
c) A torque as well as a translational force
d) A torque only

483. The equivalent capacitance of the combination shown in figure below is



a) $2C$ b) C c) $\frac{1}{2}C$ d) None of these

484. The plates of a parallel plate capacitor of capacity $50\mu C$ are charged to a potential of 100 $volts$ and then separated from each other so that the distance between them is doubled. How much is the energy spent in doing so

a) $25 \times 10^{-2}\,J$ b) $-12.5 \times 10^{-2}\,J$ c) $-25 \times 10^{-2}\,J$ d) $12.5 \times 10^{-2}\,J$

485. What is the angle between the electric dipole moment and the electric field strength due to it on the equatorial line

a) 0^o b) 90^o c) 180^o d) None of these

486. Positive and negative point charges of equal magnitude are kept at $\left(0,0,\frac{a}{2}\right)$ and $\left(0,0,\frac{-a}{2}\right)$, respectively. The work done by the electric field when another positive point charge is moved from $(-a,0,0)$ to $(0,a,0)$ is

a) Positive b) Negative c) Zero d) Depends on the path connecting the initial and final positions

487. What is the potential energy of the equal positive point charges of $1\mu C$ each held $1\ m$ apart in air

a) $9\times10^{-3}\ J$ b) $9\times10^{-3}eV$ c) $2eV/m$ d) Zero

488. A point charge $+q$ is placed at the centre of a cube of side L. The electric flux emerging from the cube is

a) $\frac{q}{\varepsilon_0}$ b) Zero c) $\frac{6qL^2}{\varepsilon_0}$ d) $\frac{q}{6L^2\varepsilon_0}$

489. Two condensers of capacities $1\mu F$ and $2\mu F$ are connected in series and the system is charged to 120 $volts$. Then the P.D. on $1\mu F$ capacitor (in volts) will be

a) 40 b) 60 c) 80 d) 120

490. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then the $\frac{Q}{q}$ eQuals

a) $-2\sqrt{2}$ b) -1 c) 1 d) $-\frac{1}{\sqrt{2}}$

491. When a proton is accelerated through $1V$, then its kinetic energy will be

a) 1840 eV b) 13.6 eV c) 1 eV d) 0.54 eV

492. If there are n capacitors in parallel connected to $V\ volt$ source, then the energy stored is equal to

a) CV b) $\frac{1}{2}nCV^2$ c) CV^2 d) $\frac{1}{2n}CV^2$

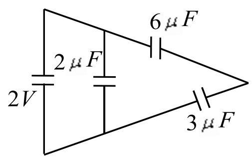
493. What is not true for equipotential surface for uniform electric field

a) Equipotential surface is flat b) Equipotential surface is spherical c) Electric lines are perpendicular to equipotential surface d) Work done is zero

494. Flux coming out from a unit positive charge enclosed in air is

a) ε_0 b) $(\varepsilon_0)^{-1}$ c) $(4\pi\varepsilon_0)^{-1}$ d) $4\pi\varepsilon_0$

495. The total energy stored in the condenser system shown in the figure will be



a) $8\ \mu J$ b) $16\ \mu J$ c) $2\ \mu J$ d) $4\ \mu J$

496. The inward and outward electric flux for a closed surface in units of $N-m^2/C$ are respectively 8×10^3 and 4×10^3. Then the total charge inside the surface is [where ε_0 = permittivity constant]

a) $4\times10^3\ C$ b) $-4\times10^3\ C$ c) $\frac{(-4\times10^3)}{\varepsilon}C$ d) $-4\times10^3\varepsilon_0\ C$

497. An electric dipole consists of two opposite charges, each of magnitude 1.0 μC separated by a distance of 2.0 cm. the dipole is placed in an external electric field of 10^5 NC^{-1}. The maximum torque on the dipole is

a) 0.2×10^{-3}N-m b) 1×10^{-3}N-m c) 2×10^{-3}N-m d) 4×10^{-3}N-m

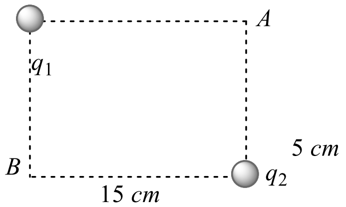
498. An electron of mass m and charge e is accelerated from rest through a potential difference V in vacuum. The final speed of the electron will be

a) $V\sqrt{e/m}$ b) $\sqrt{eV/m}$ c) $\sqrt{2eV/m}$ d) $2eV/m$

499. What is the magnitude of a point charge due to which the electric field $30cm$ away has the magnitude $2newton/coulomb$ $1/4\pi\varepsilon_0 = 9\times10^9 Nm^2/C^2$]

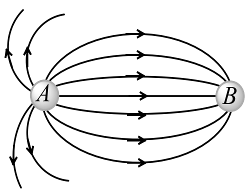
a) $2 \times 10^{-11} coulomb$ b) $3 \times 10^{-11} coulomb$ c) $5 \times 10^{-11} coulomb$ d) $9 \times 10^{-11} coulomb$

500. In the rectangle, shown below, the two corners have charges $q_1 = 5\mu C$ and $q_2 = +2.0\mu C$. The work done in moving a charge $+3.0\mu C$ from B to A is (take $1/4\pi\varepsilon_0 = 10^{10}\ N - m^2/C^2$)



a) 2.8 J b) 3.5 J c) 4.5 J d) 5.5 J

501. The spatial distribution of the electric field due to charges (A, B) is shown in figure. Which one of the following statements is correct



a) A is $+ve$ and $B - ve$ and $|A| > |B|$ b) A is $-ve$ and $B + ve$; $|A| = |B|$
c) Both are $+ve$ but $A > B$ d) Both are $-ve$ but $A > B$

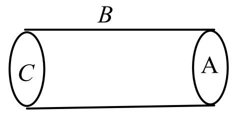
502. The electric field and the potential of an electric dipole vary with distance r as

a) $\frac{1}{r}$ and $\frac{1}{r^2}$ b) $\frac{1}{r^2}$ and $\frac{1}{r}$ c) $\frac{1}{r^2}$ and $\frac{1}{r^3}$ d) $\frac{1}{r^3}$ and $\frac{1}{r^2}$

503. Tow positive charges of magnitude q are placed at the ends of a side1 of a square of side $2a$. Two negative charges of the same magnitude are kept at the other corners. Starting from rest, if a charge Q moves from the middle of side 1 to the centre of square, its kinetic energy at the centre of square is

a) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1 - \frac{1}{\sqrt{5}}\right)$ b) Zero c) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1 + \frac{1}{\sqrt{5}}\right)$ d) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1 - \frac{2}{\sqrt{5}}\right)$

504. A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in unit of voltmeter associated with the curved surface B, the flux linked with the plane surface A in unit of voltmeter will be

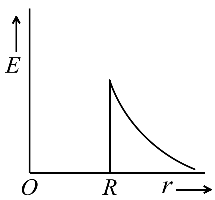


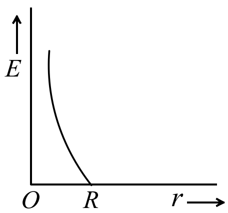
a) $\frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$ b) $\frac{q}{2\varepsilon_0}$ c) $\frac{\phi}{3}$ d) $\frac{q}{\varepsilon_0} - \phi$

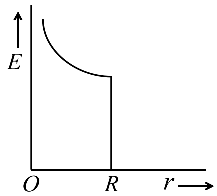
505. Two metallic spheres of radii 1 cm and 2cm are given charges $10^{-2}\ C$ and $5 \times 10^{-2} C$ respectively. If they are connected by a conducting wire, the final charge on the smaller sphere is

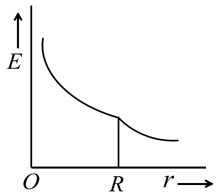
a) $3 \times 10^{-2} C$ b) $1 \times 10^{-2} C$ c) $4 \times 10^{-2} C$ d) $2 \times 10^{-2} C$

506. A metallic shell of radius R has a charge $-Q$ on it. A point charge $+Q$ is placed at the centre of the shell. Which of the graphs shown below may correctly represent the variation of the electric field E with distance r from the centre of the shell

a) 

b) 

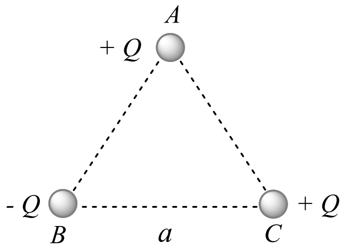
c) 

d) 

507. Two equal negative charges $-q$ are fixed at points $(0, a)$ and $(0, -a)$ on the Y-axis. A positive charge $'q'$ is released from rest at the point $(x << a)$ on the x-axis. What is the frequency of motion

a) $\sqrt{\frac{2q^2}{4\pi \in_0 ma^3}}$ b) $\sqrt{\frac{4q^2}{2\pi \in_0 ma^3}}$ c) $\sqrt{\frac{q^2}{2\pi \in_0 ma^3}}$ d) $\sqrt{\frac{q^2}{\pi \in_0 ma^3}}$

508. Three charges are placed at the vertices of an equilateral triangle of side $''a''$ as shown in the following figure. The force experienced by the charge placed at the vertex A in a direction normal to BC is



a) $Q^2/(4\pi\varepsilon_0 a^2)$ b) $-Q^2/(4\pi\varepsilon_0 a^2)$ c) Zero d) $Q^2/(2\pi\varepsilon_0 a^2)$

509. The distance between charges $5 \times 10^{-11} C$ and $-2.7 \times 10^{-11} C$ is $0.2\ m$. The distance at which a third charge should be placed in order that it will not experience any force along the line joining the two charges is
a) $0.44\ m$
b) $0.65\ m$
c) $0.556\ m$
d) $0.350\ m$

510. The Value (in vacuum) of energy density at a place in a region of electric field intensity E, due to it, is given by
a) $\frac{\varepsilon_0 E^2}{2}$ b) $\frac{\varepsilon_0 E}{2}$ c) $\frac{E^2}{2\varepsilon_0}$ d) $\frac{E\varepsilon_0^2}{2}$

511. A capacitor is used to store 24 $watt$ hour of energy at 1200 $volt$. What should be the capacitance of the capacitor
a) $120\ mF$ b) $120\ \mu F$ c) $24\ \mu F$ d) $24\ mF$

512. When a positive q charge is taken from lower potential to a higher potential point, then its potential energy will
a) Decrease b) Increase c) Remain unchanged d) Become zero

513. A dipole of electric dipole moment p is placed in a uniform electric field of strength E. If θ is the angle between positive directions of p and E, then the potential energy of the electric dipole is largest when θ is
a) $\frac{\pi}{4}$ b) $\frac{\pi}{2}$ c) π d) Zero

514. The outer sphere of a spherical air capacitor is earthed. For increasing its capacitance
a) Vacuum is created between two spheres
b) Dielectric material is filled between the two spheres
c) The space between two spheres is increased
d) The earthing of the outer sphere is removed

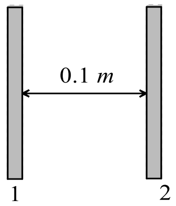
515. A charge Q is divided into two parts of q and $Q - q$. If the coulomb repulsion between them when they are separated is to be maximum, the ratio of $\frac{Q}{q}$ should be
a) 2 b) 1/2 c) 4 d) 1/4

516. Two parallel plates have equal and opposite charge. When the space between them is evacuated, the electric field between the plates is $2 \times 10^5\ V/m$. When the space is filled with dielectric, the electric field becomes $1 \times 10^5\ V/m$. The dielectric constant of the dielectric material
a) 1/2 b) 1 c) 2 d) 3

517. When a body is earth connected, electrons from the earth flow into the body. This means the body is
a) Charged negatively b) An insulator
c) Uncharged d) Charged positively

518. Two condensers of capacity $0.3\mu F$ and $0.6\mu F$ respectively are connected in series. The combination is connected across a potential of 6 $volts$. The ratio of energies stored by the condensers will be
a) $\frac{1}{2}$ b) 2 c) $\frac{1}{4}$ d) 4

519. Two insulating plates are both uniformly charged in such a way that the potential difference between them is $V_2 - V_1 = 20V$. ($i.e.$ plate 2 is at a higher potential). The plates are separated by $d = 0.1m$ and can be treated as infinitely large. An electron is released from rest on the inner surface of plate 1. What is its speed when it hits plate 2
$(e = 1.6 \times 10^{-19}C, m_e = 9.11 \times 10^{-31}kg)$

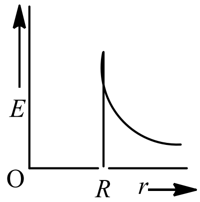


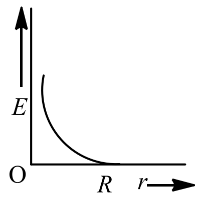
a) $7.02 \times 10^{12}\ m/s$ b) $1.87 \times 10^{6}\ m/s$ c) $32 \times 10^{-19}\ m/s$ d) $2.65 \times 10^{6}\ m/s$

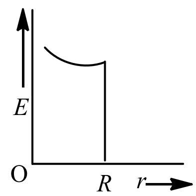
520. A potential difference of 300 $volts$ is applied to a combination of $2.0\mu F$ and $8.0\mu F$ capacitors connected in series. The charge on the $2.0\mu F$ capacitor is
a) $2.4 \times 10^{-4}C$ b) $4.8 \times 10^{-4}C$ c) $7.2 \times 10^{-4}C$ d) $9.6 \times 10^{-4}C$

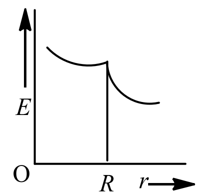
521. The electric potential due to a small electric dipole at a large distance r from the centre of the dipole is proportional to
a) r b) $1/r$ c) $\frac{1}{r^5}$ d) $1/r^2$

522. A metallic spherical shell of radius R has a charge $-Q$ on it. A point charge $+Q$ is placed at the centre of the shell. Which of the graphs shown below may correctly represent the variation of the electric field E with distance r from the centre of the shell?

a) 

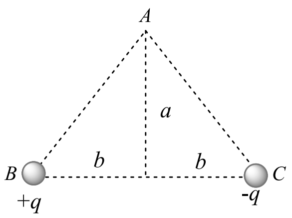
b) 

c) 

d) 

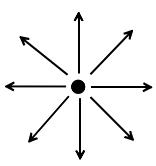
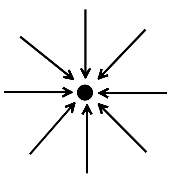
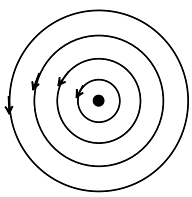
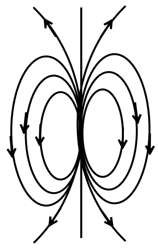
523. The energy stored in a condenser is in the form of
a) Kinetic energy b) Electrostatic potential energy
c) Elastic energy d) Magnetic energy

524. As shown in the figure, charges $+q$ and $-q$ are placed at the vertices B and C of an isosceles triangle. The potential at the vertex A is

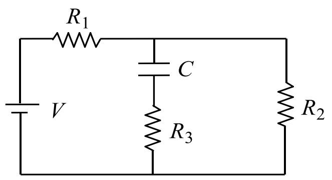


a) $\frac{1}{4\pi\varepsilon_0} \cdot \frac{2q}{\sqrt{a^2 + b^2}}$ b) Zero c) $\frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{\sqrt{a^2 + b^2}}$ d) $\frac{1}{4\pi\varepsilon_0} \cdot \frac{(-q)}{\sqrt{a^2 + b^2}}$

525. Which of the field patterns given below is valid for electric field as well as for magnetic field

a) 
b) 
c) 
d) 

526. In the circuit here, the steady state voltage across capacitor C is a fraction of the battery e.m.f. The fraction is decided by



a) R_1 only b) R_1 and R_2 only c) R_1 and R_3 only d) R_1, R_2 and R_3

527. What about Gauss theorem is not incorrect?
 a) It can be derived by using Coulomb's law
 b) It is valid for conservative field, obeys inverse square root law
 c) Gauss theorem is not applicable in gravitation
 d) Both (a) and (b)

528. The respective radii of the two spheres of a spherical condenser are 12 cm and 9 cm. The dielectric constant of the medium between them is 6. The capacity of the condenser will be
 a) 240 pF b) 240 μF c) 240 F d) None of the above

529. Number of electrons in one coulomb of charge will be
 a) 5.46×10^{29} b) 6.25×10^{18} c) $1.6 \times 10^{+19}$ d) 9×10^{11}

530. Two identical charged spheres suspended from a common point by two massless strings of length l are initially a distance $d(d << l)$ apart because of their mutual repulsion. The charge begins to leak from both the spheres at a constant rate. As a result charges approach each other with a velocity v .Then as a function of distance x between them
 a) $v \propto x^{-1}$ b) $v \propto x^{1/2}$ c) $v \propto x$ d) $v \propto x^{-1/2}$

531. A parallel plate capacitor has capacitance C. If it is equally filled with parallel layers of materials of dielectric constants K_1 and K_2 its capacity becomes C_1. The ratio of C_1 to C is
 a) $K_1 + K_2$ b) $\frac{K_1 K_2}{K_1 - K_2}$ c) $\frac{K_1 + K_2}{K_1 K_2}$ d) $\frac{2K_1 K_2}{K_1 + K_2}$

532. Consider a thin spherical shell of radius R consisting of uniform surface charge densityσ. The electric field at a point of distance x from its centre and outside the shell is
 a) inversely proportional to σ b) directly proportional tox^2
 c) directly proportional to σ d) inversely proportional tox^2

533. Two point charges $+8q$ and $-2q$ are located at $x = 0$ and $x = L$ respectively. The location of a point on the x-axis at which the net electric field due to these two point charges is zero is
 a) 8 L
 b) 4 L
 c) 2 L
 d) $\frac{L}{4}$

534. A particle of mass m carrying charge q is kept at rest in a uniform electric field E and then released. The kinetic energy gained by the particle, when it moves through a distance y is
 a) $\frac{1}{2}qEy^2$ b) qEy c) qEy^2 d) qE^2y

535. An electric dipole of moment $\vec{p}$ is placed normal to the lines of force of electric intensity $\vec{E}$, then the work done in deflecting it through an angle of 180^o is
 a) pE
 b) $+2pE$
 c) $-2pE$
 d) Zero

536. Two particle of equal mass m and charge q are placed at a distance of 16 cm. They do not experience any force. The value of $\frac{q}{m}$ is
 a) l b) $\sqrt{\frac{\pi\varepsilon_0}{G}}$ c) $\sqrt{\frac{G}{4\pi\varepsilon_0}}$ d) $\sqrt{4\pi\varepsilon_0 G}$

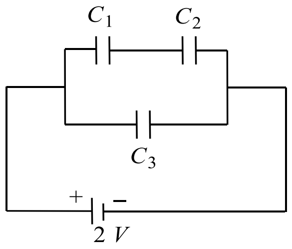
537. A series combination of three capacitors of capacities $1\mu F$, $2\mu F$ and $8\mu F$ is connected to a battery of e.m.f. 13 *volt*. The potential difference across the plates of $2\mu F$ capacitor will be

a) $1V$ b) $8V$ c) $4V$ d) $\frac{13}{3}V$

538. Eight small drops, each of radius r and having same charge q are combined to form a big drop. The ratio between the potentials of the bigger drop and the smaller drop is

a) 8 : 1 b) 4 : 1 c) 2 : 1 d) 1 : 8

539. Two capacitors $C_1 = 2\mu F$ and $C_2 = 6\mu F$ in series, are connected in parallel to a third capacitor $C_3 = 4\mu F$. This arrangement is then connected to a battery of e. m. f. $= 2V$, as shown in the figure. How much energy is lost by the battery in charging the capacitors



a) $22 \times 10^{-6} J$ b) $11 \times 10^{-6} J$ c) $\left(\frac{32}{3}\right) \times 10^{-6} J$ d) $\left(\frac{16}{3}\right) \times 10^{-6} J$

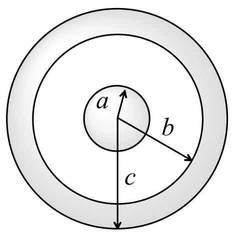
540. Three concentric metallic spherical shells of radii *R, 2R, 3R* given charges Q_1, Q_2, Q_3 respectively. It is found that the surface charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells, $Q_1 : Q_2 : Q_3$ is

a) 1:2:3 b) 1:3:5 c) 1:4:9 d) 1:8:18

541. A molecule with a dipole moment p is placed in an electric field of strength E. Initially the dipole is aligned parallel to the field. If the dipole is to be rotated to be anti-parallel to the field, the work required to be done by an external agency is

a) $-2\,pE$ b) $-pE$ c) pE d) $2\,pE$

542. A solid conducting sphere of radius a has a net positive charge $2Q$. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and has a net charge $-Q$. The surface charge density on the inner and outer surfaces of the spherical shell will be



a) $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$ b) $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$ c) $0, \frac{Q}{4\pi c^2}$ d) None of the above

543. The value of electric permittivity of free space is

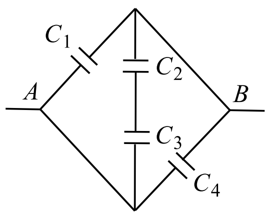
a) $9 \times 10^9\ NC^2/m^2$ b) $8.85 \times 10^{-12} Nm^2/C^2 sec$

c) $8.85 \times 10^{-12} C^2/Nm^2$ d) $9 \times 10^9 C^2/Nm^2$

544. An electric charge $10^{-3}\ \mu C$ is placed at the origin (0,0) of $X - Y$ co-ordinate system. Two points A and B are situated at $(\sqrt{2}, \sqrt{2})$ and $(2, 0)$ respectively. The potential difference between the points A and B will be

a) 9 *volt* b) Zero c) 2 *volt* d) 3.5 *volt*

545. In a given network the equivalent capacitance between A and B is $[C_1 = C_4 = 1\mu F, C_2 = C_3 = 2\mu F]$



a) 3 μF b) 6 μF c) 4.5 μF d) 2.5 μF

546. The electrostatic potential of a uniformly charged thin spherical shell of charge Q and radius R at a distance r from the centre is

a) $\frac{Q}{4\pi\varepsilon_0 r}$ for points outside and $\frac{Q}{4\pi\varepsilon_0 R}$ for points inside the shell

b) $\frac{Q}{4\pi\varepsilon_0 r}$ for both points inside and outside the shell

c) Zero for point outside and $\frac{Q}{4\pi\varepsilon_0 r}$ for points inside the shell

d) Zero for both points inside and outside the shell

547. Two charges $+5\mu C$ and $+10\mu C$ are placed 20 cm apart. The net electric field at the mid-point between the two charges is

a) $4.5 \times 10^6\ N/C$ directed towards $+5\mu C$
b) $4.5 \times 10^6\ N/C$ directed towards $+10\mu C$
c) $13.5 \times 10^6\ N/C$ directed towards $+5\mu C$
d) $13.5 \times 10^6\ N/C$ directed towards $+10\mu C$

548. A parallel plate capacitor of capacity C_0 is charged to a potential V_0

(i) The energy stored in the capacitor when the battery is disconnected and the separation is doubled E_1

(ii) The energy stored in the capacitor when the charging battery is kept connected and the separation between the capacitor plates is doubled is E_2. Then E_1/E_2 value is

a) 4 b) 3/2 c) 2 d) 1/2

549. Two charged spherical conductors of radii R_1 and R_2 are connected by a wire. Then the ratio of surface charge densities of the spheres σ_1/σ_2 is

a) $\frac{R_1}{R_2}$ b) $\frac{R_2}{R_1}$ c) $\sqrt{\left(\frac{R_1}{R_2}\right)}$ d) $\frac{R_1^2}{R_2^2}$

550. An electric dipole has a pair of equal and opposite point charges q and $-q$ separated by a distance $2x$. The axis of the dipole is defined as

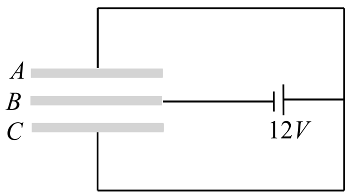
a) Direction from positive charge to negative charge

b) Direction from negative charge to positive charge

c) Perpendicular to the line joining the two charges drawn at the centre and pointing upward direction

d) Perpendicular to the line joining the two charges drawn at the centre and pointing downward direction

551. Three plates A, B, C each of area $50 cm^2$ have separation $3 mm$ between A and B and $3 mm$ between B and C. The energy stored when the plates are fully charged is



a) $1.6 \times 10^{-9} J$ b) $2.1 \times 10^{-9} J$ c) $5 \times 10^{-9} J$ d) $7 \times 10^{-9} J$

552. Which of the following is the correct statement of Gauss law for electrostatics in a region of charge distribution in free space?

a) $\oint \mathrm{E.ds} = 0$ b) $\oint E.ds = \frac{\rho}{\varepsilon_0}$ c) $\oint E.ds = \rho$ d) $\oint E.ds = \varepsilon_0 \rho$

553. An electron is moving around the nucleus of a hydrogen atom in a circular orbit of radius r. The coulomb force $\vec{F}$ between the two is $\left(\text{where } K = \frac{1}{4\pi\varepsilon_0}\right)$

a) $-K\frac{e^2}{r^3}\hat{r}$ b) $K\frac{e^2}{r^3}\vec{r}$ c) $-K\frac{e^2}{r^3}\vec{r}$ d) $K\frac{e^2}{r^3}\hat{r}$

554. Two unlike charges of magnitude q are separated by a distance $2d$. The potential at a point midway between them is

a) Zero b) $\frac{1}{4\pi\varepsilon_0}$ c) $\frac{1}{4\pi\varepsilon_0}.\frac{q}{d}$ d) $\frac{1}{4\pi\varepsilon_0}.\frac{2q}{d^2}$

555. Two point charges $(+Q)$ and $(-2Q)$ are fixed on the X-axis at positions a and $2a$ from origin respectively. At what positions on the axis, the resultant electric field is zero

a) Only $x = \sqrt{2}a$ b) Only $x = -\sqrt{2}a$ c) Both $x = \pm\sqrt{2}a$ d) $x = \frac{3a}{2}$ only

556. The number of electrons to be put on a spherical conductor of radius $0.1m$ to produce an electric field of $0.036N/C$ just above its surface is

a) 2.7×10^5 b) 2.6×10^5 c) 2.5×10^5 d) 2.4×10^5

557. A comb run through one's dry hair attracts small bits of paper. This is due to

a) Comb is a good conductor
b) Paper is a good conductor
c) The atoms in the paper get polarised by the charged comb
d) The comb possesses magnetic properties

558. An electric dipole of moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Then

(i) The torque on the dipole is $\vec{p} \times \vec{E}$

(ii) The potential energy of the system is $\vec{p}.\vec{E}$

(iii) The resultant force on the dipole is zero

a) (i), (ii) and (iii) are correct
b) (i) and (iii) are correct and (ii) is wrong
c) Only (i) is correct
d) (i) and (ii) are correct (iii) is wrong

559. The potential at a point x(measured in μm) due to some charges situated on the x-axis is given by $V(x) = 20/(x^2 - 4)$ volt

The electric field E at x=4 μm is given by

a) $\frac{5}{3}\text{V}\mu^{-1}\text{m}^{-1}$ and in the $-$ ve x direction
b) $\frac{5}{3}\text{V}\mu^{-1}\text{m}^{-1}$ and in the $+$ ve x direction
c) $\frac{10}{9}\text{V}\mu^{-1}\text{m}^{-1}$ and in the $-$ ve x direction
d) $\frac{10}{9}\text{V}\mu^{-1}\text{m}^{-1}$ and in the $+$ ve x direction

560. Two electric charges $12\mu C$ and $-6\mu C$ are placed 20 cm apart in air. There will be a point P on the line joining these charges and outside the region between them, at which the electric potential is zero. The distance of P from $-6\mu C$ charge is

a) 0.10 m
b) 0.15 m
c) 0.20 m
d) 0.25 m

561. If the charge on a capacitor is increased by 2 coulomb, the energy stored in it increase by 21%. The original charge on the capacitor is

a) 10 C b) 20 C c) 30 C d) 40 C

562. Four equal charges Q are placed at the four corners of a square of each side is $'a'$. Work done in removing a charge $-Q$ from its centre to infinity is

a) 0 b) $\frac{\sqrt{2}Q^2}{4\pi\varepsilon_0 a}$ c) $\frac{\sqrt{2}Q^2}{\pi\varepsilon_0 a}$ d) $\frac{Q^2}{2\pi\varepsilon_0 a}$

563. A conducting sphere of radius $R = 20\ cm$ is given a charge $Q = 16\mu C$. What is $\vec{E}$ at centre

a) $3.6 \times 10^6\ N/C$ b) $1.8 \times 10^6\ N/C$ c) Zero d) $0.9 \times 10^6\ N/C$

564. A capacitor having capacitance C is charged to a voltage V. It is then removed and connected in parallel with another identical capacitor which is uncharged. The new charge on each capacitor is now

a) CV b) $CV/2$ c) $2\ CV$ d) $CV/4$

565. There are two charges $+1\ \mu C$ and $+5\ \mu C$ respectively. The ratio of the forces acting on them will be

a) 1 : 5 b) 1 : 1 c) 5 : 1 d) 1 : 25

566. An electric dipole is situated in an electric field of uniform intensity E whose dipole moment is p and moment of inertia is I. If the dipole is displaced slightly from the equilibrium position, then the angular frequency of its oscillations is

a) $\left(\frac{pE}{I}\right)^{1/2}$ b) $\left(\frac{pE}{I}\right)^{3/2}$ c) $\left(\frac{I}{pE}\right)^{1/2}$ d) $\left(\frac{p}{IE}\right)^{1/2}$

567. An electron of mass M_e, initially at rest, moves through a certain distance in a uniform electric field in time t_1. A proton of mass M_p also initially at rest, takes time t_2 to move through an equal distance in this uniform electric field, neglecting the effect of gravity, the ratio t_1/t_2 is nearly equal to

a) 1 b) $\sqrt{M_p/M_e}$ c) $\sqrt{M_e/M_p}$ d) 1836

568. An electric charge q is placed at the centre of a cube of side a. The electric flux on one of its faces will be

a) $\frac{q}{6\varepsilon_0}$ b) $\frac{q}{\varepsilon_0 a^2}$ c) $\frac{q}{4\pi\varepsilon_0 a^2}$ d) $\frac{q}{\varepsilon_0}$

569. Two parallel large thin metal sheets have equal surface charge densities ($\sigma = 26.4 \times 10^{-12} \text{Cm}^{-2}$)of opposite signs. The electric field between these sheets is

a) 1.5 NC^{-1} b) $1.5 \times 10^{-10} \text{NC}^{-1}$ c) 3 NC^{-1} d) $3 \times 10^{-10} \text{NC}^{-1}$

570. Value of potential at a point due to a point charge is

a) Inversely proportional to square of the distance
b) Directly proportional to square of the distance
c) Inversely proportional to the distance
d) Directly proportional to the distance

571. A ring of radius r carries a charge Q uniformly distributed over its length. A charge q is placed at its centre will experience a force equal to

a) $\frac{qQ}{4\pi\varepsilon_0 r^2}$ b) $\frac{qQ}{8\pi\varepsilon_0 r^3}$ c) Zero d) None of these

572. Two identical spheres with charges $4q, -2q$ kept some distance apart exert a force F on each other. If they are made to touch each other and replaced at their old positions, the force between them will be

a) $\frac{1}{9}F$ b) $\frac{1}{8}F$ c) $\frac{9}{8}F$ d) $\frac{8}{9}F$

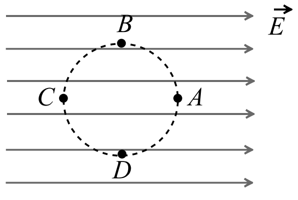
573. A comb run through one's dry hair attracts small bits of paper. This is due to

a) Comb is good conductor
b) Paper is good conductor
c) The atoms in the paper get polarised by the charged comb
d) The comb possesses magnetic properties

574. Electric charges of $+10\mu C, +5\mu C, -3\mu C$ and $+ 8\mu C$ are placed at the corners of a square of side $\sqrt{2}m$. the potential at the centre of the square is

a) $1.8\ V$
b) $1.8 \times 10^6\ V$
c) $1.8 \times 10^5\ V$
d) $1.8 \times 10^4\ V$

575. The electric field in a region surrounding the origin is uniform and along the x-axis. A small circle is drawn with the centre at the origin cutting the axes at points A, B, C, D having co-ordinates $(a, 0), (0, a), (-a, 0), (0, -a)$; respectively as shown in figure then potential in minimum at the point



a) A b) B c) C d) D

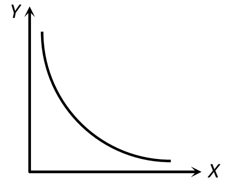
576. A uniform electric field pointing in positive x-direction exists in a region. Let A be the origin, B be the point on the x-axis at $x = +1\ cm$ and C be the point on the y-axis at $y = +1\ cm$. Then the potentials at the points A, B and C satisfy

a) $V_A < V_B$ b) $V_A > V_B$ c) $V_A < V_C$ d) $V_A > V_C$

577. A solid metallic sphere has a charge $+3Q$. Concentric with this sphere is a conducting spherical shell having charge $-Q$. The radius of the sphere is a and that of the spherical shell is $b(b > a)$. What is the electric field at a distance $R(a < R < b)$ from the centre

a) $\frac{Q}{2\pi\varepsilon_0 R}$ b) $\frac{3Q}{2\pi\varepsilon_0 R}$ c) $\frac{3Q}{4\pi\varepsilon_0 R^2}$ d) $\frac{4Q}{4\pi\varepsilon_0 R^2}$

578. What physical quantities may X and Y reprsent? (Y represents the first mentioned quantity)

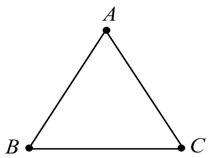


a) Pressure v/s temperature of a given gas (constant volume)
b) Kinetic energy v/s velocity of a particle
c) Capacitance v/s charge to give a constant potential
d) Potential v/s capacitance to give a constant charge

579. The electric charges are distributed in a small volume. The flux of the electric field through a spherical surface of radius 10 cm surrounding the total charge is 20 Vm. The flux over a concentric sphere of radius 20 cm will be

a) 20 Vm b) 25 Vm c) 40 Vm d) 200 Vm

580. Three identical charges, each of $2\mu C$ are placed at the vertices of a triangle ABC as shown in the figure



If $AB + AC = 12\ cm$ and $AB.AC = 32\ cm^2$, the potential energy of the charge at A is

a) 1.53 J b) 5.31 J c) 3.15 J d) 1.35 J

581. A solid sphere of radius R has a charge Q distributed in its volume with a charge density $\rho = k\,r^a$, where k and a are constants and r is the distance from its centre. If the electric field at $r = \frac{R}{2}$ is $\frac{1}{8}$ times that at $r = R$, find the value of a

a) 3 b) 5 c) 2 d) Both (a) and (b)

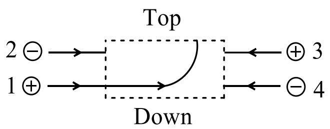
582. A parallel plate capacitor has circular plates of $0.08m$ radius and $1.0 \times 10^{-3}m$ separation. If a P.D. of 100 $volt$ is applied, the charge will be

a) $1.8 \times 10^{-10}C$ b) $1.8 \times 10^{-8}C$ c) $1.8 \times 10^{-20}C$ d) None of these

583. A simple pendulum of period T has a metal bob which is negatively charged. If it is allowed to oscillate above a positively charged metal plate, its period will

a) Remains equal to T b) Less than T c) Greater than T d) Infinite

584. The figure shows the path of a positively charged particle 1 through a rectangular region of uniform electric field as shown in the figure. What is the direction of electric field and the direction of particles 2, 3 and 4



a) Top; down, top, down
b) Top; down, down, top
c) Down; top, top, down
d) Down; top, down, down

585. Between the plates of a parallel plate condenser there is $1mm$ thick paper of dielectric constant 4. It is charged at 100 $volt$. The electric field in $volt/metre$ between the plates of the capacitor is

a) 100 b) 100000 c) 25000 d) 4000000

586. One of the following is not a property of field lines

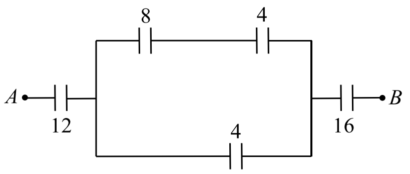
a) Field lines are continuous curves without any breaks

b) Two field lines cannot cross each other
c) Field lines start at positive charge and end at negative charges
d) They form closed loop

587. The electric field in the space between the plates of a discharge tube is 3.25×10^4 NC^{-1}. If mass of proton is 1.67×10^{-27} kg and its charge is 1.6×10^{-19}C, the force often the proton in the field is
a) 10.4×10^{-15} N
b) 2.0×10^{-23} N
c) 5.40×10^{-15} N
d) 5.20×10^{-15} N

588. A drop of $10^{-6} kg$ water carries $10^{-6} C$ charge. What electric field should be applied to balance its weight (assume $g = 10 m/s^2$)
a) 10 V/m upward
b) 10 V/m downward
c) 0.1 V/m downward
d) 0.1 V/m upward

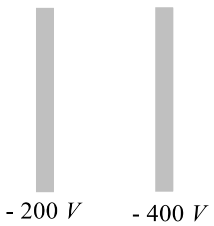
589. What is the equivalent capacitance between A and B in the given figure (all are in farad)



a) $\frac{13}{18} F$
b) $\frac{48}{13} F$
c) $\frac{1}{31} F$
d) $\frac{240}{71} F$

590. A parallel plate capacitor having a plate separation of 2 mm is charged by connecting it to a 300 V supply. The energy density is
a) 0.01 J/m^3
b) 0.1 J/m^3
c) 1.0 J/m^3
d) 10 J/m^3

591. In the following figure two parallel metallic plates are maintained at different potential. If an electron is released midway between the plates, it will move



a) Right ward at constant speed
b) Left ward at constant speed
c) Accelerated right ward
d) Accelerated left ward

592. Two point charges exert on each other a force $F$when they are placed $r$distance apart in air. When they are placed R distance apart in a medium of dielectric constant K, they exert the same force. The distance R equals
a) $\frac{r}{k}$
b) rK
c) $r\sqrt{K}$
d) $\frac{r}{\sqrt{K}}$

593. A point charge +q is placed at the midpoint of a cube of side$a$. The electric flux emerging from the cube is
a) Zero
b) $\frac{3qa^2}{\varepsilon_0}$
c) $\frac{q}{\varepsilon_0}$
d) $\frac{\varepsilon_0}{4qa^2}$

594. The ratio of electric field and potential (E/V) at midpoint of electric dipole, for which separation is l
a) $\frac{1}{l}$
b) l
c) $\frac{2}{l}$
d) None of these

595. What happens when some charge is placed on a soap bubble?
a) Its radius decreases
b) Its radius increases
c) The bubble collapses
d) None of these

596. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and work done by the battery will be
a) 1
b) 2
c) 1/4
d) 1/2

597. The charge q is projected into a uniform electric field E, work done when it moves a distance Y is

a) qEY b) $\frac{qY}{E}$ c) $\frac{qE}{Y}$ d) $\frac{Y}{qE}$

598. Three capacitors of capacity C_1, C_2, C_3 are connected in series. Their total capacity will be
a) $C_1 + C_2 + C_3$ b) $1/(C_1 + C_2 + C_3)$ c) $(C_1^{-1} + C_2^{-1} + C_3^{-1})^{-1}$ d) None of these

599. Force of attraction between two point charges Q and $-Q$ separated by d $meter$ is F_e. When these charges are placed on two identical spheres of radius $R = 0.3d$ whose centres and d $meter$ apart, the force of attraction between them is
a) Greater than F_e b) Equal to F_e c) Less then F_e d) None of these

600. A positively charged particle moving along x −axis with a certain velocity enters a uniform electric field directed along positive y −axis. Its
a) Vertical velocity changes but horizontal velocity remains constant
b) Horizontal velocity changes but vertical velocity remains constant
c) Both vertical and horizontal velocities change
d) Neither vertical nor horizontal velocity changes

601. Charge q_2 of mass m revolves around a stationary charge q_1 in a circular orbit of radius r. The orbital periodic time of q_2 would be
a) $\left[\frac{4\pi^3 mr^2}{kq_1q_2}\right]^{1/2}$ b) $\left[\frac{kq_1q_2}{4\pi^2 mr^2}\right]^{1/2}$ c) $\left[\frac{4\pi^2 mr^4}{kq_1q_2}\right]^{1/2}$ d) $\left[\frac{4\pi^2 mr^2}{kq_1q_2}\right]^{1/2}$

602. The mean electric energy density between the plates of a charged capacitor is (here q = charge on the capacitor and A = area of the capacitor plate)
a) $\frac{q^2}{2\varepsilon_0 A^2}$ b) $\frac{q}{2\varepsilon_0 A^2}$ c) $\frac{q^2}{2\varepsilon_0 A}$ d) None of the above

603. A $6\mu F$ capacitor is charged from 10 $volts$ to 20 $volts$. Increase in energy will be
a) $18 \times 10^{-4}\,J$ b) $9 \times 10^{-4}\,J$ c) $4.5 \times 10^{-4}\,J$ d) $9 \times 10^{-6}\,J$

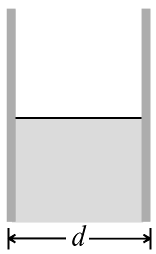
604. The unit of intensity of electric field is
a) $Newton/Coulomb$ b) $Joule/Coulomb$ c) $Volt - metre$ d) $Newton/metre$

605. Three capacitors of capacitance $3\mu F$, $10\mu F$ and $15\mu F$ are connected in series to a voltage source of $100V$. The charge on $15\mu F$ is
a) 50 μC b) 100 μC c) 200 μC d) 280 μC

606. Two copper balls, each weighting 10g are kept in air 10 cm apart. If one electron from every 10^6 atoms is transferred from one ball to the other, the coulomb force between them is (atomic weight of copper is 63.5)
a) $2.0 \times 10^{10} N$ b) $2.0 \times 10^4 N$ c) $2.0 \times 10^8 N$ d) $2.0 \times 10^6 N$

607. An α −particle of mass $6.4 \times 10^{-27} kg$ and charge $3.2 \times 10^{-19} C$ is situated in a uniform electric field of $1.6 \times 10^5 Vm^{-1}$. The velocity of the particle at the end of $2 \times 10^{-2} m$ path when it starts from rest is
a) $2\sqrt{3} \times 10^5 ms^{-1}$ b) $8 \times 10^5 ms^{-1}$ c) $16 \times 10^5 ms^{-1}$ d) $4\sqrt{2} \times 10^5 ms^{-1}$

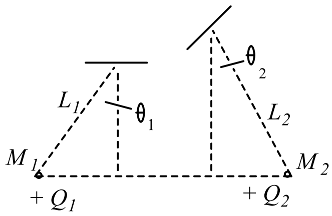
608. A parallel plate air capacitor has capacitance C. When it is half filled with a dielectric of dielectric constant 5, the percentage increase in the capacitance will be



a) 400% b) 66.6% c) 33.3% d) 200%

609. Two small spheres of masses M_1 and M_2 are suspended by weightless insulating threads of lengths L_1 and L_2. The spheres carry charges Q_1 and Q_2 respectively. The spheres are suspended such that they are in

level with one another and the threads are inclined to the vertical at angles of θ_1 and $\theta_2$as shown. Which one of the following conditions is essential, if $\theta_1 = \theta_2$?



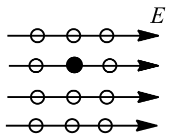
a) $M_1 \neq M_2$, but $Q_1 = Q_2$
b) $M_1 = M_2$
c) $Q_1 = Q_2$
d) $L_1 = L_1$

610. The charge on two identical metallic balls are $+40\mu$ and -10μC respectively and they are separated at 2.0 m. How much and nature of force will act between them?
a) 2.9 N, repulsive
b) 1.9 N, attractive
c) 1.2 N, repulsive
d) 0.9 N, attractive

611. If identical charges $(-q)$ are placed at each corner of a cube of side b, then electric potential energy of charge $(+q)$ which is placed at centre of the cub will be
a) $\frac{8\sqrt{2}q^2}{4\pi\varepsilon_0 b}$
b) $\frac{-8\sqrt{2}q^2}{\pi\varepsilon_0 b}$
c) $\frac{-4\sqrt{2}q^2}{\pi\varepsilon_0 b}$
d) $\frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 b}$

612. Three concentric metallic spherical shells of radii $R, 2R, 3R$, are given charges Q_1, Q_2, Q_3, respectively. It is found that the surface charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells, $Q_1: Q_2: Q_3$, is
a) 1:2:3
b) 1:3:5
c) 1:4:9
d) 1:8:18

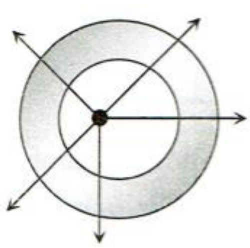
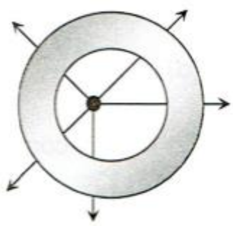
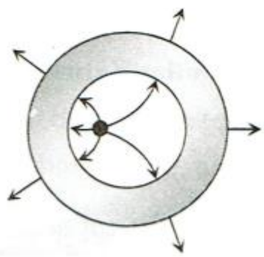
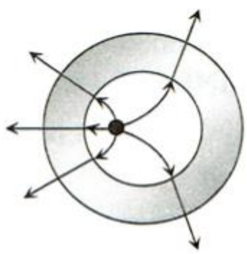
613. There is a uniform electric field of intensity E which is as shown. How many labeled points have the same electric potential as the fully shaded point?



a) 2
b) 3
c) 8
d) 11

614. Electric potential of earth is taken to be zero because earth is a good
a) Insulator
b) Conductor
c) Semiconductor
d) Dielectric

615. A metallic shell has a point charge $'q'$ kept inside its cavity. Which one of the following diagrams correctly represents the electric lines of forces

a) 
b) 
c) 
d) 

616. A simple pendulum has a length l and the mass of the bob is m. The bob is given a charge q coulomb. The pendulum is suspended between the vertical plates of a charged parallel plate capacitor. If E is the electric field strength between the plates, the time period of the pendulum is given by
a) $2\pi\sqrt{\frac{1}{g}}$
b) $2\pi\sqrt{\frac{l}{\sqrt{g+\frac{qE}{m}}}}$

c) $2\pi\sqrt{\frac{l}{\sqrt{g-\frac{qE}{m}}}}$

d) $2\pi\sqrt{\frac{l}{\sqrt{g^2+\left(\frac{qE}{m}\right)^2}}}$

617. ABC is a right angled triangle in which $AB = 3cm$ and $BC = 4cm$. And $\angle ABC = \pi/2$. The three charges $+15, +12$ and -20 $e.s.u$ are placed respectively on A, B and C. The force acing on B is

a) 125 $dynes$ b) 35 $dynes$ c) 25 $dynes$ d) Zero

618. An electric line of force in the xy plane is given by equaton $x^2 + y^2 = 1$. A particle with unit positive charge, initially at rest at the point $x = 1, y = 0$ in the xy plane

a) Not move at all
b) Will move along straight line
c) Will move along the circular line of force
d) Information is insufficient to draw any conclusion

619. The insulation property of air breaks down at $E = 3 \times 10^6$ $volt/metre$. The maximum charge that can be given to a square of diameter $5m$ is approximately
(in coulombs)

a) 2×10^{-2} b) 2×10^{-3} c) 2×10^{-4} d) 2×10^{-5}

620. A parallel plate capacitor of capacitance C is connected to a battery and is charged to a potential difference V. Another capacitor of capacitance $2C$ is connected to another battery and is charged to potential difference $2V$. The charging batteries are now disconnected and the capacitors are connected in parallel to each other in such a way that the positive terminal of one is connected to the negative terminal of the other. The final energy of the configuration is

a) Zero b) $\frac{25CV^2}{6}$ c) $\frac{3CV^2}{2}$ d) $\frac{9CV^2}{2}$

621. An elementary particle of mass m and charge $+e$ is projected with velocity v at a much more massive particle of charge Ze, where $Z > 0$. What is the closest possible approach of the incident particle

a) $\frac{Ze^2}{2\pi\varepsilon_0 mv^2}$ b) $\frac{Ze}{4\pi\varepsilon_0 mv^2}$ c) $\frac{Ze^2}{8\pi\varepsilon_0 mv^2}$ d) $\frac{Ze}{8\pi\varepsilon_0 mv^2}$

622. The radius of a metallic sphere if its capacitance is $1/9F$, is

a) 10^6 m b) 10^7 m c) 10^9 m d) 10^8 m

623. If the charge on a capacitor is doubled, the value of its capacitance C will be

a) Doubled b) Halved c) Remain the same d) None of these

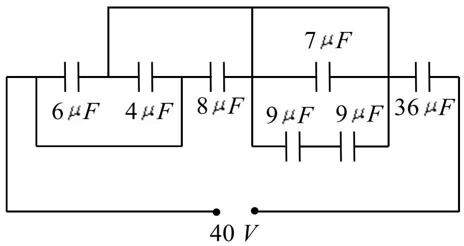
624. To obtain $3\mu F$ capacity from three capacitors of $2\mu F$ each, they will be arranged

a) All the three in series
b) All the three in parallel
c) Two capacitors in series and the third in parallel with the combination of first two
d) Two capacitors in parallel and the third in series with the combination of first two

625. An electric dipole consisting of two opposite charges of $2 \times 10^{-6}C$ each separated by a distance of 3 cm is placed in an electric field of 2×10^5 N/C. The maximum torque on the dipole will be

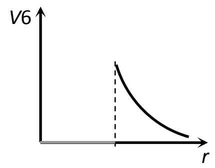
a) 12×10^{-1} Nm b) 12×10^{-3} Nm c) 24×10^{-1} Nm d) 24×10^{-3} Nm

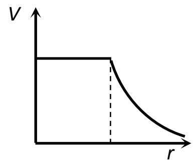
626. In the following diagram, the charge and potential difference across 8 μF capacitance will be respectively

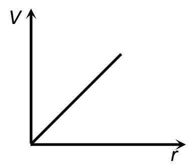


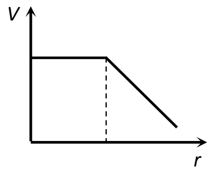
a) 320 μ C, 40 V b) 420 μ C, 50 V c) 214 μ C, 27 V d) 360 μ C, 45 V

627. In a hollow spherical shell potential (V) changes with respect to distance (r) from centre

a) 

b) 

c) 

d) 

628. The electric strength of air is 2×10^7 NC^{-1}. The maximum charge that a metallic sphere of diameter 6 mm can hold is

a) 3 nC b) 20 nC c) 1.5 nC d) 2 nC

629. If a unit positive charge is taken from one point to another over an equipotential surface, then

a) Work is done on the charge b) Work is done by the charge
c) Work done is constant d) No work is done

630. A charge of $40\mu C$ is given to a capacitor having capacitance $C = 10\mu F$. The stored energy in ergs is

a) 80×10^{-6} b) 800 c) 80 d) 8000

631. The law, governing the force between electric charges is known as

a) Ampere's law b) Ohm's law c) Faraday's law d) Coulomb's law

632. The dimensional formula of electric intensity is

a) $[MLT^{-2} A^{-1}]$ b) $[MLT^{-3} A^{-1}]$ c) $[ML^2T^{-3} A^{-1}]$ d) $[ML^2T^{-3} A^{-2}]$

633. A parallel plate capacitor is first charged and then a dielectric slab is introduced between the plates. The quantity that remains unchanged is

a) Charge Q b) Potential V c) Capacity C d) Energy U

634. An electron enters in an electric field with its velocity in the direction of the electric lines of force. Then

a) The path of the electron will be a circle b) The path of the electron will be a parabola
c) The velocity of the electron will decrease d) The velocity of the electron will increase

635. Three charges each of $+ 1\mu C$ are placed at the corners of an equilateral triangle. If the force between any two charges be F, then the net force on either charge will be

a) $\sqrt{2}\, F$ b) $F\sqrt{3}$ c) 2F d) 3F

636. Angle between equipotential surface and lines of force is

a) Zero b) 180° c) 90° d) 45°

637. If a conducting medium is placed between two charges, then the electric force between them will become.

a) Zero b) Infinity c) 1 N d) 1 dyne

638. A solid metallic sphere has a charge $+3Q$. Concentric with this sphere is a conducting spherical shell having charge-Q. The radius of the sphere is a and that of the spherical shell is b $(b > a)$. What is the electric field at a distance $R(a < R < b)$ from the centre?

a) $\dfrac{4Q}{2\pi\varepsilon_0 R^2}$ b) $\dfrac{3Q}{4\pi\varepsilon_0 R^2}$ c) $\dfrac{3Q}{2\pi\varepsilon_0 R^2}$ d) $\dfrac{Q}{2\pi\varepsilon_0 R}$

639. According to Gauss' Theorem, electric field of an infinitely long straight wire is proportional to

a) r b) $1/r^2$ c) $1/r^3$ d) $1/r$

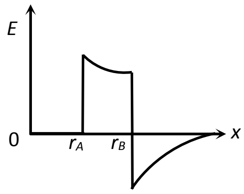
640. Two identical thin rings each of radius R meters are coaxially placed at a diatance R meters apart. If Q_1 coulomb and Q_2 coulomb are respectively the charges uniformly spread on the two rings, the work done in moving a charge q from the centre of one ring to that of other is

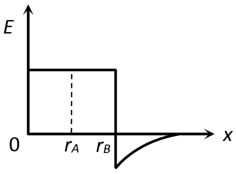
a) Zero b) $\dfrac{q(Q_1 - Q_2)(\sqrt{2} - 1)}{\sqrt{2}.4\pi\varepsilon_0 R}$ c) $\dfrac{q\sqrt{2}(Q_1 + Q_2)}{4\pi\varepsilon_0 R}$ d) $\dfrac{q(Q_1 + Q_2)(\sqrt{2} + 1)}{\sqrt{2}.4\pi\varepsilon_0 R}$

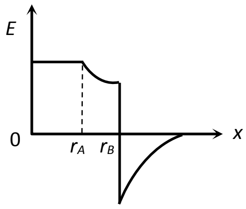
641. Three capacitors of capacitance $3\,\mu F$ are connected in a circuit. Then their maximum and minimum capacitance will be

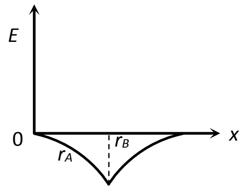
a) $9\,\mu F, 1\,\mu F$ b) $8\,\mu F, 2\,\mu F$ c) $9\,\mu F, 0\,\mu F$ d) $3\,\mu F, 2\,\mu F$

642. Two concentric conducting thin spherical shells A, and B having radii r_A and $r_B (r_B > r_A)$ are charged to Q_A and $-Q_B(|Q_B| > |Q_A|)$. The electrical field along a line, (passing through the centre) is

a) 

b) 

c) 

d) 

643. Two equal negative charge $-q$ are fixed at the fixed points $(0, a)$ and $(0, -a)$ on the Y-axis. A positive charge Q is released from rest at the point $(2a, 0)$ on the X-axis. The charge Q will

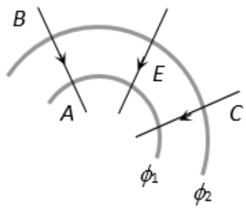
a) Execute simple harmonic motion about the origin

b) Move to the origin and remain at rest

c) Move to infinity

d) Execute oscillatory but not simple harmonic motion

644. In moving from A to B along an electric field line, the electric field does $6.4 \times 10^{-19} J$ of work on an electron. If ϕ_1, ϕ_2 are equipotential surfaces, then the potential difference $(V_C - V_A)$ is

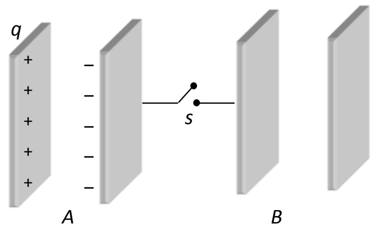


a) $-4\ V$ b) $4\ V$ c) Zero d) $64\ V$

645. Gauss's law is true only if force due to a charge varies as

a) r^{-1} b) r^{-2} c) r^{-3} d) r^{-4}

646. Consider the situation shown in the figure. The capacitor A has a charge q on it whereas B is uncharged. The charge appearing on the capacitor B a long time after the switch is closed is



a) Zero b) $q/2$ c) q d) $2q$

647. Two spherical conductors each of capacity C are charged to potentials V and $-V$. These are then connected by means of a fine wire. The loss of energy will be

a) Zero b) $\frac{1}{2}CV^2$ c) CV^2 d) $2CV^2$

648. Two points P and Q are maintained at the potential of $10\ V$ and $-4V$, respectively. The work done in moving 100 electrons from P to Q is

a) $-9.60 \times 10^{-17}\ J$ b) $9.60 \times 10^{-17}\ J$ c) $-2.24 \times 10^{-16}\ J$ d) $2.24 \times 10^{-16}\ J$

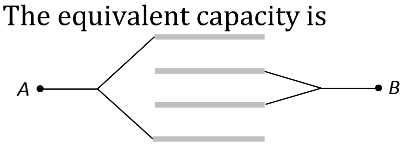
649. Two capacitors connected in parallel having the capacities C_1 and C_2 are given $'q'$ charge, which is distributed among them. The ratio of the charge on C_1 and C_2 will be

a) $\frac{C_1}{C_2}$ b) $\frac{C_2}{C_1}$ c) C_1C_2 d) $\frac{1}{C_1C_2}$

650. Which of the following is deflected by electric field

a) X-rays b) γ –rays c) Neutrons d) α-particles

651. Four plates of equal area A are separated by equal distances d and are arranged as shown in the figure. The equivalent capacity is



a) $\frac{2\varepsilon_0 A}{d}$ b) $\frac{3\varepsilon_0 A}{d}$ c) $\frac{4\varepsilon_0 A}{d}$ d) $\frac{\varepsilon_0 A}{d}$

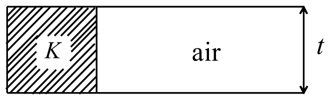
652. The charges on two spheres are $+7\mu C$ and $-5\mu C$ respectively. They experience a force F. If each of them is given and additional charge of $-2\mu C$, the new force of attraction will be

a) F b) $F/2$ c) $F/\sqrt{3}$ d) $2F$

653. The net charge on capacitor is

a) $2q$ b) $q/2$ c) 0 d) ∞

654. A parallel plate capacitor with air as the dielectric has a capacitance C. A slab of dielectric constant K and having the same thickness as the separation between the plates is introduced so as to fill one-fourth of the capacitor as shown in the figure The new capacitance will be



a) $(K+3)\frac{C}{4}$ b) $(K+2)\frac{C}{4}$ c) $(K+1)\frac{C}{4}$ d) $\frac{KC}{4}$

655. Under the influence of the coulomb field of charge$+Q$, a charge $-q$ is moving around it in an elliptical orbit .Find out the correct statements(s).

a) The angular momentum of the charge $-q$ is constant

b) The linear momentum of the charge$-q$ is constant

c) The angular velocity of the charge$-q$ is constant

d) The linear speed of the charge$-q$ is constant

656. Electric lines of force about negative point charge are

a) Circular, anticlockwise

b) Circular, clockwise

c) Radial, inward

d) Radial, outward

657. Two identical charged spheres suspended from a common point by two massless stings of length l are initially a distance $d(d << l)$ apart because of their mutual repulsion. The charge begins to leak from both the spheres at a constant rate. As a result the charges approach each other with a velocity v. Then as a function of distance x between them

a) $v \propto x^{-1/2}$ b) $v \propto x^{-1}$ c) $v \propto x^{1/2}$ d) $v \propto x$

658. If a slab of insulating material $4 \times 10^{-3} m$ thick is introduced between the plates of a parallel plate capacitor, the separation between plates has to be increased by $3.5 \times 10^{-3} m$ to restore the capacity to original value. The dielectric constant of the material will be

a) 6 b) 8 c) 10 d) 12

659. A point charge of 40 stat coulomb is placed 2 cm in front of an earthed metallic plane plate of large size. Then the force of attraction on the point charge is

a) 100 $dynes$ b) 160 $dynes$ c) 1600 $dynes$ d) 400 $dynes$

660. A charge of 5 C experiences a force of 5000 N when it is kept in a uniform electric field. What is the potential difference between two points separated by a distance of 1cm

a) 10 V b) 250 V c) 1000 V d) 2500 V

661. The potential at a point due to an electric dipole will be maximum and minimum when the angles between the axis of the dipole and the line joining the point to the dipole are respectively

a) 90^o and 180^o b) 0^o and 90^o c) 90^o and 0^o d) 0^o and 180^o

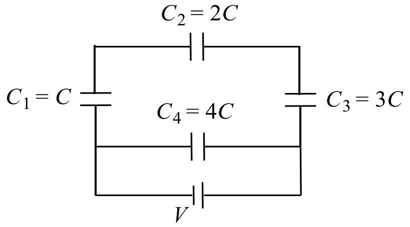
662. The ratio of charge to potential of a body is known as

a) Capacitance b) Conductance c) Inductance d) Resistance

663. An electron initially at rest falls a distance of 1.5cm in a uniform electric field of magnitude $2 \times 10^4 N/C$. The time taken by the electron to fall this distance is

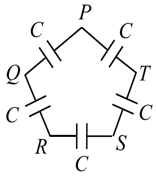
a) $1.3 \times 10^2 s$ b) $2.1 \times 10^{-12} s$ c) $1.6 \times 10^{-10} s$ d) $2.9 \times 10^{-9} s$

664. A network of four capacitors of capacity equal to $C_1 = C, C_2 = 2C, C_3 = 3C$ and $C_4 = 4C$ are conducted in a battery as shown in the figure. The ratio of the charges on C_2 and C_4 is



a) $\frac{22}{3}$ b) $\frac{3}{22}$ c) $\frac{7}{4}$ d) $\frac{4}{7}$

665. Five capacitors, each of capacitance value C are connected as shown in the figure. The ratio of capacitance between P and R, and the capacitance between P and Q, is



a) 3 : 1 b) 5 : 2 c) 2 : 3 d) 1 : 1

666. A charged particle of mass $5 \times 10^{-5} kg$ is held stationary in space by placing it in an electric field of strength $10^7 NC^{-1}$ directed vertically downwards. The charge on the particle is

a) $-20 \times 10^{-5} \mu C$ b) $-5 \times 10^{-5} \mu C$ c) $5 \times 10^{-5} \mu C$ d) $20 \times 10^{-5} \mu C$

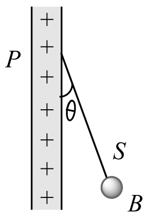
667. An electric dipole of length 1 cm is placed with the axis making an angle of 30° to an electric field of strength$10^4 \mathrm{NC}^{-1}$. If it experiences a torque of $10\sqrt{2}$Nm, the potential energy of the dipole is

a) 0.245J b) 2.45×10^{-4}J c) 0.0245 J d) 24.5×10^{-4}J

668. A spherical drop of capacitance 1 μF is broken into eight drops of equal radius. Then, the capacitance of each small drop is ……

a) $\frac{1}{8} \mu F$ b) $8 \mu F$ c) $\frac{1}{2} \mu F$ d) $\frac{1}{4} \mu F$

669. A charged ball B hangs from a silk thread S, which makes an angle θ with a large charged conducting sheet P, as shown in the figure. The surface charge density σ of the sheet is proportional to

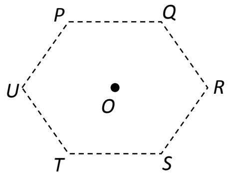


a) $\sin \theta$
b) $\tan \theta$
c) $\cos \theta$
d) $\cot \theta$

670. A hollow conducting spherical shell of radius R is charged with Q coulomb. The amount of work done for moving any charge q from the centre to the surface of the shell will be

a) $\frac{qQ}{4\pi\varepsilon_0 R}$ b) Zero c) $\frac{Qq}{\pi\varepsilon_0 R}$ d) $\frac{Qq}{2\pi\varepsilon_0 R}$

671. Six charges, three positive and three negative of equal magnitude are to be placed at the vertices of a regular hexagon such that the electric field at O is double the electric field when only one positive charge of same magnitude is placed at R. Which of the following arrangements of charges is possible for P, Q, R, S, T and U respectively

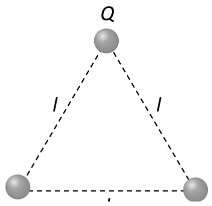


a) $+, -, +, -, -, +$
b) $+, -, +, -, +, -$
c) $+, +, -, +, -, -$
d) $-, +, +, -, +, -$

672. A charge of $5C$ is given a displacement of $0.5m$. The work done in the process is $10J$. The potential difference between the two points will be
a) $2V$
b) $0.25V$
c) $1V$
d) $25V$

673. Equal charges are given to two spheres of different radii. The potential will
a) Be more on the smaller sphere
b) Be more on the bigger sphere
c) Be equal on both the spheres
d) Depend on the nature of the materials of the spheres

674. Three charges $Q, +q$ and $+q$ are placed at the vertices of an equilateral triangle of side l as shown in the figure. If the net electrostatic energy of the system is zero, then Q is equal to



a) $\left(-\frac{q}{2}\right)$
b) $(-q)$
c) $(+q)$
d) Zero

675. What about Gauss theorem is not incorrect
a) It can be derived by using Coulomb's Law
b) It is valid for conservative field obeys inverse square root law
c) Gauss theorem is not applicable in gravitation
d) (A) & (B) both

676. The ratio of momenta of an electron and an α −particle which are accelerated from rest by a potential difference of 100 $volt$ is
a) 1
b) $\sqrt{\frac{2m_e}{m_\alpha}}$
c) $\sqrt{\frac{m_e}{m_\alpha}}$
d) $\sqrt{\frac{m_e}{2m_\alpha}}$

677. Two identical spheres carrying charges $-9\mu C$ and $5\mu C$ respectively are kept in contact and then separated from each other. Point out true statement from the following. In each sphere
a) 1.25×10^{13} electrons are in deficit
b) 1.25×10^{13} electrons are in excess
c) 2.15×10^{13} electrons are in excesss
d) 2.15×10^{13} electrons are in deficit

678. A charge Q.is divided in two parts $Q - q$.What is value of q for maximum force between them?
a) $\frac{3Q}{4}$
b) $\frac{Q}{3}$
c) Q
d) $\frac{Q}{2}$

679. The capacitance of an air capacitor is $15\mu F$ the separation between the parallel plates is $6mm$. A copper plate of $3mm$ thickness is introduced symmetrically between the plates. The capacitance now becomes
a) $5\mu F$
b) $7.5\mu F$
c) $22.5\mu F$
d) $30\mu F$

680. Between the plates of a parallel plate condenser, a plate of thickness t_1 and dielectric constant k_1 is placed. In the rest of the space, there is another plate of thickness t_2 and dielectric constant k_2. The potential difference across the condenser will be
a) $\frac{Q}{A\varepsilon_0}\left(\frac{t_1}{k_1} + \frac{t_2}{k_2}\right)$
b) $\frac{\varepsilon_0 Q}{A}\left(\frac{t_1}{k_1} + \frac{t_2}{k_2}\right)$
c) $\frac{Q}{A\varepsilon_0}\left(\frac{k_1}{t_1} + \frac{k_2}{t_2}\right)$
d) $\frac{\varepsilon_0 Q}{A}(k_1 t_1 + k_2 t_2)$

681. The plates of parallel plate capacitor are charged upto 100 V. A $2mm$ thick plate is inserted between the plates. Then to maintain the same potential difference, the distance between the plates is increased by 1.6 mm. The dielectric constant of the plate is

a) 5 b) 1.25 c) 4 d) 2.5

682. A parallel plate condenser has a uniform electric field $E(V/m)$ in the space between the plates. If the distance between the plates is $d(m)$ and area of each plate is $A(m^2)$ the energy (joules) stored in the condenser is

a) $\frac{1}{2}\varepsilon_0 E^2 Ad$ b) $E^2 Ad/\varepsilon_0$ c) $\frac{1}{2}\varepsilon_0 E^2$ d) $\varepsilon_0 EAd$

683. Identify the WRONG statement

a) The electrical potential energy of a system of two protons shall increase if the separation between the two is decreased
b) The electrical potential energy of a proton electron system will increase if the separation between the two is decreased
c) The electrical potential energy of a proton electron system will increase if the separation between the two is increased
d) The electrical potential energy of a system of two electrons shall increase if the separation between the two is decreased

684. Ten capacitor are joined in parallel and charged with a battery up to a potential V. They are then disconnected from battery and joined again in series then the potential of this combination will be

a) V b) $10V$ c) $5V$ d) $2V$

685. If the force exerted by an electric dipole on a charge q at a distance of 1 m is F, the force at a point 2 m away in the same direction will be

a) $\frac{F}{2}$ b) $\frac{F}{4}$ c) $\frac{F}{6}$ d) $\frac{F}{8}$

686. An electron and a proton are in a uniform electric field, the ratio of their accelerations will be

a) Zero b) Unity
c) The ratio of the masses of proton and electron d) The ratio of the masses of electron and proton

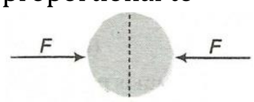
687. If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2 the electric charge inside the surface will be

a) $(\phi_1 + \phi_2)\varepsilon_0$ b) $(\phi_2 - \phi_1)\varepsilon_0$ c) $(\phi_1 + \phi_2)/\varepsilon_0$ d) $(\phi_2 - \phi_1)/\varepsilon_0$

688. An electric dipole is kept in non-uniform electric field. It experiences

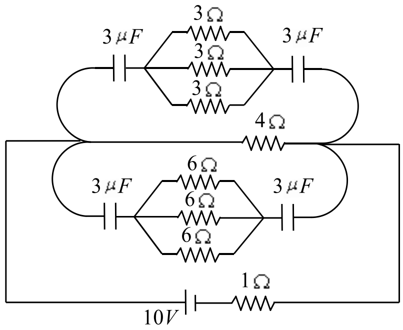
a) A force and a torque b) A force but not a torque
c) A torque but not a torque d) Neither a force nor a torque

689. A uniformly charged thin spherical shell of radius R carries uniform surface charge density of σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F (see figure). F is proportional to



a) $\frac{1}{\varepsilon_0}\sigma^2 R^2$ b) $\frac{1}{\varepsilon_0}\sigma^2 R$ c) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R}$ d) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R^2}$

690. In the following figure, the charge on each condenser in the steady state will be



a) 3 μC b) 6 μC c) 9 μC d) 12 μC

691. A parallel plate capacitor of plate area A and plate separation d is charged to potential V and then the battery is disconnected. A slab of dielectric constant k is then inserted between the plates of the capacitors so as to fill the space between the plates. If Q, E and W denote respectively, the magnitude of charge on each plate, the electric field between the plates (after the slab is inserted) and work done on the system in question in the process of inserting the slab, then state incorrect relation from the following

a) $Q = \frac{\varepsilon_0 AV}{d}$ b) $W = \frac{\varepsilon_0 AV^2}{2kd}$ c) $E = \frac{V}{kd}$ d) $W = \frac{\varepsilon_0 AV^2}{2d}\left(1 - \frac{1}{k}\right)$

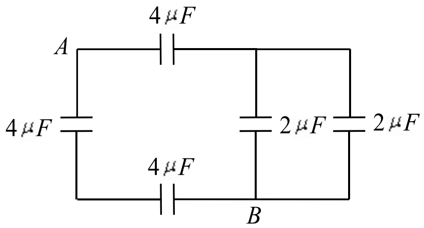
692. What is the total charge in coulomb of 75.0 kg of electrons?

a) 0.32×10^{13}C b) 3.2×10^{16}C c) -1.32×10^{13}C d) $+1.32 \times 10^{-13}$C

693. Two small conducting sphere of equal radius have charges $+10\ \mu$C and -20μC respectively and placed at a distance R from each other experience force F_1. If they are brought in contact and separated to the same distance, they experience force F_2. the ratio of F_1 to F_2 is

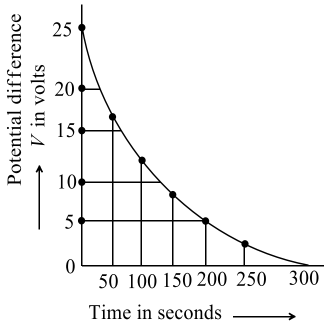
a) 1 : 2 b) -8 : 1 c) 1 : 8 d) -2 : 1

694. In the circuit as shown in the figure the effective capacitance between A and B is



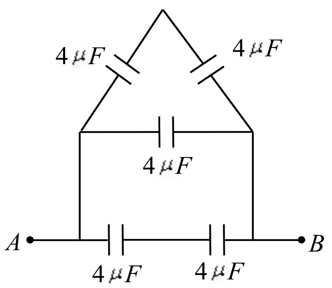
a) 3 μ F
b) 2 μ F
c) 4 μ F
d) 8 μ F

695. The figure shows an experimental plot discharging of a capacitor in an RC circuit. The time constant τ of this circuit lies between



a) 150 sec and 200 sec b) 0 and 50 sec c) 50 sec and 100 sec d) 100 sec and 150 sec

696. Equivalent capacitance between A and B is



a) 8 μ F b) 6 μ F c) 26 μ F d) 10/3 μ F

697. The S.I. unit of electric flux is

a) *Weber* b) *Newton per coulomb* c) *Volt* × *metre* d) *Joule* per *coulomb*

698. Two point charges $-q$ and $+q$ are located at points $(0,0-a)$ and $(0,0a)$, respectively. The potential at a point $(0,0,z)$ where $z >$ a is

a) $\dfrac{qa}{4\pi\varepsilon_0 z^2}$ b) $\dfrac{q}{4\pi\varepsilon_0 a}$ c) $\dfrac{2qa}{4\pi\varepsilon_0(z^2-a^2)}$ d) $\dfrac{2qa}{4\pi\varepsilon_0(z^2+a^2)}$

699. The work done in bringing a 20 *coulomb* charge from point A to point B for distance $0.2m$ is $2j$. The potential difference between the two points will be (in *volt*)

a) 0.2 b) 8 c) 0.1 d) 0.4

700. A molecule with a dipole moment p is placed in an electric field of strength E. Initially the dipole is aligned parallel to the field. If the dipole is to be related to be anti-parallel to the field the work required to be done by an external agency is

a) $-2pE$ b) $-pE$ c) pE d) $2pE$

701. There exists an electric field of 1N/C along y-direction. The flux passing through the square of 1m placed in xy plane inside the electric field is

a) 1.0 N/m^2 b) 10.0Nm^2/C c) 2.0Nm^2/C d) Zero

702. The electric field that can balance a deuteron of mass 3.2×10^{-27} kg is

a) 19.6×10^{-10} NC^{-1} b) 19.6×10^{-8} NC^{-1} c) 19.6×10^{10} NC^{-1} d) 19.6×10^{8} NC^{-1}

703. The electric intensity due to a dipole of length 10 *cm* and having a charge of $500\mu C$, at a point on the axis at a distance 20 *cm* from one of the charges in air, is

a) 6.25×10^7 N/C b) 9.28×10^7 N/C c) 13.1×11^{11} N/C d) 20.5×10^7 N/C

704. A body of capacity 4 μ F is charged to 80 V and another body of capacity 6μ F is charged to 30V. When they are connected the energy lost by 4μ F capacitor is

a) 7.8 *mJ* b) 4.6 *mJ* c) 3.2 *mJ* d) 2.5 *mJ*

705. The electric field created by a point charge falls with distance r from the point charge as

a) $\dfrac{1}{r}$ b) $\dfrac{1}{r^2}$ c) $\dfrac{1}{r^3}$ d) $\dfrac{1}{r^4}$

706. The potential at a point x (measured in μm) due to some charges situated on the x-axis is given by $V(x) = 20/(x^2-4)$ *Volts*. The electric field E at $x = 4\mu m$ is given by

a) 5/3 $Volt/\mu m$ and in the $-ve$ x direction b) 5/3 $Volt/\mu m$ and in the $+ve$ x direction

c) 10/9 $Volt/\mu m$ and in the $-ve$ x direction d) 10/9 $Volt/\mu m$ and in the $+ve$ x direction

707. Force of attraction between the plates of a parallel plate capacitor is

a) $\dfrac{q^2}{2\varepsilon_0 AK}$ b) $\dfrac{q^2}{\varepsilon_0 AK}$ c) $\dfrac{q}{2\varepsilon_0 A}$ d) $\dfrac{q^2}{2\varepsilon_0 A^2 K}$

708. Let $p(r) = \frac{Qr}{\pi R^4}$ be the charge density distribution for a solid sphere of radius R and total charge Q. For a point P inside the sphere at distance r_1 from the centre of the sphere, the magnitude of electric field is

a) Zero b) $\dfrac{Q}{4\pi\varepsilon_0 r_1^2}$ c) $\dfrac{Qr_1^2}{4\pi\varepsilon_0 R^4}$ d) $\dfrac{Qr_1^2}{3\pi\varepsilon_0 R^4}$

709. There is a solid sphere of radius $'R'$ having uniformly distributed charge. What is the relation between electric field $'E'$ (inside the sphere) and radius of sphere $'R'$ is

a) $E \propto R^{-2}$ b) $E \propto R^{-1}$ c) $E \propto \frac{1}{R^3}$ d) $E \propto R^2$

710. Three capacitors each of capacity $4\mu\ F$ are to be connected in such a way that the effective capacitance is $6\mu\ F$. This can be done by
a) Connecting them in parallel
b) Connecting two in series and one in parallel
c) Connecting two in parallel and one in series
d) Connecting all of them in series

711. A parallel plate air capacitor is charged to a potential difference of V. After disconnecting the battery, distance between the plates of the capacitor is increased using an insulating handle. As a result, the potential difference between the plates
a) Decreases b) Increases c) Becomes zero d) Does not change

712. At a point 20 cm from the centre of a uniformly charged dielectric sphere of radius 10 cm, the electric field is 100 V/m. The electric field at 3 cm from the centre of the sphere will be
a) 150 V/m b) 125 V/m c) 120 V/m d) Zero

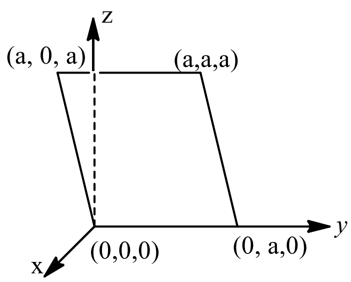
713. Two identical capacitors each of capacitance 5 μF are charged to potential 2 kV and 1 kV respectively. The −ve ends are connected together. When the +ve ends are also connected together, the loss of energy of the system is
a) 160 J b) 0 J c) 5 J d) 1.25 J

714. Charges $4Q, q$ and Q and placed along x −axis at positions $x = 0, x = l/2$ and $x = l$, reapectively. Find the value of q so that force on charge Q is zero
a) Q b) $Q/2$ c) $-Q/2$ d) $-Q$

715. Two electric dipoles of moment P and 64 P are placed in opposite direction on a line at a distance of 25 cm. The electric field will be zero at point between the dipoles whose distance from the dipole of moment P is
a) 5 cm
b) $\frac{25}{9}$ cm
c) 10 cm
d) $\frac{4}{13}$ cm

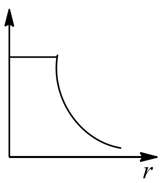
716. Gauss's law should be invalid if
a) There were magnetic monopoles
b) The inverse square law were not exactly true
c) The velocity of light were not a universal constant
d) None of these

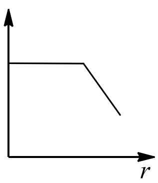
717. Consider an electric field $\mathbf{E}=E_0\hat{\mathbf{x}}$, where E_0 is a constant. The flux through the shaded area(as shown in the figure) due to this field is

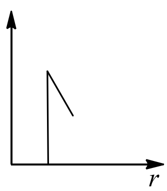


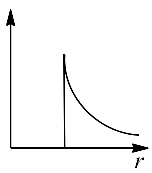
a) $2E_0a^2$ b) $\sqrt{2}E_0a^2$ c) E_0a^2 d) $\frac{E_0a^2}{\sqrt{2}}$

718. Which one of the following graphs, shows the variation of electric field strength E with distance d from the centre of the hollow conducting sphere?

a) 

b) 

c) 

d) 

719. An air capacitor of capacity $C = 10\mu F$ is connected to a constant voltage battery of 12 V. Now the space between the plates is filled with a liquid of dielectric constant 5. The charge that flows now from battery to the capacitor is

a) $120\mu C$ b) $699\mu C$ c) $480\mu C$ d) $24\mu C$

720. When a body is earth connected, electrons from the earth flow into the body. This means the body is

a) Unchanged b) Charged positively c) Charged negatively d) An insulator

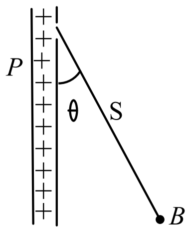
721. Putting a dielectric substance between two plates of condenser, capacity, potential and potential energy respectively

a) Increase, decrease, decrease b) Decrease, increase, increase
c) Increase, increase, increase d) Decrease, decrease, decrease

722. In nature, the electric charge of any system is always equal to

a) Half integral multiple of the least amount of charge
b) Zero
c) Square of the least amount of charge
d) Integral multiple of the least amount charge

723. A charged ball B hangs from a silk thread S, which makes an angle θ with a large charged conducting sheet P, as shown in the figure. The surface charge density σ of the sheet is proportional to



a) $\cos\theta$ b) $\cot\theta$ c) $\sin\theta$ d) $\tan\theta$

724. The electric field in a region is radially outward with magnitude $E = A\gamma_0$. The charge contained in a sphere of radius γ_0 centered at the origin is

a) $\frac{1}{4\pi\varepsilon_0}A\gamma_0^3$ b) $4\pi\varepsilon_0 A\gamma_0^3$ c) $\frac{4\pi\varepsilon_0 A}{\gamma_0}$ d) $\frac{1}{4\pi\varepsilon_0}\frac{A}{\gamma_0^3}$

725. The torque acting on a dipole of a moment $\vec{P}$ in an electric field $\vec{E}$ is

a) $\vec{P}.\vec{E}$ b) $\vec{P}\times\vec{E}$ c) Zero d) $\vec{E}\times\vec{P}$

726. The area of the plates of a parallel plate condenser is A and the distance between the plates is $10mm$. There are two dielectric sheets in it, one of dielectric constant 10 and thickness $6mm$ and the other of dielectric constant 5 and thickness $4mm$. The capacity of the condenser is

a) $\frac{12}{35}\varepsilon_0 A$ b) $\frac{2}{3}\varepsilon_0 A$ c) $\frac{5000}{7}\varepsilon_0 A$ d) $1500\ \varepsilon_0 A$

727. The earth has Volume $'V'$ and surface area $'A'$ then capacitance would be

a) $4\pi\ \epsilon_0\frac{A}{V}$ b) $4\pi\ \epsilon_0\frac{V}{A}$ c) $12\pi\ \epsilon_0\frac{V}{A}$ d) $12\pi\ \epsilon_0\frac{A}{V}$

728. A charge q is placed at the centre of the open end of cylindrical vessel. The flux of the electric field through the surface of the vessel is

a) Zero b) $\frac{q}{\varepsilon_0}$ c) $\frac{q}{2\varepsilon_0}$ d) $\frac{2q}{\varepsilon_0}$

729. Equal charges q are placed at the four corners A, B, C, D of a square of length a. The magnitude of the force on the charge at B will be

a) $\frac{3q^2}{4\pi\varepsilon_0 a^2}$ b) $\frac{4q^2}{4\pi\varepsilon_0 a^2}$ c) $\left(\frac{1+2\sqrt{2}}{2}\right)\frac{q^2}{4\pi\varepsilon_0 a^2}$ d) $\left(2+\frac{1}{\sqrt{2}}\right)\frac{q^2}{4\pi\varepsilon_0 a^2}$

730. 64 drops each having the capacity C and potential V are combined to form a big drop. If the charge on the small drop is q, then the charge on the big drop will be

a) $2q$ b) $4q$ c) $16q$ d) $64q$

731. Two identical parallel plate capacitors are connected in series to a battery of 100 V. A dielectric slab of dielectric constant 4.0 is inserted between the plates of second capacitor. The potential difference across the capacitors will now be respectively

a) $50\ V, 50\ V$ b) $80\ V, 20\ V$ c) $20\ V, 80\ V$ d) $75\ V, 25\ V$

732. Two equal charges as separated by distance d. A third charge placed on a perpendicular bisector at x distance from centre will experience maximum coulomb force, when

a) $x = d/\sqrt{2}$ b) $x = d/2$ c) $x = d/2\sqrt{2}$ d) $x = d/2\sqrt{3}$

733. Work done by an external agent in separating the parallel plate capacitor is

a) CV b) $\frac{1}{2}C^2V$ c) $\frac{1}{2}CV^2$ d) None of these

734. A parallel plate capacitor is charged. If the plates are pulled apart

a) The capacitance increases
b) The potential difference increases
c) The total charge increases
d) The charge and potential difference remain the same

735. Consider two points 1 and 2 in a region outside a charged sphere. Two points are not very far away from the sphere. If E and V represent the electric field vector and the electric potential, which of the following is not possible

a) $|\vec{E}_1| = |\vec{E}_2|, V_1 = V_2$ b) $\vec{E}_1 \neq \vec{E}_2, V_1 \neq V_2$ c) $\vec{E}_1 \neq \vec{E}_2, V_1 = V_2$ d) $|\vec{E}_1| = |\vec{E}_2|, V_1 \neq V_2$

736. A solid spherical conductor of radius R has a spherical cavity of radius $a (a < R)$ at its centre. A charge $+Q$ is kept at the centre. The charge at the inner surface, outer surface and at a position $r (a < r < R)$ are respectively

a) $+Q, -Q, 0$ b) $-Q, +Q, 0$ c) $0, -Q, 0$ d) $+Q, 0,0$

737. A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is

a) qEy^2 b) qE^2y c) qEy d) q^2Ey

738. Two charges $+3.2 \times 10^{-19} C$ and $-3.2 \times 10^{-9} C$ kept 2.4 Å apart forms a dipole. If it is kept in uniform electric field of intensity $4 \times 10^5\ volt/m$ then what will be its electrical energy in equilibrium

a) $+3 \times 10^{-23} J$ b) $-3 \times 10^{-23} J$ c) $-6 \times 10^{-23} J$ d) $-2 \times 10^{-23} J$

739. An electric dipole has the magnitude of its charge as q and its dipole moment is p. It is placed in a uniform electric field E. If its dipole moment is along the direction of the field, the force on it and its potential energy are respectively

a) $2q.E$ and minimum b) $q.E$ and $p.E$ c) Zero and minimum d) $q.E$ and maximum

740. A parallel plate condenser with a dielectric of dielectric constant K between the plates has a capacity C and is charged to a potential $V\ volts$. The dielectric stab is slowly removed from between the plates and then reinserted. The net work done by the system in this process is

a) $\frac{1}{2}(K-1)CV^2$ b) $CV^2(K-1)/K$ c) $(K-1)CV^2$ d) Zero

741. A Gaussian sphere encloses an electric dipole within it. The total flux across the sphere is

a) Zero
b) Half that due to a single charge
c) Double that due to a single charge
d) Dependent on the position of the dipole

742. When a glass rod is rubbed with silk, it

a) Gains electrons from silk
b) Gives electrons to silk
c) Gains protons from silk
d) Gives protons to silk

743. Force between two identical charges placed at a distance of r in vacuum is F. Now a slab of dielectric of dielectric constant 4 is inserted between these two charges. If the thickness of the slab is $r/2$, then the force between the charges will become

a) F b) $\frac{3}{5}F$ c) $\frac{4}{9}F$ d) $\frac{F}{4}$

744. Equal charges q each are placed at the vertices A and B of an equilateral triangle ABC of side$a$. The magnitude of electric intensity at the point C is

a) $\frac{q}{4\pi\varepsilon_0 a^2}$ b) $\frac{\sqrt{2}\,q}{4\pi\varepsilon_0 a^2}$ c) $\frac{\sqrt{3}\,q}{4\pi\varepsilon_0 a^2}$ d) $\frac{2q}{4\pi\varepsilon_0 a^2}$

745. A hollow insulated conducting sphere is given a positive charge of $10\mu C$. What will be the electric field at the centre of the sphere if its radius is 2 meters

a) Zero b) $5\,\mu\,Cm^{-2}$ c) $20\,\mu\,Cm^{-2}$ d) $8\,\mu\,Cm^{-2}$

746. A parallel plate capacitor has a plate separation of 0.01 mm and use a dielectric (whose dielectric strength is 19 KV/mm) as an insulator. The maximum potential difference that can be applied to the terminals of the capacitor is

a) 190 V b) 290 V c) 95 V d) 350 V

747. The electric potential V at any point $O(x, y, z$ all in metres) in space is given by $V = 4x^2\ volt$. The electric field at the point $(1m, 0, 2m)$ in $volt/metre$ is

a) 8 along negative $C-$ axis
b) 8 along positive $X-$ axis
c) 16 along negative $X-$ axis
d) 16 along positive $Z-$ axis

748. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then Q/q equals

a) $-2\sqrt{2}$ b) -1 c) 1 d) $-\frac{1}{\sqrt{2}}$

749. When an electric dipole $\vec{P}$ is placed in a uniform electric field $\vec{E}$ then at what angle between $\vec{P}$ and $\vec{E}$ the value of torque will be maximum

a) 90° b) 0° c) 180° d) 45°

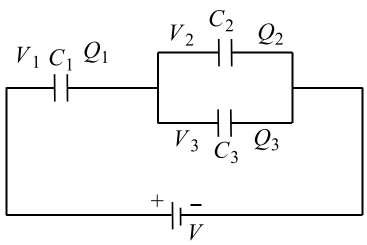
750. The displacement of a charge Q in the electric field $\vec{E} = e_1\hat{\imath} + e_2\hat{\jmath} + e_3\hat{k}$ is $\vec{r} = a\hat{\imath} + b\hat{\jmath}$. The work done is

a) $Q(ae_1 + be_2)$
b) $Q\sqrt{(ae_1)^2 + (be_2)^2}$
c) $Q(e_1 + e_2)\sqrt{a^2 + b^2}$
d) $Q\left(\sqrt{e_1^2 + e_2^2}\right)(a + b)$

751. Capacitance of a parallel plate capacitor becomes 4/3 times its original value if a dielectric slab of thickness $t = d/2$ is inserted between the plates (d is the separation between the plates). The dielectric constant of the slab is

a) 8 b) 4 c) 6 d) 2

752. In an adjoining figure are shown three capacitors C_1, C_2 and C_3 joined to a battery. The correct condition will be (Symbols have their usual meanings)



a) $Q_1 = Q_2 = Q_3$ and $V_1 = V_2 = V_3 = V$
b) $Q_1 = Q_2 + Q_3$ and $V = V_1 + V_2 + V_3$
c) $Q_1 = Q_2 + Q_3$ and $V = V_1 + V_2$
d) $Q_2 = Q_3$ and $V_2 = V_3$

753. A bullet of mass 2 gm is having a charge of $2\mu C$. Through what potential difference must it be accelerated, starting from rest, to acquire a speed of 10 m/s

a) 5 kV b) 50 kV c) 5 V d) 50 V

754. Two conducting spheres of radii R_1 and R_2 having charges Q_1 and Q_2 respectively are connected to each other. There is

a) No change in the energy of the system
b) An increase in the energy of the system
c) Always a decrease in the energy of the system
d) A decrease in the energy of the system unless $Q_1R_2 = Q_2R_1$

755. Two spherical conductors A and B of radii 1mm and 2mm are separated by a distance of 5cm and are uniformly charged. If the spheres are connected by a conducting wire then in equilibrium condition, the ratio of the magnitude of the electric fields at the surfaces of spheres A and B is

a) 4:1 b) 1;2 c) 2:1 d) 1:4

756. Two opposite and equal charges 4×10^{-8} *coulomb* when placed $2 \times 10^{-2} cm$ away, form a dipole. If this dipole is placed in an external electric field 4×10^8 *newton/coulomb*, the value of maximum torque and the work done in rotating in through 180^o will be

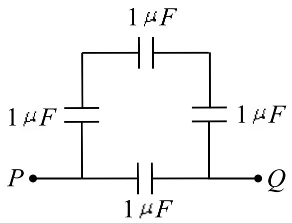
a) $64 \times 10^{-4} Nm$ and $64 \times 10^{-4} J$ b) $32 \times 10^{-4} Nm$ and $32 \times 10^{-4} J$

c) $64 \times 10^{-4} Nm$ and $32 \times 10^{-4} J$ d) $32 \times 10^{-4} Nm$ and $64 \times 10^{-4} J$

757. Four point charges $-Q, -q, 2q$ and $2Q$ are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is

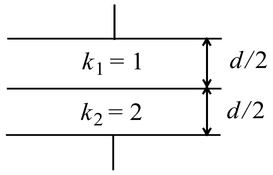
a) $Q = -q$ b) $Q = -\frac{1}{q}$ c) $Q = q$ d) $Q = \frac{1}{q}$

758. Four capacitors are connected as shown in the equivalent capacitance between the points P and Q is



a) $4\mu F$ b) $\frac{1}{4}\mu F$ c) $\frac{3}{4}\mu F$ d) $\frac{4}{3}\mu F$

759. Two parallel plate of area A are separated by two different dielectrics as shown in figure. The net capacitance is



a) $\frac{4\varepsilon_0 A}{3d}$ b) $\frac{3\varepsilon_0 A}{4d}$ c) $\frac{2\varepsilon_0 A}{d}$ d) $\frac{\varepsilon_0 A}{d}$

760. For a given surface the Gauss's law is stated as $\oint E.ds = 0$. From this we can conclude that

a) E is necessarily zero on the surface b) E is perpendicular to the surface at every point

c) The total flux through the surface is zero d) The flux is only going out of the surface

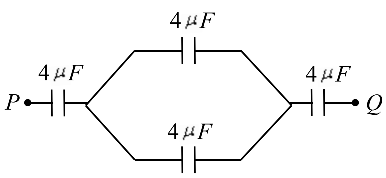
761. The electric field due to an electric dipole at a distance r from its centre in axial position is E. If the dipole is rotated through an angle of 90^o about its perpendicular axis, the electric field at the same point will be

a) E b) $\frac{E}{4}$ c) $\frac{E}{2}$ d) $2E$

762. A charged water drop whose radius is 0.1 μm is in equilibrium in an electric field. If charge on it is equal to charge of an electron, then intensity of electric field will be $(g = 10 ms^{-1})$

a) 1.61 N/C b) 26.2 N/C c) 262 N/C d) 1610 N/C

763. Four condenser each of capacity $4\mu F$ are connected as shown in figure. $V_P - V_Q = 15$ *volts*. The energy stored in the system is

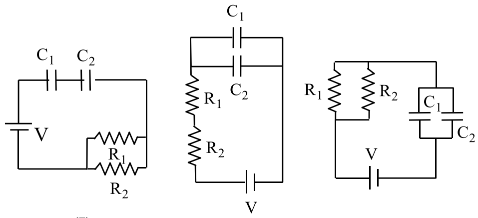


a) 2400 *ergs* b) 1800 *ergs* c) 3600 *ergs* d) 5400 *ergs*

764. Given,

$R_1 = 1\Omega \quad C_1 = 2\mu F$

$R_2 = 2\Omega \quad C_2 = 4\mu F$

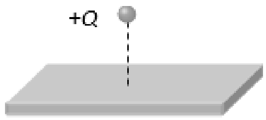


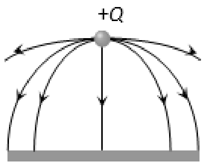
(I) (II) (III)

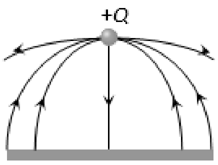
The time constant (in $\mu\ s$) for the circuits, I, II, III, are respectively

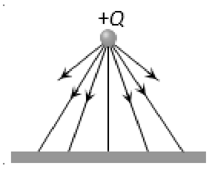
a) 18, 18/9, 4 b) 18,4,8/9 c) 4,8/9,18 d) 8/9,18,4

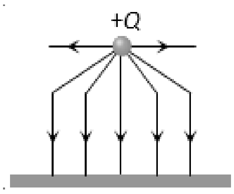
765. A charge Q is fixed at a distance d in front of an infinite metal plate. The lines of force are represented by



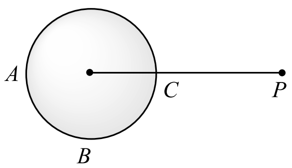
a) 

b) 

c) 

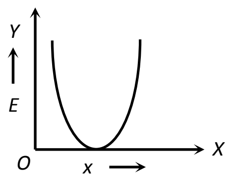
d) 

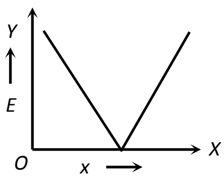
766. A hollow conducting sphere is placed in an electric field produced by a point charge placed at P as shown in figure. Let V_A, V_B, V_C be the potentials at points A, B and C respectively. Then

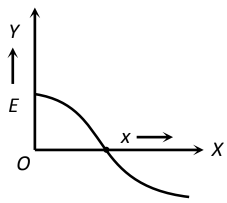


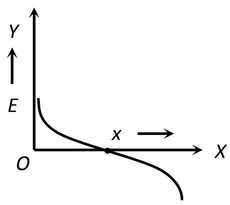
a) $V_C > V_B$ b) $V_B > V_C$ c) $V_A > V_B$ d) $V_A = V_C$

767. Two identical point charges are placed at a separation of d. P is a point on the line joining the charges, at a distance x from any one charge. The field at P is E, E is plotted against x for values of x from close to zero to slightly less than d. Which of the following represents the resulting curve

a) 

b) 

c) 

d) 

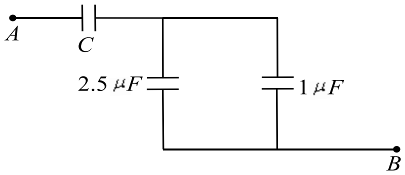
768. A charge of $10^{-9}C$ is placed on each of the 64 identical drops of radius 2 cm. They are then combined to form a bigger drop. Find its potential

a) $7.2 \times 10^3 V$ b) $7.2 \times 10^2 V$ c) $1.44 \times 10^2 V$ d) $1.44 \times 10^3 V$

769. An electric dipole is placed along the x −axis at the origin O. A point P is at a distance of 20cm from this origin such that OP makes an angle $\frac{\pi}{3}$ with the x −axis. If the electric field at P makes an angle θ with the x −axis, the value of θ would be

a) $\frac{\pi}{3}$ b) $\frac{\pi}{3} + \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ c) $\frac{2\pi}{3}$ d) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

770. The equivalent capacitance between A and B in the figure is $1\mu F$. Then the value of capacitance C is

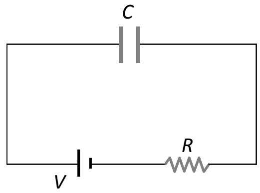


a) $1.4\mu F$ b) $2.5\mu F$ c) $3.5\mu F$ d) $1.2\mu F$

771. In a capacitor of capacitance $20\mu F$, the distance between the plates is $2mm$. If a dielectric of width 1 mm and dielectric constant 2 is inserted between the plates, then the new capacitance is

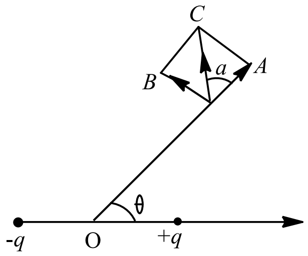
a) $2\mu F$ b) $15.5\mu F$ c) $26.6\mu F$ d) $32\mu F$

772. As in figure shown, if a capacitor C is charged by connecting it with resistance R, then energy is given by the battery will be



a) $\frac{1}{2}CV^2$ b) More than $\frac{1}{2}CV^2$ c) Less than $\frac{1}{2}CV^2$ d) zero

773. An electric dipole of moment **p** is placed at the origin along the x-axis. The electric field at a point P, whose position vector makes an angle θ with the x-axis, will make an angle With the x-axis, where $\tan\alpha = \frac{1}{2}\tan\theta$.



a) α b) θ c) $\theta + \alpha$ d) $2\theta + \alpha$

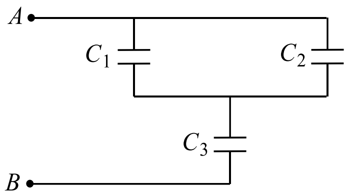
774. Energy associated with a moving charge is due to a

a) Electric field
b) Magnetic field
c) Both electric field and magnetic field
d) None of these

775. If on the concentric hollow spheres of radii r and $R(> r)$ the charge Q is distributed such that their surface densities are same then the potential at their common centre is

a) $\frac{Q(R^2+r^2)}{4\pi\varepsilon_0(R+r)}$ b) $\frac{QR}{R+r}$ c) Zero d) $\frac{Q(R+r)}{4\pi\varepsilon_0(R^2+r^2)}$

776. In the given network capacitance, $C_1 = 10\mu F$, $C_2 = 5\mu F$ and $C_3 = 4\mu F$. What is the resultant capacitance between A and B



a) 2.2 μF b) 3.2 μF c) 1.2 μF d) 4.7 μF

777. Two equally charged, identical metal spheres A and B repel each other with a force $'F'$. The spheres are kept fixed with a distance $'r'$ between them. A third identical, but uncharged sphere C is brought in contact with A and then placed at the mid-point of the line joining A and B. The magnitude of the net electric force on C is

a) F b) $3F/4$ c) $F/2$ d) $F/4$

778. Two charges of 4 μC each are placed at the corners A and B of an equilateral triangle of side length 0.2 m in air. The electric potential at C is $\left[\frac{1}{4\pi\varepsilon_0} = 9\times10^9 \frac{N-m^2}{C^2}\right]$

a) $9\times10^4\ V$ b) $18\times10^4\ V$ c) $36\times10^4\ V$ d) $36\times10^{-4}\ V$

779. The potential to which a conductor is raised, depends on

a) The amount of charge
b) Geometry and size of the conductor
c) Both (a) and (b)
d) None of these

780. A solid sphere of radius R_1 and volume charge density $\rho = \frac{\rho_0}{r}$ is enclosed by a hollow sphere of radius R_2 with negative surface charge density σ, such that the total charge in the system is zero. ρ_0 is a positive constant and r is the distance from the centre of the sphere. The ratio R_2/R_1 is

a) $\frac{\sigma}{\rho_0}$ b) $\sqrt{\frac{2\sigma}{\rho_0}}$ c) $\sqrt{\frac{\rho_0}{2\sigma}}$ d) $\frac{\rho_0}{\sigma}$

781. Electric field intensity at a point in between two parallel sheets with like charges of same surface charge densities (σ) is

a) $\frac{\sigma}{2\varepsilon_0}$ b) $\frac{\sigma}{\varepsilon_0}$ c) Zero d) $\frac{2\sigma}{\varepsilon_0}$

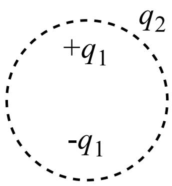
782. The intensity of electric field at a point between the plates of a charged capacitor

a) Is directly proportional to the distance between the plates
b) Is inversely proportional to the distance between the plates
c) Is inversely proportional to the square of the distance between the plates
d) Does not depend upon the distance between the plates

783. Under the influence of the Coulomb field of charge $+Q$, a charge $-q$ is moving around it in an elliptical orbit. Fine out the correct statement(s)

a) The angular momentum of the charge $-q$ is constant
b) The linear momentum of the charge $-q$ is constant
c) The angular velocity of the charge $-q$ is constant
d) The linear speed of the charge $-q$ is constant

784. Consider the charge configuration and a spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface, the electric field will be due to

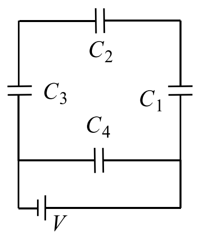


a) q_2 b) Only the positive charges
c) All the charges d) $+q_1$ and $-q_1$

785. If a charged spherical conductor of radius $10 cm$ has potential V at a point distant 5 cm from its centre, then the potential at a point distant 15 cm from the centre will be

a) $\frac{1}{3}V$ b) $\frac{2}{3}V$ c) $\frac{3}{2}V$ d) $3V$

786. A network of four capacitors of capacities equal to $C_1 = C, C_2 = 2C, C_3 = 3C$ and $C_4 = 4C$ are connected to a battery as shown in the figure



The ratio of the charges on C_2 and C_4 is

a) $\frac{22}{3}$ b) $\frac{3}{22}$ c) $\frac{7}{4}$ d) $\frac{4}{7}$

787. Consider two point charges of equal magnitude and opposite sign separated by a certain distance. Then neutral point between them

a) Does not exist
b) Will be in mid way between them
c) Lies on the perpendicular bisector of the line joining the two

d) Will be closer to the negative charge

788. The direction of electric field intensity $(\vec{E})$ at a point on the equatorial line of an electric dipole of dipole moment $(\vec{p})$ is
a) Along the equatorial line towards the dipole
b) Along equatorial line away from the dipole
c) Perpendicular to the equatorial line and opposite to $(\vec{p})$
d) Perpendicular to the equatorial line and parallel to $(\vec{p})$

789. A conducting sphere of radius $10 cm$ is charged $10 \mu C$. Another uncharged sphere of radius $20\ cm$ is allowed to touch it for some time. After that if the sphere are separated, then surface density of charges, on the spheres will be in the ratio of
a) 1 : 4 b) 1 : 3 c) 2 : 1 d) 1 : 1

790. The inward and outward electric flux from a closed surface are respectively 8×10^3 and 4×10^3 units. Then the net charge inside the closed surface is
a) $-4 \times 10^3 C$ b) $4 \times 10^3 C$ c) $\frac{-4 \times 10^3}{\varepsilon_0} C$ d) $-4 \times 10^3 \varepsilon_0 C$

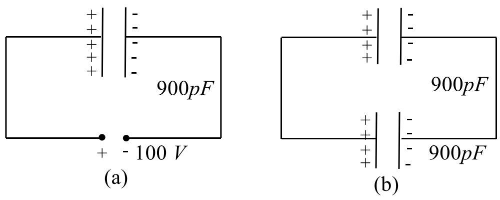
791. When air in a capacitor is replaced by a medium of dielectric constant K, the capacity
a) Decreases K times b) Increases K times c) Increases K^2 times d) Remains constant

792. The intensity of the electric field required to keep a water drop of radius $10^{-5} cm$ just suspended in air when charged with one electron approximately
$(g = 10\ newton/kg, e = 1.6 \times 10^{-19}\ coulomb)$
a) 260 $volt/cm$ b) 260 $newtons/coulomb$
c) 130 $volt/cm$ d) 130 $newton/coulomb$

793. To increase the charge on the plate of a capacitor means to
a) Decrease the potential difference between the plates
b) Decrease the capacitance of the capacitor
c) Increase the capacitance of the capacitor
d) Increase the potential difference between the plates

794. In an hydrogen atom, the electron revolves around the nucleus in an orbit of radius $0.53 \times 10^{-10}\ m$. Then the electrical potential produced by the nucleus at the position of the electron is
a) $-13.6\ V$ b) $-27.2\ V$ c) $27.2\ V$ d) $13.6\ V$

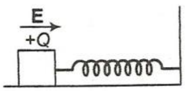
795. The energy stored in the capacitor as shown in the figure (a) is $4.5 \times 10^{-6} J$. If the battery is replaced by another capacitor of 900 pF as shown in figure (b), then the total energy of system is



a) $4.5 \times 10^{-6}\ J$ b) $2.25 \times 10^{-6}\ J$ c) Zero d) $9 \times 10^{-6}\ J$

796. The capacitance of a parallel plate capacitor is $12 \mu F$. If the distance between the plates is doubled and area is halved, then new capacitance will be
a) 8 μF b) 6 μF c) 4 μF d) 3 μF

797. A wooden block performs SHM on a frictionless surface with frequency v_0. The block carries a charge $+Q$ on its surface. If now a uniform electric field **E** is switched on as shown, then the SHM of the block will be



a) of the same frequency and with shifted mean position
b) of the same frequency and with same mean position
c) of changed frequency and with shifted mean position
d) of changed frequency and with same mean position

798. An uncharged capacitor is connected to a battery. On charging the capacitor
a) All the energy supplied is stored in the capacitor
b) Half the energy supplied is stored in the capacitor
c) The energy stored depends upon the capacity of the capacitor only
d) The energy stored depends upon the time for which the capacitor is charged

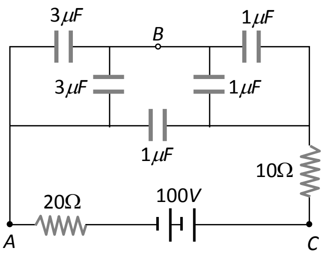
799. Three capacitances of capacity $10\mu F, 5\mu F$ and $5\mu F$ are connected in parallel. The total capacity will be
a) $10\mu F$ b) $5\mu F$ c) $20\mu F$ d) None of the above

800. Two small spheres each carrying a charge q are placed r metre apart. If one of the sphere is taken around the other one in a circular path of radius r, the work done will be equal to
a) Force between them $\times r$
b) Force between them $\times 2\pi r$
c) Force between them $/2\pi r$
d) Zero

801. Capacitance (in F) of a spherical conductor with radius $1m$ is
a) 1.1×10^{-10} b) 10^{-6} c) 9×10^{-9} d) 10^{-3}

802. A long, hollow conducting cylinder is kept coaxially inside another long, hollow conducting cylinder of larger radius. Both the cylinders are initially electrically neutral
a) A potential difference appears between the two cylinders when a charge density is given to the inner cylinder
b) A potential difference appears between the two cylinders when a charge density is given to the outer cylinder
c) No potential difference appears between the two cylinders when a uniform line charge is kept along the axis of the cylinders
d) No potential difference appears between the two cylinders when same charge density is given to both the cylinders

803. In the figure below, what is the potential difference between the points A and B and between B and C respectively in steady state

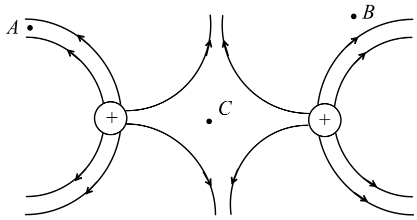


a) $V_{AB} = V_{BC} = 100\ V$
b) $V_{AB} = 75\ V, V_{BC} = 25\ V$
c) $V_{AB} = 25\ V, V_{BC} = 75\ V$
d) $V_{AB} = V_{BC} = 50\ V$

804. A capacitor of capacitance $C_1 = 1\ \mu F$ can with stand maximum voltage $V_1 = 6kV\ (kilo - volt)$ and another capacitor of capacitance $C_2 = 3\mu F$ can withstand maximum voltage $V_2 = 4\ kV$. When the two capacitors are connected in series, the combined system can withstand a maximum voltage of
a) $4kV$ b) $6kV$ c) $8kV$ d) $10kV$

805. A charged particle of mass m and charge q is released from rest in an electric field of constant magnitude$E$. The kinetic energy of the particle after time t is
a) $\frac{E^2q^2t^2}{2m}$ b) $\frac{2\ E^2t^2}{qm}$ c) $\frac{E\ q\ m}{2t}$ d) $\frac{Eq^2m}{2t^2}$

806. The figure below shows the electric field lines due to two positive charges. The magnitudes E_A, E_B and E_C of the electric fields at points A, B and C respectively are related as

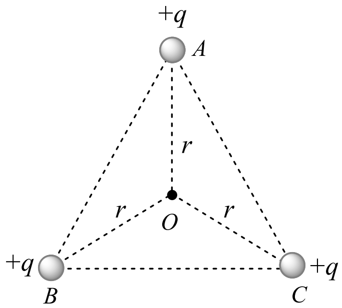


a) $E_A > E_B > E_C$ b) $E_B > E_A > E_C$ c) $E_A = E_B > E_C$ d) $E_A > E_B = E_C$

807. The energy of a charged capacitor is given by the expression ($q =$ charge on the conductor and $C =$ its capacity)

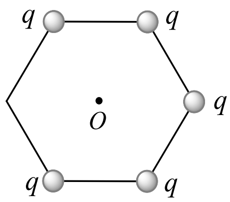
a) $\frac{q^2}{2C}$ b) $\frac{q^2}{C}$ c) $2qC$ d) $\frac{q}{2C^2}$

808. ABC is an equilateral triangle. Charges $+q$ are placed at each corner. The electric intensity at O will be



a) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ b) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ c) Zero d) $\frac{1}{4\pi\varepsilon_0}\frac{3q}{r^2}$

809. Five point charge each having magnitude $''q''$ are placed at the corner of hexagon as shown in fig. Net electric field at the centre $''O''$ is $\vec{E}$. To get net electric field at $''O''$ be $6\vec{E}$, charge placed on the remaining sixth corner should be



a) $6\ q$ b) $-6\ q$ c) $5\ q$ d) $-5\ q$

810. Two metal spheres of radii R_1 and R_2 are charged to the same potential. The ratio of charges on the spheres is

a) $\sqrt{R_1} : \sqrt{R_2}$ b) $R_1 : R_2$ c) $R_1^2 : R_2^2$ d) $R_1^3 : R_2^3$

811. Two identical capacitors are joined in parallel, charged to a potential V and then separated and then connected in series $i.e.$ the positive plate of one is connected to negative of the other

a) The charges on the free plates connected together are destroyed

b) The charges on the free plates are enhanced

c) The energy stored in the system increases

d) The potential difference in the free plates becomes $2V$

812. Three point charges $+q, -2q$ and $+q$ are placed at points $(x = 0, y = a, z = 0)$, $(x = 0, y = 0, z = 0)$ and $(x = a, y = 0, z = 0)$ respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are

a) $\sqrt{2}qa$ along $+y$ direction

b) $\sqrt{2}qa$ along the line joining points $(x = 0, y = 0, z = 0)$ and $(x = a, y = a, z = 0)$

c) qa along the line joining points $(x = 0, y = 0, z = 0)$ and $(x = a, y = a, z = 0)$

d) $\sqrt{2}qa$ along $+x$ direction

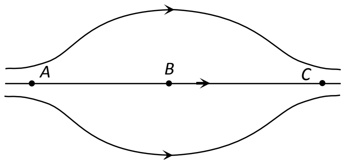
813. The radii of the inner and outer spheres of a condenser are $9cm$ and $10cm$ respectively. If the dielectric constant of the medium between the two spheres is 6 and charge on the inner sphere is 18×10^{-9} $coulomb$, then the potential of inner sphere will be, if the outer sphere is earthed

a) 180 $volts$ b) 30 $volts$ c) 18 $volts$ d) 90 $volts$

814. A $4\mu F$ condenser is connected in parallel to another condenser of $8\mu F$. Both the condensers are then connected in series with a $12\mu F$ condenser and charged to 20 $volts$. The charge on the plate of $4\mu F$ condenser is

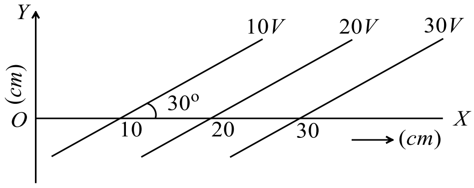
a) $3.3\mu C$ b) $40\mu C$ c) $80\mu C$ d) $240\mu C$

815. The figure shows some of the electric field lines corresponding to an electric field. The figure suggest



a) $E_A > E_B > E_C$ b) $E_A = E_B = E_C$ c) $E_A = E_C > E_B$ d) $E_A = E_C < E_B$

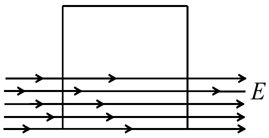
816. Equipotential surfaces are shown in figure. Then the electric field strength will be



a) 100 Vm^{-1} along X-axis b) 100 Vm^{-1} along Y-axis
c) 200 Vm^{-1} at an angle 120° with X-axis d) 50 Vm^{-1} at an angle 120° with X-axis

817. When a charge of 3 *coulomb* is placed in a uniform electric field, it experiences a force of 3000 *Newton*. Within this field, potential difference between two points separated by a distance of 1*cm* is
a) 10 *volts* b) 90 *volts* c) 1000 *volts* d) 3000 *volts*

818. A square surface of side L *meteres* is in the plane of the paper. A uniform electric field $\vec{E}$ (*volt*/*m*), also in the plane of the paper, is limited only to the lower half of the square surface, (see figure). The electric flux is SI units associated with the surface is

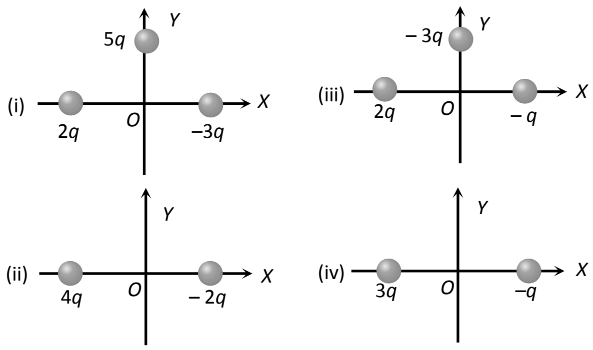


a) Zero b) EL^2 c) $EL^2/(2\varepsilon_0)$ d) $EL^2/2$

819. If the linear charge density of a cylinder is 4μCm^{-1} then electric field intensity at point 3.6 cm from axis is
a) 4×10^5 NC^{-1} b) 2×10^6NC^{-1} c) 8×10^7 NC^{-1} d) 12×10^7NC^{-1}

820. Two point charge $-q$ and $+q/2$ are situated at the origin and at the point $(a, 0,0)$ respectively. The point along the X-axis where the electric field vanishes is
a) $x = \frac{a}{\sqrt{2}}$ b) $x = \sqrt{2}a$ c) $x = \frac{\sqrt{2}a}{\sqrt{2}-1}$ d) $x = \frac{\sqrt{2}a}{\sqrt{2}+1}$

821. In the following four situations charged particles are at equal distance from the origin. Arrange them the magnitude of the net electric field at origin greatest first



a) (i) > (ii) > (iii) > (iv) b) (ii) > (i) > (iii) > (iv)
c) (i) > (iii) > (ii) > (iv) d) (iv) > (iii) > (ii) > (i)

822. A hollow sphere of charge does not produce an electric field at any
a) Interior point b) Outer point c) Beyond 2m d) Beyond 10m

823. The surface charge density (in C/m^2) of the earth is about
a) 10^{-9} b) -10^9 c) 10^9 d) -10^{-9}

824. 64 identical spheres of charge q and capacitance C each are combined to form a large sphere. The charge and capacitance of the large sphere is

a) $64q, C$ b) $16q, 4C$ c) $64q, 4C$ d) $16q, 64C$

825. Two identical conducting spheres carrying different charges attract each other with a force F when placed in air medium at a distance d apart. The spheres are brought into contact and then taken to their original positions. Now the two spheres repel each other with a force whose magnitude is equal to that of the initial attractive force. The ratio between initial charges on the spheres is

a) $-(3+\sqrt{8})$ only b) $-3+\sqrt{8}$ only

c) $-3(3+\sqrt{8})$ or $(-3+\sqrt{8})$ d) $+\sqrt{3}$

826. Three particles, each having a charge of $10\mu C$ are placed at the corners of an equilateral of side $10cm$, the corners of an equilateral triangle of side 10 cm. The electrostatic potential energy of the system is (Given $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 N - m^2/C^2$)

a) Zero b) Infinite c) 27 J d) 100 J

827. An electron enters between two horizontal plates separated by $2mm$ and having a potential difference of $1000V$. The force on electron is

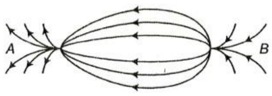
a) $8 \times 10^{-12} N$ b) $8 \times 10^{-14} N$ c) $8 \times 10^9 N$ d) $8 \times 10^{14} N$

828. A conductor has been given a charge $-3 \times 10^{-7} C$ by transferring electron. Mass increase (in kg) of the conductor and the number of electron added to the conductor are respectively

a) 2×10^{-16} and 2×10^{31} b) 5×10^{-31} and 5×10^{19}

c) 3×10^{-19} and 9×10^{16} d) 2×10^{-18} and 2×10^{12}

829. The spatial distribution of the electric field due to charges (A, B) is shown in figure. Which one of the following statements is correct?



a) A is + ve and B − ve, $|A| > |B|$ b) A is − ve and B + ve, $|A| = |B|$

c) Both are +ve but $A > B$ d) Both are –ve but $A > B$

830. Three capacitor each of $6\mu F$ are available. The minimum and maximum capacitances which may be obtained are

a) $6\mu F, 18\mu F$ b) $3\mu F, 12\mu F$ c) $2\mu F, 12\mu F$ d) $2\mu F, 18\mu F$

831. Minimum number of capacitors of $2\mu F$ capacitance each required to obtain a capacitor of $5\mu F$ will be

a) Three b) Four c) Five d) Six

832. A capacitor is charged to 200 $volt$ it has 0.1 $coulomb$ charge. When it is discharged, energy will be

a) 1 J b) 4 J c) 10 J d) 20 J

833. When a dielectric material is introduced between the plates of a charged condenser then electric field between the plates

a) Decreases b) Increases c) Remain constant d) First (b) and (a)

834. Gauss law of gravitation is

a) $\oint \vec{g}.\overrightarrow{ds} = m$ b) $\oint \vec{g}.\overrightarrow{ds} = Gm$ c) $\oint \vec{g}.\overrightarrow{ds} = -4\, G\pi m$ d) All the above

835. Two spheres A and B of radius $4cm$ and 6 cm are given charges of $80\mu c$ and $40\mu c$ respectively. If they are connected by a fine wire, the amount of charge flowing from one to the other is

a) $20\mu C$ from A to B b) $16\mu C$ from A to B c) $32\mu C$ from B to A d) $32\mu C$ from A to B

836. Two equal charges q of opposite sign separated by a distance $2a$ constitute an electric dipole of dipole moment p. If P is a point at a distance r from the centre of the dipole and the line joining the centre of the dipole to this point makes an angle θ with the axis of the dipole, then the potential at P is given by $(r >> 2a)$(Where $p = 2\,qa$)

a) $V = \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$ b) $V = \frac{p\cos\theta}{4\pi\varepsilon_0 r}$ c) $V = \frac{p\sin\theta}{4\pi\varepsilon_0 r}$ d) $V = \frac{p\cos\theta}{2\pi\varepsilon_0 r^2}$

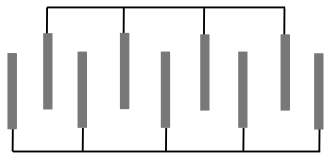
837. Two charged spheres separated at a distance d exert a force F on each other. If they are immersed in a liquid of dielectric constant 2, then what is the force (If all conditions are same)

a) $\frac{F}{2}$ b) F c) $2F$ d) $4F$

838. When a negative charge is taken at a height from earth's surface, then its potential energy

a) Decrease b) Increases c) Remains unchanged d) Will become infinity

839. A gang capacitor is formed by interlocking a number of plates as shown in figure. The distance between the consecutive plates is 0.885 cm and the overlapping area of the plate is 5 cm^2. The capacity of the unit is



a) 1.0 b) 4 pF c) 6.36 pF d) 12.72 pF

840. A condenser of capacity C_1 is charged to a potential V_0. The electrostatic energy stored in it is U_0. It is connected to another uncharged condenser of capacity C_2 in parallel. The energy dissipated in the process is

a) $\frac{C_2}{C_1+C_2}U_0$ b) $\frac{C_1}{C_1+C_2}U_0$ c) $\left(\frac{C_1-C_2}{C_1+C_2}\right)U_0$ d) $\frac{C_1C_2}{2(C_1+C_2)}U_0$

841. A charge of 10 $e.s.u.$ is placed at a distance of 2 cm from a charge of 40 $e.s.u.$ and 4 cm from another charge of 20 $e.s.u.$ The potential energy of the charge 10 $e.s.u.$ is (in $ergs$)

a) 87.5 b) 112.5 c) 150 d) 250

842. A solid spherical conductor of radius R has a spherical cavity of radius $a(a<R)$ at its centre. A charge $+Q$ is kept at the center. The charge at the inner surface, outer and at a position $r(a<r<R)$ are respectively

a) $+Q,-Q,0$ b) $-Q,+Q,0$ c) $0,-Q,0$ d) $+Q,0,0$

843. A point charge causes an electric flux of $-1.0\times10^3 Nm^2C^{-1}$ to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. If the radius of the Gaussian surface were three times, how much flux would pass through the surface

a) $3.0\times10^3 Nm^2/C$ b) $-1.0\times10^3 Nm^2/C$ c) $-3.0\times10^3 Nm^2/C$ d) $-2.0\times10^3 Nm^2/C$

844. Two identical capacitors, have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are connected together. When the positive ends are also connected, the decrease in energy of the combined system is

a) $\frac{1}{4}C(V_1^2-V_2^2)$ b) $\frac{1}{4}C(V_1^2+V_2^2)$ c) $\frac{1}{4}C(V_1-V_2)^2$ d) $\frac{1}{4}C(V_1+V_2)^2$

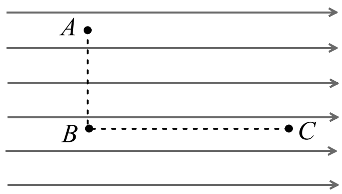
845. A hollow metallic sphere of radius 10 cm is given a charge of 3.2×10^{-9} C.The electric intensity at a point 4 cm from the centre is

a) 9×10^{-9} NC^{-1} b) 288 NC^{-1} c) 2.88 NC^{-1} d) Zero

846. A regular hexagon of side $'a'$ has a charge Q at each vertex. Potential at the centre of the hexagon is $\left(K=\frac{1}{4\pi\varepsilon_0}\right)$

a) Zero b) $\frac{KQ}{a}Volts$ c) $12\frac{KQ}{a}$ d) $6\frac{KQ}{a}$

847. Figure shows three points A,B and C in a region of uniform electric field $\vec{E}$. The line AB is perpendicular and BC is parallel to the field lines. Then which of the following holds good. Where V_A,V_B and V_C represent the electric potential at points A,B and C respectively



a) $V_A=V_B=V_C$ b) $V_A=V_B>V_C$ c) $V_A=V_B<V_C$ d) $V_A>V_B=V_C$

848. A $10pF$ capacitor is connected to a 50 V battery. How much electrostatic energy is stored in the capacitor
a) $1.25 \times 10^{-8}\,J$ b) $2.5 \times 10^{-7}\,J$ c) $3.5 \times 10^{-5}\,J$ d) $4.5 \times 10^{-2}\,J$

849. 1000 small water drops each of radius r and charge q coalesce together to form one spherical drop. The potential of the big drop is larger than that of the smaller drop by a factor of
a) 1000 b) 100 c) 10 d) 1

850. Two capacitors of capacities C_1 and C_2 are charged to voltages V_1 and V_2 respectively. There will be no exchange of energy in connecting them in parallel, if
a) $C_1 = C_2$ b) $C_1V_1 = C_2V_2$ c) $V_1 = V_2$ d) $\frac{C_1}{V_1} = \frac{C_2}{V_2}$

851. A flat circular disc has a charge $+Q$ uniformly distributed on the disc. A charge $+q$ is thrown with kinetic energy E towards the disc along its normal axis. The charge q will
a) Hit the disc at the centre
b) Return back along its path after touching the disc
c) Return back along its path without touching the disc
d) Any of the above three situations is possible depending on the magnitude of E

852. Two point charges $+3\mu C$ and $+8\mu C$ repel each other with a force of $40N$. If a charge of $-5\mu C$ is added to each of them, then the force between them will become
a) $-10N$ b) $+10N$ c) $+20N$ d) $-20N$

853. A semi-circular are of radius a is charged uniformly and the charge per unit length is λ. the electric field at its centre is
a) $\frac{\lambda}{2\pi\varepsilon_0 a^2}$ b) $\frac{\lambda}{4\varepsilon_0 a}$ c) $\frac{\lambda^2}{4\pi\varepsilon_0 a}$ d) $\frac{\lambda}{2\pi\varepsilon_0 a}$

854. The wrong statement about electric lines of force is
a) These originate from positive charge and end on negative charge
b) They do not intersect each other at a point
c) They have the same form for a point charge and a sphere
d) They have physical existence

855. Gauss's law of electrostatics would be invalid if
a) There were magnetic monopoles
b) The speed of light was not a universal constant
c) The inverse square law was not exactly true
d) The electrical charge was not quantized

856. A conductor has been given a charge $-3 \times 10^{-7}C$ by transferring electrons. Mass increase (in kg) of the conductor and the number of electrons added to the conductor are respectively
a) 2×10^{-16} and 2×10^{31}
b) 5×10^{-31} and 5×10^{19}
c) 3×10^{-19} and 9×10^{16}
d) 2×10^{-18} and 2×10^{12}

857. The potential on the hollow sphere of radius 1 m is 100 volt. The potential at $1/4\ m$ from the centre of sphere is
a) 1000 $volt$ b) 500 $volt$ c) 250 $volt$ d) 0 $volt$

858. If n drops, each of capacitance C, coalesce to form a single big drop, then the ratio of the energy stored in the big drop to that in each small drop will be
a) $n : 1$ b) $n^{1/3} : 1$ c) $n^{5/3} : 1$ d) $n^2 : 1$

859. A point charge of 1.8μC is at the centre of cubical Gaussian surface 55cm on edge. What is the net electric flux through the surface?
a) $1.0 \times 10^5 \mathrm{N-m^2C^{-1}}$
b) $3.0 \times 10^5 \mathrm{N-m^2C^{-1}}$
c) $2.0 \times 10^5 \mathrm{N-m^2C^{-1}}$
d) $4.0 \times 10^5 \mathrm{N-m^2C^{-1}}$

860. Eight drops of mercury of equal radii possessing equal charges combine to form a big drop. Then the capacitance of bigger drop compared to each individual small drop is
a) 8 times b) 4 times c) 2 times d) 32 times

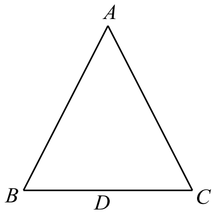
861. The distance between a proton and electron both having a charge 1.6×10^{-19} *coulomb*, of a hydrogen atom is 10^{-10}*metre*. The value of intensity of electric field produced on electron due to proton will be

a) $2.304 \times 10^{-10} N/C$ b) $14.4\ V/m$ c) $16V/m$ d) $1.44 \times 10^{11} N/C$

862. Work done in carrying a charge around an equipotential surface will

a) Increase b) Decrease c) Zero d) Infinity

863. Three charges, each $+q$, are placed at the corners of an isosceles triangle ABC of sides BC and AC, $2a$, D and E are the mid points of BC and CA. The work done in taking a charge Q from D to E is

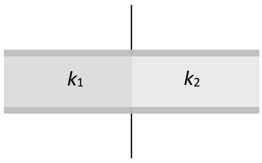


a) Zero b) $\frac{3qQ}{4\pi \in_0\ a}$ c) $\frac{3qQ}{8\pi \in_0\ a}$ d) $\frac{qQ}{4\pi \in_0\ a}$

864. Two identical charges repel each other with a force equal to 10 $mg\ wt$ when they are 0.6 m apart in the air. $g = (10ms^{-2})$. The value of each charge is

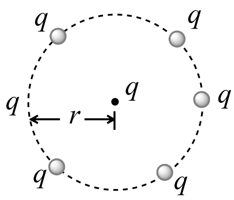
a) $2\ mC$ b) $2 \times 10^{-7}\ C$ c) $2\ nC$ d) $2\ \mu C$

865. A parallel plate capacitor with air as medium between the plates has a capacitance of $10\mu F$. The area of capacitor of divided into two equal halves and filled with two media as shown in the figure having dielectric constant $k_1 = 2$ and $k_2 = 4$. The capacitance of the system will now be



a) $10\mu F$ b) $20\mu F$ c) $30\mu F$ d) $40\mu F$

866. A point charge is surrounded symmetrically by six identical charges at distance r as shown in the figure. How much work is done by the forces of electrostatic repulsion when the point charge q at the centre is removed at infinity

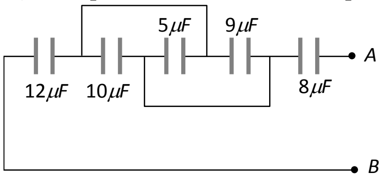


a) Zero b) $6q^2/4\pi\varepsilon_0 r$ c) $q^2/4\pi\varepsilon_0 r$ d) $12q^2/4\pi\varepsilon_0 r$

867. Let E_a be the electric field due to a dipole in its axial plane distant l and let E_q be the field in the equatorial plane distant l', then the relation between $E_a$and E_q will be

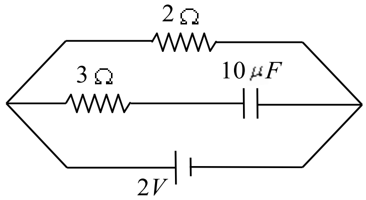
a) $E_a = 4E_q$ b) $E_q = 2E_a$ c) $E_a = 2E_q$ d) $E_q = 3E_a$

868. The capacities and connection of five capacitors are shown in the adjoining figure. The potential difference between the points A and B is 60 *volts*. Then the equivalent capacity between A and B and the charge on $5\mu F$ capacitance will be respectively



a) $44\mu F$; $300\mu C$ b) $16\mu F$; $150\mu C$ c) $15\mu F$; $200\mu C$ d) $4\mu F$; $50\mu C$

869. The charge on a capacitor of capacitance $10\mu F$ connected as shown in the figure is



a) $20\mu C$ b) $15\mu C$ c) $10\mu C$ d) Zero

870. A uniform electric field having a magnitude E_0 and direction along the positive $X -$ axis exists. If the potential V is zero as $x = 0$, then its value at $X = +x$ will be

a) $V_{(x)} = +x\,E_0$ b) $V_x = -xE_0$ c) $V_x = +x^2E_0$ d) $V_x = -x^2E_0$

871. An electric dipole of moment $'p'$ is placed in an electric field of intensity $'E'$. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when $\theta = 90^o$, the torque and the potential energy of the dipole will respectively be

a) $pE\sin\theta, -pE\cos\theta$ b) $pE\sin\theta, -2pE\cos\theta$ c) $pE\sin\theta, 2pE\cos\theta$ d) $pE\cos\theta, -pE\cos\theta$

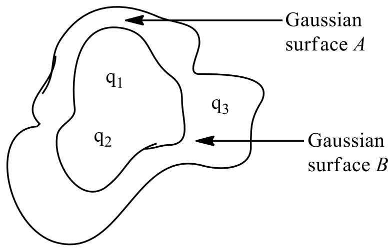
872. If an electron moves from rest from a point at which potential is 50 volt to another point at which potential is 70 volt, then its kinetic energy in the final state will be

a) $3.2 \times 10^{-10}\,J$ b) $3.2 \times 10^{-18}\,J$ c) $1\,N$ d) $1\,dyne$

873. A capacitor of capacitance $6\mu F$ is charged upto $100\,volt$. The energy stored in the capacitor is

a) $0.6\,Joule$ b) $0.06\,Joule$ c) $0.03\,Joule$ d) $0.3\,Joule$

874. The electric flux for Gaussian surface A that enclose the charged particles in free space is (given $q_1 = -14\text{nC}, q_2 = 78.85\text{nC}, q_3 = -56\text{nC}$)



a) $10^3\text{Nm}^2\text{C}^{-1}$ b) $10^3\text{CN}^{-1}\text{m}^{-2}$ c) $6.32 \times 10^3\text{Nm}^2\text{C}^{-1}$ d) $6.32 \times 10^3\text{CN}^{-1}\text{m}^{-1}$

875. A capacitor of capacity C is connected with a battery of potential V in parallel. The distance between its plates is reduced to half at once, assuming that the charge remains the same. Then to charge the capacitance upto the potential V again, the energy given by the battery will be

a) $CV^2/4$ b) $CV^2/2$ c) $3CV^2/4$ d) CV^2

876. The Gaussian surface for calculating the electric field due to a charge distribution is

a) Any surface near the charge distribution
b) Always a spherical surface
c) A symmetrical closed surface containing the charge distribution, at every point of which electric field has a single fixed value
d) None of the given options

877. An air capacitor is charged with an amount of charge q and dipped into an oil tank. If the oil is pumped out, the electric field between the plates of capacitor will

a) Increase b) Decrease c) Remain the same d) Become zero

878. Three equal charges are placed on the three corners of a square. If the force between q_1 and q_2 is F_{12} and that between q_1 and q_3 is F_{13}, the ratio of magnitudes $\frac{F_{12}}{F_{13}}$ is

a) $1/2$ b) 2 c) $1/\sqrt{2}$ d) $\sqrt{2}$

879. Two identical charged spheres are suspended by strings of equal lengths. The stings make an angle of 30^o with each other. When suspended in a liquid of density $0.8g\,cm^{-3}$, the angle remains the same. If density of the material of the sphere is $1.6g\,cm^{-3}$, the dielectric constant of the liquid is

a) 1 b) 4 c) 3 d) 2

880. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron)

a) $\frac{4\pi \in_0 Fd^2}{q^2}$ b) $\frac{4\pi \in_0 Fd^2}{e^2}$ c) $\sqrt{\frac{4\pi \in_0 Fe^2}{d^2}}$ d) $\sqrt{\frac{4\pi \in_0 Fd^2}{e^2}}$

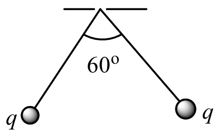
881. The charge q is projected into a uniform electric field E, work done when it moves a distance Y is

a) qEY b) $\frac{qY}{E}$ c) $\frac{qE}{Y}$ d) $\frac{Y}{qE}$

882. Two spherical conductors B and C having equal radii and carrying equal charges in them repel each other with force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged, is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between $B$and C is

a) $\frac{F}{4}$ b) $\frac{3F}{4}$ c) $\frac{F}{8}$ d) $\frac{3F}{8}$

883. Two small sphere balls each carrying charges $q = 10\mu$C are suspended by two insulated threads of equal length 1m each, from a point fixed in the ceiling. It is found that in equilibrium, threads are separated by an angle 60° between them as shown in figure, the tension in the thread is



a) 0.18 N b) 18 N c) 1.8 N d) None of the above

884. The electric field at a distance $\frac{3R}{2}$ from the centre of a charged conducting spherical shell of radius R is E. The electric field at a distance $\frac{R}{2}$ from the centre of the sphere is

a) Zero b) E c) $\frac{E}{2}$ d) $\frac{E}{3}$

885. Gauss's Law is valid for

a) Any closed surface b) Only regular close surfaces
c) Any open surface d) Only irregular open surfaces

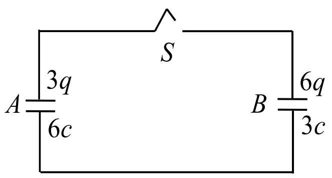
886. The electric field between the plates of a parallel plate capacitor when connected to a certain battery is E_0. If the space between the plates of the capacitor is filled by introducing a material of dielectric constant K without disturbing the battery connections, the field between the plates shall be

a) KE_0 b) E_0 c) $\frac{E_0}{K}$ d) None of the above

887. The capacities of two conductors are C_1 and C_2 and their respective potentials are V_1 and V_2. If they are connected by a thin wire, then the loss of energy will be given by

a) $\frac{C_1C_2(V_1+V_2)}{2(C_1+C_2)}$ b) $\frac{C_1C_2(V_1-V_2)}{2(C_1+C_2)}$ c) $\frac{C_1C_2(V_1-V_2)^2}{2(C_1+C_2)}$ d) $\frac{(C_1+C_2)(V_1-V_2)}{C_1C_2}$

888. In given circuit when switch S has been closed then charge on capacitor A & B respectively

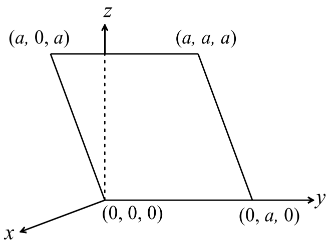


a) 3 q, 6 q b) 6 q, 3 q c) 4.5 q, 4.5 q d) 5 q, 4 q

889. A and B are two identical spherical charged bodies which repel each other with force F, kept at a finite distance. A third uncharged sphere of same size is brought in contact with sphere B and removed. It is then kept at midpoint of $A$and B. Find the magnitude of force on C.

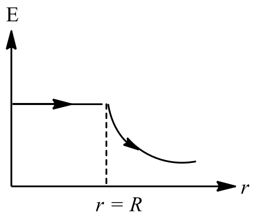
a) $F/2$ b) $F/8$ c) F d) Zero

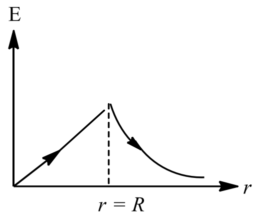
890. Consider an electric field $\vec{E} = E_0\hat{x}$, where E_0 is a constant. The flux through the shaded area (as shown in the figure) due to this field is

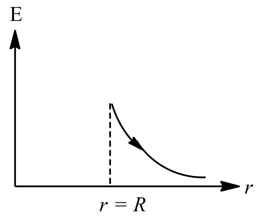


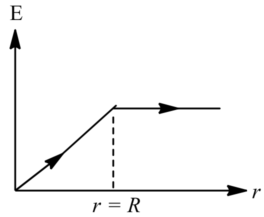
a) $2E_0a^2$ b) $\sqrt{2}E_0a^2$ c) E_0a^2 d) $\frac{E_0a^2}{\sqrt{2}}$

891. Which one of the following graphs represents the variation of electric field with distance r from the centre of a charged spherical conductor of radius R?

a) 

b) 

c) 

d) 

892. Infinite charges of magnitude q each are lying at $x = 1,2,4,8..$metre on X-axis. The value of intensity of electric field at point $x = 0$ due to these charges will be

a) $12 \times 10^9\ q$ NC^{-1} b) zero c) $6 \times 10^9\ q$ NC^{-1} d) $4 \times 10^9\ q$ NC^{-1}

893. What is the value of capacitance if the thin metallic plate is introduced between two parallel plates of area A and separated at distance d

a) $\frac{\epsilon_0 A}{d}$ b) $\frac{2 \epsilon_0 A}{d}$ c) $\frac{4 \epsilon_0 A}{d}$ d) $\frac{\epsilon_0 A}{2d}$

894. Charges +2q, +q and +q are placed at the corners A, B and C of an equilateral triangle ABC. If E is the electric field at the circumcentre O of the triangle, due to the charge +q, then the magnitude and direction of the resultant electric field at O is

a) E along AO b) $2E$ along AO c) E along BO d) E along CO

895. Which of the following is the correct statement of Gauss law for electrostatics in a region of charge distribution in free space

a) $\oint E.ds = 0$ b) $\oint E.ds = \rho/\varepsilon_0$ c) $\oint E.ds = \rho$ d) $\oint E.ds = \varepsilon_0\rho$

896. When air is replaced by a dielectric medium of constant k, the maximum force of attraction between two charges separated by a distance

a) Decreases k times b) Remains unchanged c) Increases k times d) Increases k^{-1} times

897. Two point charges placed at certain distance r in air exert a force F on each other. Then the distance r' at which these charges will exert the same force in a medium of dielectric constant k is given by

a) r b) r/k c) $r/\sqrt{k}$ d) $r\sqrt{k}$

898. A parallel plate capacitor has plate area A and separation d. It is charged to a potential difference V_0. The charging battery is disconnected and the plates are pulled apart to three times the initial separation. The work required to separate the plates is

a) $\frac{3\varepsilon_0AV_0^2}{d}$ b) $\frac{\varepsilon_0AV_0^2}{2d}$ c) $\frac{\varepsilon_0AV_0^2}{3d}$ d) $\frac{\varepsilon_0AV_0^2}{d}$

899. If E is the electric field intensity of an electrostatic field, then the electrostatic energy density is proportional to

a) E b) E^2 c) $1/E^2$ d) E^3

900. The number of ways one can arrange three identical capacitors to obtain distinct effective capacitances is

a) 8 b) 6 c) 4 d) 3

901. What is the area of the plates of a $3F$ parallel plate capacitor, if the separation between the plates is $5mm$

a) $1.694 \times 10^9 m^2$ b) $4.529 \times 10^9 m^2$ c) $9.281 \times 10^9 m^2$ d) $12.981 \times 10^9 m^2$

902. Two capacitor of capacitance $2\mu F$ and $3\mu F$ are joined in series. Outer plate first capacitor is at 1000 $volt$ and outer plate of second capacitor is earthed (grounded). Now the potential on inner plate of each capacitor will be

a) 700 $Volt$ b) 200 $Volt$ c) 600 $Volt$ d) 400 $Volt$

903. Three charges each of magnitude q are placed at the corners of an equilateral triangle, the electrostatic force on the charge placed at the center is (each side of triangle is L)

a) Zero b) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{L^2}$ c) $\frac{1}{4\pi\varepsilon_0}\frac{3q^2}{L^2}$ d) $\frac{1}{12\pi\varepsilon_0}\frac{q^2}{L^2}$

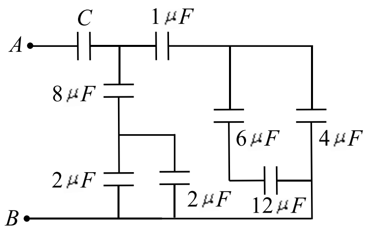
904. The electrostatic potential inside a charged spherical ball is given by $\phi = ar^2 + b$ where r is the distance from the centre; a, b are constants. Then the charge density inside the ball is

a) $-24\pi a\varepsilon_0 r$ b) $-6a\varepsilon_0 r$ c) $-24\pi a\varepsilon_0$ d) $-6a\varepsilon_0$

905. Two identical conducting balls A and B have positive charges q_1 andq_2 respectively but $q_1 \neq q_2$. The balls are brought together so that they touch each other and then kept in their original positions. The force between them is

a) Less than that before the balls touched b) Greater than that before the balls touched
c) Same as that before the balls touched d) Zero

906. In the following circuit, the resultant capacitance between A and B is $1\mu F$. Then value of C is



a) $\frac{32}{11}\mu F$ b) $\frac{11}{32}\mu F$ c) $\frac{23}{32}\mu F$ d) $\frac{32}{23}\mu F$

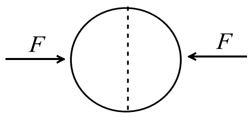
907. A point charge q produces an electric field of magnitude $2 NC^{-1}$ at a point distance 0.25 m from it. What is the value of charge?

a) 1.39×10^{-11} C b) 1.39×10^{11} C c) 13.9×10^{-11} C d) 13.9×10^{11} C

908. Which is known as capacitive time constant

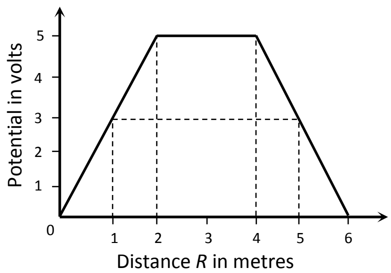
a) R/L b) R/C c) R/LC d) $\frac{R \in_0 A}{d}$

909. A uniformly charged thin spherical shell of radius R carries uniform surface charge density of σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F (see figure). F is proportional to



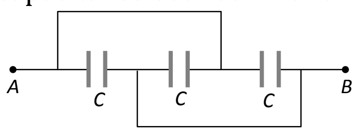
a) $\frac{1}{\varepsilon_0}\sigma^2 R^2$ b) $\frac{1}{\varepsilon_0}\sigma^2 R$ c) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R}$ d) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R^2}$

910. The variation of potential with distance R from a fixed point is as shown below. The electric field at $R = 5m$ is



a) $2.5\ volt/m$ b) $-2.5\ volt/m$ c) $2/5\ volt/m$ d) $-2/5\ volt/m$

911. Three equal capacitors, each with capacitance C are connected as shown in figure. Then the equivalent capacitance between A and B is

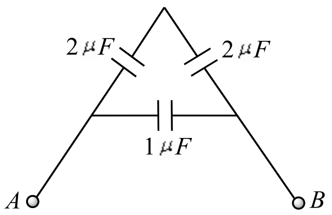


a) C b) $3C$ c) $\frac{C}{3}$ d) $\frac{3C}{2}$

912. A parallel plate capacitor carries a charge q. The distance between the plates is doubled by application of a force. The work done by the force is

a) Zero b) $\frac{q^2}{C}$ c) $\frac{q^2}{2C}$ d) $\frac{q^2}{4C}$

913. What is the effective capacitance between A and B in the following figure



a) $1\mu\ F$ b) $2\mu\ F$ c) $1.5\mu\ F$ d) $2.5\mu\ F$

914. A conducting sphere of radius R, and carrying a charge q is joined to a conducting sphere of radius $2R$, and carrying a charge $-2q$. The charge flowing between them will be

a) $\frac{q}{3}$ b) $\frac{2q}{3}$ c) q d) $\frac{4q}{3}$

915. The voltage of clouds is $4 \times 10^6\ volt$ with respect to ground. In a lightening strike lasting 100 $m\ sec$, a charge of 4 coulombs is delivered to the ground. The power of lightening strike is

a) 160 MW b) 80 MW c) 20 MW d) 500 KW

916. N identical drops of mercury are charged simultaneously to 10 volt. When combined to form one large drop, the potential is found to be 40 volt, the value of N is

a) 4 b) 6 c) 8 d) 10

917. The electric field at the centroid of an equilateral triangle carrying an equal charge q at each of the vertices is

a) Zero b) $\frac{\sqrt{2kq}}{r^2}$ c) $\frac{kq}{\sqrt{2r^2}}$ d) $\frac{3kq}{r^2}$

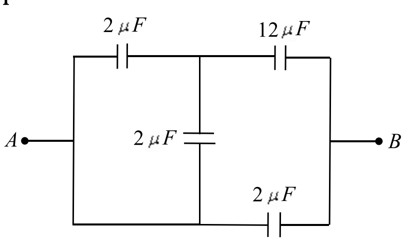
918. To form a composite $16\mu F$, $1000V$ capacitor from a supply of identical capacitors marked $8\mu F$, $250V$, we require a minimum number of capacitors

a) 40 b) 32 c) 8 d) 2

919. A $10\mu F$ capacitor and a $20\mu F$ capacitor are connected in series across a 200 V supply line. The charged capacitors are then disconnected from the line and reconnected with their positive plates together and negative plates together and no external voltage is applied. What is the potential difference across each capacitor

a) $\frac{400}{9}V$ b) $\frac{800}{9}V$ c) 400 V d) 200 V

920. Four capacitors are connected in a circuit as shown in the figure. The effective capacitance in μF between points A and B will be



a) $\frac{28}{9}$ b) 4 c) 5 d) 18

921. Two positive point charges of $12\mu C$ and $8\mu C$ are 10 cm apart. The work done in bringing them 4 cm closer is

a) 5.8 J b) 5.8 eV c) 13 J d) 13 eV

922. An electric dipole of the dipole moment **p** is placed in a uniform electric field **E**. The maximum torque experienced by the dipole is

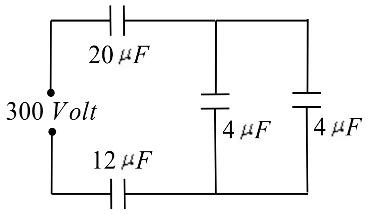
a) pE b) $\frac{P}{E}$ c) $\frac{E}{P}$ d) **p.E**

923. The electric field between the two spheres of a charged spherical condenser

a) Is zero b) Is constant

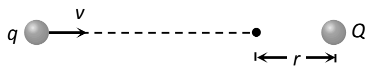
c) Increases with distance from the Centre d) Decreases with distance from the Centre

924. In the adjoining figure, four capacitors are shown with their respective capacities and the P.D. applied. The charge and the P.D. across the $4\mu F$ capacitor will be



a) $600\mu C$; 150 $volts$ b) $300\mu C$; 75 $volts$ c) $800\mu C$; 200 $volts$ d) $580\mu C$; 145 $volts$

925. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches Q upto a closest distance r and then returns. If q were given a speed $2v$, the closest distances of approach would be

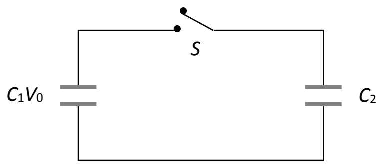


a) r b) $2r$ c) $r/2$ d) $r/4$

926. An electric dipole of moment **p** placed in a uniform electric field **E** has minimum potential energy when the angle between **p** and **E** is

a) Zero b) $\frac{\pi}{2}$ c) π d) $\frac{3\pi}{2}$

927. A capacitor of capacity C_1 is charged to the potential of V_0. On disconnecting with the battery, it is connected with a capacitor of capacity C_2 as shown in the adjoining figure. The ratio of energies before and after the connection of switch S will be



a) $(C_1 + C_2)/C_1$ b) $C_1/(C_1 + C_2)$ c) C_1C_2 d) C_1/C_2

928. An infinite number of charges, each of charge 1 μC, are placed on the x −axis with co-ordinates x = 1,2,4,8, … . ∞. If a charge of 1C is kept at the origin, then what is the net force acting on 1C charge

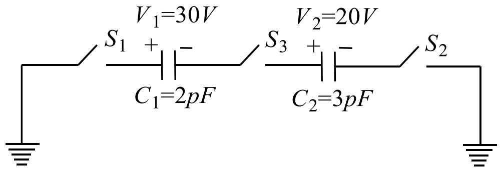
a) 9000 N b) 12000 N c) 24000 N d) 36000 N

929. An air capacitor is connected to a battery. The effect of filling the space between the plates with a dielectric is to increase

a) The charge and the potential difference b) The potential difference and the electric field

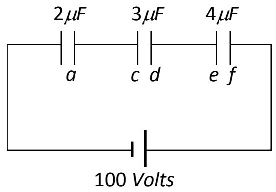
c) The electric field and the capacitance d) The charge and the capacitance

930. For the circuit shown, which of the following statements is true



a) With S_1 closed, $V_1 = 15\ V, V_2 = 20\ V$ b) With S_3 closed $V_1 = V_2 = 25V$
c) With S_1 and S_2 closed $V_1 = V_2 = 0$ d) With S_1 and S_3 closed, $V_1 = 30V, V_2 = 20V$

931. Three capacitors are connected to $D.C.$ source of 100 $volts$ shown in the adjoining figure. If the charge accumulated on plates of C_1, C_2 and C_3 are q_a, q_b, q_c, q_d, q_e and q_f respectively, then

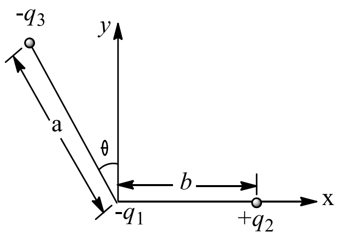


a) $q_b + q_d + q_f = \frac{100}{9} C$ b) $q_b + q_d + q_f = 0$ c) $q_a + q_c + q_e = 50\ C$ d) $q_b = q_d = q_f$

932. There is an electric field E in X-direction. If the work done on moving a charge 0.2 C through a distance of $2m$ along a line making an angle 60° with the X-axis is 4.0, what is the value of E

a) $\sqrt{3}N/C$ b) $4N/C$ c) $5\ N/C$ d) None of these

933. Three charges $-q_1, +q_2$ and $-q_3$ are placed as shown in figure. The x component of the force on $-q_1$ is proportional to

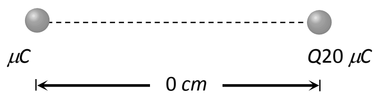


a) $\frac{q_2}{b^2} - \frac{q_3}{b^2} \sin\theta$ b) $\frac{q_2}{b^2} - \frac{q_3}{b^2} \cos\theta$ c) $\frac{q_2}{b^2} + \frac{q_3}{b^2} \sin\theta$ d) $\frac{q_2}{b^2} + \frac{q_3}{b^2} \cos\theta$

934. What will be the capacity of a parallel-plate capacitor when the half of parallel space between the plates is filled by a material of dielectric constant ε_r? Assume that the capacity of the capacitor in air is C

a) $\frac{2\varepsilon_r C}{1+\varepsilon_r}$ b) $\frac{C(\varepsilon_r + 1)}{2}$ c) $\frac{C\varepsilon_r}{1+\varepsilon_r}$ d) $\varepsilon_r C$

935. In the given figure distance of the point from A where the electric field is zero is



a) 20 cm
b) 10 cm
c) 33 cm
d) None of these

936. An electron is moving towards x −axis. An electric field is along y −direction then path of electron is

a) Circular b) Elliptical c) Parabola d) None of these

937. Charge Q is placed at the diagonal faced corners of a square and charge q is placed at another two corners of square. The condition for net electric force on Q to be zero will be

a) $Q = (-2\sqrt{2})q$ b) $Q = -\frac{q}{2}$ c) $Q = (2\sqrt{2})q$ d) $Q = -\frac{q}{2}$

938. The total electric flux through a cube when a charge $8q$ is placed at one corner of the cube is

a) $\varepsilon_0 q$ b) $\frac{\varepsilon_0}{q}$ c) $4\pi\varepsilon_0 q$ d) $\frac{q}{\varepsilon_0}$

939. Force acting upon a charged particle kept between the plates of a charged condenser is F. If one plate of the condenser is removed, then the force acting on the same particle will become

a) 0 b) $F/2$ c) F d) $2F$

940. Electric potential at an equatorial point of a small dipole with dipole moment P (r, distance from the dipole) is

a) Zero b) $\frac{P}{4\pi\varepsilon_0 r^2}$ c) $\frac{P}{4\pi\varepsilon_0 r^3}$ d) $\frac{2P}{4\pi\varepsilon_0 r^3}$

941. An electron enters in high potential region V_2 from lower potential region V_1 then its velocity

a) Will increase b) Will change in direction but not in magnitude
c) No change in direction of field d) No change in direction perpendicular to field

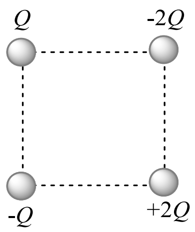
942. The distance between H^+ and Cl^- ions in HCl molecule is 1.28 Å. What will be the potential due to this dipole at a distance of 12 Å on the axis of dipole

a) 0.13 V b) 1.3 V c) 13 V d) 130 V

943. The relation between the intensity of the electric field of an electric dipole at a distance r from its centre on its axis and the distance r is where ($r \gg 2l$)

a) $E \propto \frac{1}{r}$ b) $E \propto \frac{1}{r^2}$ c) $E \propto \frac{1}{r^4}$ d) $E \propto \frac{1}{r^3}$

944. Four charges are placed on corners of a square as shown in figure having side of 5 cm. If Q is one microcoulomb, then electric field intensity at centre will be



a) $1.02 \times 10^7 N/C$ upwards
b) $2.04 \times 10^7 N/C$ downwards
c) $2.04 \times 10^7 N/C$ upwards
d) $1.02 \times 10^7 N/C$ downwards

945. Identify the wrong statement in the following. Coulomb's law correctly described the electric force that

a) binds the electrons of an atom to its nucleus
b) binds the protons and neutrons in the nucleus of an atom
c) binds atoms together to form molecules
d) Binds atoms and molecules to from solids

946. When a lamp is connected in series with capacitor, then

a) Lamp will not glow b) Lamp will burst out
c) Lamp will glow normally d) None of these

947. Separation between the plates of a parallel plate capacitor is d and the area of each plate is A. When a slab of material of dielectric constant k and thickness $t(t < d)$ is introduced between the plates, its capacitance becomes

a) $\frac{\varepsilon_0 A}{d + t\left(1 - \frac{1}{k}\right)}$ b) $\frac{\varepsilon_0 A}{d + t\left(1 + \frac{1}{k}\right)}$ c) $\frac{\varepsilon_0 A}{d - t\left(1 - \frac{1}{k}\right)}$ d) $\frac{\varepsilon_0 A}{d - t\left(1 + \frac{1}{k}\right)}$

948. A charge q is placed at the corner of a cube of side$a$. The electric flux through the cube is

a) $\frac{q}{\varepsilon_0}$ b) $\frac{q}{3\varepsilon_0}$ c) $\frac{q}{6\varepsilon_0}$ d) $\frac{q}{8\varepsilon_0}$

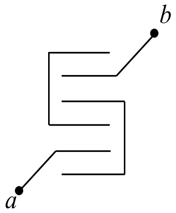
949. A force of 2.25 N acts on a charge of 15×10^{-4}C. Calculate the intensity of electric field at that point

a) 1500 NC^{-1} b) 150 NC^{-1} c) 15000 NC^{-1} d) None of these

950. An electric field is spread uniformly in Y-axis. Consider a point A as origin point. The co-ordinates of point B are equal to $(0, 2)m$. The co-ordinates of point C are $(2,0)m$. At points A, B and C, electric potentials are V_A, V_B and V_C respectively. From the following options, which is correct

a) $V_A = V_C < V_B$ b) $V_A = V_B = V_C$ c) $V_A = V_B > V_C$ d) $V_A = V_C > V_B$

951. Plates of area A are arranged as shown. The distance between each plate is d, the net capacitance is

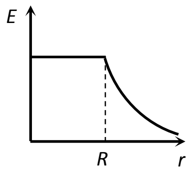


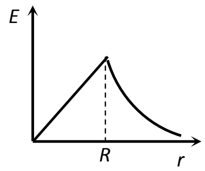
a) $\frac{\varepsilon_0 A}{d}$ b) $\frac{7\varepsilon_0 A}{d}$ c) $\frac{6\varepsilon_0 A}{d}$ d) $\frac{5\varepsilon_0 A}{d}$

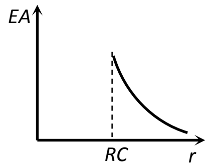
952. A series combination of n_1 capacitors each of value C_1, is charged by a source of potential difference $4V$. When another parallel combination of n_2 capacitors, each of value C_2, is charged by a source of potential difference V, it has the same (total) energy stored in it, as the first combination has, The value of C_2, in terms of C_1, is then

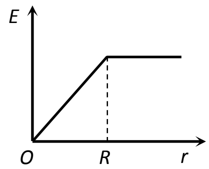
a) $\frac{16C_1}{n_1 n_2}$ b) $\frac{2C_1}{n_1 n_2}$ c) $16\frac{n_2}{n_1}C_1$ d) $2\frac{n_2}{n_1}C_1$

953. The electric field due to a uniformly charged sphere of radius R as a function of the distance from its centre is represented graphically by

a) 

b) 

c) 

d) 

954. Two identical conducting balls A and B have positive charges q_1 and q_2 respectively. But $q_1 \neq q_2$. The balls are brought together so that they touch each other and kept in their original positions. The force between them is

a) Less than that before the balls touched b) Greater than that before the balls touched
c) Same as that before the balls touched d) Zero

955. A ball with charge $-50\ e$ is placed at the centre of a hollow spherical shell which has a net charge of $-50\ e$. What is the charge on the shell's outer surface

a) $-50e$ b) Zero c) $-100e$ d) $+100e$

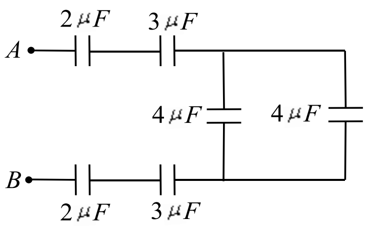
956. At a certain distance from a point charge the electric field is $500\ V/m$ and the potential is $3000\ V$. What is this distance

a) $6\ m$ b) $12\ m$ c) $36\ m$ d) $144\ m$

957. The radius of solid metallic non-conducting sphere is 60 cm and charge on the sphere is 500μC. The electric field at a distance 10cm from centre of sphere is

a) $2 \times 10^6 \text{NC}^{-1}$ b) $2 \times 10^8 \text{NC}^{-1}$ c) $5 \times 10^6 \text{NC}^{-1}$ d) $5 \times 10^8 \text{NC}^{-1}$

958. The effective capacity between A and B in the figure given is

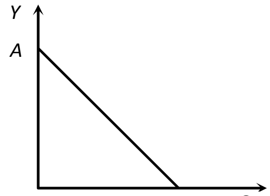


a) $\frac{43}{24}\mu F$ b) $\frac{24}{43}\mu F$ c) $\frac{43}{12}\mu F$ d) $\frac{12}{43}\mu F$

959. The electric potential V at any point (x, y, z), all in meters in space is given by $V = 4x^2\ volt$. The electric field at the point (1,0,2) in $volt/meter$, is

a) 16 along positive X-axis b) 8 along negative X-axis
c) 8 along positive X-axis d) 16 along negative X-axis

960. As per this diagram a point charge $+q$ is placed at the origin O. Work done in taking another point charge $-Q$ from the point A [co-ordinates $(0, a)$] to another point B[co-ordinates $(a, 0)$] along the straight path AB is



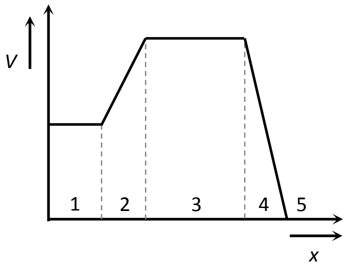
a) Zero
b) $\left(\frac{-qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right)\sqrt{2}a$
c) $\left(\frac{qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right)\frac{a}{\sqrt{2}}$
d) $\left(\frac{qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right)\sqrt{2}a$

961. Two point charges $+q$ and $-q$ are held fixed at $(-d, 0)$ and $(d, 0)$ respectively of a (X, Y) coordinate system. Then
a) E at all points on the $Y-$ axis is along $\hat{\imath}$
b) The electric field $\vec{E}$ at all points on the X-axis has the same direction
c) Dipole moment is $2qd$ directed along $\hat{\imath}$
d) Work has to be done in bringing a test charge from infinity to the origin

962. The electric potential at a point in free space due to a charge Q coulomb is $Q \times 10^{11}$ volts. The electric field at the point is
a) $4\pi \in_0\ Q \times 10^{20} V/m$
b) $12\pi \in_0\ Q \times 10^{22} V/m$
c) $4\pi \in_0\ Q \times 10^{22} V/m$
d) $12\pi \in_0\ Q \times 10^{20} V/m$

963. Choose the incorrect statement from the following. When two identical capacitors are charged individually to different potentials and connected parallel to each other after disconnecting them from the source
a) Net charge equals the sum of initial charges
b) The net energy stored in the two capacitors is less than the sum of the initial individual energies
c) The net potential difference across them is different from the sum of the individual initial potential difference
d) The net potential difference across them equals the sum of the individual initial potential differences

964. The figure gives the electric potential V as a function of distance through five regions on x-axis. Which of the following is true for the electric field E in these regions



a) $E_1 > E_2 > E_3 > E_4 > E_5$
b) $E_1 = E_3 = E_5$ and $E_2 < E_4$
c) $E_2 = E_4 = E_5$ and $E_1 < E_3$
d) $E_1 < E_2 < E_3 < E_4 < E_5$

965. Two spheres A and B of radius $'a'$ and $'b'$ respectively are at same electric potential. The ratio of the surface charge densities of A and B is
a) $\frac{a}{b}$
b) $\frac{b}{a}$
c) $\frac{a^2}{b^2}$
d) $\frac{b^2}{a^2}$

966. An oil drop having charge $2e$ is kept stationary between two parallel horizontal plates 2.0 cm apart when a potential difference of 12000 volts is applied between them. If the density of oil is 900 kg/m^3, the radius of the drop will be
a) $2.0 \times 10^{-6} m$
b) $1.7 \times 10^{-6} m$
c) $1.4 \times 10^{-6} m$
d) $1.1 \times 10^{-6} m$

967. Pick out the false statement from the following
a) The direction of eddy current is given by Fleming's right hand rule
b) A choke coil is a pure inductor used for controlling current in an a.c circuit

c) The energy stored in a conductor of capacitance C having a charge q is $\frac{1}{2}\frac{q^2}{C}$

d) The magnetic energy stored in a coil of self-inductance L carrying current is $\frac{1}{2}LI^2$

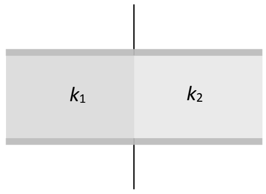
968. A condenser of capacity C is charged to a potential difference of V_1. The plates of the condenser are then connected to an ideal inductor of inductance L. The current through the inductor when the potential difference across the condenser reduces to V_2 is

a) $\left(\frac{C(V_1-V_2)^2}{L}\right)^{\frac{1}{2}}$ b) $\frac{C(V_1^2-V_2^2)}{L}$ c) $\frac{C(V_1^2+V_2^2)}{L}$ d) $\left(\frac{C(V_1^2-V_2^2)}{L}\right)^{\frac{1}{2}}$

969. The capacity of a parallel plate condenser is $15\mu\, F$, when the distance between its plates is 6 cm. If the distance between the plates is reduced to 2 cm, then the capacity of this parallel plate condenser will be

a) $15\mu\, F$ b) $30\mu\, F$ c) $45\mu\, F$ d) $60\mu\, F$

970. A parallel plate condenser is filled with two dielectrics as shown. Area of each plate is $A\, metre^2$ and the separation is $t\, metre$. The dielectric constants are k_1 and k_2 respectively. Its capacitance in farad will be



a) $\frac{\varepsilon_0 A}{t}(k_1+k_2)$ b) $\frac{\varepsilon_0 A}{t}.\frac{k_1+k_2}{2}$ c) $\frac{2\varepsilon_0 A}{t}(k_1+k_2)$ d) $\frac{\varepsilon_0 A}{t}.\frac{k_1-k_2}{2}$

971. Two equal and opposite charge $(+q$ and $-q)$ are situated at x distance from each other, the value of potential at very far point will depend upon

a) Only on q b) Only on x c) On qx d) On $\frac{q}{x}$

972. In identical mercury droplets charged to the same potential V coalesce to form a single bigger drop. The potential of new drop will be

a) $\frac{V}{n}$ b) nV c) nV^2 d) $n^{2/3}V$

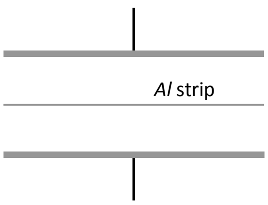
973. Dipole is placed parallel to the electric field. If Q is the work done in rotating the dipole by 60°, then work done in rotating it by 180° is

a) $2W$ b) $3W$ c) $4W$ d) $W/2$

974. An insulated sphere of radius R has charge density ρ. The electric field at a distance r from the centre of the sphere $(r< R)$

a) $\frac{\rho r}{3\varepsilon_0}$ b) $\frac{\rho R}{3\varepsilon_0}$ c) $\frac{\rho r}{\varepsilon_0}$ d) $\frac{\rho R}{\varepsilon_0}$

975. As shown in the figure, a very thin sheet of aluminium is placed in between the plates of the condenser. Then the capacity

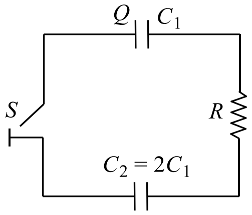


a) Will increase
b) Will decrease
c) Remains unchanged
d) May increase or decrease

976. An electric dipole consists of two opposite charges each 0.05μC separated by 30 mm. The dipole is placed in an uniform external electric field of $10^6 NC^{-1}$. The maximum torque exerted by the field on the dipole is

a) $6\times10^{-3}N-m$ b) $3\times10^{-3}N-m$ c) $15\times10^{-3}N-m$ d) $1.5\times10^{-3}N-m$

977. Two capacitors C_1 and $C_2 = 2C_1$ are connected in a circuit with a switch between them as shown in the figure. Initially the switch is open and C_1 holds charge Q. The switch is closed. At steady state, the charge on each capacitor will be



a) $Q, 2Q$ b) $Q/3, 2Q/3$ c) $3Q/2, 3Q$ d) $2Q/3, 4Q/3$

978. Two charges $+6\ \mu C$ and $+15\ \mu C$ are placed along the x −axis at $x = 0$ and $x = 2$m respectively A negative charge is placed between them such that the resultant force on it is zero. The negative charge is placed at

a) $x = 0.775m$ b) $x = 1.2m$
c) $x = 0.5m$ d) Position depends on the amount of charge

979. n identical capacitors each of capacitance C when connected in parallel give the effective capacitance 90 μF and when connected in series give 2.5 μF. Then the values of n and C respectively are

a) 6 and 15 μF b) 5 and 18 μF c) 15 and 6 μF d) 18 and 5 μF

980. The ratio of electric field and potential (E/V) at mid-point of electric dipole, for which separation $l$is

a) $1/l$ b) l c) $2/l$ d) None of these

981. When we touch the terminals of a high voltage capacitor, even after a high voltage has been cut off, then the capacitor has a tendency to

a) Restore energy b) Discharge energy c) Affect dangerously d) Both (b) and (c)

982. The energy stored in a condenser of capacity C which has been raised to a potential V is given by

a) $\frac{1}{2}CV$ b) $\frac{1}{2}CV^2$ c) CV d) $\frac{1}{2VC}$

983. A parallel plate capacitor with air between the plates has a capacitance of 9 pF. The separation between its plates is $'d'$. The space between the plates is now filled with two dielectrics. One of the dielectrics has dielectric constant $k_1 = 3$ and thickness $d/3$ while the other one has dielectric constant $k_2 = 6$ and thickness $2d/3$. Capacitance of the capacitor is now

a) 45 pF b) 40.5 pF c) 20.25 pF d) 1.8 pF

984. On increasing the plate separation of a charged condenser, the energy

a) Increases b) Decreases c) Remains unchanged d) Becomes zero

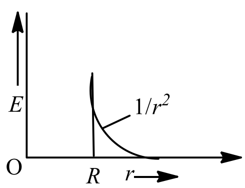
985. Two metallic charged spheres whose radii are 20cm and 10 cm respectively, have each 150 $micro-coulomb$ positive charge. The common potential after they are connected by a conducting wire is

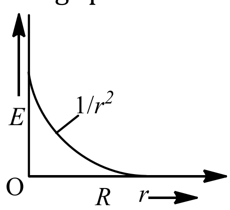
a) $9 \times 10^6\ volts$ b) $4.5 \times 10^6\ volts$ c) $1.8 \times 10^7\ volts$ d) $13.5 \times 10^6\ volts$

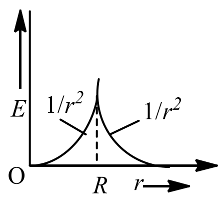
986. Under the action of a given coulombic force the acceleration of an electron is 2.5×10^{22}m/s^2. Then the magnitude of acceleration of a proton under the action of same force is nearly

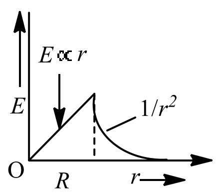
a) 1.6×10^{-19}m/s^2 b) 9.1×10^{31}m/s^2 c) 1.5×10^{19}m/s^2 d) 1.6×10^{27}m/s^2

987. Which of the following plots represents the variation of the electric field with distance from the centre of a uniformly charged non-conducting sphere of radius R?

a) 

b) 

c) 

d) 

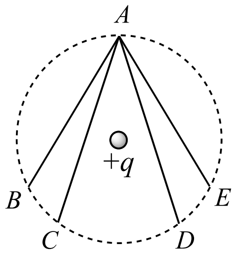
988. A charged particle is suspended in equilibrium in a uniform vertical electric field of intensity 20000 V/m. If mass of the particle is $9.6 \times 10^{-16}\ kg$, the charge on it and excess number of electrons on the particle are respectively ($g = 10\ m/s^2$)

a) $4.8 \times 10^{-19}C, 3$ b) $5.8 \times 10^{-19}C, 4$ c) $3.8 \times 10^{-19}C, 2$ d) $2.8 \times 10^{-19}C, 1$

989. Charge q is uniformly distributed over a thin half ring of radius R. The electric field at the centre of the ring is

a) $\frac{q}{2\pi^2\varepsilon_0 R^2}$ b) $\frac{q}{4\pi^2\varepsilon_0 R^2}$ c) $\frac{q}{4\pi\varepsilon_0 R^2}$ d) $\frac{q}{2\pi\varepsilon_0 R^2}$

990. In the electric field of point charge q, a certain charge is carried from point A to B, C, D and E. Then the work done



a) Is least along the path AB b) Is least along the path AD
c) Is zero along all the parts AB, AC, AD and AE d) Is least along AE

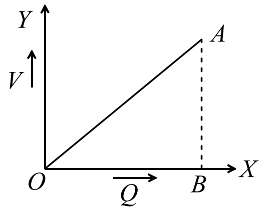
991. Two plates are 2 cm apart, a potential difference of 10 $volt$ is applied between them, the electric field between the plates is

a) 20 N/C b) 500 N/C c) 5 N/C d) 250 N/C

992. Electric charge of $1\mu C$, $-1\mu C$ and $2\mu C$ are placed in air at the corners A, B and C respectively of an equilateral triangle ABC having length of each side 10 cm. The resultant force on charge at C is

a) $0.9N$ b) $1.8N$ c) $2.7N$ d) $3.6N$

993. Charge Q on a capacitor varies with voltage V as shown in the figure, where Q is taken along the X-axis and V along the Y-axis. The area of triangle OAB represents



a) Capacitance b) Capacitive reactance
c) Magnetic field between the plates d) Energy stored in the capacitor

994. The unit of electric field is not equivalent to

a) N/C b) J/C c) V/m d) $J/C-m$

995. A particle has a mass 400 times than that of the electron and charge is double than that of a electron. It is accelerated by $5V$ of potential difference. Initially the particle was at rest, then its final kinetic energy will be

a) 5 eV b) 10 eV c) 100 eV d) 2000 eV

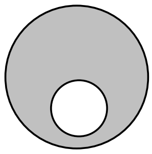
996. The electric potential inside a conducting sphere

a) Increases from centre to surface b) Decreases from centre to surface
c) Remains constant from centre to surface d) Is zero at every point inside

997. An air filled parallel plate capacitor the capacity C. If distance between plates is doubled and it is immersed in a liquid then capacity becomes twice. Dielectric constant of the liquid is

a) 1 b) 2 c) 3 d) 4

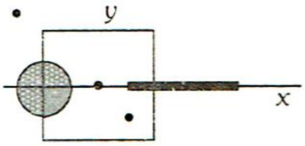
998. A spherical portion has been removed from a solid sphere having a charge distributed uniformly in its volume in the figure. The electric field inside the emptied space is



a) Zero everywhere b) Non-zero and uniform
c) Non-uniform d) Zero only at its center

999. In nature, the electric charge of any system is always equal to
a) Half integral multiple of the least amount of charge
b) Zero
c) Square of the least amount of charge
d) Integral multiple of the least amount of charge

1000. A disk of radius $a/4$ having a uniformly distributed charge $6C$ is placed in the $x-y$ plane with its centre at $(-a/2, 0,0)$. A rod of length a carrying a uniformly distributed charge $8C$ is placed on the x-axis from $x = a/4$ to $x = 5a/4$. Two point charges $-7C$ and $3C$ are placed at $(a/4, -a/4,0)$ and $(-3a/4,3a/4,0)$, respectively. Consider a cubical surface formed by six surfaces $x = \pm a/2, y = \pm a/2, z = \pm a/2$. The electric flux through this cubical surface is



a) $\frac{-2C}{\varepsilon_0}$
b) $\frac{2C}{\varepsilon_0}$
c) $\frac{10C}{\varepsilon_0}$
d) $\frac{12C}{\varepsilon_0}$

1001. Two spherical conductors B and C having equal radii and carrying equal charges in them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is
a) $F/4$
b) $3F/4$
c) $F/8$
d) $3F/8$

1002. Two condensers of capacities $2C$ and C are joined in parallel and charged upto potential V. The battery is removed and the condenser of capacity C is filled completely with a medium of dielectric constant K. The p.d. across the capacitors will now be
a) $\frac{3V}{K+2}$
b) $\frac{3V}{K}$
c) $\frac{V}{K+2}$
d) $\frac{V}{K}$

1003. A parallel plate air capacitor is charged and then isolated. When a dielectric material is inserted between the plates of the capacitor, then which of the following does not change
a) Electric field between the plates
b) Potential difference across the plates
c) Charge on the plates
d) Energy stored in the capacitor

1004. Four capacitor of equal capacitance have an equivalent capacitance C_1 when connected in series and an equivalent capacitance C_2 when connected in parallel. The ratio C_1/C_2 is
a) 1/4
b) 1/16
c) 1/8
d) 1/12

1005. The potential energy of a charged parallel plate capacitor is U_0. if a slab of dielectric constant k is inserted between the plates, than the new potential energy will be
a) $\frac{U_0}{k}$
b) $U_0 k^2$
c) $\frac{U_0}{k^2}$
d) U_0^2

1006. A sample of HCl gas is placed in an electric field of $3 \times 10^4 \text{NC}^{-1}$. The dipole moment of each HCl molecule is 6×10^{-30}Cm. The maximum torque that can act on a molecule is
a) $2 \times 10^{-34}\text{C}^2\text{mN}^{-1}$
b) 2×10^{-34}Nm
c) 18×10^{-26}Nm
d) $0.5 \times 10^{34}\text{C}^{-2}\text{Nm}^{-1}$

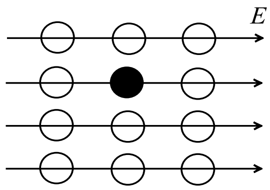
1007. If the distance between parallel plates of a capacitor is halved and dielectric constant is doubled then the capacitance
a) Decreases two times
b) Increases two times
c) Increases four times
d) Remains the same

1008. Let $P(r) = \frac{Q}{\pi R^4} r$ be the charge density distribution for a solid sphere of radius R and total charge Q. For a point $'p'$ inside the sphere at distance r_1 from the centre of the sphere, the magnitude of electric field is
a) 0
b) $\frac{Q}{4\pi \epsilon_0 r_1^2}$
c) $\frac{Q r_1^2}{4\pi \epsilon_0 R^4}$
d) $\frac{Q r_1^2}{3\pi \epsilon_0 R^4}$

1009. Electric intensity due to an electric dipole varies with distance (r) as $E \propto r^n$, where n is

a) -3 b) -2 c) -1 d) Zero

1010. There is a uniform electric field of intensity E which is as shown. How many labelled points have the same electric potential as the fully shaded point



a) 2 b) 3 c) 8 d) 11

1011. A $500\mu F$ capacitor is charged at a steady rate of $100\mu C$/second. The potential difference across the capacitor will be 10 V after an interval of

a) 5 sec b) 25 sec c) 20 sec d) 50 sec

1012. Equipotential surfaces associated with an electric field which is increasing in magnitude along the x-direction are

a) Planes parallel to yz-plane
b) Planes parallel to xy-plane
c) Planes parallel to xz-plane
d) Coaxial cylinders of increasing radii around the x-axis

1013. Two point charges repel each other with a force of 100 N. One of the charges is increased by 10% and other is reduced by 10%. The new force of repulsion at the same distance would be

a) 100 N b) 121 N c) 99 N d) None of these

1014. Kinetic energy of an electron accelerated in a potential difference of 100 V is

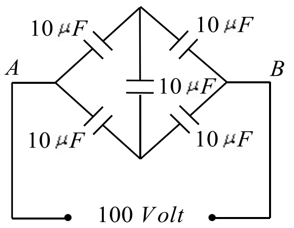
a) $1.6 \times 10^{-17} J$ b) $1.6 \times 10^{21} J$ c) $1.6 \times 10^{-29} J$ d) $1.6 \times 10^{-34} J$

1015. An electric dipole coincides on Z-axis and its mid point is on origin of the co-ordinate system. The electric field at an axial point at a distance z from origin is $\vec{E}_{(z)}$ and electric field at an equatorial point at a distance y from origin is $\vec{E}_{(y)}$ Here

$z = y \gg a$, so $\left|\frac{\vec{E}_{(z)}}{\vec{E}_{(y)}}\right| = \cdots$

a) 1 b) 4 c) 3 d) 2

1016. Five capacitors of $10\mu F$ capacity each are connected to a $d.c.$ potential of 100 $volts$ as shown in the adjoining figure. The equivalent capacitance between the points A and B will be equal to



a) $40\mu F$ b) $20\mu F$ c) $30\mu F$ d) $10\mu F$

1017. Two positive point charges of 12 and 5 microcoulombs, are placed 10cm apart in air. The work needed to bring them 4cm closer is

a) 2.4 J b) 3.6 J c) 4.8 J d) 6.0 J

1018. A point charge is kept at the centre of a metallic insulated spherical shell. Then

a) Electric field out side the sphere is zero
b) Electric field inside the sphere is zero
c) Net induced charge on the sphere is zero
d) Electric potential inside the sphere is zero

1019. A charge q is placed at the centre of the line joining two equal charges Q. The system of the three charges will be in equilibrium, if q is equal to

a) $-\frac{Q}{2}$ b) $-\frac{Q}{4}$ c) $+\frac{Q}{4}$ d) $+\frac{Q}{2}$

PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

: ANSWER KEY :

1)	a	2)	a	3)	d	4)	d	153)	d	154)	d	155)	d	156)	a
5)	d	6)	c	7)	d	8)	c	157)	c	158)	c	159)	a	160)	c
9)	b	10)	a	11)	c	12)	c	161)	c	162)	d	163)	a	164)	c
13)	b	14)	c	15)	b	16)	a	165)	b	166)	b	167)	d	168)	c
17)	a	18)	b	19)	c	20)	c	169)	b	170)	b	171)	c	172)	c
21)	a	22)	c	23)	c	24)	c	173)	d	174)	b	175)	c	176)	b
25)	c	26)	d	27)	a	28)	a	177)	a	178)	a	179)	a	180)	d
29)	a	30)	d	31)	d	32)	c	181)	c	182)	a	183)	a	184)	b
33)	c	34)	a	35)	d	36)	a	185)	c	186)	b	187)	b	188)	d
37)	a	38)	d	39)	c	40)	c	189)	d	190)	c	191)	c	192)	a
41)	a	42)	b	43)	d	44)	a	193)	c	194)	c	195)	b	196)	d
45)	d	46)	c	47)	d	48)	c	197)	b	198)	c	199)	c	200)	d
49)	d	50)	b	51)	b	52)	b	201)	a	202)	c	203)	b	204)	a
53)	b	54)	a	55)	d	56)	a	205)	c	206)	a	207)	a	208)	c
57)	d	58)	d	59)	d	60)	c	209)	c	210)	b	211)	a	212)	d
61)	a	62)	c	63)	b	64)	b	213)	a	214)	c	215)	c	216)	b
65)	c	66)	c	67)	c	68)	c	217)	c	218)	d	219)	b	220)	d
69)	a	70)	c	71)	c	72)	c	221)	d	222)	b	223)	b	224)	c
73)	c	74)	a	75)	c	76)	b	225)	d	226)	b	227)	a	228)	d
77)	a	78)	d	79)	b	80)	c	229)	c	230)	d	231)	b	232)	d
81)	a	82)	c	83)	c	84)	a	233)	c	234)	b	235)	c	236)	b
85)	b	86)	d	87)	d	88)	b	237)	d	238)	a	239)	a	240)	c
89)	c	90)	b	91)	b	92)	d	241)	c	242)	a	243)	c	244)	c
93)	c	94)	a	95)	a	96)	b	245)	a	246)	d	247)	c	248)	b
97)	b	98)	b	99)	b	100)	c	249)	b	250)	c	251)	c	252)	a
101)	c	102)	a	103)	d	104)	a	253)	b	254)	b	255)	a	256)	b
105)	d	106)	c	107)	c	108)	c	257)	d	258)	d	259)	c	260)	c
109)	d	110)	d	111)	d	112)	a	261)	b	262)	a	263)	a	264)	c
113)	d	114)	d	115)	d	116)	c	265)	d	266)	b	267)	b	268)	c
117)	a	118)	c	119)	d	120)	a	269)	a	270)	a	271)	a	272)	a
121)	b	122)	d	123)	d	124)	c	273)	d	274)	b	275)	a	276)	d
125)	c	126)	c	127)	c	128)	a	277)	a	278)	c	279)	b	280)	d
129)	a	130)	c	131)	d	132)	b	281)	c	282)	d	283)	a	284)	d
133)	c	134)	b	135)	a	136)	c	285)	c	286)	a	287)	a	288)	a
137)	b	138)	d	139)	c	140)	b	289)	a	290)	d	291)	d	292)	d
141)	b	142)	d	143)	a	144)	a	293)	d	294)	a	295)	c	296)	c
145)	a	146)	c	147)	d	148)	b	297)	b	298)	b	299)	c	300)	c
149)	a	150)	c	151)	b	152)	b	301)	c	302)	c	303)	d	304)	b

305)	b	306)	a	307)	c	308)	a
309)	d	310)	d	311)	c	312)	d
313)	a	314)	c	315)	b	316)	c
317)	c	318)	d	319)	b	320)	d
321)	a	322)	b	323)	d	324)	c
325)	b	326)	c	327)	c	328)	b
329)	c	330)	b	331)	c	332)	a
333)	d	334)	c	335)	b	336)	b
337)	a	338)	d	339)	d	340)	c
341)	a	342)	b	343)	a	344)	b
345)	a	346)	d	347)	b	348)	b
349)	b	350)	b	351)	b	352)	a
353)	c	354)	b	355)	a	356)	b
357)	b	358)	c	359)	c	360)	c
361)	b	362)	a	363)	a	364)	d
365)	a	366)	d	367)	d	368)	d
369)	c	370)	c	371)	c	372)	b
373)	d	374)	c	375)	c	376)	b
377)	d	378)	a	379)	b	380)	c
381)	a	382)	b	383)	c	384)	a
385)	b	386)	a	387)	a	388)	a
389)	c	390)	c	391)	b	392)	c
393)	d	394)	a	395)	a	396)	a
397)	d	398)	d	399)	c	400)	d
401)	d	402)	d	403)	c	404)	d
405)	a	406)	b	407)	a	408)	b
409)	d	410)	c	411)	d	412)	b
413)	a	414)	b	415)	c	416)	d
417)	b	418)	d	419)	a	420)	b
421)	a	422)	d	423)	d	424)	b
425)	c	426)	b	427)	a	428)	d
429)	a	430)	a	431)	c	432)	a
433)	a	434)	c	435)	b	436)	b
437)	c	438)	b	439)	b	440)	c
441)	c	442)	b	443)	b	444)	d
445)	b	446)	c	447)	b	448)	b
449)	a	450)	d	451)	b	452)	b
453)	d	454)	a	455)	d	456)	d
457)	b	458)	a	459)	b	460)	a
461)	c	462)	d	463)	d	464)	c
465)	a	466)	a	467)	b	468)	b
469)	d	470)	b	471)	a	472)	d
473)	b	474)	a	475)	c	476)	b
477)	c	478)	c	479)	c	480)	c
481)	c	482)	c	483)	a	484)	a
485)	c	486)	c	487)	a	488)	a
489)	c	490)	a	491)	c	492)	b

493)	b	494)	b	495)	a	496)	d
497)	c	498)	c	499)	a	500)	a
501)	a	502)	d	503)	a	504)	a
505)	d	506)	b	507)	d	508)	c
509)	c	510)	a	511)	a	512)	b
513)	c	514)	b	515)	a	516)	c
517)	d	518)	b	519)	d	520)	b
521)	b	522)	c	523)	b	524)	b
525)	c	526)	b	527)	c	528)	a
529)	b	530)	d	531)	d	532)	d
533)	c	534)	b	535)	d	536)	d
537)	c	538)	b	539)	b	540)	b
541)	d	542)	a	543)	c	544)	b
545)	a	546)	a	547)	a	548)	a
549)	b	550)	b	551)	b	552)	b
553)	c	554)	a	555)	b	556)	c
557)	c	558)	b	559)	d	560)	c
561)	b	562)	c	563)	c	564)	b
565)	b	566)	c	567)	b	568)	a
569)	c	570)	c	571)	c	572)	b
573)	c	574)	c	575)	a	576)	b
577)	c	578)	d	579)	a	580)	d
581)	c	582)	b	583)	b	584)	a
585)	b	586)	d	587)	d	588)	a
589)	d	590)	b	591)	d	592)	d
593)	c	594)	d	595)	b	596)	d
597)	a	598)	c	599)	a	600)	a
601)	a	602)	a	603)	b	604)	a
605)	c	606)	c	607)	d	608)	d
609)	b	610)	a	611)	d	612)	b
613)	a	614)	b	615)	c	616)	d
617)	c	618)	c	619)	b	620)	c
621)	a	622)	c	623)	c	624)	c
625)	b	626)	c	627)	b	628)	d
629)	d	630)	b	631)	d	632)	b
633)	a	634)	c	635)	b	636)	c
637)	a	638)	b	639)	d	640)	b
641)	a	642)	a	643)	d	644)	b
645)	b	646)	a	647)	c	648)	d
649)	a	650)	d	651)	a	652)	a
653)	c	654)	a	655)	b	656)	c
657)	a	658)	b	659)	a	660)	a
661)	d	662)	a	663)	d	664)	b
665)	c	666)	b	667)	d	668)	c
669)	b	670)	b	671)	d	672)	a
673)	a	674)	a	675)	d	676)	d
677)	b	678)	d	679)	d	680)	a

681)	a	682)	a	683)	c	684)	b
685)	d	686)	c	687)	b	688)	a
689)	a	690)	d	691)	d	692)	c
693)	b	694)	c	695)	d	696)	a
697)	c	698)	c	699)	c	700)	d
701)	d	702)	b	703)	a	704)	a
705)	b	706)	d	707)	a	708)	c
709)	c	710)	b	711)	b	712)	c
713)	d	714)	d	715)	a	716)	b
717)	c	718)	d	719)	c	720)	b
721)	a	722)	d	723)	d	724)	b
725)	b	726)	c	727)	c	728)	c
729)	c	730)	d	731)	b	732)	c
733)	c	734)	b	735)	d	736)	b
737)	c	738)	b	739)	c	740)	d
741)	a	742)	b	743)	d	744)	c
745)	a	746)	a	747)	a	748)	a
749)	a	750)	a	751)	d	752)	c
753)	b	754)	d	755)	a	756)	d
757)	a	758)	d	759)	a	760)	c
761)	c	762)	c	763)	b	764)	d
765)	a	766)	d	767)	d	768)	a
769)	b	770)	a	771)	c	772)	b
773)	b	774)	c	775)	d	776)	b
777)	a	778)	c	779)	c	780)	c
781)	c	782)	d	783)	a	784)	c
785)	b	786)	b	787)	a	788)	c
789)	c	790)	d	791)	b	792)	b
793)	d	794)	c	795)	b	796)	d
797)	d	798)	b	799)	c	800)	d
801)	a	802)	a	803)	c	804)	c
805)	a	806)	a	807)	a	808)	c
809)	d	810)	b	811)	d	812)	b
813)	b	814)	b	815)	c	816)	c
817)	a	818)	a	819)	b	820)	c
821)	c	822)	a	823)	d	824)	c
825)	c	826)	c	827)	b	828)	d
829)	a	830)	d	831)	b	832)	c
833)	a	834)	c	835)	d	836)	a
837)	a	838)	b	839)	b	840)	a
841)	d	842)	b	843)	b	844)	c
845)	d	846)	d	847)	b	848)	a
849)	b	850)	c	851)	d	852)	a

853)	b	854)	d	855)	c	856)	d
857)	a	858)	c	859)	c	860)	c
861)	d	862)	c	863)	a	864)	d
865)	c	866)	b	867)	c	868)	d
869)	a	870)	b	871)	a	872)	b
873)	c	874)	a	875)	d	876)	c
877)	a	878)	b	879)	d	880)	d
881)	a	882)	d	883)	c	884)	a
885)	a	886)	b	887)	c	888)	b
889)	c	890)	c	891)	c	892)	a
893)	a	894)	a	895)	b	896)	a
897)	c	898)	d	899)	b	900)	d
901)	a	902)	d	903)	a	904)	d
905)	b	906)	d	907)	a	908)	d
909)	a	910)	a	911)	b	912)	c
913)	b	914)	d	915)	b	916)	c
917)	a	918)	b	919)	b	920)	c
921)	c	922)	a	923)	d	924)	d
925)	d	926)	a	927)	a	928)	b
929)	d	930)	d	931)	d	932)	d
933)	c	934)	a	935)	c	936)	c
937)	a	938)	d	939)	b	940)	a
941)	a	942)	a	943)	d	944)	a
945)	b	946)	a	947)	c	948)	d
949)	a	950)	d	951)	a	952)	a
953)	b	954)	b	955)	c	956)	a
957)	a	958)	b	959)	b	960)	a
961)	a	962)	c	963)	d	964)	b
965)	b	966)	b	967)	a	968)	d
969)	c	970)	b	971)	c	972)	d
973)	c	974)	a	975)	c	976)	d
977)	b	978)	a	979)	a	980)	d
981)	d	982)	b	983)	b	984)	a
985)	a	986)	c	987)	d	988)	a
989)	a	990)	c	991)	b	992)	b
993)	d	994)	b	995)	b	996)	c
997)	d	998)	b	999)	d	1000)	a
1001)	d	1002)	a	1003)	c	1004)	b
1005)	a	1006)	c	1007)	c	1008)	c
1009)	a	1010)	b	1011)	d	1012)	a
1013)	c	1014)	a	1015)	d	1016)	d
1017)	b	1018)	c	1019)	b		

PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

: HINTS AND SOLUTIONS :

1 **(a)**

Here, $q = \pm 6.0\text{nC} = \pm 6.0 \times 10^{-9}\text{C}$

$2\,a = 6\text{ cm} = 6 \times 10^{-2}\text{m}$

$r = 4\text{ cm}$(on equatorial line)

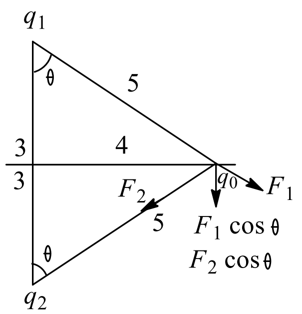
$= 4 \times 10^{-2}\text{m}$

$q_0 = 2\text{ nC}$

$= 2 \times 10^{-9}\,C, F = ?$

$F = F_1 \cos\theta + F_2 \cos\theta$

$= 2 \times \frac{1}{4\pi\varepsilon_0}\frac{qq_0}{r^2}\cos\theta$



$= 2 \times 9 \times 10^9 \times \frac{6\times10^{-9}\times2\times10^{-9}}{(5\times10^{-2})^2} \times \frac{3}{5}$

$= 5.18 \times 10^{-5}\text{N}$

$\vec{F} = -51.8\hat{\text{j}}\mu\text{N}$

2 **(a)**

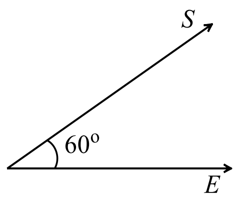
The electric intensity outside a charged sphere.

$$E = \frac{\sigma R^2}{\varepsilon_0 r^2}$$

3 **(d)**

Force acting on the charged particle $= q\vec{E}$

Work done in moving a distance S,



$W = q\vec{E}.\vec{S} = (qE) \times S \times \cos\theta$

$10J = (0.5\,C) \times E \times 2\cos 60^o$

$\Rightarrow E = 10 \times 2 = 20\,NC^{-1} = 20\,Vm^{-1}$

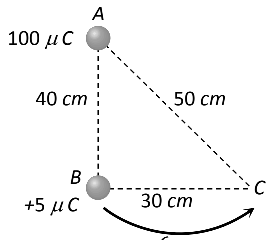
4 **(d)**

$$\frac{\sigma_{small}}{\sigma_{Big}} = \frac{q}{Q} \times \frac{R^2}{r^2} = \frac{q}{(nq)} \times \frac{\left(n^{1/3}r\right)^2}{r^2} = n^{-1/3}$$

$$= (64)^{-1/3} = \frac{1}{4}$$

5 **(d)**

Work done in displacing charge of $5\mu C$ from B to C is $W = 5 \times 10^{-6}(V_C - V_B)$ where



$V_B = 9 \times 10^9 \times \frac{100 \times 10^{-6}}{0.4} = \frac{9}{4} \times 10^6 V$

and $V_C = 9 \times 10^9 \times \frac{100\times10^{-6}}{0.5} = \frac{9}{5} \times 10^6 V$

so $W = 5 \times 10^{-6} \times \left(\frac{9}{5} \times 10^6 - \frac{9}{4} \times 10^6\right) = -\frac{9}{4}\,J$

6 **(c)**

Here, $\theta = 60^0, \text{E} = 10^5\text{NC}^{-1}$

$\tau = 8\sqrt{3}\,\text{Nm}, q = ?, 2a = 2\text{cm} = 2 \times 10^{-2}\text{m}$

From $\tau = pE\sin\theta = q(2a)\,E\sin\theta$

$q = \frac{\tau}{2aE\sin\theta} = \frac{8\sqrt{3}}{2\times10^{-2}\times10^5\times\sin 60^\circ}$

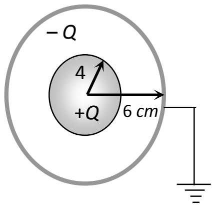
$= \frac{8\sqrt{3}}{2\times10^3\times\sqrt{3}/2}$

$q = 8 \times 10^{-3}\text{ C}$

7 **(d)**

Suppose charge on inner sphere is $+Q$ as shown.

Potential on inner sphere



$$V=\frac{Q}{4}-\frac{Q}{6}$$

$$\Rightarrow 3=Q\left(\frac{1}{4}-\frac{1}{6}\right)\Rightarrow Q=36\ e.s.u$$

8 **(c)**

Solid angle, $\Omega=\frac{A}{r^2}$

$$=\frac{\pi R^2}{r^2}\Rightarrow\frac{\pi\times(1)^2}{10^6}\Rightarrow 0.00018^{\circ}$$

9 **(b)**

$F=\frac{q_1q_2}{4\pi\varepsilon_0r^2}=\frac{q_1(q_1-q_2)}{4\pi\varepsilon_0r^2}$

$\therefore F$ will be maximum, if

$\frac{dF}{dq_1}=0$

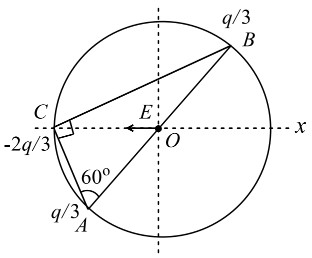
$\therefore q-2q_1=0$ or $q_1=q/2$ or $q_1/q=0.5$

10 **(a)**

$$E=\frac{V}{d}=\frac{30-(-10)}{(2\times10^{-2})}=2000\ V/m$$

11 **(c)**

Net electric field due to both charges $q/3$, will get cancelled. Electric field due to $\left(\frac{-2q}{3}\right)$ will be directed in −ve axis



$$E=\frac{k\left(\frac{2q}{3}\right)}{R^2}\Rightarrow E=\frac{q}{6\pi\varepsilon_0R^2}$$

P.E. of system $=\frac{K\left(\frac{q}{3}\right)^2}{2R}+\frac{K\frac{q}{3}\left(-\frac{2q}{3}\right)}{2R\sin60^{o}}+\frac{K\frac{q}{3}\left(-\frac{2q}{3}\right)}{2R\cos60^{o}}$

P.E. of system $\neq 0$

Force between B and C

$$F=\frac{K\left(\frac{2q}{3}\right)\left(\frac{q}{3}\right)}{(2R\sin60^{o})^2}=\frac{4\times2Kq^2}{9\times4\times3R^2}$$

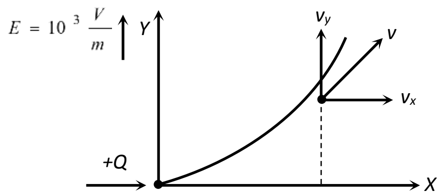
$$=\frac{2q^2}{9\times3\times4\pi\varepsilon_0R^2}$$

(attractive) $=\frac{1}{54}\frac{q^2}{\pi\in_0R^2}$

Potential at O, $V=\frac{K\left(\frac{q}{3}+\frac{q}{3}-\frac{2q}{3}\right)}{R}=0$

12 **(c)**

Body moves along the parabolic path



For vertical motion : By using $v=u+at$

$$\Rightarrow v_y=0+\frac{QE}{m}.t=\frac{10^{-6}\times10^3}{10^{-3}}\times10=10m/sec$$

For horizontal motion – It's horizontal velocity remains the same $i.e.$ after 10 sec, horizontal velocity of body $v_x=10m/sec$

Velocity after 10 sec $v=\sqrt{v_x^2+v_y^2=10\sqrt{2}}\ m/sec$

13 **(b)**

Capacitance of a cylindrical capacitor $=\frac{2\pi\varepsilon_0L}{\ln(b/a)}$

Energy stored in the capacitor

$$\frac{1}{2}\frac{Q^2}{C}=\frac{1}{2}\frac{Q^2\ln(b-a)}{2\pi\varepsilon_0L}=[\text{const}]\frac{Q^2}{L}$$

If the charge is doubled and length is doubled,

$[const]\frac{Q'^2}{L'}=\frac{4}{2}\left(\frac{Q^2}{L}\right)=2$ times the energy

14 **(c)**

Electric field

$$E=-\frac{d\phi}{\text{dt}}=-2ar$$

By Gauss's theorem

$$E(4\pi r^2)=\frac{q}{\varepsilon_0}$$

$$q=-8\pi\varepsilon_0ar^2$$

$$\rho=\frac{dq}{dV}=\frac{dq}{dr}\times\frac{dr}{dV}$$

$$=(-24\pi\varepsilon_0ar^2)\times\frac{1}{4\pi r^2}$$

$$\rho=-6\varepsilon_0a$$

15 **(b)**

Because metals are good conductor

16 **(a)**

$$E=-\frac{dV}{dx}=-\frac{d}{dx}(5x^2+10x-9)=-10x-10$$

$\therefore (E)_{x=1}=-10\times1-10=-20V/m$

17 **(a)**

Work done $W=Q(V_B-V_A)\Rightarrow(V_B-V_A)=\frac{W}{Q}$

$$= \frac{10 \times 10^{-3}}{5 \times 10^{-6}} J/C = 2\ kV$$

18 **(b)**

The given arrangement is equivalent to the parallel combination of three identical capacitors.

Hence equivalent capacitance $= 3C = 3\frac{\varepsilon_0 A}{d}$

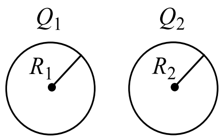
19 **(c)**

Inside a conducting body, potential is same everywhere and equals to the potential of it's surface

20 **(c)**

$c \propto r \Rightarrow C = 4\pi\varepsilon_0 R$

21 **(a)**



Let Q_1 and Q_2 are the charges on sphere of radii R_1 and R_2 respectively. Surface charge density $\sigma = \frac{\text{Charge}}{\text{Area}}$

According to given problem, $\sigma_1 = \sigma_2$

$$\frac{Q_1}{4\pi R_1^2} = \frac{Q_2}{4\pi R_2^2}$$

$\therefore \frac{Q_1}{Q_2} = \frac{R_1^2}{R_2^2}$ ...(i)

In case of a charged sphere, $V_s = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$

$$\therefore V_1 = \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1}, V_2 = \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2}$$

$$\Rightarrow \frac{V_1}{V_2} = \frac{Q_1}{R_1} \times \frac{R_2}{Q_2} = \frac{Q_1}{Q_2} \times \frac{R_2}{R_1}$$

$= \left(\frac{R_1}{R_2}\right)^2 \times \left(\frac{R_2}{R_1}\right) = \frac{R_1}{R_2}$ ...[Using(i)]

22 **(c)**

The magnitude of electric field in the annular region of a charged cylindrical capacitor is given by $E = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$ where λ is the charge per unit length and r is the distance from the axis of the cylinder.

Thus $E \propto \frac{1}{r}$

23 **(c)**

Potential energy depends upon the charge at peaks of irregularities. Since every event in universe leads to the minimisation of energy

24 **(c)**

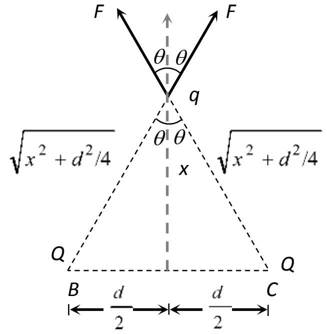
By using $Q = ne \Rightarrow Q = +2e = +3.2 \times 10^{-19}C$

25 **(c)**

Suppose third charge is similar to Q and it is q

So net force on it

$F_{net} = 2F\cos\theta$



Where $F = \frac{1}{4\pi\varepsilon_0}.\frac{Qq}{\left(x^2+\frac{d^2}{4}\right)}$ and $\cos\theta = \frac{x}{\sqrt{x^2+\frac{d^2}{4}}}$

$$\therefore F_{net} = 2 \times \frac{1}{4\pi\varepsilon_0}.\frac{Qq}{\left(x^2+\frac{d^2}{4}\right)} \times \frac{x}{\left(x^2+\frac{d^2}{4}\right)^{1/2}}$$

$$= \frac{2Qqx}{4\pi\varepsilon_0\left(x^2+\frac{d^2}{4}\right)^{3/2}}$$

For F_{net} to be maximum $\frac{dF_{net}}{dx} = 0$

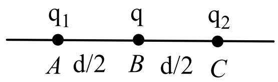
$$i.e. \frac{d}{dx}\left[\frac{2Qqx}{4\pi\varepsilon_0\left(x^2+\frac{d^2}{4}\right)^{3/2}}\right] = 0$$

$$\text{or} \left[\left(x^2+\frac{d^2}{4}\right)^{-3/2} - 3x^2\left(x^2+\frac{d^2}{4}\right)^{-5/2}\right] = 0$$

$$i.e.\ x = \pm\frac{d}{2\sqrt{2}}$$

26 **(d)**

For equilibrium, we have



$$F_{AB} + F_{AC} = 0$$

or $\frac{1}{4\pi\varepsilon_0}\frac{q_1 q}{(d/2)^2} + \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{d^2} = 0$

Given, $q_1 = q_2 = -1\mu C$

So, $-\frac{q}{(d/2)^2} + \frac{1}{d^2} = 0$

or $q = \frac{1}{4} = 0.25$ C

27 **(a)**

Initial energy $= \frac{1}{2} \times 1 \times 10^{-6} \times (30)^2 = 450 \times 10^{-6}\,J$

Final energy $= \frac{1}{2}(C_1 + C_2)V_{common}^2$ $\left[\because V = \frac{V_1C_1+V_2C_2}{C_1+C_2}\right]$

$$= \frac{1}{2} \times 3 \times 10^{-6} \times (10)^2$$

$= 150 \times 10^{-6}\,J$

Loss of energy $= (450 - 150) \times 10^{-6} J = 300 \times 10^{-6} J$
$= 300 \mu J$

28 **(a)**

From Gauss's law,

$$\frac{\text{charge enclosed}}{\varepsilon_0}$$

=Flux leaving the surface

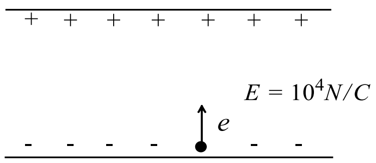
$$\frac{q}{\varepsilon_0} = \phi_2 - \phi_1$$

$$\Longrightarrow q = (\phi_2 - \phi_1)\varepsilon_0$$

29 **(a)**

The force acting on the electron $= e.E$

Acceleration of the electron $= \frac{eE}{m}$



$u = 0, v = ?\ \ v^2 - u^2 = 2aS$

$S = 2 \times 10^{-2} m$

$\therefore v^2 = 2\left(\frac{e}{m}\right) E \times 2 \times 10^{-2} m$

$\frac{e}{m} = 1.76 \times 10^{11}$ coulomb$/kg$

$\therefore v^2 = 2 \times 1.76 \times 10^{11} \times 10^4 \times 2 \times 10^{-2}$

$= 7.04 \times 10^{13} = 70.4 \times 10^{12}$

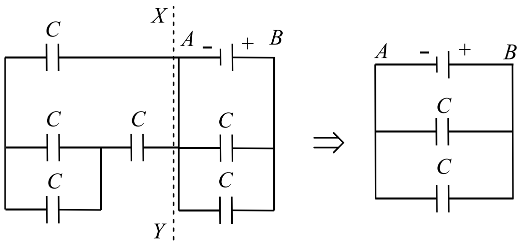
$\therefore v \approx 0.85 \times 10^7\ m/s$

30 **(d)**

The work done is given by $= q(V_2 - V_1) = 0$

31 **(d)**

All capacitor lying in left side of line XY are short circuited so circuit can be reduced as follows



$C_{AB} = 2C$

32 **(c)**

The energy will be minimum in this case and every system tends to possess minimum energy

33 **(c)**

Work done $= \frac{1}{2}\left(\frac{3C}{2}\right).V^2 = \frac{3CV^2}{4}$

34 **(a)**

$$U = \frac{1}{2}CV^2 = \frac{1}{2}\left(\frac{\varepsilon_0 A}{x}\right)V^2$$

$$\therefore \frac{dU}{dt} = \frac{1}{2}\varepsilon_0 A V^2\left(-\frac{1}{x^2}\frac{dx}{dt}\right) \Rightarrow \frac{dU}{dt} \propto x^{-2}$$

35 **(d)**

As $\sigma_1 = \sigma_2$

$\therefore\ \frac{Q_1}{4\pi r_1^2} = \frac{Q_2}{4\pi r_2^2}$

Or $\frac{Q_1}{4\pi\varepsilon_0 r_1^2} = \frac{Q_2}{4\pi\varepsilon_0 r_2^2}$

$\therefore\ E_1 = E_2$ or $E_1/E_2 = 1$

36 **(a)**

The total energy before connection

$= \frac{1}{2} \times 4 \times 10^{-6} \times (50)^2 + \frac{1}{2} \times 2 \times 10^{-6} \times (100)^2$

$= 1.5 \times 10^{-2} J$

When connected in parallel

$4 \times 50 + 2 \times 100 = 6 \times V \Rightarrow V = \frac{200}{3}$

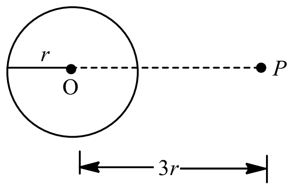
Total energy after connection

$= \frac{1}{2} \times 6 \times 10^{-6} \times \left(\frac{200}{3}\right)^2 = 1.33 \times 10^{-2} J$

38 **(d)**

The potential at a distance r, due to charge q is

$$V = \frac{1}{4\pi\varepsilon_0}.\frac{q}{r}$$



Potential at a distance $(3r)$ is

$$V = \frac{1}{4\pi\varepsilon_0}.\frac{q}{3r}$$

Difference in potential

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r} - \frac{1}{3r}\right]$$

$$\Longrightarrow V = \frac{2q}{4\pi\varepsilon_0 \times 3r}$$

Intensity of electric field

$$E = \frac{q}{4\pi\varepsilon_0}\frac{1}{(3r)^2}$$

$$\therefore \frac{E}{V} = \frac{q}{4\pi\varepsilon_0 q r^2} \times \frac{4\pi\varepsilon_0 3r}{2q}$$

$\Rightarrow \frac{E}{V} = \frac{1}{6r}$

$\Rightarrow E = \frac{V}{6r}$

40 **(c)**

$$E = \frac{1}{4\pi\varepsilon_0}.\left[\frac{5\times10^{-9}}{(1\times10^{-2})^2} - \frac{5\times10^{-9}}{(2\times10^{-2})^2} + \frac{5\times10^{-9}}{(4\times10^{-2})^2} - \frac{(5\times10^{-9})}{(8\times10^{-2})^2} + \cdots\cdots\right]$$

$$\Rightarrow E = \frac{9\times10^9\times5\times10^{-9}}{10^{-4}}\left[1 - \frac{1}{(2)^2} + \frac{1}{(4)^2} - \frac{1}{(8)^2} + \cdots\right]$$

$$\Rightarrow E = 45\times10^4\left[1 + \frac{1}{(4)^2} + \frac{1}{(16)^2} + \cdots\right]$$

$$-45\times10^4\left[\frac{1}{(2)^2} + \frac{1}{(8)^2} + \frac{1}{(32)^2} + \cdots\right]$$

$$\Rightarrow E = 45\times10^4\left[\frac{1}{1-\frac{1}{16}}\right] - \frac{45\times10^4}{(2)^2}\left[1 + \frac{1}{4^2} + \frac{1}{(16)^2} + ..\right]$$

$E = 48\times10^4 - 12\times10^4 = 36\times10^4 N/C$

41 **(a)**

Since, the proton is moving against the direction of electric field, so work is done by the proton against electric field. It implies that electric field does negative work on the proton. Again, proton is moving in electric field from low potential region to high potential region hence, its potential energy increases

42 **(b)**

Potential energy of the system will be given by

$$= \frac{(-e)(-e)}{4\pi\varepsilon_0 r} = \frac{e^2}{4\pi\varepsilon_0 r}$$

As r decreases, potential energy increases

43 **(d)**

$$V = \frac{2q}{4\pi\varepsilon_0 L} - \frac{2q}{4\pi\varepsilon_0 L\sqrt{5}} = \frac{2q}{4\pi\varepsilon_0 L}\left[1 - \frac{1}{\sqrt{5}}\right] volt$$

44 **(a)**

$\frac{1}{2}mv^2 = \frac{kQq}{r_1}$

$\frac{1}{2}m(4v^2) = \frac{kQq}{r_2}$

From Eqs.(i) and (ii), we get

$\frac{r_1}{r_2} = 4$

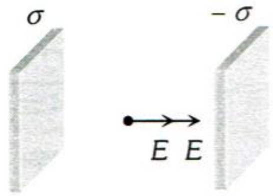
$r_2 = \frac{r}{4}$

45 **(d)**

$F \propto \frac{1}{r^2}$; so when r is halved the force becomes four times

46 **(c)**

Electric field between the plates is



$= \frac{\sigma}{2\varepsilon_0} - \frac{(-\sigma)}{2\varepsilon_0}$

$= \frac{\sigma}{\varepsilon_0} volt/meter$

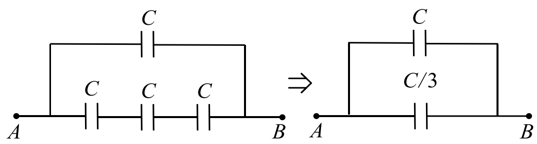
48 **(c)**

According to Gauss law $\oint E.ds = \frac{ql}{\varepsilon_0}$

$\oint E.ds = 2\pi rl$; [E is constant]

$\therefore E.2\pi rl = \frac{ql}{\varepsilon_0} \Rightarrow E = \frac{q}{2\pi\varepsilon_0 r}$ $i.e. E \propto \frac{1}{r}$

49 **(d)**



$\Rightarrow C_{eq} = \frac{C}{3} + C = \frac{4C}{3}$

50 **(b)**

$F \propto \frac{1}{r^2} \Rightarrow \frac{F_1}{F_2} = \left(\frac{r_2}{r_1}\right)^2 \Rightarrow \frac{5}{F_2} = \left(\frac{0.04}{0.06}\right)^2 = F_2$

$= 11.25N$

51 **(b)**

The charged particle could be positive or negative. The positive charge will move in the direction of the field. But negative charge will move opposite to the field

52 **(b)**

All the three plates will produce electric field at P along negative z-axis. Hence,

$$\boldsymbol{E}_p = \left[\frac{\sigma}{2\varepsilon_0} + \frac{2\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}\right](-\hat{\boldsymbol{k}})$$

$$= -\frac{2\sigma}{\varepsilon_0}\hat{\boldsymbol{k}}$$

53 **(b)**

Charge enclosed by cylindrical surface (length 100 cm) is $Q_{enc} = 100Q$. By applying Gauss's law $\phi = \frac{1}{\varepsilon_0}(Q_{enc.}) = \frac{1}{\varepsilon_0}(100Q)$

54 **(a)**

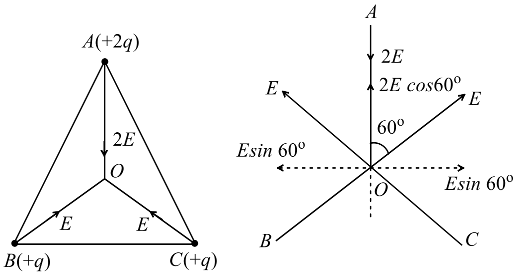
$KE = qV$

55 **(d)**

In the pressure of medium force becomes $\frac{1}{K}$ times

56 **(a)**

Resolve E along CO and BO into two perpendicular components



The sine components cancel each other

The cosine components add up along OA to give $2E\cos 60^{o}$

$\therefore$ Resultant field along $AO = 2E - 2E\cos 60° = 2E - E = E$

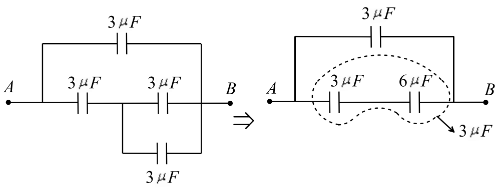
$\therefore$ Resultant field is E along AO

57 **(d)**

Potential due to dipole in general position is given by

$$V = \frac{k.p\cos\theta}{r^2} \Rightarrow V = \frac{k.p\cos\theta\, r}{r^3} = \frac{k.(\vec{p}.\vec{r})}{r^3}$$

58 **(d)**



$\Rightarrow C_{AB} = 5\mu F$

59 **(d)**

The given figure is equivalent to a balanced Wheatstone's bridge, hence $C_{eq} = 6\ \mu F$

61 **(a)**

Electric field inside a conductor is zero

62 **(c)**

As the capacitors $4\mu F$ and $2\mu F$ connected in parallel, are in series with $6\mu F$ capacitor, their equivalent capacitance is $\frac{(2+4)\times 6}{2+4+6} = 3\mu F$

Charge in the circuit, $Q = 3\mu F \times 12V = 36\mu C$

Since the capacitors $4\mu F$ and $2\mu F$ are connected in parallel, therefore potential difference across them is same

$$\Rightarrow \frac{Q_1}{Q_2} = \frac{C_1}{C_2} = \frac{4}{2} \Rightarrow Q_1 = 2Q_2$$

Also, $Q = Q_1 + Q_2$

$$\therefore 36\mu C = 2Q_2 + Q_2 \Rightarrow Q_2 = \frac{36\mu C}{3} = 12\mu C$$

$$Q_1 = Q - Q_2 = 36\mu C - 12\mu C = 24\mu C = 24\times 10^{-6}C$$

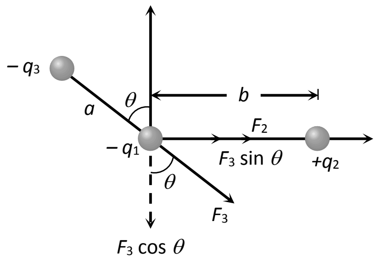
63 **(b)**

According to the question, $eE = mg \Rightarrow E = \frac{mg}{e}$

64 **(b)**

By inserting the dielectric slab. Capacitance ($i.e.$ ability to hold the charge) increases. In the presence of battery more charge is supplied from battery

65 **(c)**



F_2 = Force applied by q_2 on $-q_1$

F_3 = Force applied by $(-q_3)$ on $-q_1$

x-component of Net force on $-q_1$ is

$$F_x = F_2 + F_3\sin\theta = k\frac{q_1q_2}{b^2} + k.\frac{q_1q_3}{a^2}\sin\theta$$

$$\Rightarrow F_x = k.q_1\left[\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta\right] \Rightarrow F_x \propto \left[\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta\right]$$

66 **(c)**

Charge on C_1 = charge on C_2

$\Rightarrow C_1(V_A - V_D) = C_2(V_D - V_B)$

$$\Rightarrow C_1(V_1 - V_D) = C_2(V_D - V_2) \Rightarrow V_D = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

67 **(c)**

Capacitance will increase but not 5 times [Because dielectric is not filled completely]. Hence new capacitance may be 200 $\mu\mu F$

69 **(a)**

Potential gradient along equipotential surface is zero.

i.e., $E\cos\theta = -\frac{dV}{dr} = 0$

∴ $\theta = 90°$

70 **(c)**

$$U_{system} = \frac{1}{4\pi\varepsilon_0}\frac{(q)(-2q)}{a} + \frac{1}{4\pi\varepsilon_0}\frac{(-2q)(q)}{a} + \frac{1}{4\pi\varepsilon_0}\frac{(q)(q)}{2a}$$

$$U_{system} = -\frac{7\,q^2}{8\pi\varepsilon_0 a}$$

71 **(c)**

In electric dipole, the flux coming out from positive charge is equal to the flux coming in at negative charge $i.e.$ total charge on sphere = 0. From Gauss law, total flux passing through the sphere = 0

72 **(c)**

$$U = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1Q_2}{r_1} + \frac{Q_2Q_3}{r_2} + \frac{Q_1Q_3}{r_3}\right]$$

$$U_{net} = 3 \times \frac{1}{4\pi\varepsilon_0}.\frac{q^2}{l}$$

74 **(a)**

There will be an electric field between two cylinders (using Gauss theorem). This electric field will produce a potential difference.

75 **(c)**

There will be a electrostatic repulsion between two charged bobs, but it does not affect the motion of pendulum. Thus, time period of pendulum remains same ie, $T = 2\pi\sqrt{\frac{l}{g}}$.

76 **(b)**

Inside the cavity, field at any point is uniform and non-zero.

77 **(a)**

The sphere will retain the charge for longer time, because in case of spherical metal conductor, the charge quickly spreads uniformly over the entire surface.

78 **(d)**

Coulomb force is given by

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$$

$$\therefore (10 \times 10^{-3}) \times 10 = \frac{(9 \times 10^9) \times q^2}{(0.6)^2}$$

$(\because q_1 = q_2 = q)$

or $q^2 = \frac{10^{-1} \times 0.36}{9 \times 10^9}$

$= 4 \times 10^{-12}$

$q = 2 \times 10^{-6}$C$= 2\mu$C

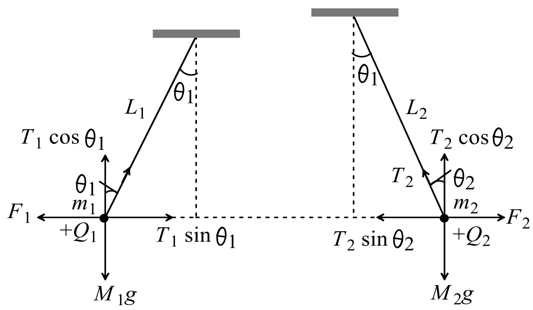
79 **(b)**

The three forces acting on each sphere are :

(i) Tension

(ii) Weight

(iii) Electrostatic force of repulsion



For sphere 1

In equilibrium, from figure

$T_1 \cos\theta_1 = M_1g; T_1 \sin\theta_1 = F_1$

$\therefore \tan\theta_1 = \frac{F_1}{M_1g}$

For sphere 2

In equilibrium, from figure

$T_2 \cos\theta_2 = M_2g; T_2 \sin\theta_2 = F_2$

$\therefore \tan\theta_2 = \frac{F_2}{M_2g}$

Force of repulsion between two charges are same.

$\therefore F_1 = F_2$

$\theta_1 = \theta_2$ only if $\frac{F_1}{M_1g} = \frac{F_2}{M_2g}$

But $F_1 = F_2$, then $M_1 = M_2$

80 **(c)**

Electric field is zero everywhere inside a metal (conductor) $i.e.$, field lines do not enter a 3 metal plus these are perpendicular to a metal surface (equipotential surface).

81 **(a)**

All charge resides on the outer surface so that according to Gauss law, electric field inside a shell is zero

82 **(c)**

Plane conducting surfaces facing each other must have equal and opposite charge densities. Here as the plate areas are equal, $Q_2 = -Q_3$.

The charge on a capacitor means the charge on the inner surface of the positive plate [Here it is Q_2]

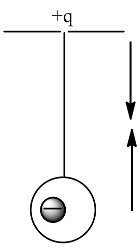
Potential difference between the plates

$$= \frac{\text{charge}}{\text{capacitance}} = \frac{Q_2}{C} = \frac{2Q_2}{2C}$$

$$= \frac{Q_2 - (-Q_2)}{2C} = \frac{Q_2 - Q_3}{2C}$$

83 **(c)**

There is no change in the restoring force as the electrostatic forces are the central forces. Negative and positive charges at the two extremeties of the string affect tension T which does not affect the restoring force



84 **(a)**

By using charge conservation $0.2 \times 600 = (0.2 + 1)V$

$$\Rightarrow V = \frac{0.2 \times 600}{1.2} = 100\ V$$

85 **(b)**

Nuclear force binds the protons and neutrons in the nucleus of an atom

86 **(d)**

Point charge produces non-uniform electric field

87 **(d)**

Due to symmetric charge distribution

88 **(b)**

$$V = \frac{C_1V_1 - C_2V_2}{C_1 + C_2} = \frac{6 \times 12 - 3 \times 12}{3 + 6} = 4\ volt$$

89 **(c)**

Because in case of metallic sphere either solid or hollow, the charge will reside on the surface of the sphere. Since both the spheres have same surface area, so they can hold equal maximum charge

90 **(b)**

Relation for electric field is given by $E = \frac{\lambda}{2\pi\varepsilon_0 r}$

[Given: $E = 7.182 \times 10^8\ N/C$]

$r = 2\ cm = 2 \times 10^{-2} m$

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \Rightarrow \lambda = 2\pi\varepsilon_0 rE = \frac{2 \times 2\pi\varepsilon_0 rE}{2}$$

$$= \frac{1 \times 2 \times 10^{-2} \times 7.182 \times 10^8}{2 \times 9 \times 10^9} = 7.98 \times 10^{-4} C/m$$

91 **(b)**

$$\vec{E} = -\frac{\sigma}{2\varepsilon_0}\hat{k} - \frac{2\sigma}{2\varepsilon_0}\hat{k} - \frac{\sigma}{2\varepsilon_0}\hat{k} = -\frac{2\sigma}{\varepsilon_0}\hat{k}$$

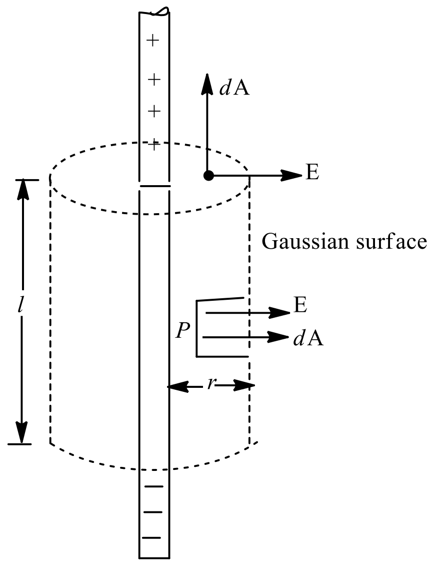
92 **(d)**

Force on charge $F = q(E_a) = q \times \frac{k.2p}{r^3} \Rightarrow F \propto \frac{1}{r^3}$

When $r \to$ doubled; $F \to \frac{1}{8}$ times

94 **(a)**

According to Gauss theorem for closed surface



Taking cylindrical Gaussian surface of radius r, height h curved surface=$2\pi rh$.

Electric flux through it $= E \times 2\pi rh$

Charge enclosed=λh

∴ From Gauss theorem,

Charge $= \varepsilon_0 \times$ (Electric flux)

$\Longrightarrow \varepsilon_0 E \times 2\pi rh = \lambda h$

$$\Rightarrow E = \frac{1}{2\pi\varepsilon_0}.\frac{\lambda}{r} = \frac{\lambda}{2\pi\varepsilon_0 r}$$

95 **(a)**

In series $C' = C/n\ i.e.\ C = nC' = 2 \times 3 = 6\ \mu F$

In parallel $C' = nC\ i.e.\ C = \frac{C'}{n} = \frac{12}{2} = 6\ \mu F$

96 **(b)**

$F_a = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}, F_b = \frac{q_1 q_2}{K4\pi\varepsilon_0 r^2} \Rightarrow F_a : F_b = K:1$

97 **(b)**

Axis of an electric dipole is always directed from negative charge to the positive charge.

98 **(b)**

By using, $KE = QV \Rightarrow 4 \times 10^{20} \times 1.6 \times 10^{-19}$
$= 0.25 \times V \Rightarrow V = 256\ volt$

99 **(b)**

Charge of capacitor A is given by
$Q_1 = 15 \times 10^{-6} \times 100 = 15 \times 10^{-4} C$
Charge on capacitor B is given by
$Q_2 = 1 \times 10^{-6} \times 100 = 10^{-4} C$
Capacity of capacitor A after removing dielectric
$= \frac{15 \times 10^{-6}}{15} = 1\mu F$
Now when both capacitors are connected in parallel their equivalent capacitance will be $C_{eq} = 1 + 1 = 2\mu F$

So common potential $= \frac{(15\times10^{-4})+(1\times10^{-4})}{2\times10^{-6}} = 800V$

101 **(c)**

$\frac{1}{C} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2} \Rightarrow C = \frac{2}{3} F$

102 **(a)**

By using $\frac{1}{2} m(v_1^2 - v_1^2) = QV$

$\Rightarrow \frac{1}{2} \times 10^{-3}[v_1^2 - (0.2)^2] = 10^{-8}(600 - 0)$

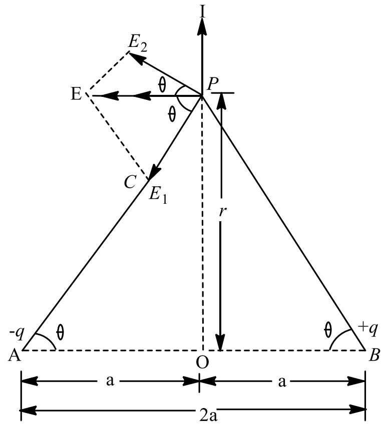
$\Rightarrow v_1 = 22.8\ cm/s$

103 **(d)**

Potential energy of dipole in electric field $U = -PE\cos\theta$; where θ is the angle between electric field and dipole

104 **(a)**

Consider an electric dipole consisting of two point charges –q and +q separated by a small distance $AB = 2a$ with centre at O,



As shown in figure, on equatorial line, the resultant electric field $\boldsymbol{E}$ of $\boldsymbol{E}_1$ and $\boldsymbol{E}_2$ is parallel to the axis of the dipole but opposite to the direction of the dipole moment **p** as it is directed from negative charge to positive charge.

105 **(d)**

Number of electric transferred, $n = \frac{q}{e}$

Mass transferred $= m_e \times n = m_e \times \left(\frac{q}{e}\right)$

$= 9.1 \times 10^{-31} \times \left(\frac{2\times10^{-7}}{1.6\times10^{-19}}\right)$

11.38×10^{-19} kg

106 **(c)**

Electric force $qE = ma \Rightarrow a = \frac{qE}{m}$

$\therefore a = \frac{1.6 \times 10^{-19} \times 1 \times 10^3}{9 \times 10^{-31}} = \frac{1.6}{9} \times 10^{15}$

$u = 5 \times 10^6$ and $v = 0$

$\therefore$ From $v^2 = u^2 - 2as \Rightarrow s = \frac{u^2}{2a}$

$\therefore$ Distance $s = \frac{(5\times10^6)^2\times9}{2\times1.6\times10^{15}} = 7\ cm.$ (approx)

107 **(c)**

Capacitance of a parallel plate capacitor with air is $C = \frac{\varepsilon_0 A}{d}$

Capacitance of a same parallel plate capacitor with the introduction of a dielectric medium is $C' = \frac{K\varepsilon_0 A}{d}$ where K is the dielectric constant of a medium

$\Rightarrow \frac{C'}{C} = K$ or $\frac{15}{3} = 5$ or $K = \frac{\varepsilon}{\varepsilon_0}$

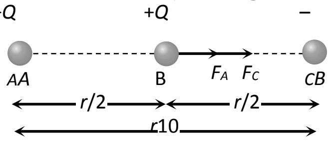
$\Rightarrow \varepsilon = K\varepsilon_0 = 5 \times 8.854 \times 10^{-12}$
$= 0.4427 \times 10^{-10} C^2 N^{-1} m^{-2}$

108 **(c)**

Initially, force between A and C $F = K\frac{Q^2}{r^2}$

When a similar sphere B having charge $+Q$ is kept at the mid point of the line joining A and C, then

Net force on B is



$F_{net} = F_A + F_C = k\frac{Q^2}{(r/2)^2} + \frac{kQ^2}{(r/2)^2} = 8\frac{kQ^2}{r^2} = 8F$

109 **(d)**

If charge acquired by the smaller sphere is Q then it's

potential $120 = \frac{kQ}{2}$ ...(i)

Whole charge comes to outer sphere

Also potential of the outer sphere

$V = \frac{kQ}{6}$ ...(ii)

From equation (i) and (ii) $V = 40\ volt$

110 **(d)**

$C = \frac{\varepsilon_0 A}{d}$ and $C' = \frac{\varepsilon_0 A}{\left(d - \frac{d}{2} + \frac{(d/2)}{\infty}\right)} = \frac{2\varepsilon_0 A}{d}$

$\Rightarrow C' = 2C$

111 **(d)**

$$C_{air} = \frac{C_{medium}}{K} = \frac{C}{2}$$

112 **(a)**

From Gauss' theorem,

$E \propto \frac{q}{r^2}$ (q = charge enclosed)

$$\frac{E_2}{E_1} = \frac{q_2}{q_1} = \frac{r_1^2}{r_2^2}$$

$$8 = \frac{\int_0^R (4\pi r^2) kr^a dr}{\int_0^{R/2} (4\pi r^2) kr^a dr} \times \frac{\left(\frac{R}{2}\right)^2}{(R)^2}$$

Solving this equation we get, $a = 2$

114 **(d)**

There are 10 electrons and 10 protons in a neutral water molecule.

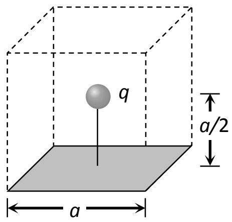
So it's dipole moment is $p = q(2l) = 10\ e\ (2l)$

Hence length of the dipole $i.e.$ distance between centres of positive and negative charges is

$$2l = \frac{p}{10e} = \frac{6.4 \times 10^{-30}}{10 \times 1.6 \times 10^{-19}} = 4 \times 10^{-12} m$$
$$= 4\ pm$$

115 **(d)**

An imaginary cube can be made by considering charge q at the centre and given square is one of it's face



So flux from given square ($i.e.$ one face) $\phi = \frac{q}{6\varepsilon_0}$

116 **(c)**

Let d be the distance between the plates and k be the dielectric constant. Without disconnecting the battery, V is the same

$$E_0 = \frac{\sigma}{\varepsilon_0}; V_0 = E_0 d; C_0 = \frac{Q}{V_0} = \frac{\varepsilon_0 A}{d}$$

With dielectric,

V remains the same, capacitance increases, U which is energy stored $\left(\frac{1}{2}CV^2\right)$ increases; $Q = CV$, charge increases

117 **(a)**

The potential difference across the parallel plate capacitor is $10V - (-10V) = 20V$

Capacitance $= \frac{Q}{V} = \frac{40}{20} = 2F$

118 **(c)**

Common potential $V = \frac{6\times20+3\times0}{(6+3)} = \frac{120}{9} Volt$

So, charge on 3 μF capacitor

$$Q_2 = 3 \times 10^{-6} \times \frac{120}{9} = 40\mu C$$

119 **(d)**

The surface of the conductor is an equipotential surface since there is free flow of electrons within the conductor. Thus potential at Q is the same as that at P. That is $V_P = V_Q = V$. The electric field E at a point on the equipotential surface of the conductor is inversely proportional to the square of the radius of curvature r at that point. That is $E \propto r^{-2}$

Since point Q has a larger radius of curvature than that at point P, the electric field at Q is less than that at P. That is $E_Q < E_P = E$

121 **(b)**

Potential of both spheres will be same

122 **(d)**

$E_{equatorial} = \frac{kp}{r^3} i.e. E \propto p$ and $E \propto r^{-3}$

123 **(d)**

$$U = \frac{1}{2}CV^2$$

$\frac{U_0}{2} = \frac{1}{2}CV_0^2 e^{-2t_1/RC}$

$\frac{1}{2} = e^{-2t_1/RC}$ $\quad [\because U_0 = \frac{1}{2}CV_0^2]$

$-\frac{2t_1}{RC} = \ln 2$

$t_1 = \frac{RC\ln 2}{2}$ ...(i)

And $\frac{q_0}{4} = q_0 e^{-t_2/RC}$

$-\frac{t_2}{RC} = 2\ln 2$

$t_2 = 2RC\ln 2$ ...(ii)

from equation (i) and (ii)

$\frac{t_1}{t_2} = \frac{1}{4}$

124 **(c)**

From FBD of sphere, using Lami's theorem

$\frac{F}{mg} = \tan\theta$ ... (i)

When suspended in liquid, as θ remains same,

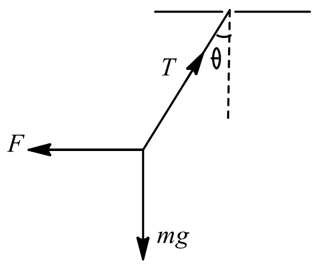
$\therefore \frac{F'}{mg(1-\frac{\rho}{d})} = \tan\theta$ ... (ii)

Using Eqs. (i) and (ii)

$\frac{F}{mg} = \frac{F\prime}{mg\left(1-\frac{\rho}{d}\right)} =$ where, $F' = \frac{F}{k}$

$\therefore \frac{F}{mg} = \frac{F}{mgk\left(1-\frac{\rho}{d}\right)}$

0r $k = \frac{1}{1-\frac{\rho}{d}} = \frac{1}{(1-\frac{0.8}{1.6})} = 2$



125 **(c)**

When dielectric is introduced, the capacitance will increase and as the battery remains connected, so the voltage will remain constant. Hence according to $Q = CV$, the charge will increase

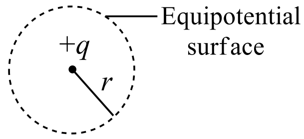
126 **(c)**

When charge q is released in uniform electric field E then its acceleration $a = \frac{qE}{m}$ (is constant)

So its motion will be uniformly accelerated motion and its velocity after time t is given by $v = at = \frac{qE}{m}t$

$\Rightarrow KE = \frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{qE}{m}t\right)^2 = \frac{q^2E^2t^2}{2m}$

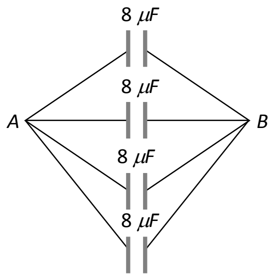
127 **(c)**



When a charge is moved from one point to the other over an equipotential surface, work done will be zero

129 **(a)**

Given circuit can be drawn is



Equivalent capacitance $= 4 \times 8 = 32\mu F$

130 **(c)**

The acceleration of the electron due to given coulombic

force F is $a_e = \frac{F}{m_e}$ ... (i)

where m_e is the mass of the electron

The acceleration of the proton due to same force F is

$a_p = \frac{F}{m_p}$ ....(ii)

Where m_p is the mass of the proton

Divide (ii) by (i), we get $\frac{a_p}{a_e} = \frac{m_e}{m_p}$

$a_p = \frac{a_e m_e}{m_p} = \frac{(2.5 \times 10^{22} ms^{-2})(9.1 \times 10^{-31} kg)}{(1.67 \times 10^{-27} kg)}$

$= 13.6 \times 10^{18} ms^{-2} \approx 1.5 \times 10^{19} ms^{-2}$

132 **(b)**

For equilibrium $mg = qE$

$\therefore 1.96 \times 10^{-15} \times 9.8 = q \times \left(\frac{800}{0.02}\right)$

$\Rightarrow q = \frac{1.96 \times 10^{-15} \times 9.8 \times 0.02}{800}$

$\Rightarrow n \times 1.6 \times 10^{-19} = \frac{1.96 \times 10^{-15} \times 9.8 \times 0.02}{800}$

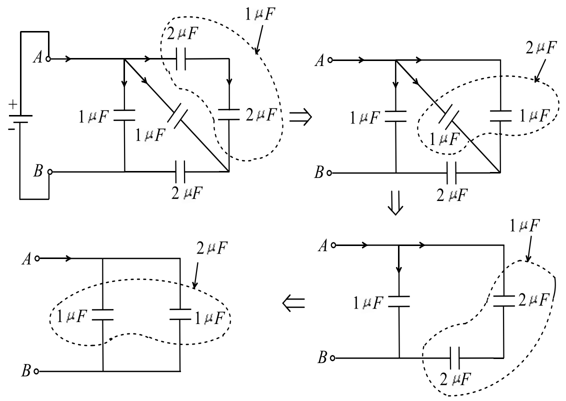
$\Rightarrow n = 3$

133 **(c)**

Common potential $V' = \frac{C_1V + C_2 \times 0}{C_1 + C_2} = \frac{C_1}{C_1 + C_2}.V$

134 **(b)**

The given circuit can be simplified as follows



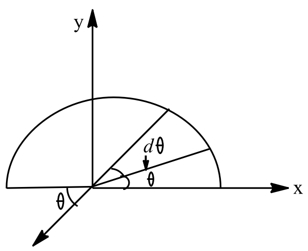
Hence equivalent capacitance between A and B is $2\mu F$

135 **(a)**

The work done in moving a charge on equipotential surface is zero

136 **(c)**

Linear charge density



$$\lambda = \left(\frac{q}{\pi r}\right)$$

$$E = \int dE \sin\theta(-\hat{\boldsymbol{J}})$$

$$= \int \frac{K.dq}{r^2} \sin\theta(-\hat{\boldsymbol{J}})$$

$$E = \frac{K}{r^2}\int \frac{qr}{\pi r} d\,\theta \sin\theta(-\hat{\mathrm{J}})$$

$$= \frac{K}{r^2}\frac{q}{\pi}\int_0^{\pi} \sin\theta(-\hat{\boldsymbol{J}})$$

$$= \frac{q}{2\pi^2\varepsilon_0 r^2}(-\hat{\boldsymbol{J}})$$

137 **(b)**

In series combination of capacitors, voltage distributes on them, in the reverse ratio of their capacitance *i.e.*

$\frac{V_A}{V_B} = \frac{3}{2}$ ...(i)

Also $V_A + V_B = 10$ ...(ii)

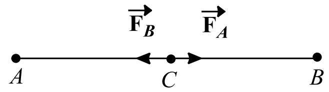
On solving (i) and (ii) $V_A = 6V, V_B = 4V$

138 **(d)**

If same charges on spheres A and B are q

$F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2} = 3 \times 10^{-5}$N

Charge on A and C after touching



$$q'_A = qc = \frac{q}{2}$$

Net force on C

$$\vec{F} = \vec{F_A} + \vec{F_B}$$

$$\therefore F = \frac{1}{4\pi \in_0}\frac{(q/2)(q/2)}{(e/2)^2} - \frac{1}{4\pi \in_0}\frac{(q/2)\times q}{(r/2)^2}$$

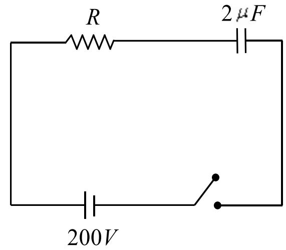
$$= \frac{1}{4\pi \in_0}\frac{q^2}{r^2} - 2\frac{1}{4\pi \in_0}\frac{q^2}{r^2} = -\left(\frac{1}{4\pi \in_0}.\frac{q}{r^2}\right)$$

$$= -3 \times 10^{-5}N$$

139 **(c)**

$$V = V_0(1 - e^{-t/\tau})$$

$$120 = 200(1 - e^{-t/RC})$$



$$\Rightarrow 1 - e^{-t/RC} = \frac{3}{5}$$

$$e^{-t/RC} = \frac{2}{5}$$

$$\Rightarrow \frac{t}{RC} = \ln\left(\frac{5}{2}\right)$$

$$\frac{t}{RC} = 2.303\log_{10}(2.5)$$

$$\Rightarrow R = \frac{5}{2\times 10^{-6}\times 2.303 \times 0.4} \Rightarrow R = 2.7 \times 10^6\Omega$$

140 **(b)**

New force $F = \frac{1}{4\pi\varepsilon_0}\frac{(6-2)(2-2)}{r^2} \times 10^{-12} = 0$

141 **(b)**

After connecting through a wire $V_A = V_B$

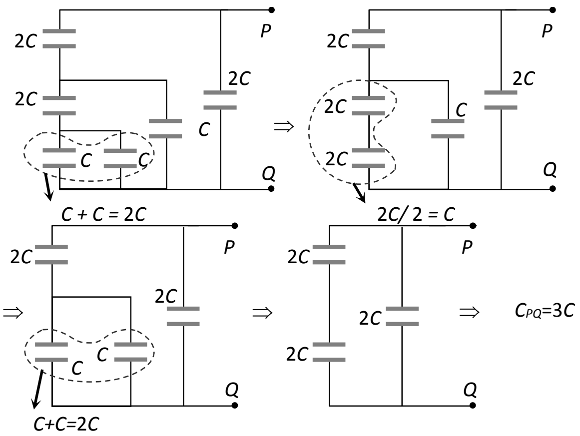
$$\Rightarrow \frac{kQ_A}{r_A} = \frac{kQ_B}{r_B} \Rightarrow \frac{Q_A}{Q_B} = \frac{r_A}{r_B}$$

Ratio of electric field

$$\frac{E_A}{E_B} = \frac{Q_A}{Q_B}\times\left(\frac{r_B}{r_A}\right)^2 \quad \left[\because E = \frac{kQ}{r^2}\right]$$

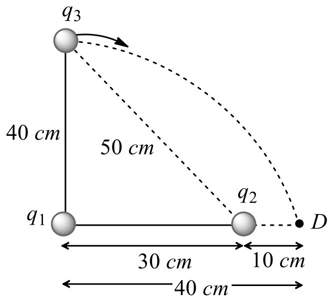
$$\Rightarrow \frac{E_A}{E_B} = \frac{r_A}{r_B}\times\left(\frac{r_B}{r_A}\right)^2 = \frac{r_B}{r_A} = \frac{2}{1}$$

143 **(a)**



144 **(a)**

Change in potential energy $(\Delta U) = U_f - U_i$



$$\Rightarrow \Delta U = \frac{1}{4\pi\varepsilon_0}\left[\left(\frac{q_1q_3}{0.4} + \frac{q_2q_3}{0.1}\right) - \left(\frac{q_1q_3}{0.4} + \frac{q_2q_3}{0.5}\right)\right]$$

$$\Rightarrow \Delta U = \frac{1}{4\pi\varepsilon_0}[8q_2q_3] = \frac{q_3}{4\pi\varepsilon_0}(8q_2)$$

$\therefore k = 8q_2$

145 **(a)**

Thin metal plates doesn't affect the capacitance

147 **(d)**

Electric field at the centre of charged circular ring is zero. Hence electric field at O due to the part $ACDB$ is equal in magnitude and opposite in direction that due to the part AKB

148 **(b)**

An electric field is zero non-zero on the axis of hollow current carrying conductor.

So, this statement is correct.

150 **(c)**

Common potential $V = \frac{C_1V_1}{C_1+C_2} = \frac{10^{-2}}{16\times10^{-6}} = 625V$

151 **(b)**

$$C = \frac{\varepsilon_0 A}{x}$$

$$\therefore \frac{dC}{dt} = \varepsilon_0 A\frac{d}{dt}\left(\frac{1}{x}\right) = \frac{-\varepsilon_0 A}{x^2}\left(\frac{dx}{dt}\right) = \frac{-\varepsilon_0 A}{d^2}\left(\frac{dx}{dt}\right)$$

$$\Rightarrow \left|\frac{dC}{dt}\right| = \frac{\varepsilon_0 A}{d^2}v \ i.e. \left|\frac{dC}{dt}\right| \propto \frac{1}{d^2}$$

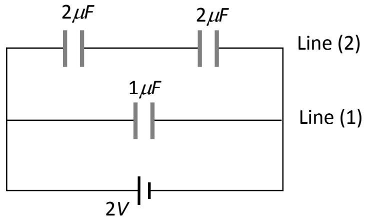
152 **(b)**

$U = \frac{Q^2}{2C}$; in given case C increases so U will decrease

155 **(d)**

Potential difference across both the lines is same i.e. $2V$. Hence charge flowing in line 2

$$Q = \left(\frac{2\times2}{2+2}\right) = 2\mu C$$



So charge on each capacitor in line (2) is 2 μC

Charge time $1Q = 2\times1 = 2\mu C$

156 **(a)**

During the growth of voltage in a $C - R$ circuit the voltage across a capacitor at time t is given by $V = V_0(1 - e^{\frac{t}{CR}})$ for the given circuit as per given conduction at time t

$V = \frac{3}{4}$th of the voltage applied across $C = \frac{3}{4}V_0$

So, $\frac{3}{4}V_0 = V_0\left(1 - e^{\frac{t}{RC}}\right) \Rightarrow e^{\frac{t}{RC}} = \frac{1}{4} \Rightarrow e^{\frac{t}{RC}} = 2^2$

$\Rightarrow 2RC\ln 2 = 2\times(2.5\times10^6)\times(4\times10^{-6})\times(0.693)$

$= 13.86\ s$

157 **(c)**

Electric lines of force are always normal to metallic body

158 **(c)**

Energy stored in the capacitor $= \frac{1}{2}CV^2\times100$

$$= \frac{1}{2}\times10\times10^{-6}\times(100\times10^3)^2\times100$$

$$= 5\times10^6\ J$$

Electric energy costs $= 108\ paise\ per\ kWH = \frac{108\ Paise}{3.6\times10^6\ J}$

$\therefore$ Total cost of charging $= \frac{5\times10^6\times108}{3.6\times10^6} = 150\ Paise$

159 **(a)**

In case of spherical metal conductor to charge quickly spreads uniformly over the entire surface because of which charges stay for longer time on the spherical surface. While in case of non-spherical surface, the charge concentration is different at different points due to which the charges do not stay on the surface for longer time

160 **(c)**

$F_1 = \frac{kQ_1Q_2}{d^2}$ and $F_2 = \frac{k\left(\frac{Q_1-Q_2}{2}\right)^2}{d^2}$

According to question,

$F_1 = F_2$

$$Q_1Q_2 = \frac{(Q_1 - Q_2)^2}{4} \Rightarrow 4Q_1Q_2 = Q_1^2 + Q_2^2 - 2Q_1Q_2$$

$$0 = Q_1^2 + Q_2^2 - 6Q_1Q_2 \Rightarrow \frac{Q_1}{Q_2} = -3 \pm \sqrt{8}$$

161 **(c)**

The torque on a dipole moment is $\vec{\tau} = \vec{p} \times \vec{E}$. The maximum value is when they are perpendicular to each other so that $pE\sin\theta$ is maximum

$i.e., \sin\theta = 1$

$$\tau = (3 \times 10^4 NC^{-1})(6 \times 10^{-30} c \times m)$$
$$= 18 \times 10^{-26} Nm$$

162 **(d)**

The electric field is always perpendicular to the surface of a conductor and field lines never cross the conducting surface

163 **(a)**

From $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$

$$\varepsilon_0 = \frac{1}{4\pi F}\frac{q_1q_2}{r^2} = \frac{[\mathrm{A^2T^2}]}{[\mathrm{MLT^{-2}}][\mathrm{L^2}]}$$
$$= [\mathrm{M^{-1}L^{-3}T^4A^2}]$$

164 **(c)**

Electric field in vacuum $E_0 = \frac{\sigma}{\varepsilon_0}$

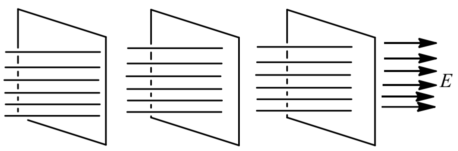
In medium $E = \frac{\sigma}{\varepsilon_0 K}$

If $K > 1$, then $E < E_0$

165 **(b)**

An equipotential surface is a surface with a constant value of potential at all points on the surface. For a uniform electric field, say, along the x-axis, the equipotential

surfaces are planes normal to the x-axis, $i.e.$, planes parallel to the $y - z$ plane. Equipotential surfaces for a dipole and its electric field lines are shown in figure.



As said above that on equipotential surface, potential at all points is constant, this means that on equipotential surface work done in moving a test charge from one point to other point is zero.

166 **(b)**

According to Gauss's applications

167 **(d)**

$$\phi_E = \frac{Q_{\text{enclosed}}}{\varepsilon_0}, Q_{\text{enclosed}} \text{ remains unchanged}$$

168 **(c)**

Distance

$$BC = AB\sin 60° = (2R)\frac{\sqrt{3}}{2} = \sqrt{3}R$$

$$\therefore |F_{BC}| = \frac{1}{4\pi\varepsilon_0}\frac{\left(\frac{q}{3}\right)\left(\frac{2q}{3}\right)}{\left(\sqrt{3}R\right)^2} = \frac{q^2}{54\pi\varepsilon_0 R^2}$$

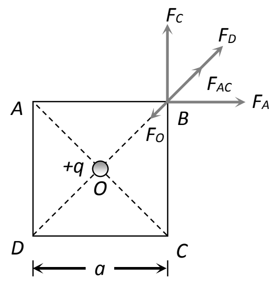
169 **(b)**

If all charges are in equilibrium, system is also in equilibrium.

Charge at centre : charge q is in equilibrium because no net force acting on it corner charge :

If we consider the charge at corner B. This charge will experience following forces

$$F_A = k\frac{Q^2}{a^2}, F_C = \frac{kQ^2}{a^2}, F_D = \frac{kQ^2}{(a\sqrt{2})^2} \text{ and } F_O = \frac{KQq}{(a\sqrt{2})^2}$$



Force at B away from the centre $= F_{AC} + F_D$

$$= \sqrt{F_A^2 + F_B^2} + F_D = \sqrt{2}\frac{kQ^2}{a^2} + \frac{kQ^2}{2a^2}$$
$$= \frac{kQ^2}{a^2}\left(\sqrt{2} + \frac{1}{2}\right)$$

Force at B towards the centre $= F_O = \frac{2kQq}{a^2}$

For equilibrium of charge at B, $F_{AC} + F_D = F_O$

$$\Rightarrow \frac{kQ^2}{a^2}\left(\sqrt{2} + \frac{1}{2}\right) = \frac{2KQq}{a^2} \Rightarrow q = \frac{Q}{4}(1 + 2\sqrt{2})$$

170 **(b)**

Charge on smaller sphere

$$= \text{Total charge}\left(\frac{r_1}{r_1 + r_2}\right) = 30\left(\frac{5}{5 + 10}\right) = 10\mu C$$

171 **(c)**

$$q_3 = \frac{C_3}{C_2 + C_3}.Q$$

$$q_3 = \frac{3}{3 + 2} \times 80 = \frac{3}{5} \times 80$$

$= 48\ \mu C$

172 **(c)**

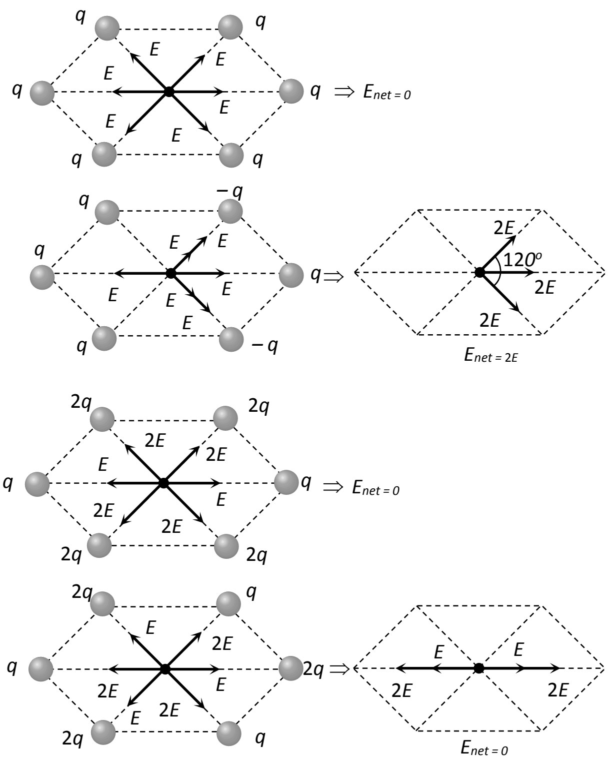
Inside the hollow charged spherical conductor electric field is zero

173 **(d)**

On equatorial line of electric dipole, $\propto \frac{1}{r^3}$.

174 **(b)**

Electric field at a point due to positive charge acts away from the charge and due to negative charge it act's towards the charge



175 **(c)**

For non-conducting sphere $E_{in} = \frac{k.Qr}{R^3} = \frac{\rho r}{3\varepsilon_0}$

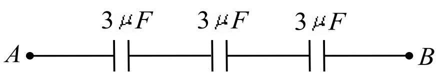
176 **(b)**

Every system tends to decrease its potential energy to attain more stability when we increase charge on soap bubble its radius increases $\left[U \propto \frac{1}{r}\right]$

177 **(a)**

Electric field $E = \frac{1}{4\pi\varepsilon_0} \times \frac{Q}{r^2}$

178 **(a)**



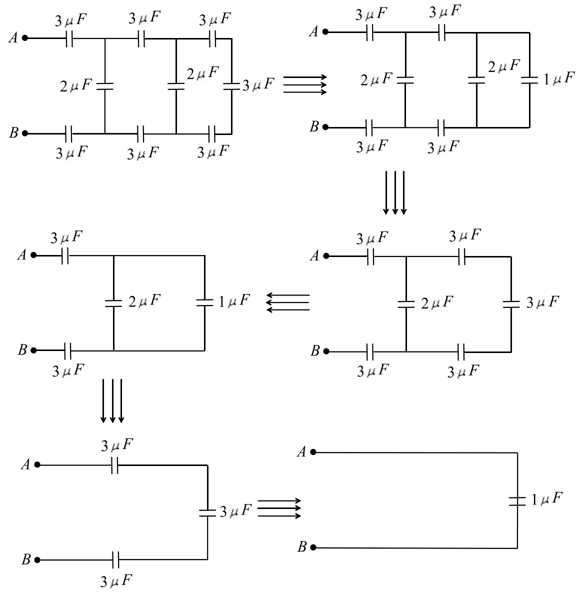
$$\frac{1}{C_{AB}} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = 1 \Rightarrow C_{AB} = 1\mu F$$

179 **(a)**

$$C_{AB} = 3 + \frac{3}{3} = 4\mu F\ , C_{AC} = \frac{3}{2} + \frac{3}{2} = 3\mu F$$

$\therefore C_{AB} : C_{AC} = 4 : 3$

180 **(d)**



Starting from the right end of the network, three $3\mu\ F$ capacitors are connected in series. The equivalent capacitance of these three capacitors is

$$\frac{1}{C_S} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} \Rightarrow C_S = 1\mu\ F$$

C_S and $2\mu F$ are in parallel. The equivalent capacitance of these two capacitors is

$C_P = C_S + 2\mu\ F = 1\ \mu\ F + 2\mu\ F = 3\mu\ F$

Proceeding in this way, finally three $3\mu\ F$ are in series. Therefore, the equivalent capacitance between A and B is

$$\frac{1}{C_{AB}} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} \Rightarrow C_{AB} = 1\mu\ F$$

181 **(c)**

$\tau_{\max} = pE = q(2l)E = 2 \times 10^{-6} \times 0.01 \times 5 \times 10^5$
$= 10 \times 10^{-3} N - m$

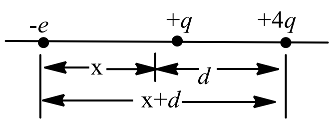
182 **(a)**

Following figures show the situations of charges fixed on the axis. An electron is placed to the left of these charges. The cases are as follows

Case I Let distance between $+q$ and $-4q = d$

$\therefore$ distance between $-e$ and $+q = x$

$\therefore$ distance between $-e$ and $-4q = (x + d)$



Now, force between $-e$ and $+q$

$F_1 = -\frac{1}{4\pi\varepsilon_0} \frac{qe}{x^2}$ (attractive)

Force between $-e$ and $-4q$

$$F_2 = \frac{1}{4\pi\varepsilon_0}\frac{4qe}{(x+d)^2} \qquad \text{(repulsive)}$$

Solving, we get

$$x = d$$

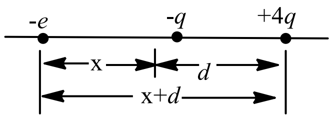
$$\therefore F_1 = -F_2$$

$$F_{\text{net}} = 0$$

Hence no net force acts on the electron and so it will be in equilibrium.

Case II In this case force acting between e and $-q$

$$F_1 = \frac{1}{4\pi\varepsilon_0}\frac{qe}{x^2} \qquad \text{(repulsive)}$$



and force between $-e$ and $+4q$

$$F_2 = -\frac{1}{4\pi\varepsilon_0}\frac{4qe}{(x+d)^2} \qquad \text{(attractive)}$$

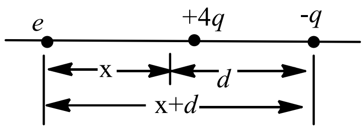
Solving we get

$$x = d$$

$$\therefore \quad F_1 = -F_2 \qquad \text{(numerically)}$$

$\therefore$ Net force on $-e$ is zero

Case III Again force between $-e$ and $4q$



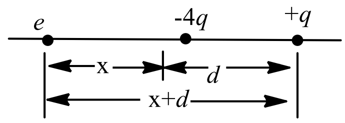
Similarly, $F_1 = -\frac{1}{4\pi\varepsilon_0}\frac{4qe}{x^2}$ (attractive)

$$F_2 = -\frac{1}{4\pi\varepsilon_0}\frac{qe}{(x+d)^2} \qquad \text{(repulsive)}$$

Since, electron is closer to $+4q$ than $-q$, so $F_1 > F_2$

In this case electron will not remain at rest and starts moving towards the system.

Case IV In this case force between $-e$ and $-4q$



$$F_1 = +\frac{1}{4\pi\varepsilon_0}\frac{4qe}{x^2} \qquad \text{(repulsive)}$$

Force between $-e$ and $+q$

$$F_2 = -\frac{1}{4\pi\varepsilon_0}\frac{qe}{(x+d)^2} \qquad \text{(attractive)}$$

Since, electron is closer to $-4q$ than +q, then $F_1 > F_2$.

Thus, electron will move away from the system. It means equilibrium stage cannot be obtained.

183 **(a)**

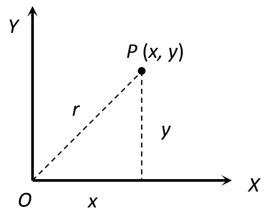
Electric flux is equal to the product of an area element and the perpendicular component of **E**. As the surface is lying in Y-Z plane

$$\therefore \boldsymbol{E}.d\boldsymbol{A} = \phi = (5)(20)$$

$$= 100 \text{ unit.}$$

184 **(b)**

$$E_x = -\frac{dV}{dx} = +ky\,; E_y = -\frac{dV}{dy} = +kx$$



$$\Rightarrow E = \sqrt{E_x^2 + E_y^2} = k\sqrt{x^2+y^2} = kr \Rightarrow E \propto r$$

185 **(c)**

The time required to fall through distance d is

$$d = \frac{1}{2}\left(\frac{qE}{m}\right)t^2 \text{ or } t = \sqrt{\frac{2dm}{qE}}$$

Since $t^2 \propto m$, a proton takes more time

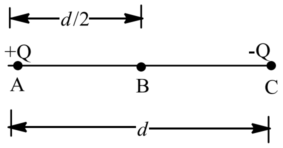
186 **(b)**

For electron $s = \frac{eE}{m_e} \times t_1^2$, For proton $s = \frac{eE}{m_p} \times t_2^2$

$$\therefore \frac{t_2^2}{t_1^2} = \frac{m_p}{m_e} \Rightarrow \frac{t_2}{t_1} = \sqrt{\frac{m_p}{m_e}} = \left(\frac{m_p}{m_e}\right)^{1/2}$$

187 **(b)**

Two equal and opposite charges are placed at a distance d. Electric field at centre(B) due to $+Q$charge



$$(E_1) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{\left(\frac{d}{2}\right)^2}$$

Similarly, electric field due to $-Q$charge

$$(E_2) = \frac{1}{4\pi\varepsilon_0}\frac{(Q)}{\left(\frac{d}{2}\right)^2}$$

Therefore, net electric field at point

$E = E_1 + E_2$

$$= \frac{1}{4\pi\varepsilon_0}\frac{4Q}{d^2} + \frac{1}{4\pi\varepsilon_0}\frac{4Q}{d^2} = \frac{1}{4\pi\varepsilon_0}\frac{8Q}{d^2}$$

188 **(d)**

Capacitance of the given assembly

$$C = 4\pi\varepsilon_0\left(\frac{R_1R_2}{R_2 - R_1}\right) \Rightarrow C \propto \frac{R_1R_2}{(R_2 - R_1)}$$

189 **(d)**

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} \Rightarrow 20 = \frac{10 \times 50 + C_2 \times 0}{10 + C_2}$$

$\Rightarrow 200 + 20C_2 = 500 \Rightarrow C_2 = 15\mu F$

190 **(c)**

According to graph we can say that potential difference across the capacitor C_1 is more than that across C_2. Since charge Q is same $i.e., Q = C_1V_1 = C_2V_2$

$\Rightarrow \frac{C_1}{C_2} = \frac{V_2}{V_1} \Rightarrow C_1 < C_2 \quad [V_1 > V_2]$

191 **(c)**

$U = \frac{1}{2}CV^2$

Now if V is constant, then U is greatest when $'C_{eq}'$ is maximum. This is when all the three are in parallel

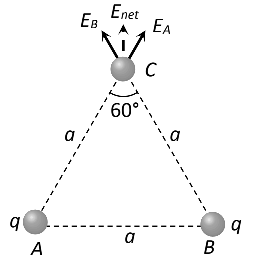
192 **(a)**

$\frac{1}{C_{eq}} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} \Rightarrow C_{eq} = 1\,\mu\,F$

Total charge $Q = C_{\text{eq}}.V = 1 \times 24 = 24\,\mu C$

So p.d. across 6 μF capacitor $= \frac{24}{6} = 4\,volt$

193 **(c)**



$|E_A| = |E_B| = k.\frac{q}{a^2}$

So, $E_{net} = \sqrt{E_A^2 + E_B^2 + 2E_AE_B\cos 60^o}$

$= \frac{\sqrt{3}k.q}{a^2}$

$\Rightarrow E_{net} = \frac{\sqrt{3}\,q}{4\pi\varepsilon_0 a^2}$

194 **(c)**

Electric lines of force never intersect the conductor. They are perpendicular and slightly curved near the surface of conductor

195 **(b)**

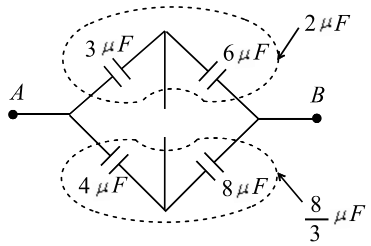
When a dielectric K is introduced in a parallel plate condenser its capacity becomes K times.

Hence $C' = 5C_0$. Energy stored $W_0 = \frac{q^2}{2C_0}$

$\therefore W' = \frac{q^2}{2C'} = \frac{q^2}{2 \times 5C_0} \Rightarrow W' = \frac{W_0}{5}$

196 **(d)**

Given circuit is balanced Wheatstone bridge. So capacitor of $2\mu F$ can be dropped from the circuit



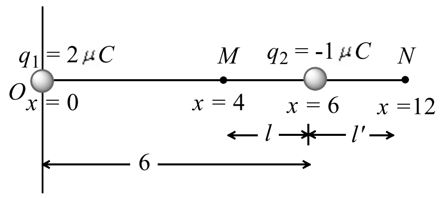
$\Rightarrow C_{AB} = 2 + \frac{8}{3} = \frac{14}{3}\mu F$

197 **(b)**

Because current flows from higher potential to lower potential

198 **(c)**

Potential will be zero at two points



At internal point (M): $\frac{1}{4\pi\varepsilon_0} \times \left[\frac{2\times10^{-6}}{(6-l)} + \frac{(-1\times10^{-6})}{l}\right] = 0$

$\Rightarrow l = 2$

So distance of M from origin; $x = 6 - 2 = 4$

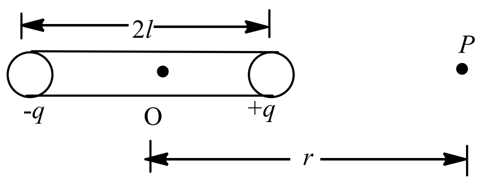
At exterior point (N)

$$\frac{1}{4\pi\varepsilon_0} \times \left[\frac{2\times10^{-6}}{(6+l'')} + \frac{(-1\times10^{-6})}{l''}\right] = 0 \Rightarrow l'' = 6$$

So distance of N from origin, $x = 6 + 6 = 12$

199 **(c)**

When a dipole AB of very small length is taken, then for a point p located at a distance r from the axis the electric field is given by

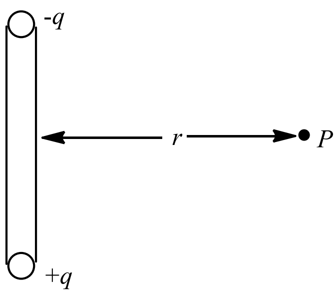


$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2p}{r^3} \quad \ldots \text{(i)}$$

Where p is dipole moment. When dipole is rotated by 90°, then electric field is given by

$$E' = \frac{1}{4\pi\varepsilon_0} \cdot \frac{p}{r^3} \quad \ldots \text{(ii)}$$

From Eqs. (i) and (ii), we get



$$E' = \frac{E}{2}$$

200 **(d)**

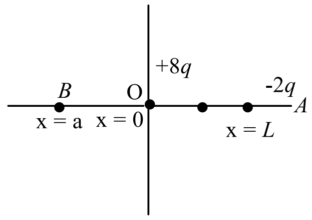
$Q_1 + Q_2 = Q$ ...(i) and $F = k\frac{Q_1Q_2}{r^2}$ ...(ii)

From (i) and (ii) $F = \frac{kQ_1(Q-Q_1)}{r^2}$

For F to be maximum $\frac{dF}{dQ_1} = 0 \Rightarrow Q_1 = Q_2 = \frac{Q}{2}$

201 **(a)**

Suppose that a point B, where net electric field is zero due to charges $8q$ and $-2q$.



$$\boldsymbol{E}_{BO} = \frac{-1}{4\pi\varepsilon_0} \cdot \frac{8q}{a^2}\hat{\boldsymbol{\imath}}$$

$$\boldsymbol{E}_{BA} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{+2q}{(a+L)^2}\hat{\boldsymbol{\imath}}$$

According to condition $\boldsymbol{E}_{BO} + \boldsymbol{E}_{BA} = 0$

$$\therefore \frac{1}{4\pi\varepsilon_0}\frac{8q}{a^2} = \frac{1}{4\pi\varepsilon_0}\frac{2q}{(a+L)^2}$$

$$\Rightarrow \frac{2}{a} = \frac{1}{a+L}$$

$$\Rightarrow 2a + 2L = a$$

$$\therefore \; 2L = -a$$

Thus, at distance $2L$ from origin, net electric field will be zero.

202 **(c)**

Force acting between two current carrying conductors

$$F = \frac{\mu_0}{2\pi}\frac{I_1I_2}{d}l \quad \text{....(i)}$$

Where d = distance between the conductors

l = length of each conductor

Again, $F' = \frac{\mu_0}{2\pi}\frac{(-2I_1)(I_2)}{(3d)} . l$

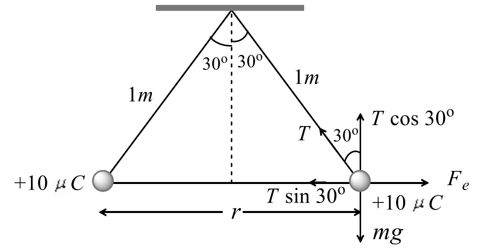
$$= -\frac{\mu_0}{2\pi}\frac{2I_1I_2}{d} . l \quad \ldots \text{(ii)}$$

Thus, from Eqs.(i) and ii

$$\frac{F'}{F} = -\frac{2}{3} \Rightarrow F' = -\frac{2}{3}F$$

203 **(b)**

In the following figure, in equilibrium $F_e = T\sin 30^{\text{o}}$, $r = 1m$



$$\Rightarrow 9\times10^9.\frac{Q^2}{r^2}=T\times\frac{1}{2}$$

$$\Rightarrow 9\times10^9.\frac{(10\times10^{-6})^2}{1^2}=T\times\frac{1}{2}\Rightarrow T=1.8\,N$$

204 **(a)**

Electric field due to a hollow spherical conductor is governed by following equation

$E=0$, for $r<R$ ...(i)

and $E=\frac{Q}{4\pi\varepsilon_0 r^2}$ for $r\geq R$ ...(ii)

$i.e.$ inside the conductor field will be zero and outside the conductor will vary according to $E\propto\frac{1}{r^2}$

205 **(c)**

$E=\frac{\sigma}{2\varepsilon}=\frac{\sigma}{2\varepsilon_0 K}$

208 **(c)**

In uniform electric field dipole experience only torque but no force

209 **(c)**

$$K=\frac{t}{t-d'}\Rightarrow 2=\frac{1}{1-d'}\Rightarrow d'=\frac{1}{2}mm$$

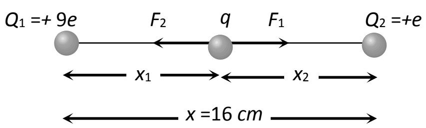
So new distance $=3+\frac{1}{2}=3.5\,mm$

210 **(b)**

Suppose q is placed at a distance x from $+9e$, then for equilibrium net force on it must be zero

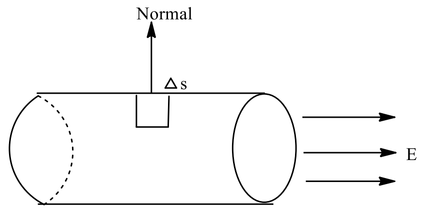
$i.e. |F_1|=|F_2|$

Which gives $x_1=\frac{x}{\sqrt{\frac{Q_2}{Q_1}}+1}=\frac{16}{\sqrt{\frac{e}{9e}}+1}=12\,cm$



211 **(a)**

Let us take a small area ΔS on the cylindrical surface.



The normal to this area will be perpendicular to the axis of the cylinder and electric field is parallel to axis of cylinder.

So, flux $\Delta\phi=\mathbf{E}.\Delta\mathbf{S}$

$=E\Delta S\cos 90°=0$

Summing over the entire surface, the total flux from the surface of cylinder is zero.

212 **(d)**

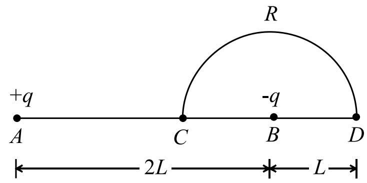
Potential at C $V_C=0$

Potential at D $V_D=\frac{K(-q)}{L}+\frac{Kq}{3L}=-\frac{2}{3}\frac{Kq}{L}$

$\therefore$ Potential difference $V_D-V_C=-\frac{2}{3}\frac{Kq}{L}$

$$\Rightarrow W=Q.(V_D-V_C)=-\frac{2}{3}\times\frac{1}{4\pi\in_0}.\frac{qQ}{L}$$

$$=-\frac{qQ}{6\pi\in_0 L}$$



213 **(a)**

Energy required to charge the capacitor is $W=U=QV$

$$\Rightarrow U=CV^2=\frac{\varepsilon_0 A}{d}.V^2=\frac{\varepsilon_0 Ad}{d^2}V^2=\varepsilon_0 E^2 Ad$$

$$\left[\because E=\frac{V}{d}\right]$$

214 **(c)**

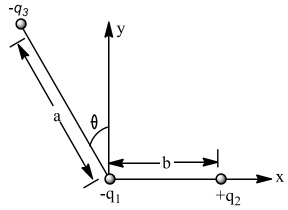
$$U=\frac{1}{2}CV^2=\frac{1}{2}\times2\times(200)^2\times10^{-6}=0.04J$$

215 **(c)**

Electric field near the conductor surface is given by $\frac{\sigma}{\varepsilon_0}$ and it is perpendicular to surface

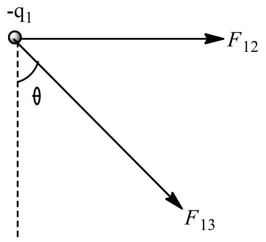
216 **(b)**

Force on $-q_1$



$$\boldsymbol{F} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{b^2}\hat{\boldsymbol{\imath}} + \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{a^2}[\sin\theta\hat{\boldsymbol{\imath}} - \cos\theta\hat{\boldsymbol{\jmath}}]$$

From above, x' component of force is



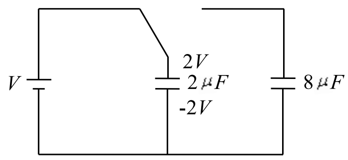
$$F_x = \frac{q_1}{4\pi\varepsilon_0}\left[\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta\right]$$

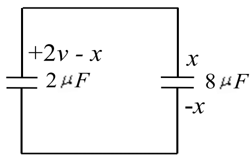
$$F_x \propto \left[\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta\right]$$

217 **(c)**

Top of the stratosphere has an electric field E is nearly equal to $100V/m$

218 **(d)**





$$U_i = \frac{1}{2}(2)V^2, V_{common} = \frac{V}{5}$$

$$U_f = \frac{1}{2}(2+8)\left(\frac{V}{5}\right)^2$$

$$\frac{U_i - U_f}{U_i} \times 100$$

$$= \frac{V^2 - \frac{V^2}{5}}{V^2} \times 100$$

$$\frac{4}{5} \times 100 = 80\ \%$$

219 **(b)**

$$E = 9 \times 10^9 . \frac{Q}{r^2} = 9 \times 10^9 \times \frac{5 \times 10^{-6}}{(0.8)^2}$$

$$= 7 \times 10^4 N/C$$

220 **(d)**

In case of an electric dipole, $F \propto \frac{1}{r^3}$

$\therefore$ new force $= F/2^3 = F/8$.

221 **(d)**

$$V = n^{2/3} v \Rightarrow 2.5 = (125)^{2/3} v \Rightarrow v = \frac{2.5}{25}$$

$$= 0.1\ volt$$

223 **(b)**

$V = V_0(e^{-\lambda t})$

After 1 *seconds*

$$V_1 = 320(e^{-\lambda}) \Rightarrow 240 = 320(e^{-\lambda}) \Rightarrow e^{-\lambda} = \frac{3}{4}$$

After 2 *seconds*

$$V_2 = 320(e^{-\lambda})^2 = 320 \times \left(\frac{3}{4}\right)^2 = 180\ volt$$

After 3 *seconds*

$$V_3 = 320(e^{-\lambda})^3 = 320 \times \left(\frac{3}{4}\right)^3 = 135\ volt$$

224 **(c)**

The force of interaction $F \propto \frac{1}{r^2}$

When length is increased by 10%

$F = \frac{1}{(110/100)^2}$ times $= \frac{100}{121}$ times

$= 0.03$ times

$\therefore$ Decrease in force $= (1 - 0.83)100\% = 17\%$

225 **(d)**

$\frac{q}{t} = 10^{10} \times 1.6 \times 10^{-19}$ and $q = 1C$

So, $\frac{1}{t} = 1.6 \times 10^{-9}$

$t = \frac{10^{10}}{16}$ sec $\Rightarrow t = 20$ years

226 **(b)**

$$\phi = \frac{1}{\varepsilon_0} q = \frac{100Q}{\varepsilon_0}$$

227 **(a)**

$\int_{-\infty}^{0} -\vec{E}.\vec{dl} =$ potential at centre of non-conducting ring

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r} = \frac{9 \times 10^9 \times 1.11 \times 10^{-10}}{0.5} = 2\ volt$$

228 **(d)**

Potential $(V) = 3x^2 + 5$

Intensity of the electric field=

$$\frac{dV}{dx} = 6x$$

$\therefore E$ at $x = -2$

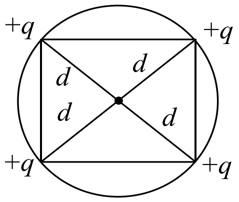
$= 6(-2) = -12\text{Vm}^{-1}$

230 **(d)**

According to option (d) the electric field due to P and S and due to Q and T add to zero. While due to U and R will be added up. Hence the correct option is (d).

231 **(b)**

Potential at centre due to all charges are



$= \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{d}+\frac{q}{d}+\frac{q}{d}+\frac{q}{d}\right]$

$= \frac{1}{4\pi\varepsilon_0}\frac{4q}{d}$ in S.I. unit

$= \frac{4q}{d}$ in C.G.S. unit

232 **(d)**

If the drops are conducting, then

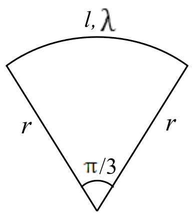
$\frac{4}{3}\pi R^3 = N\left(\frac{4}{3}\pi r^3\right) \Rightarrow R = N^{1/3}r$. Final charge $Q = Nq$

So final potential $V' = \frac{Q}{R} = \frac{Nq}{N^{1/3}r} = V \times N^{2/3}$

233 **(c)**

Length of the arc $= r\theta = \frac{r\pi}{3}$

Charge on the arc $= \frac{r\pi}{3} \times \lambda$



$\therefore$ Potential at centre $= \frac{kq}{r}$

$= \frac{1}{4\pi\varepsilon_0} \times \frac{r\pi}{3}\frac{\lambda}{r} = \frac{\lambda}{12\varepsilon_0}$

234 **(b)**

The work done in bringing unit positive charge from infinity to a point which is at a distance x from the positive charge Q is defined as the potential at the given point due to the charge Q. Therefore here $\phi = W$

235 **(c)**

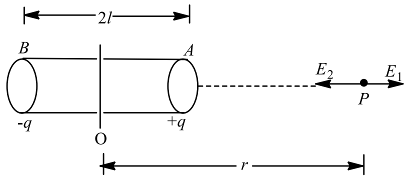
The given arrangement becomes an arrangement of $(n-1)$ capacitors connected in parallel. So $C_R = (n-1)C$

236 **(b)**

For a dipole having two charges +q and -q separated at a distance $2l$, the intensity of electric field at an axial point P is given by

$E = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3}$

Where p is dipole moment.



The direction of electric field E is along the axis of the dipole from negative charge towards positive charge.

237 **(d)**

Given, $q_1 = 5\mu\text{C}, q_2 = 10\mu\text{C}$

and $r = 0.5$ m

$W = \frac{1}{4\pi\varepsilon_0 k}\frac{q_1q_2}{r}$

$= 9 \times 10^9 \times \frac{5\times10^{-6}\times10\times10^{-6}}{0.5}$

$= 9 \times 10^{-1}$ J

238 **(a)**

Flux is due to charges enclosed per ε_0

$\therefore$ Total flux $= (-14 + 78.85 - 56)nC/\varepsilon_0$

$= 8.85 \times 10^{-9}C \times \frac{4\pi}{4\pi\varepsilon_0}$

$= 8.85 \times 10^{-9} \times 9 \times 10^9 \times 4\pi$

$= 1000.4\ Nm^2/C$ i.e. $1000\ Nm^2C^{-1}$

239 **(a)**

Given, $Q_1 = 10$ unit, $Q_2 = -20$ unit

After contact charges on both become same, *ie*,

$Q' = \frac{10-20}{2} = -5$ units

$|F_1| = \frac{1}{4\pi\varepsilon_0} \times \frac{10\times20}{r^2}$

and $|F_2| = \frac{1}{4\pi\varepsilon_0} \times \frac{5\times5}{r^2}$

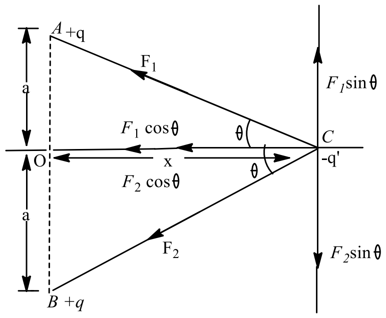
Hence, $\frac{|F_1|}{|F_2|} = \frac{8}{1}$

240 **(c)**

Effective air separation between them becomes infinite so force becomes zero

241 **(c)**

Let two identical positive charges $(+q)$ are placed on both sides at a distance a from the origin O and negative charge (-q') is placed at a large distance x from O.



Here, $F_1 = F_2 = \frac{Kqq}{(a^2+x^2)}$ ....(i)

The situation is shown in figure. Here the vertical components $F_1 \sin\theta$ and $F_2 \sin\theta$

are equal and opposite. So they cancel each other. The resultant force on the

charge q' is

$[AC = BC = \sqrt{a^2+x^2}$ and $\cos\theta = \frac{x}{\sqrt{a^2+x^2}}]$

$F = F_1 \cos\theta + F_2 \cos\theta = 2F\cos\theta$

$(\because F_1 = F_2)$

$\Rightarrow \quad F = \frac{2Kqq}{(a^2+x^2)} \cdot \frac{x}{\sqrt{a^2+x^2}}$

$= \frac{2Kqqx}{(a^2+x^2)^{3/2}}$ ... (ii)

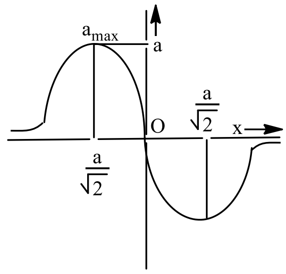
But $F = ma$(m mass of the charge q', and a=acceleration)

$ma = \frac{2Kqqx}{(a^2+x^2)^3/^2}$

for $\quad a = \frac{2Kqq}{m} \cdot \frac{x}{(a^2+x^2)^3/^2}$ ... (iii)

When the particle starts to move, its acceleration is zero and after then the acceleration of the particle is given by Eq. (iii).

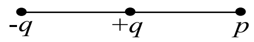
So it is clear, when $x = 0$, then $a = 0$ and when $x = \pm\frac{a}{\sqrt{2}}$ then the acceleration is maximum.
Hence the graph between acceleration and its x-coordinate is given as



242 **(a)**
Dipole moment $d = q \times r$
$= 1.6 \times 10^{-19} \times 4.3 \times 10^{-9}$ Coulomb metre
$= 6.8 \times 10^{-28} Cm$

243 **(c)**
$F_A = F_B$; because an uniform electric field produced between the plates

244 **(c)**
$\phi = \int Eds = \frac{Kq}{r^2} 4\pi r^2 = \frac{q}{\varepsilon_0}$



$W_{ext} = q(V_B - V_A)$
Comment : (d) is not correct answer because it is not given that charge is moving slowly

246 **(d)**
$C_{medium} = KC_{air} \Rightarrow K = \frac{C_{medium}}{C_{air}} = \frac{110}{50} = 2.20$

247 **(c)**
The torque acting on an electric dipole

$\tau = \boldsymbol{p} \times \boldsymbol{E} = pE \sin\theta$

Torque will maximum when value of $\sin\theta$ will be maximum or $\theta = 90°$.

248 **(b)**
Apply shell theorem, the total charge upto distance r can be calculated as followed

$dq = 4\pi r^2 . dr . \rho$

$= 4\pi r^2 . dr . \rho_0 \left[\frac{5}{4} - \frac{r}{R}\right]$

$= 4\pi\rho_0 \left[\frac{5}{4} r^2 dr - \frac{r^3}{R} dr\right]$

$\int dq = q = 4\pi\rho_0 \int_0^r \left(\frac{5}{4} r^2 dr - \frac{r^3}{R} dr\right)$

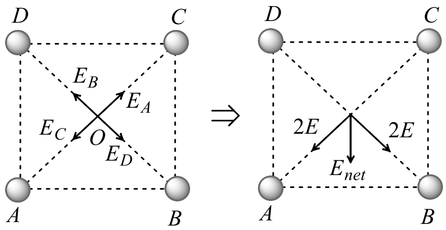
$= 4\pi\rho_0 \left[\frac{5}{4}\frac{r^3}{3} - \frac{1}{R}\frac{r^4}{4}\right]$

$$E = \frac{kq}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{1}{r^2}.4\pi\rho_0\left[\frac{5}{4}\left(\frac{r^3}{3}\right) - \frac{r^4}{4R}\right]$$

$$E = \frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$$

249 **(b)**



$E_A = E, E_B = 2E, E_C = 3E, E_D = 4E$

250 **(c)**

Capacity when outer sphere is earthed

$$C_1 = 4\pi\varepsilon_0 \frac{ab}{b-a}$$

Capacity when inner sphere is earthed

$$C_2 = 4\pi\varepsilon_0 b + \frac{4\pi\varepsilon_0 ab}{b-a} = 4\pi\varepsilon_0\left(\frac{b^2}{b-a}\right)$$

Difference in capacity $= C_2 - C_1 = 4\pi\varepsilon_0 b$

251 **(c)**

The potential energy of an electric dipole in a uniform electric field is

$U = -\vec{p}.\vec{E}$

$U = -pE\cos\theta$

For U to be maximum

$\cos\theta = -1 \Rightarrow \theta = \pi$

253 **(b)**

This combination forms a G.P. $S = 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} \dots\dots$

Sum of infinite G.P. $S = \frac{a}{1-r}$

Here a = first term = 1 and r = common ratio $= \frac{1}{2}$

$$\Rightarrow S = \frac{1}{1-\frac{1}{2}} = 2 \Rightarrow C_{eq} = 2\mu F$$

254 **(b)**

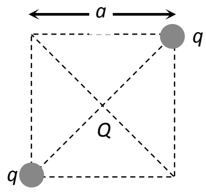
In balance condition

$$\Rightarrow QE = mg \Rightarrow Q\frac{V}{d} = \left(\frac{4}{3}\pi r^3\rho\right)g$$

$$\Rightarrow Q \propto \frac{r^3}{V} \Rightarrow \frac{Q_1}{Q_2} = \left(\frac{r_1}{r_2}\right)^3 \times \frac{V_2}{V_1}$$

$$\Rightarrow \frac{Q}{Q_2} = \left(\frac{r}{r/2}\right)^3 \times \frac{600}{2400} = 2 \Rightarrow Q_2 = Q/2$$

255 **(a)**



From symmetry of the figure all corner have same electric potential. Therefore work done in moving the charge q from the corner to the diagonally opposite corner is zero

256 **(b)**

Ratio of charges =2:3

$\therefore\ q_1 = \frac{2}{5} \times 1\mu C$ and $q_2 = \frac{3}{5} \times 1\mu C$

Electrostatic force between the two charges

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$= \frac{9\times10^9\times2\times10^{-6}\times3\times10^{-6}}{5\times5\times(1)^2}$$

$$= 2.16 \times 10^{-3}\text{N}$$

257 **(d)**

According to figure, potential at A and C are equal. Hence work done in moving $-q$ charge from A to C is zero

258 **(d)**

Option (b) is not possible because it is not obeying the fact that number of lines of force has to be proportional to magnitude of charge. Option (c) is not possible because it is violating the fact electric lines of force can never intersect.

259 **(c)**

Potential energy $= -pE\cos\theta$

When $\theta = 0$. Potential energy $= -pE$ (minimum)

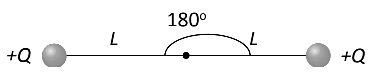
261 **(b)**

Net electrostatic energy $U = \frac{kQq}{a} + \frac{kq^2}{a} + \frac{kQq}{a\sqrt{2}} = 0$

$$\Rightarrow \frac{kq}{a}\left(Q + q + \frac{Q}{\sqrt{2}}\right) = 0 \Rightarrow Q = -\frac{2q}{2+\sqrt{2}}$$

262 **(a)**

The position of the balls in the satellite will become as shown below because it is gravitation free space



Thus angle $\theta = 180^0$ and force $= \frac{1}{4\pi\epsilon_0}.\frac{Q^2}{(2L)^2}$

263 **(a)**

When put $1cm$ apart in air, the force between Na and Cl ions $= F$. When put in water , the force between Na and Cl ions $= \frac{F}{R}$

264 **(c)**

Let q_1, q_2 be the charges on two condensers

$\therefore V = \frac{q_1}{6} = \frac{q_2}{14} \Rightarrow \frac{q_1}{q_2} = \frac{6}{14}$

Also $q_1 + q_2 = 600 \Rightarrow q_1 + \frac{14}{6}q_1 = 600 \Rightarrow q_1 = \frac{600}{20} \times 6$

$\therefore V = \frac{q_1}{6} = \frac{600}{20} = 30\ volt$

265 **(d)**

If length of the foil is l then $C = \frac{k\varepsilon_0(l \times b)}{d}$

$\Rightarrow 2 \times 10^{-6}$

$= \frac{2.5 \times 8.85 \times 10^{-12}(l \times 400 \times 10^{-3})}{0.15 \times 10^{-3}}$

$\Rightarrow l = 33.9\ m$

266 **(b)**

According to the figure, there is no other charge. A single charge when moved in a space of no field, does not experience any force. No work is done $W_A = W_B = W_C = 0$

267 **(b)**

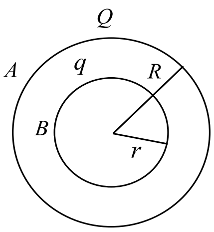
$F \propto Q_1Q_2 \Rightarrow \frac{F_1}{F_2} = \frac{Q_1Q_2}{Q_1'Q_2'} = \frac{10 \times -20}{-5 \times -5} = -\frac{8}{1}$

268 **(c)**

The potential of Q at the surface

$A = \frac{1}{4\pi\varepsilon_0}.\frac{Q}{R}$; The potential of q

At the surface $A = \frac{1}{4\pi\varepsilon_0}.\frac{q}{R}$



The potential at B is due to Q

Inside $= \frac{1}{4\pi\varepsilon_0}.\frac{Q}{R}$

The potential at B due to $q = \frac{1}{4\pi\varepsilon_0}.\frac{q}{r}$

$\therefore$ Potential at $A, V_A = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R} + \frac{q}{R}\right)$

Potential at $B, V_B = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R} + \frac{q}{R}\right)$

$\therefore V_B - V_A = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r} - \frac{q}{R}\right)$

270 **(a)**

$C_p = 4C_s \Rightarrow (C_1 + C_2) = 4\frac{C_1C_2}{(C_1 + C_2)}$

$\Rightarrow (C_1 - C_2)^2 = 0 \Rightarrow C_1 = C_2$

271 **(a)**

It is know that the electric field due to an infinite plane sheet of charge is independent of distance of point the sheet. Applying the principle of superposition.

$\vec{E}_p = \frac{\sigma}{2\varepsilon_0}(-\hat{k}) + \frac{2\sigma}{2\varepsilon_0}(-\hat{k}) + \frac{\sigma}{2\varepsilon_0}(-\hat{k})$

$\vec{E}_p = \frac{2\sigma}{\varepsilon_0}\hat{k}$

272 **(a)**

Net field at origin $E = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{4^2} + \ \dots.\infty\right]$

$= \frac{q}{4\pi\varepsilon_0}[1 + \frac{1}{4} + \frac{1}{16} + \ \dots.\infty]$

$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{1 - \frac{1}{4}}\right] = 12 \times 10^9 q\ N/C$

274 **(b)**

At centre $E = 0, V \neq 0$

275 **(a)**

$\frac{1}{C_s} = \frac{1}{3} + \frac{1}{9} + \frac{1}{18} = \frac{1}{2} \Rightarrow C_s = 2\mu F$

$C_p = 3 + 9 + 18 = 30\mu F \Rightarrow \frac{C_s}{C_p} = \frac{2}{30} = \frac{1}{15}$

276 **(d)**

$F = k.\frac{Q^2}{r^2}$. If Q is halved, r is doubled then $F \rightarrow \frac{1}{16}$ times

277 **(a)**

Let r be radius of each small drop and R be radius of bigger drop

As the volume remains constant

$\therefore \frac{4}{3}\pi R^3 = n \times \frac{4}{3}\pi r^3 \Rightarrow R = n^{1/3}r$

Capacitance of each small drop, $C_0 = 4\pi\varepsilon_0 r$

Charge of each small drop, $q_0 = C_0V = 4\pi\varepsilon_0 rV$

Charge of bigger drop, $Q = nq_0$

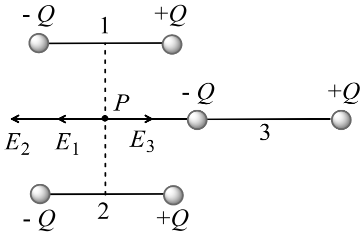
Capacitance of bigger drop, $C = 4\pi\varepsilon_0 R$

Potential of bigger drop, $= \frac{Q}{C} = \frac{nq_0}{4\pi\varepsilon_0 R}$

$= \frac{n(4\pi\varepsilon_0 rV)}{4\pi\varepsilon_0 R} = nV\left(\frac{r}{R}\right) = n\left(\frac{1}{n^{1/3}}\right)V = n^{2/3}V$

278 **(c)**

Point P lies at equatorial positions of dipole 1 and 2 and axial position of dipole 3



Hence field at P

due to dipole 1 $E_1 = \frac{k.p}{x^3}$ [towards left]

due to dipole 2

$E_2 = \frac{k.p}{x^2}$ [towards left]

Due to dipole 3 $E_3 = \frac{k.(2p)}{x^3}$ [towards right]

So net field at P will be zero

279 **(b)**

Capacity of spherical conductor of 20 cm diameter

$C_1 = 4\pi\varepsilon_0 r = 4\pi\varepsilon_0 \times 10 \times 10^{-2}$

Capacity of parallel plate air capacitor

$$C_2 = \frac{\varepsilon_0 A}{d} = \frac{\varepsilon_0[\pi(2)^2] \times 10^{-4}}{d} = \frac{\varepsilon_0 \times 4\pi \times 10^{-4}}{d}$$

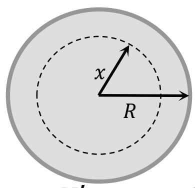
Hence $C_1 = C_2 \Rightarrow 40\pi\varepsilon_0 \times 10 \times 10^{-2} = \frac{40\pi\varepsilon_0 \times 10^{-4}}{4}$

$\Rightarrow d = 10^{-3} m$

281 **(c)**

Let sphere has uniform charge density $\rho \left(= \frac{3Q}{4\pi R^3}\right)$ and E is the electric field at distance x from the centre of the sphere

Applying Gauss law



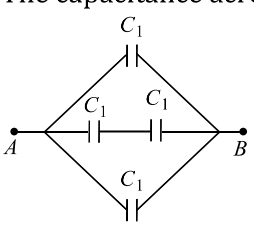
$$E.4\pi x^2 = \frac{q}{\varepsilon_0} = \frac{\rho V'}{\varepsilon_0} = \frac{\rho}{\varepsilon_0} \times \frac{4}{3}\pi x^3$$

[V' = Volume of dotted sphere]

$$\therefore E = \frac{\rho}{3\varepsilon_0} x \Rightarrow E \propto x$$

282 **(d)**

The capacitance across A and B



$$= \frac{C_1}{2} + C_1 + C_1 = \frac{5}{2} C_1$$

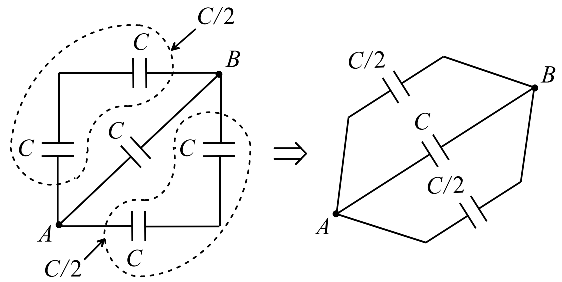
As $Q = CV$,

$$1.5\mu C = \frac{5}{2} C_1 \times 6$$

$$\Rightarrow C_1 = \frac{1.5}{15} \times 10^{-6} = 0.1 \times 10^{-6} F = 0.1\mu F$$

283 **(a)**

The given circuit can be simplified as follows



Equivalent capacitance between A and B is $C_{AB} = 2C$

285 **(c)**

Force on each charge is zero. But if any of the charge is displaced, the net force starts acting on all of them

286 **(a)**

$$F = 9 \times 10^9 \times \frac{Q^2}{r^2} = 9 \times 10^9 \times \frac{(1.6 \times 10^{-19})^2}{(10^{-10})^2}$$
$$= 2.3 \times 10^{-8} N$$

287 **(a)**

Total enclosed charge as already shown in

$$q_{\text{net}} = \frac{6C}{2} + \frac{8C}{4} - 7C$$

$$= -2C$$

From Gauss-theorem, net flux,

$$\phi_{\text{net}} = \frac{q_{\text{net}}}{\varepsilon_0} = \frac{-2C}{\varepsilon_0}$$

288 **(a)**

$$a = \frac{eE}{m} \Rightarrow a = 1.76 \times 10^{11} \times 50 \times 10^2$$
$$= 8.8 \times 10^{14}\ m/sec^2$$

289 **(a)**

Time constant $= \tau = RC$

$$C = \frac{C_1 C_2}{C_1 + C_2} = \frac{\left(\frac{A\varepsilon_0}{d-x}\right)\left(\frac{KA\varepsilon_0}{x}\right)}{\frac{A\varepsilon_0}{d-x} + \frac{KA\varepsilon_0}{x}}$$

$$C = \frac{KA\varepsilon_0}{x + K(d-x)} \Rightarrow x = \frac{d}{3} - Vt$$

$$\tau = \frac{RKA\varepsilon_0}{\frac{d}{3} - Vt + K\left(d - \frac{d}{3} + Vt\right)}$$

$$A = 1, K = 2, \tau = \frac{3 \times 2R\varepsilon_0}{d - 3Vt + 6d - 2d + 6Vt}$$

$$= \frac{6R\varepsilon_0}{5d + 3Vt}$$

290 **(d)**

As $\vec{E}$ is a vector quantity

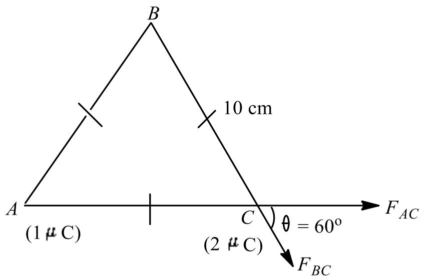
291 **(d)**

The point lies on equatorial line of a short dipole.

$$\therefore \; E = \frac{p}{4\pi\varepsilon_0 r^3} = \frac{9 \times 10^9 (10^{-6} \times 10^{-8})}{(10^{-1})^3}$$

$= 9 \times 10^{-2} = 0.09 \text{ NC}^{-1}$.

292 **(d)**



$$F_{AC} = \frac{1}{4\pi\varepsilon_0}\frac{q_A q_c}{(AC)^2}$$

$$= \frac{9\times10^9\times1\times10^{-6}\times2\times10^{-6}}{(10\times10^{-2})^2} = 1.8$$

Similarly, $F_{BC} = \frac{1}{4\pi\varepsilon_0}\frac{q_B q_c}{(BC)^2}$

$$= \frac{9 \times 10^9 \times 1 \times 10^{-6} \times 2 \times 10^{-6}}{(10 \times 10^{-2})^2} = 1.8$$

$$F_{\text{resultant}} = \sqrt{F_{AC}^2 + F_{BC}^2 + 2F_{AC}F_{BC}\cos 60°}$$

$$= \sqrt{(1.8)^2 + (1.8)^2 + 2(1.8)^2 \times \frac{1}{2}}$$

$= 3.12$ N

293 **(d)**

$C_1 + C_2 + C_3 = 12$ ...(i)

$C_1 C_2 C_3 = 48$ ...(ii)

$C_1 + C_2 = 6$ ...(iii)

From equation (i) and (iii)

$C_3 = 6$ ...(iv)

From equation (ii) and (iv) $C_1 C_2 = 8$

Also $(C_1 - C_2)^2 = (C_1 + C_2)^2 - 4C_1C_2$

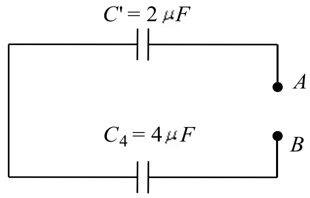
$(C_1 - C_2)^2 = (6)^2 - 4 \times 8 = 4$

$\Rightarrow C_1 - C_2 = 2$ ...(v)

On solving (iii) and (v) $C_1 = 4, C_2 = 2$

294 **(a)**

C_2 and C_3 are connected in series, parallel with C_1, then their equivalent capacitance $C'' = \frac{2\times2}{2+2} + 1 = 2\mu F$



C_4 and C'' are in series

$\therefore$ Effective capacity $C_{eff} = \frac{4}{3}\mu F$

295 **(c)**

The electric field intensity at a point in an electric field in a given direction is equal to the negative potential gradient in that direction

$$ie, \quad E = -\frac{dV}{dx}$$

The negative sign signifies that the potential decreases in the direction of the electric field.

297 **(b)**

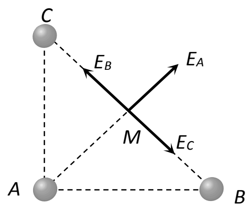
$$E_e = \frac{1}{2}E_a \;\; \therefore E_a = 2E_e$$

298 **(b)**

E_A = Electric field at M due to charge placed at A

E_B = Electric field at M due to charge placed at B

E_C = Electric field at M due to charge placed at C



As seen from figure $|\vec{E_B}| = |\vec{E_C}|$, so net electric field at $M, E_{net} = E_A$; in the direction of vector 2

299 **(c)**

$$F_{\text{initial}} = \frac{1}{4\pi\varepsilon_0} \times \frac{12\times(-8)}{r^2}$$

$$F_{\text{initial}} = \frac{1}{4\pi\varepsilon_0} \times \frac{96}{r^2}$$

Where r is the distance between them. When the charges are brought in contact, then

$q_1 = q_2 = \frac{12-8}{2} = \frac{4}{2} = 2\mu F$

$\therefore\ F_{final} = \frac{1}{4\pi\varepsilon_0} \times \frac{2\times 2}{r^2} = \frac{4}{r^2} \times \frac{1}{4\pi\varepsilon_0}$

$\Longrightarrow\ |F|_{final} = \frac{4}{r^2} \times \frac{1}{4\pi\epsilon_0}$

$\therefore\ \frac{|F|_{initial}}{|F|_{final}} = \frac{96}{4} = 24$

300 **(c)**

For solid sphere of radius R_1

$$q_1 = \int_0^{R_1} 4\pi r^2\, dr\rho$$

$$= \int_0^{R_1} 4\pi r^2 d\, r \frac{\rho_0}{r}$$

$$q_1 = 4\pi \frac{R_1^2}{2} \rho_0$$

$$q_2 = -4\pi R_2^2 \sigma$$

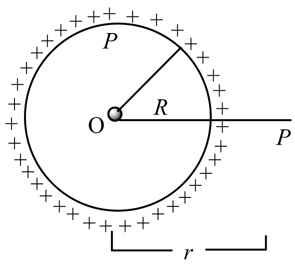
$$q_1 + q_2 = 0$$

$$4\pi \frac{R_1^2 \rho_0}{2} - 4\pi R_2^2 \sigma = 0$$

$$\left(\frac{R_1}{R_2}\right)^2 = \frac{2\sigma}{\rho_0}$$

$$\frac{R_2}{R_1} = \sqrt{\frac{\rho_0}{2\sigma}}$$

301 **(c)**



The electric field due to the spherical shell at point $+P$.

$$E = \frac{1}{4\pi\varepsilon_0} . \frac{q}{r^2} \qquad (\because r > R)$$

or $E \propto \frac{1}{r^2}$

or $E \propto r^{-2}$

According to Gauss's law inside the shell electric field is zero.

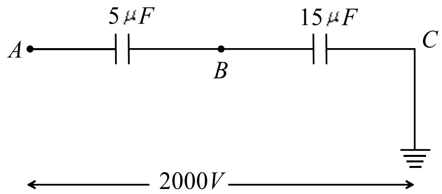
ie, $\oint \boldsymbol{E}.\boldsymbol{ds} = 0$

or $E = 0$

the electric field due to the shell at a point inside is zero and varies as r^{-2}outside it.

302 **(c)**

The given circuit can be redrawn as follows



$$(V_A - V_B) = \left(\frac{15}{5+15}\right) \times 2000 \Rightarrow V_A - V_B = 1500V$$

$$\Rightarrow 2000 - V_B = 1500V \Rightarrow V_B = 500V$$

303 **(d)**

For the drop to be stationary,

Force on the drop due to electric field = weight of the drop $qE = mg$

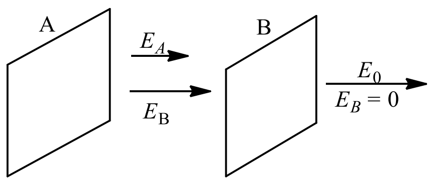
$$q = \frac{1.6 \times 10^{-6} \times 10}{100} = 1.6 \times 10^{-7} C$$

Number of electrons carried by the drop is

$$= \frac{q}{e} = \frac{1.6 \times 10^{-7} C}{1.6 \times 10^{-19} C} = 10^{12}$$

305 **(b)**

The situation is as shown in the figure



Here, $E_A = \frac{\sigma}{2\varepsilon_0}$

and $E_B = \frac{\sigma}{2\varepsilon_0}$

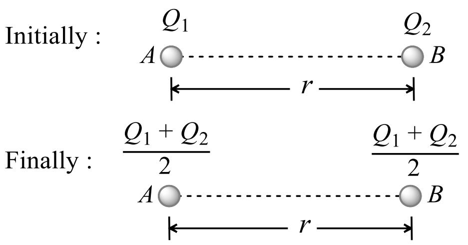
Hence, the electric field between the plates

$$E = E_A + E_B = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$$

and electric field outside the plates will be zero.

306 **(a)**

Suppose the balls having charges Q_1 and Q_2 respectively



$$F'' = \frac{k\left(\frac{Q_1+Q_2}{2}\right)^2}{\left(\frac{r}{2}\right)^2} = \frac{k(Q_1+Q_2)^2}{r^2}$$

It is given that $F'' = 4.5F$ so $\frac{k(Q_1+Q_2)^2}{r^2} = 4.5\, k.\frac{Q_1Q_2}{r^2}$
$\Rightarrow (Q_1+Q_2)^2 = 4.5\, Q_1Q_2$. On solving it gives $\frac{Q_1}{Q_2} = \frac{2}{1}$

307 **(c)**

$E_1 = \frac{\eta q}{4\pi\varepsilon_0 a^2}, E_2 = \frac{\eta q}{4\pi\varepsilon_0 a^2}$. Therefore $E = \vec{E}_1 + \vec{E}_2$

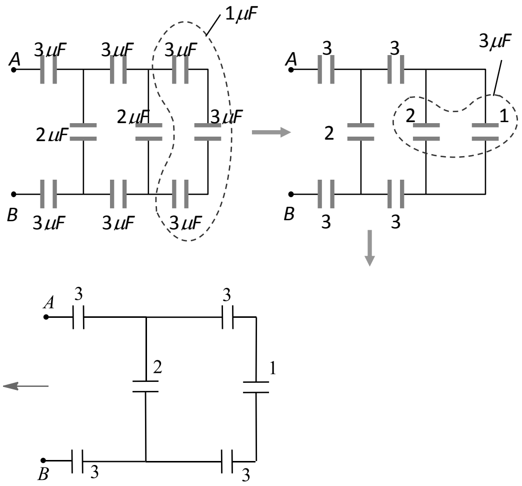
$$= \sqrt{E_1^2 + E_2^2 + 2E_1E_2\cos 60°} = \frac{\sqrt{3}\eta q}{4\pi\varepsilon_0 a^2}$$

Since $\eta^{-1} < \sqrt{3}, 1 < \sqrt{3}\eta, \sqrt{3}\eta > 1$

$$\Rightarrow \frac{\sqrt{3}\eta q}{4\pi\varepsilon_0 a^2} > \frac{q}{4\pi\varepsilon_0 a^2} \Rightarrow E_3 > E_0 \left(E_0 = \frac{q}{4\pi\varepsilon_0 a^2}\right)$$

308 **(a)**

The given circuit can be redrawn as follows



On further solving the network in similar manner equivalent capacitance obtained between A and B will be 1 μF

309 **(d)**

Charge will be induced in the conducting sphere, but net charge on it will be zero

310 **(d)**

$$E_{axial} = E_{equatorial} \Rightarrow k.\frac{2p}{x^3} = \frac{k.p}{y^3} \Rightarrow \frac{x}{y} = \frac{2^{1/3}}{1}$$
$$= \sqrt[3]{2}:1$$

311 **(c)**

$$\frac{1}{4\pi\varepsilon_0} = 9\times10^9 \Rightarrow \varepsilon_0 = \frac{1}{4\pi\times9\times10^9}$$

Electric field density or energy per unit volume is

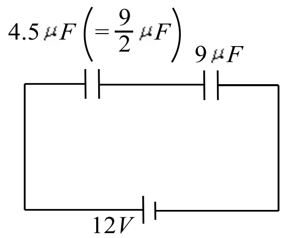
$$u = \frac{k\varepsilon_0}{2}\left(\frac{V}{d}\right)^2$$

$k = 5, V = 500$ volts, $d = 2\times10^{-3}m$

$$\therefore u = \frac{5}{2}\times\frac{1}{4\pi\times9\times10^9}\times\frac{(500)^2}{(2\times10^{-3})^2}$$
$$= 1.38\, Jm^{-3}$$

312 **(d)**

The given circuit can be redrawn as follows potential difference across 4.5 μF capacitor



$$V = \frac{9}{\left(\frac{9}{2}+9\right)}\times 12$$
$= 8\,V$

313 **(a)**

The negative charge oscillates, the resultant force acts as a restoring force and proportional to displacement. When it reaches the plane XY, the resultant force is zero and the mass moves down due to inertia. Thus oscillation is set

314 **(c)**

When the switch is open, 3μF and 6μF capacitors are in series. Hence charge on each capacitor

$$q = C_{eq}V = \frac{3\times6}{3+6}\times9 = 18\,\mu C$$

When the switch is closed, in the steady state no current will flow through the capacitor. Therefore the two resistors 3Ω and 6Ω will be in series. Current in each resistor will be

$$I = \frac{9}{3+6} = 1\,A$$

Now the $3\mu F$ capacitor and $6\mu F$ capacitor will be in parallel with 3Ω and 6Ω resistor respectively

Charge on $3\mu F$ capacitor $q_1 = CV = 3\times3 = 9\mu C$

Charge on 6μF $\quad q_2 = CV = 6\times6 = 36\mu C$

Charge flowing through the switch = increase in charge on the system consisting of right plate of $3\mu F$ and left plate of 6μF $= (-9+36) = 27\mu C$

315 **(b)**

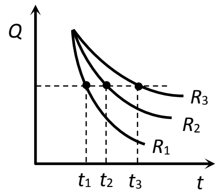
$$\phi = \frac{1}{\varepsilon_0}\times Q_{enc} = \frac{1}{\varepsilon_0}(2q)$$

316 **(c)**

During the discharge of a capacitor through a resistance charge at any instant $Q = Q_0 e^{-t/CR}$

$\Rightarrow \frac{Q_0}{Q} = e^{t/CR} \Rightarrow t = CR \log_e \frac{Q_0}{Q}$

If $Q \to$ constant, then $t \propto R$



Now, draw a line parallel to the time axis as shown. Suppose this line cut the graphs at points 1, 2 and 3. Corresponding times are t_1, t_2 and t_3 respectively. Hence from graph $t_1 < t_2 < t_3$

$\Rightarrow R_1 < R_2 < R_3$

317 **(c)**

$\frac{1}{C'} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} = \frac{3}{C}$

$C' = \frac{C}{3}$

$V' = V_1 + V_2 + V_3 = V + V + V = 3V$

320 **(d)**

There will be zero charge inside closed surface

321 **(a)**

If the value of C is chosen as $4\mu F$, the equivalent capacity across every part of the section will be $4\mu F$

322 **(b)**

Dielectric constant $K = \frac{\varepsilon}{\varepsilon_0}$

Permittivity of metals (ε) is assumed to be very high

323 **(d)**

$E = 9 \times 10^9 \times \frac{Q}{r^2} \Rightarrow 500 = 9 \times 10^9 \times \frac{Q}{(3)^2} \Rightarrow Q = 0.5\ \mu C$

324 **(c)**

Battery in disconnected so Q will be constant as $C \propto K$. So with introduction of dielectric slab capacitance will increase using $Q = CV, V$ will decrease and using $U = \frac{Q^2}{2C}$, energy will decrease

325 **(b)**

$4\pi\varepsilon_0 r = \frac{\varepsilon_0 A}{d} \Rightarrow d = \frac{A}{4\pi r} = \frac{\pi(20 \times 10^{-3})^2}{4\pi \times 1} = 0.1\ mm$

326 **(c)**

$KE = QV = e \times 10^3 V = 1KeV$

327 **(c)**

The general form of electric field in space around a charge distribution is given by

$\vec{E} = E_x\hat{\imath} + E_y\hat{\imath} + E_z\hat{k}$

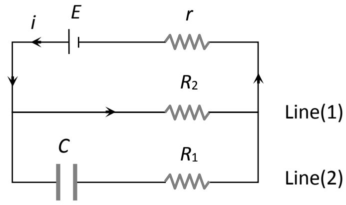
328 **(b)**

By using $Q = ne \Rightarrow Q = 10^{19} \times 1.6 \times 10^{-19} = +1.6\ C$

329 **(c)**

In steady state current drawn from the battery

$i = \frac{E}{(R_2 + r)}$



In steady state capacitor is fully charged hence No current will flow through line (2)

Hence potential difference across line (1) is $V = \frac{E}{(R_2+r)} \times R_2$, the same potential difference appears across the capacitor, so charge on capacitor

$Q = C \times \frac{ER_2}{(R_2 + r)}$

330 **(b)**

While drawing the dielectric plate outside, the capacitance decreases till the entire plate comes out and then becomes constant. So, V increases and then becomes constant

331 **(c)**

Energy density $= \frac{\text{Energy}}{\text{Volume}}$ so it's dimensions are

$\frac{ML^2T^{-2}}{L^3} = [ML^{-1}T^{-2}]$

332 **(a)**

$\frac{kq_1}{3} = 10, \frac{kq_2}{1} = 10$

$kq_1 = 30 \times 10^{-2}$

$kq_2 = 10 \times 10^{-2}$

$F = \frac{kq_1q_2}{10^{-2}}$

$= \frac{(30\times10^{-2})\times(10\times10^{-2})}{k\times10^{-2}}$

$F = \frac{1}{3} \times 10^{-9}$ N

333 **(d)**

$C \propto \frac{1}{d}$

334 **(c)**

In this process capacity increases, so battery supplies additional charge to capacitor. In order to keep same potential difference

335 **(b)**

Total flux coming out from unit charge

$$\phi = \vec{E}.d\vec{s} = \frac{1}{\varepsilon_0} \times 1 = \varepsilon_0^{-1}$$

336 **(b)**

$$C_1 = \frac{K_1 \varepsilon_0 \frac{A}{2}}{\left(\frac{d}{2}\right)} = \frac{K_1 \varepsilon_0 A}{d}$$

$$C_2 = \frac{K_2 \varepsilon_0 \frac{A}{2}}{\left(\frac{d}{2}\right)} = \frac{K_2 \varepsilon_0 A}{d} \text{ and } C_3 = \frac{K_3 \varepsilon_0 A}{\left(\frac{d}{2}\right)} = \frac{2K_3 \varepsilon_0 A}{d}$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1 + C_2} + \frac{1}{C_3} = \frac{1}{\frac{\varepsilon_0 A}{d}(K_1 + K_2)} + \frac{1}{\frac{\varepsilon_0 A}{d} \times 2K_3}$$

$$\frac{1}{C_{eq}} = \frac{d}{\varepsilon_0 A}\left(\frac{1}{K_1 + K_2} + \frac{1}{2K_3}\right)$$

$$C_{eq} = \left(\frac{1}{K_1 + K_2} + \frac{1}{2K_3}\right)^{-1} . \frac{\varepsilon_0 A}{d}$$

So $K_{eq} = \left(\frac{1}{K_1+K_2} + \frac{1}{2K_3}\right)^{-1}$

337 **(a)**

Magnetic lines of force always makes a closed loop

338 **(d)**

$$C = \frac{A\varepsilon_0}{d} = 10\mu F$$

$$C_1 = \frac{A\varepsilon_0}{d - t + \frac{t}{k}} = \frac{A\varepsilon_0}{d - \frac{d}{2} + \frac{d}{2k}} = \frac{A\varepsilon_0}{\frac{d}{2}\left(1 + \frac{1}{2}\right)} = \frac{4}{3} . \frac{A\varepsilon_0}{d}$$

$$\therefore C_1 = \frac{4}{3} \times 10 = 13.33\mu F$$

339 **(d)**

Energy density $u_e = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2} \times 8.86 \times 10^{-12} \times \left(\frac{V}{r}\right)^2$

$= 2.83\ J/m^3$

340 **(c)**

$$\Delta U = \frac{1}{2}\frac{C_1 C_2 (V_2 - V_1)^2}{(C_1 + C_2)}$$

$$= \frac{1}{2} \times \frac{(3 \times 5) \times 10^{-12} \times (500 - 300)^2}{(3 + 5) \times 10^{-6}}$$

$$= \frac{15 \times 10^{-12} \times 4 \times 10^4}{2 \times 8 \times 10^{-6}} = 0.0375\ J$$

341 **(a)**

By Gauss's theorem

$$\phi_E = \int \mathbf{E}.d\mathbf{S} = \frac{q}{\varepsilon_0}.$$

$$\phi_E \propto \int ds$$

$\therefore$ Flux will also doubled, *ie*, 2ϕ.

342 **(b)**

Electric field intensity due to infinite line charge is

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

Given,

$E = 7.182 \times 10^8 \text{NC}^{-1}$

$r = 2\text{cm} = 2 \times 10^{-2}\text{m}$

$\lambda = ?$

$$\Rightarrow \quad \lambda = 2\pi\varepsilon_0 rE = \frac{2 \times 2\pi\varepsilon_0 rE}{2}$$

$$= \frac{1 \times 2 \times 10^{-2} \times 7.182 \times 10^8}{2 \times 9 \times 10^9}$$

$= 7.98 \times 10^{-4} \text{Cm}^{-1}$

343 **(a)**

$\therefore E = \frac{1}{4\pi\varepsilon_0 r^2}$

$q = 4\pi\varepsilon_0 r^2 E$

$= \frac{(0.25)^2 \times 2}{9 \times 10^9} = 1.39 \times 10^{-11}$ C

344 **(b)**

Using $v = \sqrt{\frac{2QV}{m}} \Rightarrow v \propto \sqrt{Q} \Rightarrow \frac{v_A}{v_B} = \sqrt{\frac{Q_A}{Q_B}} = \sqrt{\frac{q}{4q}} = \frac{1}{2}$

345 **(a)**

Gravitational force $F_G = \frac{Gm_e m_p}{r^2}$

$$F_G = \frac{6.7 \times 10^{-11} \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-27}}{(5 \times 10^{-11})^2}$$

$$= 3.9 \times 10^{-47} N$$

Electrostatic force $F_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$

$$F_e = \frac{9 \times 10^9 \times 1.6 \times 10^{-19} \times 1.6 \times 10^{-19}}{(5 \times 10^{-11})^2}$$

$$= 9.22 \times 10^{-8} N$$

So, $\frac{F_e}{F_G} = \frac{9.22 \times 10^{-8}}{3.9 \times 10^{-47}} = 2.36 \times 10^{39}$

346 **(d)**

Given $2\pi R = 2 \Rightarrow R = \frac{1}{\pi}$

For sphere $C = 4\pi\varepsilon_0 KR$

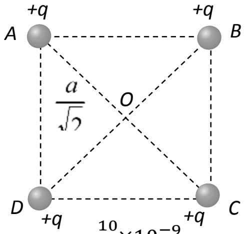
$\Rightarrow C = \frac{1}{9 \times 10^9} \times \frac{1}{\pi} \times 80$ [For water $K = 80$]

$\Rightarrow C = 2828.28\ PF$

347 **(b)**

Potential at the centre $O, V = 4 \times \frac{1}{4\pi\varepsilon_0} . \frac{Q}{a/\sqrt{2}}$

Where $Q = \frac{10}{3} \times 10^{-9} C$ and $a = 8cm = 8 \times 10^{-2} m$



So $V = 4 \times 9 \times 10^9 \times \frac{\frac{10}{3} \times 10^{-9}}{\frac{8 \times 10^{-2}}{\sqrt{2}}} = 1500\sqrt{2}\, volt$

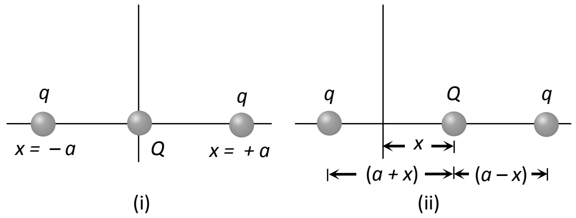
348 **(b)**

The energy stored $= \frac{1}{2} QV$

350 **(b)**

Initially according to figure (i) potential energy of Q is

$U_i = \frac{2kqQ}{a}$ ...(i)



According to figure (ii) when charge Q is displaced by small distance x then it's potential energy now

$U_f = kqQ\left[\frac{1}{(a+x)} + \frac{1}{(a-x)}\right] = \frac{2kqQa}{(a^2 - x^2)}$ ...(ii)

Hence change in potential energy

$$\Delta U = U_f - U_i = 2kqQ\left[\frac{a}{a^2 - x^2} - \frac{1}{a}\right] = \frac{2kqQx^2}{(a^2 - x^2)a}$$

Since $x << a$ so $\Delta U = \frac{2kqQx^2}{a^3} \Rightarrow \Delta U \propto x^2$

352 **(a)**

$$\phi_{\text{Total}} = \phi_A + \phi_B + \phi_C = \frac{q}{\epsilon_0};$$

$\because \phi_B = \phi$ and $\phi_A = \phi_C = \phi'$ [assumed]

$$\therefore 2\phi' + \phi = \frac{q}{\epsilon_0} \Rightarrow \phi' = \frac{1}{2}\left(\frac{q}{\epsilon_0} - \phi\right)$$

353 **(c)**

Here, $p = 6 \times 10^{-30}$ C-m

$E = 1.5 \times 10^4$ N/C

$\tau_{max} = pE \sin 90^0$

$= 6 \times 10^{-30} \times 1.5 \times 10^4 \times 1 = 9 \times 10^{-26}$ Nm

354 **(b)**

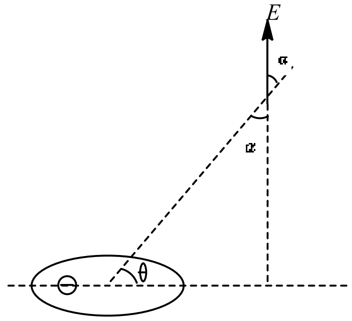
$\alpha + \theta = 90°$

$$\tan \alpha = \frac{1}{2} \tan \theta$$

$\tan \theta = 2 \tan(90° - \theta)$

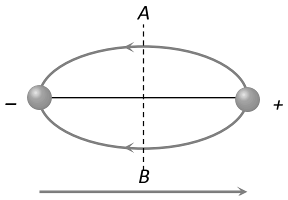
$\tan^2 \theta = 2$

$\theta = \tan^{-1}(\sqrt{2})$



356 **(b)**

The direction of electric field at equatorial point A or B will be in opposite direction, as that of direction of dipole moment



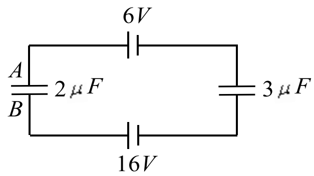
358 **(c)**

$C' = n^{1/3}C \Rightarrow C' = 2^{1/3}C \Rightarrow 2C > C' > C$

359 **(c)**

$$W = \frac{Q^2}{2C} \Rightarrow W' = 4W$$

360 **(c)**

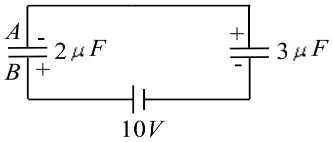


Here, $2\mu F$ and $3\mu F$ capacitors are connected in series. The equivalent capacitance is

$\frac{1}{C_S} = \frac{1}{2} + \frac{1}{3}$ or $C_S = \frac{6}{5}\mu F$

Net voltage, $V = 16V - 6V = 10V$

The equivalent circuit diagram as shown in figure below



Charge on each capacitor,

$q = C_S V = \frac{6}{5} \times 10 = 12\mu C$

The potential difference between A and B

$= -\frac{12\mu C}{2\mu F} = -6V$

362 **(a)**

$C = \frac{\varepsilon_0 KA}{d} \Rightarrow \frac{C_1}{C_2} = \frac{K_1}{K_2} \times \frac{d_2}{d_1}$

$\frac{2}{C_2} = \frac{1}{2.8} \times \frac{(0.4/2)}{(0.4)} \Rightarrow C_2 = 11.2\mu\, F$

364 **(d)**

From Coulomb's law, the force between two points charges q_1 and q_2 separated by the distance r is given by

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$$

Since, $q_1 = q_2 = q$

$\therefore \quad F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{r^2}$ ... (i)

In second case when

$q_1 = q_2 = \frac{q}{2}$ and $r' = 2r$

We have

$F' = \frac{1}{4\pi\varepsilon_0} \frac{(q/2)^2}{(2r)^2} = \frac{1}{4\pi\varepsilon_0} \frac{q^2}{16r^2}$ ..(ii)

Dividing Eq. (ii) by Eq. (i), we have

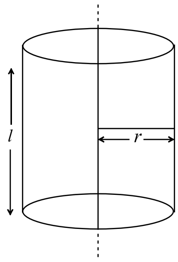
$$\frac{F'}{F} = \frac{q^2}{16r^2} \times \frac{r^2}{q^2} = \frac{1}{16}$$

$\Longrightarrow F' = \frac{F}{16}$

365 **(a)**

Charge density of long wire

$\lambda = \frac{1}{3} C - m$



From Gauss's theorem,

$\oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$

$E \oint ds = \frac{q}{\varepsilon_0}$ or $E 2\pi r l = \frac{q}{\varepsilon_0}$

$\Rightarrow E = \frac{q}{2\pi\varepsilon_0 r l} = \frac{q/l}{2\pi\varepsilon_0 r}$

$\frac{\lambda \times 2}{2\pi\varepsilon_0 r \times 2} = \frac{\lambda \times 2}{4\pi\varepsilon_0 r}$

$E = 9 \times 10^9 \times \frac{1}{3} \times 2 \times \frac{1}{18 \times 10^{-2}}$

$= 0.33 \times 10^{11} NC^{-1}$

366 **(d)**

$\phi = \frac{\Sigma q}{\varepsilon_0} = 0$ *i.e.* net charge on dipole is zero

367 **(d)**

$\Delta U = \frac{C_1 C_2}{2(C_1 + C_2)} (V_1 - V_2)^2$

$= \frac{20 \times 30}{2(20 + 30)} (5 - 0)^2 = 150J$

368 **(d)**

$E_{\text{out}} = \frac{\sigma R^2}{\varepsilon_0 x^2}$

369 **(c)**

After redistribution, charges on them will be different, but they will acquire common potential

i.e. $k\frac{Q_1}{r_1} = k\frac{Q_2}{r_2} \Rightarrow \frac{Q_1}{Q_2} = \frac{r_1}{r_2}$

As $\sigma = \frac{Q}{4\pi r^2} \Rightarrow \frac{\sigma_1}{\sigma_2} = \frac{Q_1}{Q_2} \times \frac{r_2^2}{r_1^2} \Rightarrow \frac{\sigma_1}{\sigma_2} = \frac{r_2}{r_1} \Rightarrow \sigma \propto \frac{1}{r}$

i.e. surface charge density on smaller sphere will be more

370 **(c)**

Electrostatic potential energy $= \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{d}$

$\therefore$ Energy

$= \frac{(9 \times 10^9) \times (+1.6 \times 10^{-19}) \times (-1.6 \times 10^{-19})J}{10^{-10}}$

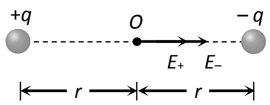
$= -9 \times 10^9 \times 1.6 \times 10^{-19} \times 10^{10} eV = -14.4eV$

Note : In the solution given all the values are positive. It is important to mention the sign

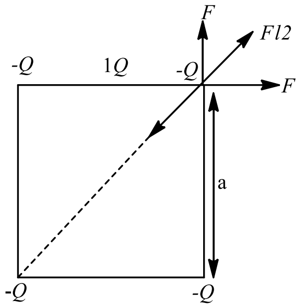
371 **(c)**

At $O, E \neq 0, V = 0$

372 **(b)**



$$F' = \sqrt{2}F + \frac{F}{2} = F\left(\sqrt{2} + \frac{1}{2}\right)$$



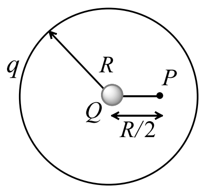
$$\frac{qQ}{\left(\frac{\sqrt{2}a}{2}\right)^2} = \frac{Q^2}{a^2}\left(\sqrt{2} + \frac{1}{2}\right)$$

$$q = \frac{Q}{2}\left(\frac{2\sqrt{2}+1}{2}\right)$$

$$q = \frac{Q}{4}(2\sqrt{2} + 1)$$

373 **(d)**

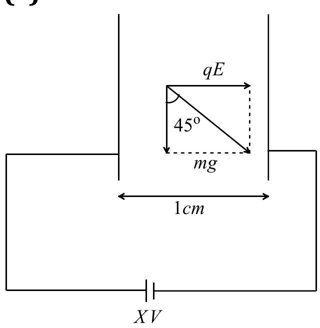
Electric potential at P



$$V = \frac{k.Q}{R/2} + \frac{k.q}{R}$$

$$= \frac{2Q}{4\pi\varepsilon_0 R} + \frac{q}{4\pi\varepsilon_0 R}$$

374 **(c)**



$$mg = qE$$

$$1.67 \times 10^{-27} \times 10 = 1.6 \times 10^{-19} \times \frac{X}{0.01}$$

$$X = \frac{1.67}{1.6} \times 10^{-9}V \Rightarrow X = 1 \times 10^{-9}V$$

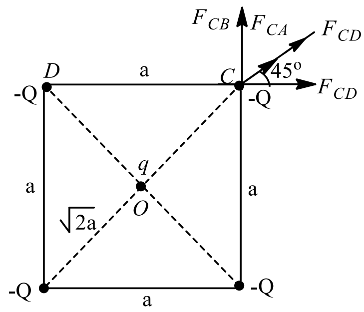
375 **(c)**

New potential difference $= \frac{V}{K} = \frac{100}{10} = 10V$

376 **(b)**

The system is in equilibrium means the force experienced by each charge is 0. It is clear that charge placed at centre would be in equilibrium for any value of q, so we are considering the equilibrium of charge placed at any corner.

$$F_{CD} + F_{CA}\cos 45° + F_{co}\cos 45° = 0$$



$$\frac{1}{4\pi\varepsilon_0} \cdot \frac{(-Q)(-Q)}{a^2} + \frac{1}{4\pi\varepsilon_0}\frac{(-Q)(-Q)}{\left(\sqrt{2}a\right)^2}$$

$$\times \frac{1}{\sqrt{2}} + \frac{1}{4\pi\varepsilon_0}\frac{(-Q)q}{\left(\sqrt{2a/2)}\right)^2} \times \frac{1}{\sqrt{2}} = 0$$

$$\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2} + \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2} \cdot \frac{1}{\sqrt{2}} - \frac{1}{4\pi\varepsilon_0}\frac{2Qq}{a^2} \times \frac{1}{\sqrt{2}} = 0$$

$$\Rightarrow Q + \frac{Q}{2\sqrt{2}} - \sqrt{2q} = 0$$

$$\Rightarrow 2\sqrt{2}Q + Q - 4q = 0$$

$$\Rightarrow 4q = (2\sqrt{2} + 1)Q$$

$$\Rightarrow q = \left(2\sqrt{2} + 1\right)\frac{Q}{4}$$

377 **(d)**

$\delta = PE\sin\theta$

$\Rightarrow 10\sqrt{2} = P \times 10^4 \sin 30\,°$

$\Rightarrow P = 2\sqrt{2} \times 10^{-3}$

$\therefore U = PE\cos\theta$

$\Rightarrow U = 2\sqrt{2} \times 10^{-3} \times 10^4 \cos 30° = 24.5\,J$

378 **(a)**

$U = -PE\cos\theta$

It has minimum value when $\theta = 0°$

$i.e. (U)_{\min} = -PE \times \cos 0° = -PE$

380 **(c)**

Heat produced = Energy of charged capacitor = $\frac{1}{2}CV^2$

$$= \frac{1}{2} \times (2 \times 10^{-6}) \times (100)^2 = 0.01J$$

381 **(a)**

$4\pi\varepsilon_0 r = 1 \times 10^{-6} \Rightarrow r = 10^{-6} \times 9 \times 10^9 = 9\,km$

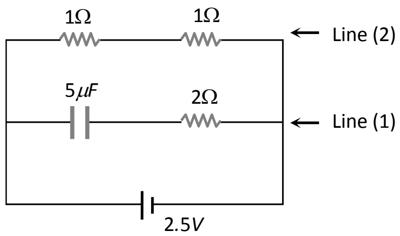
382 **(b)**

$$C = \frac{K\varepsilon_0 A}{d}; \therefore \frac{C_1}{C_2} = \frac{K_1}{K_2} \Rightarrow \frac{C}{C_2} = \frac{5}{20} \Rightarrow C_2 = 4C$$

383 **(c)**

In steady state condition. No current flows through line

(1). Hence total current $i = \frac{2.5}{(1+1+0.5)} = 1\ A$



Potential difference a cross line (2) = potential difference across capacitor

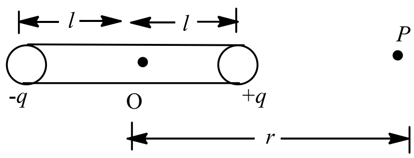
$= 1 \times 2 = 2\ Volt$

So, charge on capacitor $= 5 \times 2 = 10\ \mu C$

385 **(b)**

The electric field on the axis of a dipole of length small compared to point where electric field is to be determined is

$$E_A = \frac{1}{4\pi\varepsilon_0} . \frac{2p}{r^3} \quad \dots\dots\dots\dots (i)$$



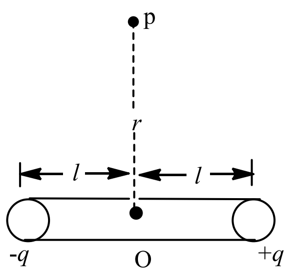
Where p is electric dipole moment.

Intensity at a point on the equatorial line of a dipole is

$$E_E = \frac{1}{4\pi\varepsilon_0} . \frac{p}{r^3} \text{NC}^{-1} \quad \dots . (ii)$$

From Eqs. (i) and (ii), we get

$$\frac{E_A}{E_E} = \frac{2p}{r^3} \times \frac{r^3}{p} = \frac{2}{1}$$

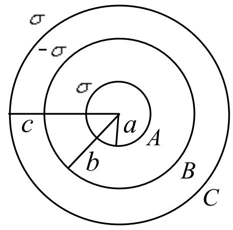


386 **(a)**

As there is no charge residing inside the cube, hence net flux is zero

387 **(a)**

$$V_A = \frac{\sigma}{\epsilon_0}(a - b + c)$$



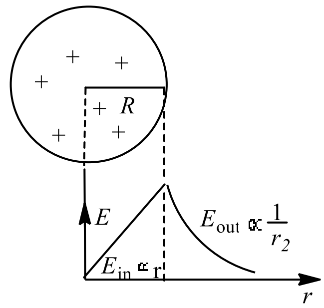
$$V_B = \frac{\sigma}{\epsilon_0}\left(\frac{a^2}{b} - b + c\right)$$

$$V_C = \frac{\sigma}{\epsilon_0}\left(\frac{a^2}{c} - \frac{b^2}{c} + c\right)$$

On putting $c = a + b \Rightarrow V_A = V_C \neq V_B$

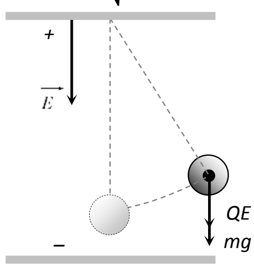
389 **(c)**

For a uniformly charged non-conducting sphere the graph between electric field and distance from the centre is given by



390 **(c)**

$$T_0 = 2\pi\sqrt{\frac{l}{g}}$$



Net downward force $mg'''''''' = mg + QE$

$\Rightarrow$ Effect acceleration $g'''''''' = \left(g + \frac{QE}{m}\right)$

Hence time period $T = 2\pi\sqrt{\frac{l}{g''''''''}} = 2\pi\sqrt{\frac{l}{\left(g + \frac{QE}{m}\right)}}$

391 **(b)**

Electric field at a point P due to a point charge q

$$E = \frac{kq}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

$$E \propto \frac{1}{r^2}$$

392 **(c)**

We put a unit positive charge at O. Resultant force due to the charge placed at A and C is zero and resultant charge due to B and D is towards D along the diagonal BD

393 **(d)**

$$E_x = -\frac{dV}{dx} = -(-5) = 5; E_y = -\frac{dV}{dy} = -3$$

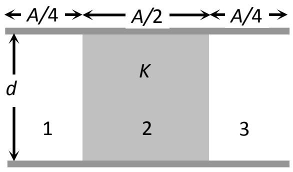
And $E_z = -\frac{dV}{dz} = -\sqrt{15}$

$$E_{net} = \sqrt{E_x^2 + E_Y^2 + E_Z^2}$$

$$= \sqrt{(5)^2 + (-3)^2 + \left(-\sqrt{15}\right)^2} = 7$$

394 **(a)**

$$C_1 = \frac{\varepsilon_0\left(\frac{A}{4}\right)}{d}, C_2 = \frac{K\varepsilon_0\left(\frac{A}{2}\right)}{d}, C_3 = \frac{\varepsilon_0\left(\frac{A}{4}\right)}{d}$$



$$C_{eq} = C_1 + C_2 + C_3 = \left(\frac{K+1}{2}\right)\frac{\varepsilon_0 A}{d} = \left(\frac{4+1}{2}\right) \times 10$$
$$= 25\mu F$$

395 **(a)**

Given six capacitors are in parallel

$\therefore C_{eq} = 6C = 6 \times 2\,\mu f = 12\mu F$

396 **(a)**

Here, $F = 40 = \frac{k(3)(8)}{r^2} = \frac{24k}{r^2}$

$F' = \frac{k(3-5)(8-5)}{r^2} = \frac{-6k}{r^2}$

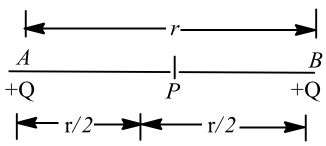
$\frac{F'}{F} = \frac{-6k}{r^2} \times \frac{r^2}{24k} = -\frac{1}{4}$

$F' = -\frac{F}{4} = -\frac{40}{4} = -10\text{N}$

397 **(d)**

For equilibrium of system of charges,

force produced between q and Q + force produced between Q and $Q = 0$



$$\frac{1}{4\pi\varepsilon_0}\frac{qQ}{(r/2)^2} + \frac{1}{4\pi\varepsilon_0}\frac{QQ}{r^2} = 0$$

$$\Rightarrow \frac{4qQ}{r^2} + \frac{QQ}{(r/2)^2} = 0 \Longrightarrow q = -\frac{Q}{4}$$

398 **(d)**

$K = eV = eEl$

$$\Rightarrow 2(eV) = eEl \Rightarrow E = \frac{2}{l} = \frac{2}{4 \times 10^{-8}} \Rightarrow E$$
$$= 5 \times 10^7 V/m$$

399 **(c)**

Initially potential difference across both the capacitor is same hence energy of the system is

$U_1 = \frac{1}{2}CV^2 + \frac{1}{2}CV^2 = CV^2$ ...(i)

In the second case when key K is opened and dielectric medium is filled between the plates, capacitance of both the capacitors becomes $3C$, while potential difference across A is V and potential difference across B is $\frac{V}{3}$ hence energy of the system now is

$U_2 = \frac{1}{2}(3C)V^2 + \frac{1}{2}(3C)\left(\frac{V}{3}\right)^2 = \frac{10}{6}CV^2$ ...(ii)

So, $\frac{U_1}{U_2} = \frac{3}{5}$

400 **(d)**

The potential at a point on the axial line due to a bar magnet is given by

$$V = \frac{\mu_0}{4\pi} \times \frac{2M}{(d^2 - l^2)}$$

Hence, $V \propto M$(if all other quantities are remains same)

$$\therefore \quad \frac{V'}{V} = \frac{M'}{M}$$

$$\Longrightarrow \frac{V'}{V} = \frac{M/4}{M} = \frac{1}{4}$$

$V' = V/4$

401 **(d)**

Electric field

$$E = -\frac{dV}{dx}$$

Given, $V = 600\text{V}$, $E = 200\text{NC}^{-1}$

$$\therefore \ dx = \frac{600}{200} = 3\text{m}$$

402 **(d)**

Cathode rays (stream of negatively charged particles) deflect in opposite direction of field *i.e.* towards north

403 **(c)**

Capacity of parallel plate capacitor $C = \frac{\varepsilon_0 A}{d} \Rightarrow C \propto A$

404 **(d)**

$q = \pm 1 \times 10^{-6}$C
$2a = 2.0$cm $= 2.0 \times 10^{-2}$m
$E = 1 \times 10^5$NC^{-1}, $\tau_{\max} =$?
$W =$?, $\theta_1 = 0^0, \theta_2 = 180^0$
$\tau_{max} = pE = q(2a)E$
$= 1 \times 10^{-6} \times 2.0 \times 10^{-2} \times 1 \times 10^5 = 2 \times 10^{-3}$ Nm
$W = pE(\cos\theta_1 - \cos\theta_2)$
$= (10^{-6} \times 2 \times 10^{-2})(10^5)(\cos 0^0 - \cos 180^0)$
$= 4 \times 10^{-3}$J

405 **(a)**

When dipole is given a small angular displacement θ about it's equilibrium position, the restoring torque will be

$\tau = -pE\sin\theta = -pE\theta$ [as $\sin\theta = \theta$]

or $I\frac{d^2\theta}{dt^2} = -pE\theta$ $\left[\text{as } \tau = I\alpha = I\frac{d^2\theta}{dt^2}\right]$

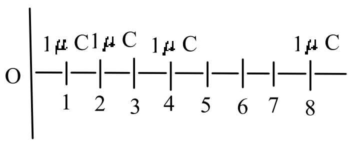
or $\frac{d^2\theta}{dt^2} = -\omega^2\theta$ with $\omega^2 = \frac{pE}{I} \Rightarrow \omega = \sqrt{\frac{pE}{I}}$

406 **(b)**

From Coulomb's law, the force between two point charges q_1, q_2 separated by distance r is

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

The schematic diagram of distribution of charges on x –axis is shown.



The total force acting on 1 C charge is given by

$$F = \Sigma\frac{1}{4\pi\varepsilon_0}.\frac{q_1 q_2}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \times \left(\frac{1 \times 1 \times 10^{-6}}{(1)^2} + \frac{1 \times 1 \times 10^{-6}}{(2)^2} + \frac{1 \times 1 \times 10^{-6}}{(4)^2} + \cdots\infty\right)$$

$$= 9 \times 10^9 \times 10^{-6}\left(\frac{1}{1-\frac{1}{4}}\right)$$

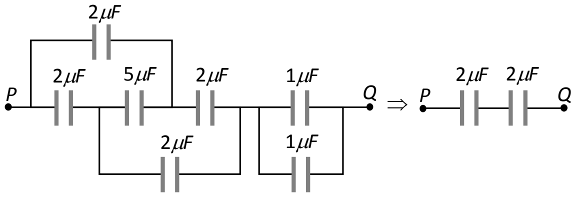
Using the fact that sum of GP series is

$S_\infty = \frac{a}{1-r}$, where a is first term of series and r the common ratio.

$$\therefore\ F = 9 \times 10^3 \times \frac{4}{3} = 12000\text{N}$$

408 **(b)**

The given circuit can be redrawn as follows



$\Rightarrow C_{PQ} = 1\ \mu F$

409 **(d)**

$$C' = C/n = \frac{6 \times 10^{-12}}{3} = 2 \times 10^{-12}F$$

410 **(c)**

By using $F = 9 \times 10^9.\frac{Q^2}{r^2}$

$$\Rightarrow F = 9 \times 10^9 \cdot \frac{(2 \times 10^{-6})^2}{(0.5)^2} = 0.144\ N$$

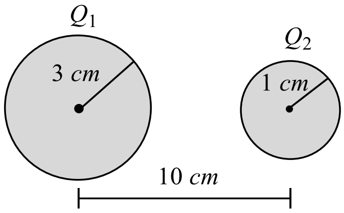
411 **(d)**

$$U = \frac{1}{2}CV^2 = \frac{1}{2}5 \times 10^{-6} \times (20 \times 10^3)^2 = 1kJ$$

412 **(b)**

$$n = \frac{q}{e} = \frac{4 \times 10^{-7}}{1.6 \times 10^{-19}} = 2.5 \times 10^{12}$$

413 **(a)**



Let Q_1 and Q_2 be the charge on the two conducting spheres of radii $R_1(= 3cm)$ and $R_2(= 1cm)$ respectively

$\therefore V_1 = \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1} \Rightarrow 10 = \frac{9 \times 10^9 \times Q_1}{3 \times 10^{-2}}$

$\Rightarrow Q_1 = \frac{10 \times 3 \times 10^{-2}}{9 \times 10^9}$ ...(i)

and $V_2 = \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2} \Rightarrow 10 = \frac{9 \times 10^9 \times Q_2}{1 \times 10^{-2}}$

$\Rightarrow Q_2 = \frac{10 \times 1 \times 10^{-2}}{9 \times 10^9}$ ...(ii)

According to coulomb's law

Force of repulsion between them is

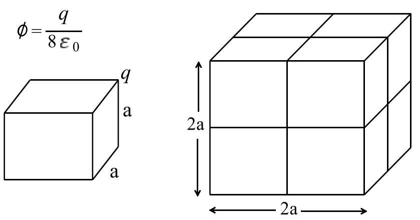
$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r^2}$

$= \frac{9\times10^9\times10\times3\times10^{-2}\times10\times1\times10^{-2}}{9\times10^9\times9\times10^9\times(10\times10^{-2})^2}$ [Using (i) & (ii)]

$= \left(\frac{1}{3}\right)\times10^{-9}N$

414 **(b)**

Eight identical cubes are required to arrange so that this charge is at centre of the cube formed so flux



415 **(c)**

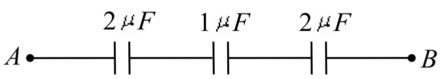
Total charge $Q = \int_0^r \rho\, dv = \int_0^r \rho_0\left(\frac{5}{4}-\frac{r}{R}\right)4\pi r^2 dr$

$= 4\pi\rho_0\int_0^r\left(\frac{5r^2}{4}-\frac{r^3}{R}\right)dr = 4\pi\rho_0\left[\frac{5r^3}{12}-\frac{r^4}{4R}\right]$

$E = \frac{KQ}{r^2} = \frac{1}{4\pi\varepsilon_0 r^2}4\pi\rho_0\left[\frac{5}{12}r^3-\frac{r^4}{4R}\right]$

$= \frac{\rho_0 r}{4\varepsilon_0}\left[\frac{5}{3}-\frac{r}{R}\right]$

416 **(d)**

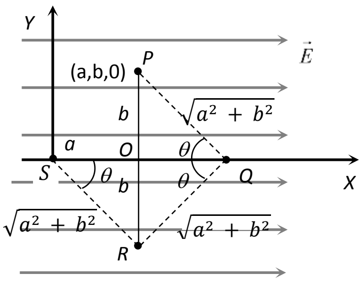


$\frac{1}{C} = \frac{1}{2}+\frac{1}{1}+\frac{1}{2} = \frac{1+2+1}{2} = \frac{4}{2} = 2 \Rightarrow C_{AB}$

$= 0.5\mu F$

417 **(b)**

As electric field is a conservative field



Hence the work done does not depend on path

$\therefore W_{PQRS} = W_{POS} = W_{PO} + W_{OS}$

$= Fb\cos 90^o + Fa\cos 180^o = 0 + qEa(-1)$

$= -qEa$

418 **(d)**

By using $K = \frac{F_a}{F_m} \Rightarrow K = \frac{10^{-4}}{2.5\times10^{-5}} = 4$

419 **(a)**

According to Gauss's law, electric flux is

$\phi_E = \oint_s \mathbf{E}.\mathbf{ds} = \frac{1}{\varepsilon_0}(q)$

ie, the flux linked with a closed body is independent of the shape and size of the surface. So electric flux remain constant.

Hence, $\phi_E = 20Vm$

420 **(b)**

According to energy conservation, energy remains the same

$\Rightarrow U_{parallel} = U_{series} \Rightarrow \frac{1}{2}(nC)V^2 = \frac{1}{2}\left(\frac{C}{n}\right)V'^2$

$\Rightarrow V' = nV$

[V' = potential difference across series combination]

422 **(d)**

The two capacitors formed by the slabs may assumed to be in series combination

423 **(d)**

Direction of **E** reverses while magnitude remains same and V remains unchanged.

424 **(b)**

Charge on glass rod is positive, so charge on gold leaves will also be positive. Due to X-rays, more electrons from leaves will be emitted, so leaves becomes more positive and diverge further

425 **(c)**

Let neutral point be obtained at a distance x from 20 μC charge. Hence at neutral point

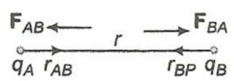
$\frac{20}{(x)^2} = \frac{80}{(10-x)^2} \Rightarrow x = +0.033\ m$

426 **(b)**

Vector from of Coulomb's law states that $\boldsymbol{F}_{\mathrm{AB}}$ and $\boldsymbol{F}_{BA}$ are equal and opposite.

Since, $\hat{\mathbf{r}}_{AB}$ *and* $\hat{\mathbf{r}}_{BA}$ are unit vectors pointing in opposite direction, we have

$\hat{\mathbf{r}}_{AB} = -\hat{\mathbf{r}}_{BA}$



Therefore, equations of force is

Given by

$\boldsymbol{F}_{AB} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}(\hat{\boldsymbol{r}}_{AB})$

$$= -\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}\hat{\mathbf{r}}_{BA} = -\mathbf{F}_{BA}$$

427 **(a)**

$$E_x = -\frac{dV}{dx} = -[-2xy - z^3]$$

$$E_y = -\frac{dV}{dy} = -[-x^2]$$

$$E_z = -\frac{dV}{dz} = -[-3xz^2]$$

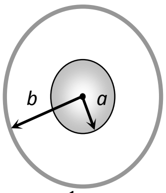
$$\therefore \vec{E} = E_x\hat{\imath} + E_y\hat{\jmath} + E_z\hat{k}$$

$$= (2xy + z^3)\hat{\imath} + x^2\hat{\jmath} + 3xz^2\hat{k}$$

428 **(d)**

Given : $(b - a) = 1 \times 10^{-3}m$ ...(i)

and $C = 4\pi\varepsilon_0\left(\frac{ab}{b-a}\right) = 1 \times 10^{-6}$



$$\Rightarrow 1 \times 10^{-6} = \frac{1}{9 \times 10^9}\left(\frac{ab}{10^{-3}}\right)$$

$\Rightarrow ab = 9$ ...(ii)

From equations (i) and (ii)

$$b - \frac{9}{b} = \frac{1}{1000} \Rightarrow 1000\,b^2 - b - 9000 = 0$$

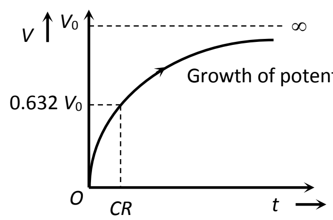
$$\Rightarrow b = \frac{1 \pm \sqrt{(-1)^2 - 4(1000)(-9000)}}{2 \times 1000}$$

[Solving of quadratic equation]

$$\Rightarrow b = \frac{1 \pm \sqrt{36 \times 10^6}}{2000} = \frac{\sqrt{36 \times 10^6}}{2000} = 3m$$

429 **(a)**

For charging of capacitor $q = q_0\left(1 - e^{\frac{t}{CR}}\right)$ and potential difference $V = V_0\left(1 - e^{-\frac{t}{CR}}\right)$



430 **(a)**

As we know $Q = CV$

431 **(c)**

Relation between electric field and electric potential is given by, $E = -\frac{dV}{dx}$

435 **(b)**

By using $\int \vec{E}.\overrightarrow{dA} = \frac{1}{\varepsilon_0}[Q_{enc}]$

436 **(b)**

Joined by a wire means they are at the same potential

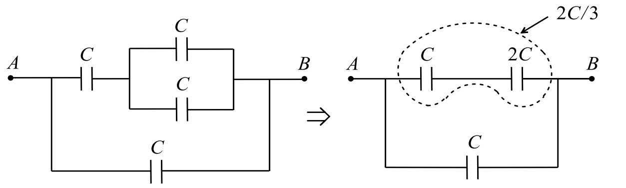
For same potential $\frac{kQ_1}{a_1} = \frac{kQ_2}{a_2} \Rightarrow \frac{Q_1}{Q_2} = \frac{a}{b}$

Further, the electric field at the surface of the sphere having radius R and charge Q is $\frac{kQ}{R^2}$

$$\therefore \frac{E_1}{E_2} = \frac{kQ_1/a^2}{kQ_2/b^2} = \frac{Q_1}{Q_2} \times \frac{b^2}{a^2} = \frac{b}{a}$$

437 **(c)**

The given circuit can be simplified as follows



Equivalent capacitance between A and B is $C_{AB} = \frac{5}{3}C$

438 **(b)**

$$V_P = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{0.2} + \frac{q_2}{0.2} + \frac{q_3}{0.3}\right]$$

$$= 9 \times 10^9\left[\frac{1}{0.2} - \frac{2}{0.2} + \frac{3}{0.3}\right] \times 10^{-6}$$

$$= 9 \times 10^3[5 - 10 + 10] = 45 \times 10^3 = 45kV$$

440 **(c)**

$$V = \frac{V_1C_1 + V_2C_2}{C_1 + C_2} = \frac{500 \times 20 + 200 \times 10}{20 + 10} = 400V$$

441 **(c)**

$$T = \sqrt{(mg)^2 + (QE)^2}$$

$$= \sqrt{(30.7 \times 10^{-6} \times 9.8)^2 + (2 \times 10^{-8} \times 20000)^2}$$

$$= 5 \times 10^{-4}N$$

442 **(b)**

$C = \frac{\varepsilon_0 A}{d} = 1\,pF$ and $C' = \frac{K\varepsilon_0 A}{2d} = 2pF \;\therefore K = 4$

443 **(b)**

We have $E_a = \frac{2kp}{r^3}$ and $E_e = \frac{kp}{r^3}$; $\therefore E_a = 2E_e$

444 **(d)**

Negative charge means excess of electrons which increases the mass of sphere B

445 **(b)**

$$E = \frac{1}{4\pi\varepsilon_0}.\frac{2p}{r^3} \Rightarrow E \propto \frac{1}{r^3}$$

446 **(c)**

The electric field is due to all charges present whether inside or outside the given surface

447 **(b)**

Electric dipole moment of a water molecule

$p = 6.4 \times 10^{-30} Cm$

$p = qd$

Where d is the distance between the centre of positive and negative charge of the molecule

$$\Rightarrow d = \frac{p}{q} = \frac{6.4 \times 10^{-30} Cm}{1.6 \times 10^{-19} C} = 4 \times 10^{-11} m$$

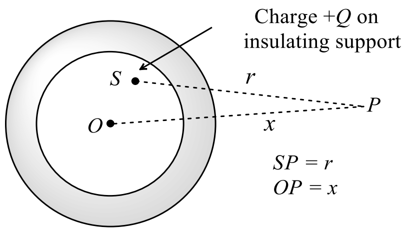
448 **(b)**

Between plate $E = \frac{\sigma}{2\varepsilon_0} - \left(\frac{-\sigma}{2\varepsilon_0}\right) = \frac{\sigma}{\varepsilon_0}$,

Outside plate $\sigma = 0 \ \therefore E' = 0$

449 **(a)**

According to Gauss's theorem



$$\oint \vec{E}.d\vec{s} = \frac{1}{\varepsilon_0} Q_{enclosed}$$

$$E.4\pi x^2 = \frac{Q}{\varepsilon_0}$$

$$E = \frac{Q}{4\pi\varepsilon_0 x^2}$$

450 **(d)**

$$C_1 = \frac{K_1 \varepsilon_0 \frac{A}{2}}{\left(\frac{d}{2}\right)} = \frac{K_1 \varepsilon_0 A}{d}$$

$C_2 = \frac{K_2 \varepsilon_0 \left(\frac{A}{2}\right)}{\left(\frac{d}{2}\right)} = \frac{K_2 \varepsilon_0 A}{d}$ and $C_3 = \frac{K_3 \varepsilon_0 A}{2d} = \frac{K_3 \varepsilon_0 A}{2d}$

Now, $C_{eq} = C_3 + \frac{C_1 C_2}{C_1 + C_2} = \left(\frac{K_3}{2} + \frac{K_1 K_2}{K_1 + K_2}\right) . \frac{\varepsilon_0 A}{d}$

451 **(b)**

$\frac{1}{C} = \frac{1}{3} + \frac{1}{6} \Rightarrow C = 2\, pF$

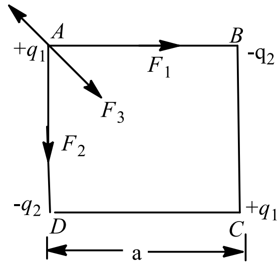
Total charge $= 2 \times 10^{-12} \times 5000 = 10^{-8} C$

The new potential when the capacitors are connected in parallel is

$$V = \frac{2 \times 10^{-8}}{(3 + 6) \times 10^{-12}} = 2222\, V$$

452 **(b)**

The charge A experiences three forces F_1, F_2 and F_3 as shown in figure.



Now

$F_1 = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{a^2}$ (along AB)

$F_2 = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{a^2}$ (along AD)

$$F_3 = \frac{1}{4\pi\varepsilon_0} \frac{q_1^2}{a^2}$$

The resultant of F_1 and F_2 should be equal and opposite to F_3 to keep the system in equilibrium.

Resultant F_1 and F_2=$F_R = \sqrt{F_1^2 + F_2^2}$

$$= \frac{1}{4\pi} \frac{q_1 q_1}{\varepsilon_0 a^2} \sqrt{2}$$

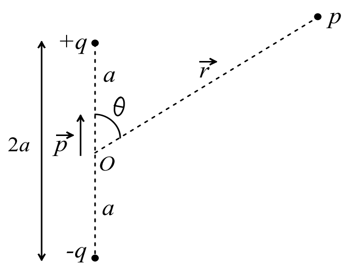
For equilibrium,

$$\frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{a^2} \sqrt{2} = \frac{1}{4\pi\varepsilon_0} \frac{q_1^2}{a^2}$$

$$\frac{q_1}{q_2} = \sqrt{2}$$

453 **(d)**

An electric dipole is a pair of equal and opposite charges q and $-q$ separated by some distance $2a$. Its dipole moment vector $\vec{p}$ has magnitude $2qa$ and is in the direction of the dipole axis from $-q$ to q



The electric field due to a dipole at a point p is

$$E = \frac{p}{4\pi\varepsilon_0} \frac{\sqrt{3\cos^2\theta + 1}}{r^3} (r >> a)$$

The electric dipole potential falls off at large distance, as $\frac{1}{r^2}$ not as $\frac{1}{r}$, characteristic of the potential due to a single charge.

In a uniform electric field $\vec{E}$, a dipole experiences a torque $\vec{\tau}$ given by $\vec{\tau} = \vec{p} \times \vec{E}$ but experiences no net force

455 **(d)**

Displacement current flows from A to B

456 **(d)**

Electric displacement vector $\vec{D} = \varepsilon\vec{E}$

But $\varepsilon = K\varepsilon_0$

Where, $K =$ dielectric constant and $\varepsilon_0 =$ permittivity of free space

$\therefore \vec{D} = K\varepsilon_0\vec{E}$

457 **(b)**

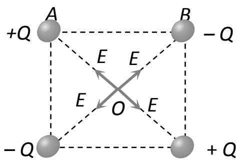
In case of RC circuit $i = \frac{E}{R}e^{-t/RC}$

$\therefore \log_e i = -\frac{t}{RC} + \log_e \frac{E}{R}$

When R is doubled, the slope of the curve increases. Further at $t = 0$, the current will be less for an increased value of resistance

458 **(a)**

At centre $E = 0$ and $V = 0$



459 **(b)**

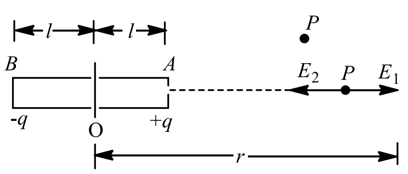
$$F = \frac{CV^2}{2d} = \frac{Q \times E}{2} = \frac{10^{-6} \times 10^5}{2} = 0.05N$$

460 **(a)**

Initially when key is closed, the capacitor acts as short-circuit, so bulb will light up. But finally the capacitor becomes fully charged, so it will act as open circuit, so bulb will not glow

461 **(c)**

Let an electric dipole AB is situated in a vacuum. Let p be a point at a distance r from the dipole when p is electric dipole moment, then electric field intensity is given by



$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2pr}{(r^2 - l^2)^2}$$

If l is very small compared to $r (l \ll r)$, then l^2 may be neglected in comparison to r^2. Then

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2p}{r^3} \text{NC}^{-1}$$

$$\Rightarrow E \propto \frac{1}{r^3}.$$

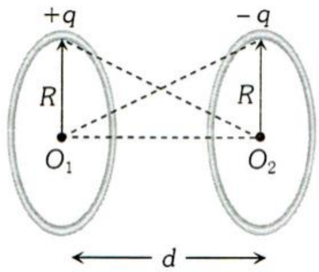
462 **(d)**

Energy $= \frac{1}{2}\varepsilon_0 E^2 \times (A \times d) = \frac{1}{2}\varepsilon_0 \left(\frac{V^2}{d^2}\right) Ad$

$$= \frac{1}{2} \times \frac{8.85 \times 10^{-12} \times (10^5)^2 \times 25 \times 10^6}{0.75 \times 10^3} = 1475J$$

463 **(d)**

Potential at the centre of rings are



$$V_{O_1} = \frac{k.q}{R} + \frac{k(-q)}{\sqrt{R^2 + d^2}}, V_{O_2} = \frac{k(-q)}{R} + \frac{kq}{\sqrt{R^2 + d^2}}$$

$$\Rightarrow V_{O_1} - V_{O_2} = 2kq\left[\frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}}\right]$$

$$= \frac{q}{2\pi\varepsilon_0}\left[\frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}}\right]$$

464 **(c)**

$$a = \frac{F}{m} = \frac{eF}{m}$$

465 **(a)**

$V = n^{2/3}v = (64)^{2/3} \times 10 = 160\ volt$

466 **(a)**

When key is open, charge in steady state will be $q_1 = CE$

When key is closed, potential difference across capacitor will be

$$V = \frac{2R}{R + 2R}E = \frac{2}{3}E$$

Charge in steady state will be $q_2 = \frac{2}{3}CE \Rightarrow \frac{q_1}{q_2} = \frac{3}{2}$

467 **(b)**

$C = 4\pi\varepsilon_0 R$

$$R = \frac{C}{4\pi\varepsilon_0} = 9 \times 10^9 \times 10^{-12} = 9 \times 10^{-3}m$$

Diameter $= 2R = 2 \times 9 \times 10^{-3} = 18 \times 10^{-3}m$

468 **(b)**

Electric potential due to dipole in it's general position is given by $V = \frac{k.p\cos\theta}{r^2} \Rightarrow V \propto \frac{1}{r^2}$

469 **(d)**

$$\Delta U = U_2 - U_1 = \frac{V^2}{2}(C_2 - C_1)$$
$$= \frac{(100)^2}{2}(10-2)\times 10^{-6} = 4\times 10^{-2} J$$

470 **(b)**

Here, mass of particle, $m = 2\times 10^{-5} Kg$
Charge of a particle, $q = 4\times 10^{-3} C$
Electric field, $E = 5\ V\ m^{-1}$
Force on a charged particle in a uniform electric field is
$F = qE$
$\therefore$ Acceleration of the particle, $a = \frac{qE}{m}$
$$= \frac{4\times 10^{-3}\times 5}{2\times 10^{-5}} = 10^3 ms^{-2}$$
Let v be velocity of particle after 10 s
As $v = u + at$
$\therefore v = at = (10^3 ms^{-2})(10\ s) = 10^4 ms^{-1}\quad [u=0]$
Kinetic energy of a particle after 10 s is
$$K = \frac{1}{2}mv^2 = \frac{1}{2}\times 2\times 10^{-5}\times 10^4\times 10^4 = 10^3 J$$

471 **(a)**

$$a = \frac{qE}{m} = \frac{q}{m}\left(\frac{V}{d}\right) = \frac{10^{-11}}{10^{-15}}\times\frac{50}{5\times 10^{-3}}$$
$$= 10^8 m/sec^2$$

472 **(d)**

As the electron is moving in a straight line and starts from rest.

Thus, from

$$s = ut + \frac{1}{2}at^2$$

We get

$$h = (0)t + \frac{1}{2}a_e t^2$$

$$t = \sqrt{\frac{2h}{a_e}}$$

$$= \sqrt{\frac{2hm_e}{eE}} \qquad \left(a_e = \frac{eE}{m_e}\right)$$

$$= \sqrt{\frac{2\times 1.5\times 10^{-2}\times 9.1\times 10^{-31}}{1.6\times 10^{-19}\times 2\times 10^4}}$$

$$= 2.9\times 10^{-9} s$$

473 **(b)**

At equitorial point

$$E_e = \frac{1}{4\pi\varepsilon_0}\frac{P}{r^3}$$

(directed from $+q$ to $-q$) and $V_e = 0$.

475 **(c)**

Since both are metals so equal amount of charge will induce on them

476 **(b)**

For equilibrium, net force on $Q = 0$
$$\therefore \frac{kQQ}{(2x)^2} + \frac{kqQ}{x^2} = 0$$
$\therefore q = -Q/4$

477 **(c)**

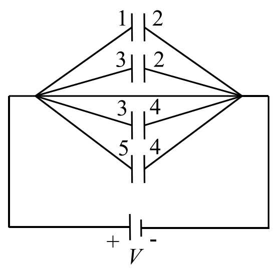
Flux coming out of the cube $\phi_1 = \frac{\lambda . a\sqrt{3}}{\varepsilon_0}$ ...(i)

And from sphere $\phi_1 = \frac{\lambda . 2a}{\varepsilon_0}$ ...(ii)

$$\therefore \frac{\phi_1}{\phi_2} = \frac{\sqrt{3}}{2}$$

478 **(c)**

The given circuit can be redrawn as follows. All capacitors are identical and each having capacitance $C = \frac{\varepsilon_0 A}{d}$

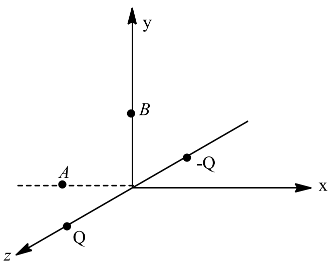


|Charge on each capacitor| = |Charge on each plate|
$$= \frac{\varepsilon_0 A}{d}V$$
Plate 1 is connected with positive terminal of battery so charge on plate 4 will be $+\frac{\varepsilon_0 A}{d}.V$
Plate 4 comes twice and it is connected with negative terminal of battery, so charge on plate 4 will be $-\frac{2\varepsilon_0 A}{d}V$

479 **(c)**

$A \equiv (-a, 0,0) B \equiv (0, a, 0)$

Point charge is moved from A to B



$V_A = V_B = 0$

$\therefore \quad W = 0$

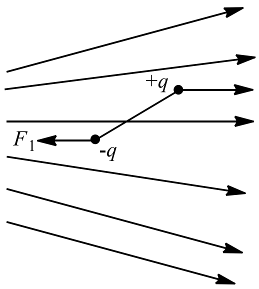
481 **(c)**

By $Q = Ne$ or $N = \frac{Q}{e} \therefore N = \frac{80\times10^{-6}}{1.6\times10^{-19}} = 5 \times 10^{14}$

482 **(c)**

In a non-uniform electric field, the dipole may experience both non-zero torque as translational force.

For example as shown in figure,



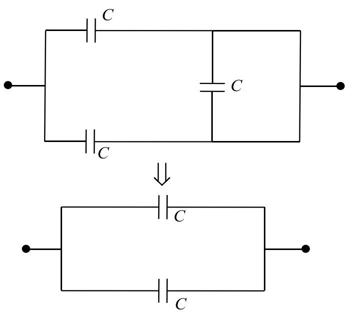
$F_1 \neq F_2$as E is non-uniform.

Torque would also be non-zero.

483 **(a)**

Third capacitor is short circuited

$C_{||} = C_1 + C_2 = 2C$



484 **(a)**

$W_{ext} = \frac{1}{2}C'V'^2 - \frac{1}{2}CV^2$

$= \left(\frac{1}{2}\right)\left(\frac{C}{2}\right)(2V)^2 - \frac{1}{2}CV^2 = \frac{1}{2}CV^2$

$W_{ext} = \frac{1}{2} \times 50 \times 10^{-6} \times (100)^2 = 25 \times 10^{-2}\, J$

485 **(c)**

The direction of electric field intensity at a point on the equatorial line of the dipole is opposite to the direction of dipole moment

487 **(a)**

By using $U = 9 \times 10^9 \frac{Q_1 Q_2}{r}$

$\Rightarrow U = 9 \times 10^9 \times \frac{10^{-6} \times 10^{-6}}{1} = 9 \times 10^{-3}\, J$

488 **(a)**

Electric flux coming out through a closed surface is q/ε_0

489 **(c)**

Charges developed are same so $C_1V_1 = C_2V_2 \Rightarrow \frac{V_1}{V_2} = 2$

$V_1 + V_2 = 120 \Rightarrow V_1 = 80\, volts$

490 **(a)**

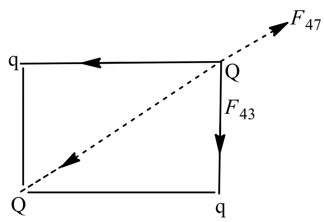
Three forces F_{41}, F_{42} and F_{43} acting on Q as shown resultant of $F_{41} + F_{43}$

$= \sqrt{2}F_{\text{each}} = \sqrt{2}\frac{1}{4\pi\varepsilon_0}\frac{Qq}{d^2}$

Resultant on Q becomes zero only when q charges are of negative nature.

$F_{42} = \frac{1}{4\pi\varepsilon_0} \frac{Q \times Q}{\left(\sqrt{2}d\right)^2}$

$\Rightarrow \sqrt{2}\frac{dQ}{d^2} = \frac{Q\times Q}{2d^2}$



$\sqrt{2} \times \mathrm{q} = \frac{Q \times Q}{2}$

$\therefore q = \frac{Q}{2\sqrt{2}}$

or $\frac{Q}{q} = -2\sqrt{2}$

491 **(c)**

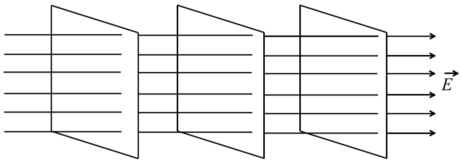
$\Delta KE = qV = eV = e \times 1V = 1eV$

492 **(b)**

$U = \frac{1}{2}C_{eq}V^2 = \frac{1}{2}(nC)V^2$

493 **(b)**

An equipotential surface is a surface with a constant value of potential at all points on the surface. For a uniform electric field, say, along the x-axis, the equipotential surfaces are planes normal to the x-axis, $i.e.$,



Plane parallel to the $y-z$ plane on equipotential surface, potential at all points is constant, this means that on equipotential surface work done in moving a test charge from one point to other point is zero

494 **(b)**

Given that,

Charge $q = +1\text{C}$

From Gauss's law, corresponding flux

$\phi = \frac{q}{\varepsilon_0}$

$\therefore \quad \phi = \frac{1}{\varepsilon_0}$

$or \quad \phi = (\varepsilon_0)^{-1}$

495 **(a)**

$3\mu F$ and $6\mu F$ are series; $\therefore \frac{3\times6}{(3+6)} = 2\mu F$

This is in parallel with $2\mu F$

Total capacitance in the circuit is $4\mu F$

$\therefore U = (1/2)V^2C = (1/2)\times 2^2 \times 4\times10^{-6}J = 8\mu J$

496 **(d)**

By Gauss's law $\phi = \frac{1}{\varepsilon_0}[Q_{enclosed}]$

$\Rightarrow Q_{enclosed} = \phi\varepsilon_0 = [-8\times10^3 + 4\times10^3]\varepsilon_0$

$= -4\times10^3\varepsilon_0\ Coulomb$

497 **(c)**

$\tau_{max} = p\,E\sin 90^0$

$= q(2a)E = 10^{-6}\times2\times20^{-2}\times10^5$

2×10^{-3} Nm

498 **(c)**

Kinetic energy $K = \frac{1}{2}mv^2 = eV \Rightarrow v = \sqrt{\frac{2eV}{m}}$

499 **(a)**

Electric field due to a point charge $E = \frac{q}{4\pi\varepsilon_0 r^2}$

$\therefore q = E\times4\pi\varepsilon_0 r^2 = 2\times\frac{1}{9\times10^9}\times\left(\frac{30}{100}\right)^2$

$= 2\times10^{-11}C$

500 **(a)**

Work done $W = 3\times10^{-6}(V_A - V_B)$; where

$V_A = 10^{10}\left[\frac{(-5\times10^{-6})}{15\times10^{-2}} + \frac{2\times10^{-6}}{5\times10^{-2}}\right]$

$= \frac{1}{15}\times10^6\ volt$

And $V_B = 10^{10}\left[\frac{(2\times10^{-6})}{15\times10^{-2}} + \frac{5\times10^{-6}}{5\times10^{-2}}\right] = -\frac{13}{15}\times 10^6\ volt$

$\therefore W = 3\times10^{-6}\left[\frac{1}{15}\times10^6 - \left(-\frac{13}{15}\times10^6\right)\right]$

$= 2.8\,J$

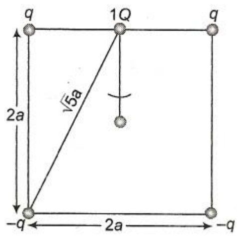
501 **(a)**

Electric lines are originating from A ($+ve$ charge) and terminate at B($-ve$ charge). Also density of lines at A is more than lines at B

503 **(a)**

$U_i = \frac{2kqQ}{a} + \frac{2k(-q)Q}{\sqrt{5a}} = \frac{1}{4\pi\varepsilon_0}.\frac{2qQ}{a}(1-\frac{1}{\sqrt{5}})$

$U_f = 0$



By conservation of energy

Gain in KE=loss in PE

$K = \frac{1}{4\pi\varepsilon_0}.\frac{2qQ}{a}(1-\frac{1}{\sqrt{5}})$

504 **(a)**

According to Gauss law, $\phi_{\text{total}} = \frac{q}{\varepsilon_0}$

Let electric flux linked with surfaces A, B and C are ϕ_A, ϕ_B and ϕ_C respectively. That is

$\phi_{\text{total}} = \phi_A + \phi_B + \phi_C$

Since $\phi_C = \phi_A$

$\therefore 2\phi_A + \phi_B = \phi_{\text{total}} = \frac{q}{\varepsilon_0}$

or $\quad \phi_A = \frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi_B\right)$

But $\quad \phi_B = \phi \quad$ (given)

Hence,

$$\phi_A = \frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$$

505 **(d)**

$Q_1 = 10^{-2}C, Q_2 = 5 \times 10^{-2}C$

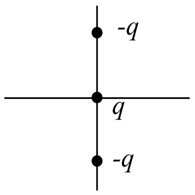
Total charge of the system $Q = 6 \times 10^{-2}\ C$

Charge on small sphere

$$Q_1' = \frac{Qr_1}{r_1 + r_2} = \frac{6 \times 10^{-2} \times 1}{1+2} = 2 \times 10^{-2}C$$

507 **(d)**

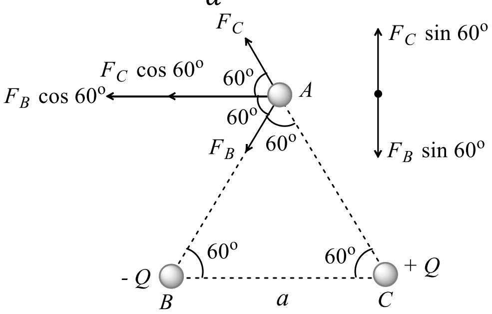
Restoring force on charge q



$$\frac{1}{4\pi\varepsilon_0} \times \frac{q.q}{(a+x)^2} - \frac{1}{4\pi\varepsilon_0}\frac{q.q}{(a-x)^2}$$
$$= \frac{1}{4\pi\varepsilon_0} \times \frac{q^2}{1}\left[\frac{(a-x)^2 - (a+x)^2}{(a^2-x^2)^2}\right]$$
$$\frac{q^2}{4\pi\varepsilon_0}\left[\frac{(a-x+a+x)(a-x-a-x)}{a^4\left(1-\frac{x^2}{a^2}\right)^2}\right]$$
$$\frac{-4ax.q^2}{4\pi\varepsilon_0 a^4} = -\frac{q^2 x}{\pi\varepsilon_0 a^3} \Rightarrow a = \frac{F}{m} = \frac{-a^2 x}{\pi\varepsilon_0 m.a^3} \Rightarrow a = -\omega^2 x$$
$$\omega^2 = \frac{a^2}{\pi\varepsilon_0 m a^3} \Rightarrow \omega = \sqrt{\frac{a^2}{\pi\varepsilon_0 m.a^3}}$$

508 **(c)**

$$|\overrightarrow{F_B}| = |\overrightarrow{F_C}| = k.\frac{Q^2}{a^2}$$

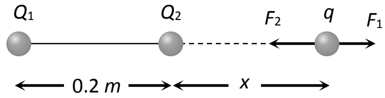


Hence force experienced by the charge at A in the direction normal to BC is zero

509 **(c)**

If two opposite charges are separated by a certain distance, then for it's equilibrium a third charge should be kept outside and near the charge which is smaller in magnitude.

Here, suppose third charge q is placed at distance x from $-2.7 \times 10^{-11}C$ then for it's equilibrium $|F_1| = |F_2|$



$$\Rightarrow \frac{kQ_1 q}{(x+0.2)^2} = \frac{kQ_2 q}{x^2} \Rightarrow x = 0.556\ m$$

$\left[\text{Here } k = \frac{1}{4\pi\varepsilon_0} \text{ and } Q_1 = 5 \times 10^{-11}C, Q_2 = -2.7 \times 10^{-11}C\right]$

511 **(a)**

$U = \frac{1}{2}CV^2$ so $24 \times 60 \times 60 = \frac{1}{2}C(1200)^2 \Rightarrow C = 120\ mF$

512 **(b)**

$\Delta\ P.E. =$ Work done by external agent

$= (V_f q - V_i q), V_f > V_i \Rightarrow \Delta P.E. > 0\ i.e. P.E.$ will increase

513 **(c)**

Dipole energy

$U = -pE\ cos\ \theta$

When U is maximum

$\cos\theta = -1$

$\theta = \pi$

514 **(b)**

In spherical capacitor $C = 4\pi\varepsilon_0 K\left(\frac{ab}{b-a}\right) \Rightarrow C \propto K$

515 **(a)**

Let separation between two parts be $r \Rightarrow F = k.q\frac{(Q-q)}{r^2}$

For F to be maximum $\frac{dF}{dq} = 0 \Rightarrow \frac{Q}{q} = \frac{2}{1}$

516 **(c)**

$$K = \frac{E_{\text{without dielectric}}}{E_{\text{with dielectric}}} = \frac{2 \times 10^5}{1 \times 10^5} = 2$$

517 **(d)**

Since, the body is connected to earth and the electrons from the earth flow to the body so, it loses its positive charge. Hence, it implies that previously it was positively charged.

518 **(b)**

In series combination Q is constant, hence according to

$$U = \frac{Q^2}{2C} \Rightarrow U \propto \frac{1}{C} \Rightarrow \frac{U_1}{U_2} = \frac{C_2}{C_1} = \frac{0.6}{0.3} = \frac{2}{1}$$

519 **(d)**

$$v = \sqrt{\frac{2QV}{m}}$$

$$= \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 20}{9.11 \times 10^{-31}}} = 2.65 \times 10^6 \; m/s$$

520 **(b)**

In series combination charge Q is same. So charge on $2\mu F$ capacitor is

$$Q = C_{eq}V = \left(\frac{2 \times 8}{2 + 8}\right) \times 300 \times 10^{-6} = 4.8 \times 10^{-4} C$$

521 **(b)**

$$V_{\text{axis}} = \frac{1}{4\pi\varepsilon_0} \times \frac{p}{r^2}$$

or $\quad V_{axis} \propto \dfrac{1}{r^2}$

524 **(b)**

Potential at A = Potential due to $(+q)$ charge + Potential due to $(-q)$ charge

$$= \frac{1}{4\pi\varepsilon_0} . \frac{q}{\sqrt{a^2 + b^2}} + \frac{1}{4\pi\varepsilon_0} \frac{(-q)}{\sqrt{a^2 + b^2}} = 0$$

525 **(c)**

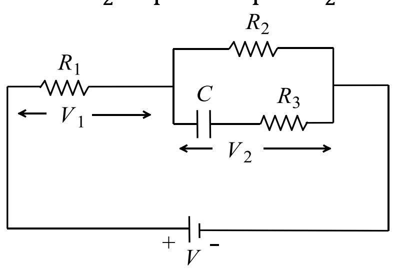
True for induced electric field and magnetic field

526 **(b)**

In steady state potential difference across capacitor

V_2 = potential difference across resistance $R_2 = \left(\frac{R_2}{R_1 + R_2}\right) V$

Hence V_2 depends upon R_2 and R_1



527 **(c)**

(i) Coulomb's law is derived by using Gauss theorem Hence, statement (a) is incorrect.

(ii) Gauss's theorem is valid for conservative field, obeys inverse square law not inverse square root law.

So, statement (b) is also incorrect.

(iii) Gauss's theorem is not applicable in gravitation. So, this statement is correct.

528 **(a)**

$$C = 4\pi\varepsilon_0 K \left[\frac{ab}{b-a}\right] = \frac{1}{9 \times 10^9} . 6 \left[\frac{12 \times 9 \times 10^{-4}}{3 \times 10^{-2}}\right]$$

$$= 24 \times 10^{-11} = 240 \; pF$$

529 **(b)**

$$n = \frac{Q}{e} = \frac{1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$$

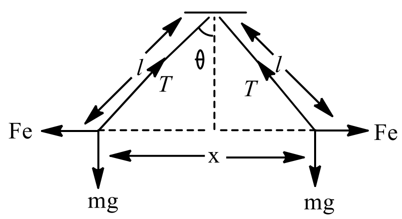
530 **(d)**

At an instants

$$T \cos\theta = mg \quad ..(\text{i})$$

$$T \sin\theta = F_e \quad ...(\text{ii})$$

$$= \frac{ka^2}{x^2}$$



From Eqs. (i) and (ii), we have

$$\frac{ka^2}{x^2} = mg \tan\theta$$

$$\Rightarrow \quad q^2 = \frac{mg}{k} \frac{x}{2l} x^2 \quad \left(\tan\theta \approx \frac{a}{2l}\right)$$

$$\Rightarrow q^2 = \frac{mg}{2kl} x^3 \qquad ...(\text{iii})$$

$$\Rightarrow 2q \frac{dq}{dt} = \frac{3mg}{2kl} x^2 \frac{dx}{dt}$$

$$\Rightarrow 2\left(\frac{mg}{2kl} \; x^3\right)^{\frac{1}{2}} \frac{dq}{dt} = \frac{3mg}{2kl} \quad x^2 v$$

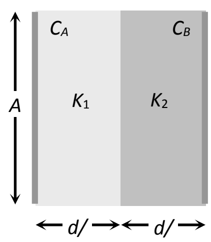
$$\left[\because q = \left(\frac{mg}{2kl} \; x^3\right)^{\frac{1}{2}}\right]$$

$$\Rightarrow \quad vx^{1/2} = \text{constant}$$

$$\Rightarrow \quad v \propto x^{-1/2}$$

531 **(d)**

$$C_A = \frac{K_1 \varepsilon_0 A}{d/2}, C_B = \frac{K_2 \varepsilon_0 A}{d/2}$$



$$\therefore C_{eq} = \frac{C_A C_B}{C_A + C_B} = \left(\frac{2K_1K_2}{K_1 + K_2}\right)\frac{\varepsilon_0 A}{d}$$

$$\left[\because c = \frac{\varepsilon_0 A}{d}\right] \therefore \frac{C_1}{C} = \frac{2K_1K_2}{K_1 + K_2}$$

532 **(d)**

Electric field at a distance x from the centre

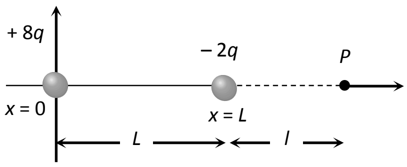
$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{x^2}$$

$$\Longrightarrow E \propto \frac{1}{x^2}$$

533 **(c)**

The net field will be zero at a point outside the charges and near the charge which is smaller in magnitude

Suppose E.F. is zero at P as shown



Hence at P; $k.\frac{8q}{(L+l)^2} = \frac{k.(2q)}{l^2} \Rightarrow l = L$

So distance of P from origin is $L + L = 2L$

534 **(b)**

Kinetic energy =work done

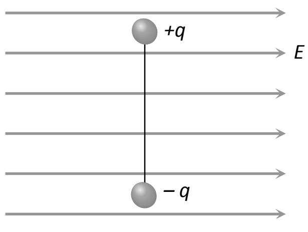
$= F.d$

$= qE \times y$

$= qEy$

535 **(d)**

Work done $= \int_{90}^{270} pE\sin\theta\, d\theta = [-pE\cos\theta]_{90}^{270} = 0$



536 **(d)**

They will not experience any force if $|\overrightarrow{F_G}| = |\overrightarrow{F_e}|$

$$\Rightarrow G\frac{m^2}{(16\times10^{-2})^2} = \frac{1}{4\pi\varepsilon_0}.\frac{q^2}{(16\times10^{-2})^2} \Rightarrow \frac{q}{m} = \sqrt{4\pi\varepsilon_0 G}$$

537 **(c)**

$$\frac{1}{C_{eq}} = \frac{1}{1} + \frac{1}{2} + \frac{1}{8} \Rightarrow C_{eq} = \frac{8}{13}\mu F$$

Total charge $Q = C_{eq}V = \frac{8}{13} \times 13 = 8\mu C$

Potential difference across $2\mu F$ capacitor $= \frac{8}{2} = 4V$

538 **(b)**

By using $V_{big} = n^{2/3}v_{small} \Rightarrow \frac{V_{Big}}{v_{small}} = (8)^{2/3} = \frac{4}{1}$

539 **(b)**

$$C_{eq} = \frac{C_1C_2}{C_1 + C_2} + C_3 = \frac{2\times6}{2+6} + 4 = 5.5\,\mu\,F$$

Energy supplied $(E) = QV = CV^2 = 22 \times 10^{-6}\,J$

P.E. stored $(U) = \frac{1}{2}C_{eq}V^2 = \frac{1}{2} \times 5.5 \times (2)^2 = 11 \times 10^{-6}\,J$

$\Rightarrow$ Energy lost $= E - U = 11 \times 10^{-6}\,J$

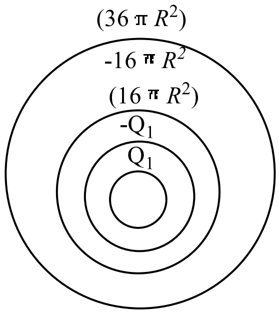
540 **(b)**

$Q_1 = \sigma(4\pi R^2) = 4\pi\sigma R^2$

$Q_2 = 16\pi\sigma R^2 - Q_1 = 12\pi\sigma R^2$

$Q_3 = 36\pi\sigma R^2 = 16\pi\sigma R^2 = 20\pi\sigma R^2$

$Q_1 : Q_2 : Q_3 = 1 : 3 : 5$



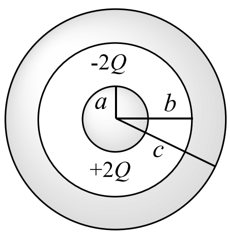
541 **(d)**

$W = PE(1 - \cos\theta)$ here $\theta = 180°$

$\therefore W = -PE\,(1 - \cos 180°) = PE[1 - (-1)]$
$= 2PE$

542 **(a)**

Surface charge density $(\sigma) = \frac{\text{Charge}}{\text{surface area}}$



So $\sigma_{inner} = \frac{-2Q}{4\pi b^2}$

And $\sigma_{Outer} = \frac{Q}{4\pi c^2}$

544 **(b)**

Both points are at same distance from the charge

545 **(a)**

C_2 and C_3 are in series so equivalent capacitance

$= \frac{2 \times 2}{2+2} = 1$

$\Rightarrow$ Now $1\mu F$, $1\mu F$ and $1\mu F$ are in parallel

$\therefore C_{eq} = 1 + 1 + 1 = 3\mu F$

547 **(a)**

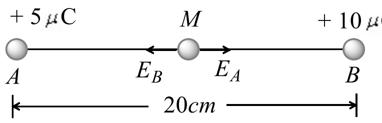
From following figure,

$E_A =$ Electric field at mid point M due to $+5\mu C$ charge

$= 9 \times 10^9 \times \frac{5 \times 10^{-6}}{(0.1)^2} = 45 \times 10^5 N/C$

$E_B =$ Electric field at M due to $+10\mu C$ charge

$= 9 \times 10^9 \times \frac{10 \times 10^{-6}}{(0.1)^2} = 90 \times 10^5 N/C$



Net electric field at

$M = |\vec{E_B}| - |\vec{E_A}| = 4.5 \times 10^5 N/C = 4.5 \times 10^6 N/C$, in the direction of E_B *i.e.* towards $+5\mu C$ charge

548 **(a)**

Let $E = \frac{1}{2} C_0 V_0^2$ then $E_1 = 2E$ and $E_2 = \frac{E}{2}$

So $\frac{E_1}{E_2} = \frac{4}{1}$

549 **(b)**

Potential at the surface of spherical conductor of radius R carrying charge Q, $V_S = \frac{Q}{4\pi\varepsilon_0 R}$

Let Q_1 and Q_2 are the charges on two spherical conductors of radii R_1 and R_2 respectively

When these two charged spherical conductors connected by a wire, the potential at their surfaces becomes equal

$\therefore Vs_1 = Vs_2$

$\frac{Q_1}{4\pi\varepsilon_0 R_1} = \frac{Q_2}{4\pi\varepsilon_0 R_2} \Rightarrow \frac{Q_1}{Q_2} = \frac{R_1}{R_2}$ ...(i)

Surface charge density, $\sigma = \frac{\text{Charge}}{\text{Area}}$

$\therefore \frac{\sigma_1}{\sigma_2} = \frac{\left(\frac{Q_1}{4\pi R_1^2}\right)}{\left(\frac{Q_2}{4\pi R_2^2}\right)} = \frac{Q_1}{Q_2} \times \frac{R_2^2}{R_1^2}$

$= \frac{R_1}{R_2} \times \frac{R_2^2}{R_1^2} = \frac{R_2}{R_1}$ [Using (i)]

551 **(b)**

There are two capacitors parallel to each other

$\therefore$ Total capacitance $= \frac{2\varepsilon_0 A}{d}$

$\therefore$ Energy stored $= \frac{1}{2}\left(\frac{2\varepsilon_0 A}{d}\right) V^2$

$= \frac{8.86 \times 10^{-12} \times 50 \times 10^{-4} \times 12^2}{3 \times 10^{-3}} = 2.1 \times 10^{-9} J$

552 **(b)**

According to Gauss law of electrostatics in a region of charge distribution in free space.

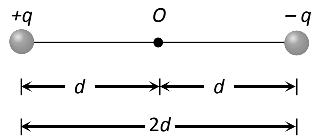
$$\oint \boldsymbol{E}.\boldsymbol{ds} = \frac{\rho}{\varepsilon_0}$$

553 **(c)**

$\vec{F} = -k\frac{e^2}{r^2}\hat{r} = -k.\frac{e^2}{r^3}\vec{r} \quad \because \left[\hat{r} = \frac{\vec{r}}{r}\right]$

554 **(a)**

Potential at mid point O, $V = \frac{kq}{d} + \frac{k(-q)}{d} = 0$

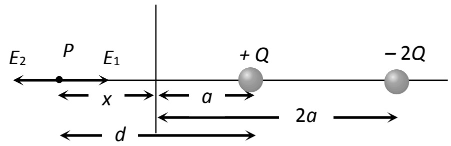


555 **(b)**

Suppose electric field is zero at a point P lies at a distance d from the charge $+Q$

At P $\frac{kQ}{d^2} = \frac{k(2Q)}{(a+d)^2}$

$\Rightarrow \frac{1}{d^2} = \frac{2}{(a+d)^2} \Rightarrow d = \frac{a}{(\sqrt{2}-1)}$



Since $d > a$ *i.e.* point P must lies on negative x-axis as shown at a distance x from origin hence $x = d - a = \frac{a}{(\sqrt{2}-1)} - a = \sqrt{2}a$. Actually P lies on negative x-axis so $x = -\sqrt{2}a$

556 **(c)**

$E = \frac{1}{4\pi\varepsilon_0}.\frac{ne}{r^2} \Rightarrow n = \frac{Er^2}{e}.4\pi\varepsilon_0$

$\Rightarrow n = \frac{0.036 \times 0.1 \times 0.1}{9 \times 10^9 \times 1.6 \times 10^{-19}} = \frac{360}{144} \times 10^5$

$= 2.5 \times 10^5 N/C$

558 **(b)**

In a uniform electric field $\vec{E}$, dipole experiences a torque $\vec{\tau}$ given by $\vec{\tau} = \vec{p} \times \vec{E}$ but experiences no force. The potential energy of the dipole in a uniform electric field $\vec{E}$ is $U = -\vec{p}.\vec{E}$

559 **(d)**

$$\boldsymbol{E} = -\frac{\partial V}{\partial x}\hat{\boldsymbol{\imath}} - \frac{\partial V}{\partial y}\hat{\boldsymbol{\jmath}} - \frac{\partial V}{\partial z}\hat{\boldsymbol{k}}$$

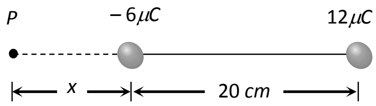
$$\Rightarrow E_x = -\frac{\partial V}{\partial x} = -\frac{d}{dx}\left[\frac{20}{x^2-4}\right] = -\frac{40x}{(x^2-4)^2}$$

$$\Rightarrow E_x at\ x = 4\mu m = \frac{10}{9} V\mu^{-1}m^{-1}$$

And is long positive x-direction

560 **(c)**

Point P will lie near the charge which is smaller in magnitude $i.e. -6\mu C$. Hence potential at P



$$V = \frac{1}{4\pi\varepsilon_0}\frac{(-6\times10^{-6})}{x} + \frac{1}{4\pi\varepsilon_0}\frac{(12\times10^{-6})}{(0.2+x)} = 0$$

$$\Rightarrow x = 0.2\ m$$

561 **(b)**

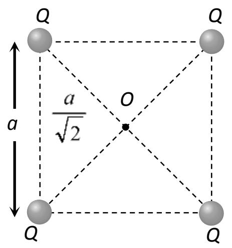
Since $U = \frac{1}{2}\frac{Q^2}{C}, \therefore 1.21U = \frac{1}{2}\frac{(Q+2)^2}{C}$

$$\therefore \frac{1.21}{1} = \frac{(Q+2)^2}{Q^2} \Rightarrow \sqrt{\frac{1.21}{1}} = \frac{Q+2}{Q}$$

$$\Rightarrow 1.1Q = Q + 2 \Rightarrow Q = 20\ C$$

562 **(c)**

Potential at centre O of the square



$$V_0 = 4\left(\frac{Q}{4\pi\ \varepsilon_0(a/\sqrt{2})}\right)$$

Work done in shifting $(-Q)$ charge from centre to infinity

$$W = -Q(V_\infty - V_0) = QV_0$$

$$= \frac{4\sqrt{2}Q^2}{4\pi\varepsilon_0 a} = \frac{\sqrt{2}Q^2}{\pi\varepsilon_0 a}$$

563 **(c)**

Electric field inside a conductor is always zero

564 **(b)**

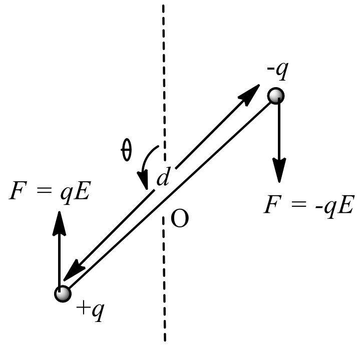
Charge flows to second capacitor until the potential is same $i.e. V/2$. So new charge $= CV/2$

565 **(b)**

The same force will act on both bodies although their directions will be different

566 **(c)**

Net force on dipole in uniform electric field is zero but net torque is the sum of torques acting on the two charges.



$$\tau = (q)\left(\frac{d}{2}\right)\times E + (q)\left(\frac{d}{2}\right)(\mathbf{E})$$

$$= qd \times E$$

Where $\mathbf{P} = qd$=dipole moment

$$\therefore\ \ \tau = \boldsymbol{p}\times\mathbf{E} = pE\sin\theta \quad \dots.(i)$$

If I is moment of inertia and α the angular acceleration, then

$$\tau = I\alpha \qquad \dots\dots\dots\dots..(ii)$$

From Eqs. (i) and (ii), we get

$$I\alpha = pE\sin\theta$$

Since, displacement is small $\sin\theta \cong \theta$

$$\therefore \quad I\alpha = pE\theta$$

$$\Rightarrow \quad \alpha = \frac{pE}{I}\theta$$

The angular frequency of oscillation is given by

$$\int = \sqrt{\frac{\theta}{\alpha}} = \sqrt{\frac{\alpha I}{\alpha\ pE}} = \sqrt{\frac{I}{pE}}$$

The potential energy is lowest when the dipole moment is aligned with the field and highest when the two are antialigned.

567 **(b)**

From $s = ut + \frac{1}{2}at^2 = \frac{1}{2}at^2$

$t = \sqrt{\frac{2s}{a}}$

As s is same,

$\therefore\ t \propto \frac{1}{\sqrt{a}}$

$\frac{t^2}{t^1} = \sqrt{\frac{a^1}{a^2}} = \sqrt{\frac{F_e/M_e}{F_p/M_p}} = \sqrt{\frac{M_p}{M_e}}$

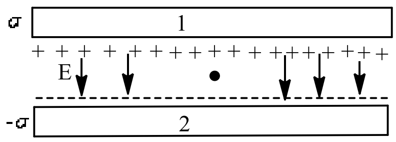
568 **(a)**

By Gauss's theorem

569 **(c)**

The situation is shown in the figure. Plate 1 has surface charge density σ and plate 2 has surface charge density$-\sigma$. The electric fields at point P due to two charged plates add up,

giving



$$E = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$$

Given, $\sigma = 26.4 \times 10^{-12}\text{Cm}^{-2}$

$\varepsilon_0 = 8.85 \times 10^{-12}\text{C}^2\text{N}^{-1}\text{m}^{-2}$

Hence,

$$E = \frac{26.4 \times 10^{-12}}{8.85 \times 10^{-12}} \approx 3\text{NC}^{-1}$$

570 **(c)**

$V = \frac{1}{4\pi\varepsilon_0} . \frac{Q}{r} \Rightarrow V \propto \frac{1}{r}$

571 **(c)**

The electric field (E) at the centre of circular charged ring of radius R is zero

$\therefore$ Force $= qE =$ Zero

572 **(b)**

When spheres are touched and separated, charge is

$$q' = \frac{4q-2q}{2} = \frac{2q}{2} = q$$

From Coulomb's law

$$F = \frac{1}{4\pi\varepsilon_0}\frac{(4q)(-2q)}{r} \qquad \text{... (i)}$$

When made to touch

$$F' = \frac{1}{4\pi\varepsilon_0}\frac{q2}{r} \qquad \text{..... (ii)}$$

From Eqs. (i) and (ii), we get

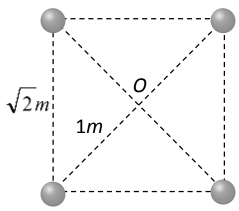
$$F' = \frac{F}{8}$$

573 **(c)**

When a comb runs through one's dry hair, then comb gets charged and when it comes close to paper, it induces opposite charges in paper. The field due to the charges in comb, polarises the atoms in the paper. Finally is attracts the paper.

574 **(c)**

Length of each side of square is $\sqrt{2}m$ so distance of it's centre from each corner is $\frac{\sqrt{2}}{\sqrt{2}} = 1m$

Potential at 

the centre

$$V = 9 \times 10^9 \left[\frac{10 \times 10^{-6}}{1} + \frac{5 \times 10^{-6}}{1} - \frac{3 \times 10^{-6}}{1} + \frac{8 \times 10^{-6}}{1}\right]$$

$= 1.8 \times 10^5\ V$

575 **(a)**

In the direction of electric field, potential decreases

577 **(c)**

Electric field at a distance R is only due to sphere because electric field due to shell inside it is always zero

Hence electric field $= \frac{1}{4\pi\varepsilon_0} . \frac{3Q}{R^2}$

578 **(d)**

From $V = \frac{Q}{C}$. For constant $Q, V \propto \frac{1}{C}$ $i.e.$ 'V' varies hyperbolically with C

579 **(a)**

According to Gauss's law total flux coming out of a closed surface enclosing charge q is given by

$$\phi = \oint \vec{E}.d\vec{S} = \frac{q}{\varepsilon_0}$$

From this expression, it is clear that total flux linked with a closed surface only depends on the enclosed charge and independent of the shape and size of the surface.

$\phi = \oint \vec{E}.d\vec{S} = \frac{q}{\varepsilon_0} = 20\ Vm$ given

This $\frac{q}{\varepsilon_0}$ is constant as long as the enclosed charge is constant

⇒ The flux over a concentric sphere of radius $20\ cm = 20Vm$

580 **(d)**

$AB + AC = 12\ cm$ ...(i)

$AB.AC = 32\ cm^2$

$\therefore AB - AC = \sqrt{(AB+AC)^2 - 4\ AB.AC}$

$AB - AC = 4$ ...(ii)

From equation (i) and (ii)

$AB = 8\ cm; AC = 4\ cm$

Potential energy at point A

$$V_A = \frac{1}{4\pi\varepsilon_0} q_1 q_2 \left[\frac{1}{AB} + \frac{1}{AC}\right]$$

$$= \frac{9\times10^9 \times 2 \times 2 \times 10^{-12}}{10^{-2}}\left(\frac{1}{8}+\frac{1}{4}\right) = 1.35\ J$$

581 **(c)**

$$\rho = K\, r^a, E\left(r = \frac{R}{2}\right) = \frac{1}{8}E(r = R)$$

$$\frac{q_{enclosed}}{4\pi\varepsilon_0 (R/2)^2} = \frac{1}{8}\frac{Q}{4\pi\varepsilon_0 R^2}$$

$32\ q_{enc.} = Q$

$$q_{enc.} = \int_0^{R/2} Kr^a\ 4\pi r^2\ dr = \frac{(4\pi K)}{a+3}\left(\frac{R}{2}\right)^{a+3}$$

$$Q = \frac{4\pi K}{(a+3)} R^{a+3} \Rightarrow \frac{Q}{q_{enc.}} = 2^{a+3} \Rightarrow 2^{a+3} = 32$$

$\Rightarrow a = 2$

582 **(b)**

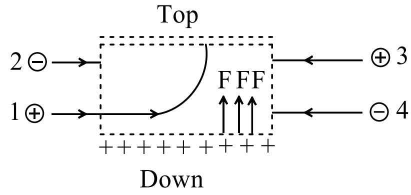
$$Q = CV = \frac{\pi (0.08)^2 \varepsilon_0}{1\times10^{-3}} \times 100 = 1.8\times10^{-8} C$$

583 **(b)**

When a negatively charged pendulum oscillates over a positively charged plate then effective value of g increases so according to $T = 2\pi\sqrt{\frac{1}{g}}, T$ decreases

584 **(a)**

The figure shows the path of a +ve charged particle (1) through a rectangular region of uniform electric field.



Since, +ve charged particle moves as a parabolic path in electric field, it means the direction of electric field is upward. The direction of particle (2) which is −ve is downward.

The direction of deflection of particle (3) which is +ve is upward and direction of deflection of particle (4) is downward

585 **(b)**

$$E = \frac{V}{d} = \frac{100}{10^{-3}} = 10{,}0000\ V/m$$

586 **(d)**

Electric field lines do not form closed loop. This follows from the conservative nature of electric field

587 **(d)**

$F = q\,E = 1.6\times10^{-19} \times 3.25\times10^4$

$= 5.20\times10^{-15}$N

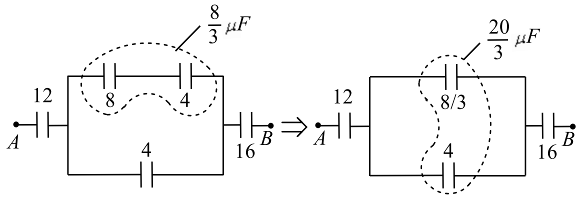
588 **(a)**

By using $QE = mg$

$\Rightarrow E = \frac{mg}{Q} = \frac{10^{-6}\times10}{10^{-6}} = 10\ V/m$; upward because charge is positive

589 **(d)**

The given circuit can be simplified as follows



Hence equivalent capacitance between A and B

$$\frac{1}{C_{AB}} = \frac{1}{12} + \frac{1}{20/3} + \frac{1}{16} \Rightarrow C_{AB} = \frac{240}{71} F$$

590 **(b)**

The energy density of parallel plate capacitor is given by

$$U = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\varepsilon_0\left(\frac{V}{d}\right)^2$$

$$= \frac{1}{2}\times 8.85\times10^{-12} C^2/Nm^2 \times \left(\frac{300\ volt}{2\times10^{-3} m}\right)^2$$

$$= 0.1\ J/m^3$$

591 **(d)**

Electric field is directed right ward (higher potential of −200 V to lower potential of −400 V). When electron left free in an electric it accelerates opposite to the electric field. Hence in the given case electron accelerates left ward

592 **(d)**

$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$

In a medium of dielectric constant, $K = \frac{\varepsilon}{\varepsilon_0}$s

$F' = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$

As $F' = F$

$\therefore \frac{q_1 q_2}{4\pi\varepsilon R^2} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$

$R^2 = \frac{\varepsilon_0}{\varepsilon} r^2 = \frac{r^2}{K}$

$\therefore R = \frac{r}{\sqrt{K}}$

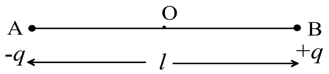
593 **(c)**

Total electric flux emerging from the cube is

$\frac{q}{\varepsilon_0}$.

594 **(d)**

Electric field at $''O''E = \frac{2kq}{l^2}$



Potential at $''O''$

$V = 0$

$\therefore E/V = \infty$

595 **(b)**

The radius of soap bubble increases because of outward force acting on the bubble due to charging

596 **(d)**

$\frac{\frac{1}{2}qV}{qV} = \frac{1}{2}$

597 **(a)**

Force on a charge q in a uniform electric field E is

$F = qE$

Work done = force × distance = qEY

598 **(c)**

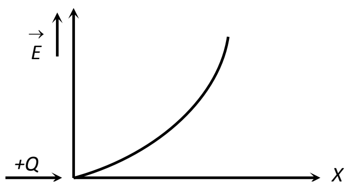
$\frac{1}{C_R} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \Rightarrow C_R = (C_1^{-1} + C_2^{-1} + C_3^{-1})^{-1}$

599 **(a)**

Separation between the spheres is not too large as compared to their radius so due to induction effect redistribution of charge takes place. Hence effective charge separation decreases so force increases

600 **(a)**

There is only acceleration in y direction due to electric field in that direction and no acceleration in x direction



601 **(a)**

$\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2} = mr\omega^2 = \frac{4\pi^2 mr^2}{T^2}$

$T^2 = \frac{(4\pi\varepsilon_0)r^2(4\pi^2 mr)}{q_1 q_2}$

$T = \left[\frac{4\pi^3 mr^2}{kq_1 q_2}\right]^{1/2}$

602 **(a)**

Energy density $= \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\varepsilon_0\left(\frac{\sigma}{\varepsilon_0}\right)^2 = \frac{\sigma^2}{2\varepsilon_0} = \frac{q^2}{2\varepsilon_0 A^2}$

603 **(b)**

$\Delta E = E_{Final} - E_{Initial} = \frac{1}{2}C\left(V_{Final}^2 - V_{Initial}^2\right)$

$= \frac{1}{2} \times 6 \times (20^2 - 10^2) \times 10^{-6}$

$= 3 \times (400 - 100) \times 10^{-6} = 3 \times 300 \times 10^{-6}$

$= 9 \times 10^{-4} J$

605 **(c)**

$\frac{1}{C_{eq}} = \frac{1}{3} + \frac{1}{10} + \frac{1}{15} \Rightarrow C_{eq} = 2\mu F$

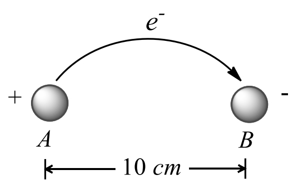
Charge on each capacitor

$Q = C_{eq} \times V \Rightarrow 2 \times 100 = 200\mu C$

606 **(c)**

Number of atoms in given mass $= \frac{10}{63.5} \times 6.02 \times 10^{23}$

$= 9.48 \times 10^{22}$



Transfer of electron between balls $= \frac{9.48 \times 10^{22}}{10^6}$

$= 9.48 \times 10^{16}$

Hence magnitude of charge gained by each ball

$Q = 9.48 \times 10^{16} \times 1.6 \times 10^{-19} = 0.015C$

Force of attraction between the balls

$F = 9 \times 10^9 \times \frac{(0.015)^2}{(0.1)^2} = 2 \times 10^8 N$

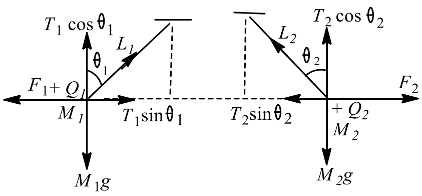
607 **(d)**

Here, mass of $\alpha -$ particle $m_a = 6.4 \times 10^{-27} kg$

Charge of $\alpha -$ particle $q_a = 3.2 \times 10^{-19} C$
Electric field $E = 1.6 \times 10^5\ Vm^{-1}$
Force on $\alpha -$ particle in a uniform electric field E is
$F = q_\alpha E = 3.2 \times 10^{-19} \times 1.6 \times 10^5 N$
$= 3.2 \times 1.6 \times 10^{-14} N$
Acceleration of the $\alpha -$ particle is
$$a = \frac{F}{m_\alpha} = \frac{3.2 \times 1.6 \times 10^{-14}}{6.4 \times 10^{-27}} ms^{-2}$$
Given : $u = 0$
$$\therefore v^2 = 2aS = \frac{2 \times 3.2 \times 1.6 \times 10^{-14} \times 2 \times 10^{-2}}{6.4 \times 10^{-27}}$$
[As $S = 2 \times 10^{-2} m$]
$= 3.2 \times 10^{11} = 32 \times 10^{10}$
or $v = 4\sqrt{2} \times 10^5\ ms^{-1}$

608 **(d)**
$C = \frac{\varepsilon_0 A}{d}$ and $C' = \frac{\varepsilon_0 A}{2d} + \frac{\varepsilon_0 (5A)}{2d}$
$$= \frac{\varepsilon_0 A}{2d}(1+5) = \frac{6\varepsilon_0 A}{2d} = \frac{3\varepsilon_0 A}{d}$$
$$\Rightarrow \Delta C = C' - C = \frac{3\varepsilon_0 A}{d} - \frac{\varepsilon_0 A}{d}$$
$$= \frac{2\varepsilon_0 A}{d}$$
Percentage change in capacitance
$$\frac{\Delta C}{C} = \frac{\frac{2\varepsilon_0 A}{d}}{\frac{\varepsilon_0 A}{d}} \times 100\% = 200\%$$

609 **(b)**
For sphere 1, in equilibrium



and $T_1 \cos\theta_1 = M_1 g$
$T_1 \sin\theta_1 = F_1$
$$\therefore \quad \tan\theta_1 = \frac{F_1}{M_1 g}$$
Similarly for sphere 2, $\tan\theta_2 = \frac{F_2}{M_2 g}$
F is same on both the charges, θ will be same only if their masses M are equal.

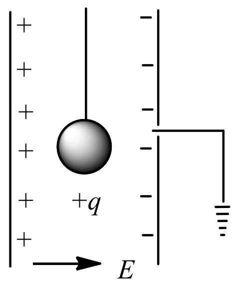
610 **(a)**
According to Coulomb's law $F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$
$$= -\frac{9 \times 10^9 \times 40 \times 10^{-6} \times 10 \times 10^{-6}}{(2.0)^2}$$
$= -0.9$ N
The force will be (attractive).

611 **(d)**
Length of the diagonal of a cube having each side b is $\sqrt{3}b$. So distance of centre of cube from each vertex is $\frac{\sqrt{3}b}{2}$
Hence potential energy of the given system of charge is
$$U = 8 \times \left[\frac{1}{4\pi\varepsilon_0}.\frac{(-q)(q)}{\sqrt{3}b/2}\right] = \frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 b}$$

612 **(b)**
Due to induction net charges on outer surfaces of spheres are as shown
$$\sigma = \frac{Q_1}{4\pi R^2} = \frac{Q_1 + Q_2}{4\pi(2R)^2} = \frac{Q_1 + Q_2 + Q_3}{4\pi(3R)^2}$$
$$\Rightarrow Q_1 = \frac{Q_1 + Q_2}{4} = \frac{Q_1 + Q_2 + Q_3}{9}$$
$\Rightarrow Q_2 = 3Q_1$ and $Q_3 = 5Q_1$
$\therefore Q_1 : Q_2 : Q_3 = 1 : 3 : 5$

615 **(c)**
Electric field is perpendicular to the equipotential surface and is zero every where inside the metal

616 **(d)**
Time period of simple pendulum in air



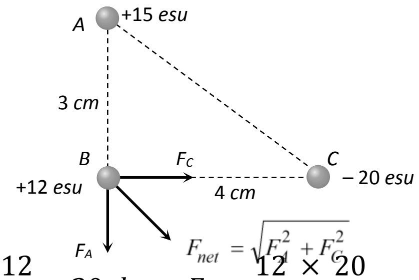
$$T = 2\pi\sqrt{\frac{l}{g}}$$
When it is suspended between vertical plates of a charged parallel plate capacitor, then acceleration due to electric field,
$$a = \frac{qE}{m}$$
This acceleration is acting horizontally and acceleration due to gravity is acting vertically. So effective acceleration.
$$g' = \sqrt{g^2 + a^2} = \sqrt{g^2 + \left(\frac{qE}{m}\right)^2}$$

Hence,

$$T' = 2\pi\sqrt{\frac{1}{\sqrt{g^2 + \left(\frac{qE}{m}\right)^2}}}$$

617 **(c)**

Net force on B $F_{net} = \sqrt{F_A^2 + F_C^2}$



$$F_A = \frac{15 \times 12}{(3)^2} = 20\, dyne, F_C = \frac{12 \times 20}{(4)^2}$$
$$= 15 dyne$$

$$\Rightarrow F_{net} = \sqrt{F_A^2 + F_C^2} = \sqrt{(20)^2 \times (15)^2} = 25 dyne$$

618 **(c)**

Charge will move along the circular line of force because $x^2 + y^2 = 1$ is the equation of circle in xy-plane

619 **(b)**

$$E = \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^2} = 9 \times 10^9 \times \frac{q}{r^2}$$

$$\therefore q = \frac{E \times r^2}{9 \times 10^9} = \frac{3 \times 10^6 \times (2.5)^2}{9 \times 10^9}$$
$$= 2.0833 \times 10^{-3}$$

q should be less than 2.0833×10^{-3}. In the given set of options 2×10^{-3} is the maximum charge which is smaller than 2.0833×10^{-3}

620 **(c)**

Total charge $= (2C)(2V) + (C)(-V) = 3CV$

$\therefore$ Common potential $= \frac{3CV}{3C} = V$

$\therefore$ Energy $= \frac{1}{2}(3C)(V)^2 = \frac{3}{2}CV^2$

621 **(a)**

Suppose distance of closest approach is r, and according to energy conservation applied for elementary charge.

Energy at the time of projection = Energy at the distance of closest approach

$$\Rightarrow \frac{1}{2}mv^2 = \frac{1}{4\pi\varepsilon_0}.\frac{(Ze).e}{r} \Rightarrow r = \frac{Ze^2}{2\pi\varepsilon_0 mv^2}$$

622 **(c)**

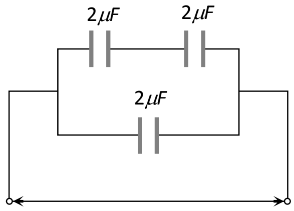
$$C = 4\pi\varepsilon_0 R, R = \frac{C}{4\pi\varepsilon_0} \Rightarrow R = (1/9) \times 9 \times 10^9$$
$$= 10^9 m$$

623 **(c)**

Capacitance does not depend on charge supplied

624 **(c)**

$$C = \frac{2 \times 2}{2 + 2} + 2 = 3\,\mu F$$



625 **(b)**

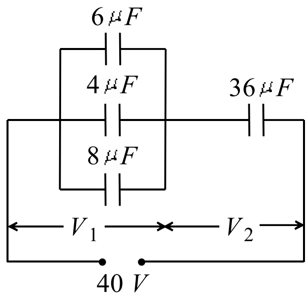
Maximum torque $= pE$

$= 2 \times 10^{-6} \times 3 \times 10^{-2} \times 2 \times 10^5$

$= 12 \times 10^{-3} N - m$

626 **(c)**

Given circuit can be redrawn as follows capacitors, $9\,\mu F$, $9\mu F$ and $7\mu F$ are short circuited. So they are deleted



$V_1 + V_2 = 40V$

and $\frac{V_1}{V_2} = \frac{36}{18} = 2$

Hence $V_1 = \frac{80}{3}V$

and $V_2 = \frac{40}{3}V$

charge on $8\mu F$ capacitor $= 8 \times \frac{80}{3} = 213.3\mu F \approx 214\mu F$

627 **(b)**

$V_{inside} = \frac{Q}{4\pi\varepsilon_0 R}$ for $r \leq R$ ...(i)

And $V_{out} = \frac{Q}{4\pi\varepsilon_0 r}$ for $r \geq R$ ...(ii)

$i.e.$ potential inside the hollow spherical shell is constant and outside varies according to $V \propto \frac{1}{r}$

628 **(d)**

$R = 3$ mm $= 3 \times 10^{-3}$ m

As $E = \frac{Q}{4\pi\varepsilon_0 R^2}$

$\therefore Q = 4\pi\varepsilon_0 R^2 E$

As maximum value of $E = 10\%$dielectric strength

$\therefore E = 10\%\ of\ 2 \times 10^7 = 2 \times 10^6 NC^{-1}$

$$Q = \frac{1}{9 \times 10^9}(3 \times 10^{-3})^2 \times 2 \times 10^6$$
$$= 2 \times 10^{-9} C = 2nc$$

629 **(d)**

On the equipotential surface, electric field is normal to the charged surface (where potential exists) so that no work will be done

630 **(b)**

$$U = \frac{Q^2}{2C} = \frac{(40 \times 10^{-6})^2}{2 \times 10 \times 10^{-6}} = 8 \times 10^{-5} J$$
$$= 8 \times 10^{-5} \times 10^7 = 800\ erg$$

632 **(b)**

$$E = \frac{F}{q} = \frac{[\text{MLT}^{-2}]}{[\text{AT}]} = [\text{MLT}^{-3}A^{-1}]$$

634 **(c)**

Because electric field applies the force on electron in the direction opposite to it's motion

635 **(b)**

Angle between two forces due to individual charges is equal to 60^0

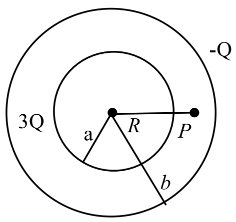
$$\therefore\ R = \sqrt{F^2 + F^2 + 2F\,F\cos 60^0} = F\sqrt{3}$$

638 **(b)**

The electric field inside a spherical charge is everywhere zero, that is

$$E = 0$$

But point P is outside the inner sphere, hence for a point very close to the surface the intensity of electric field is given by



$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{R^2}$$

Given, $q = +3Q$

Therefore,

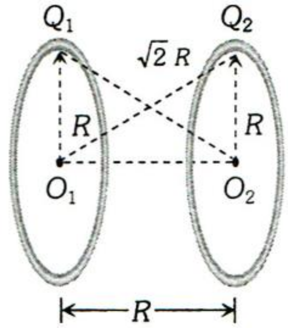
$$E = \frac{1}{4\pi\varepsilon_0}\frac{3Q}{\text{R}^2}$$

639 **(d)**

$$e = \frac{\lambda}{2\pi\varepsilon_0 r} \Rightarrow E \propto \frac{1}{r}$$

640 **(b)**

$$W = q(V_{O_2} - V_{O_1})$$



where $V_{O_1} = \frac{Q_1}{4\pi\varepsilon_0 R} + \frac{Q_2}{4\pi\varepsilon_0 R\sqrt{2}}$

and $V_{O_2} = \frac{Q_2}{4\pi\varepsilon_0 R} + \frac{Q_1}{4\pi\varepsilon_0 R\sqrt{2}}$

$$\Rightarrow V_{O_2} - V_{O_1} = \frac{(Q_2 - Q_1)}{4\pi\varepsilon_0 R}\left[1 - \frac{1}{\sqrt{2}}\right]$$

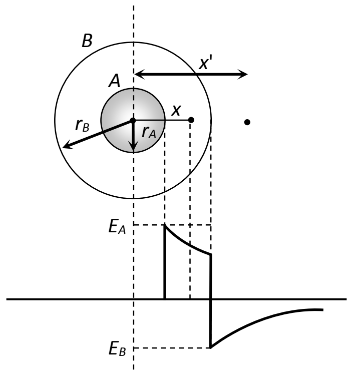
So, $W = \frac{q.(Q_2 - Q_1)}{4\pi\varepsilon_0 R}\frac{(\sqrt{2}-1)}{\sqrt{2}}$

641 **(a)**

$$C_{\max} = nC = 3 \times 3 = 9\mu F$$
$$C_{\min} = \frac{C}{n} = \frac{3}{3} = 1\ \mu F$$

642 **(a)**

Inside the shell A, electric field $E_{in} = 0$



At the surface of shell A,

$E_A = \frac{kQ_A}{r_A^2} \rightarrow$ [a fixed positive value]

Between the shell A and B, at a distance x from the common centre

$E = \frac{k.Q_A}{x^2} \rightarrow$ [as x increases E decreases]

At the surface of shell B,

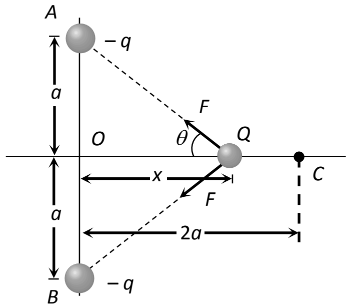
$E_B = \frac{k.(Q_A - Q_B)}{r_B^2} \rightarrow$ [a fixed negative value because $|Q_A| < |Q_B|$]

Outside the both shell, at a distance x from the common centre

$E_{out} = \frac{k(Q_A - Q_B)}{x'^2} \rightarrow$ [As x' increases negative value of E_{out} decreases and it becomes zero at $x = \infty$]

643 **(d)**

By symmetry of problem the components of force on Q due to charges at A and B along y-axis will cancel each other while along x-axis will add up and will be along CO. Under the action of this force charge Q will move towards O. If at any time charge Q is at a distance x from O. Net force on charge Q



$F_{net} \Rightarrow 2F\cos\theta$

$$= 2\frac{1}{4\pi\varepsilon_0}\frac{-qQ}{(a^2+x^2)} \times \frac{x}{(a^2+x^2)^{1/2}}$$

$i.e., F_{net} = -\frac{1}{4\pi\varepsilon_0}.\frac{2qQx}{(a^2+x^2)^{3/2}}$

As the restoring force F_{net} is not linear, motion will be oscillatory (with amplitude $2a$) but not simple harmonic

644 **(b)**

Work done by the field $W = q(-dV) = -e(V_A - V_B)$

$= e(V_B - V_A) = e(V_C - V_A) \quad [\because V_B = V_C]$

$\Rightarrow (V_C - V_A) = \frac{W}{e} = \frac{6.4 \times 10^{-19}}{1.6 \times 10^{-19}} = 4V$

646 **(a)**

The $\pm q$ charges appearing on the inner surfaces of A, are bound charges. As B is uncharged initially, as it is isolated, the charges on A will not be affected on closing the switch S. No charge will flow in to B

647 **(c)**

$\Delta V = \frac{1}{2}\frac{C \times C}{(C+C)}|V-(-V)|^2 = CV^2$

648 **(d)**

$W = 100e(-4-10) = -1400eV$

$= -1400(-1.6 \times 10^{-19})J = 2.24 \times 10^{-16}\,J$

649 **(a)**

In parallel combination $V_1 = V_2$

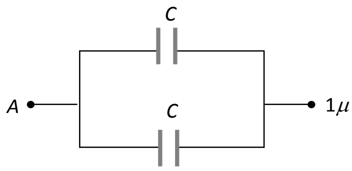
Or $\frac{q_1}{C_1} = \frac{q_2}{C_2} \Rightarrow \frac{q_1}{q_2} = \frac{C_1}{C_2}$

650 **(d)**

α-particles are charged particles, so they are deflected by electric field

651 **(a)**

The given circuit is equivalent to a parallel combination two identical capacitors



Hence equivalent capacitance between A and B is

$C = \frac{\varepsilon_0 A}{d} + \frac{\varepsilon_0 A}{d}$

$= \frac{2\varepsilon_0 A}{d}$

652 **(a)**

$$F = \frac{1}{4\pi\varepsilon_0}\frac{(+7\times10^{-6})(-5\times10^{-6})}{r^2}$$

$$= -\frac{1}{4\pi\varepsilon_0}\frac{35\times10^{12}}{r^2}N$$

$$F' = \frac{1}{4\pi\varepsilon_0}\frac{(+5\times10^{-6})(-7\times10^{-6})}{r^2}$$

$$= -\frac{1}{4\pi\varepsilon_0}\frac{35\times10^{12}}{r^2}N$$

654 **(a)**

The two condensers with K and with air are in parallel

With air, $C_1 = \frac{\varepsilon_0}{d}\left(\frac{3A}{4}\right) = \frac{3\varepsilon_0 A}{4d}$

With medium, $C_2 = \frac{\varepsilon_0 K}{d}\left(\frac{A}{4}\right) = \frac{\varepsilon_0 AK}{4d}$

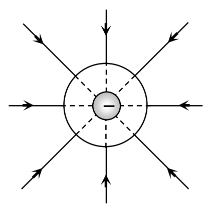
$\therefore C' = C_1 + C_2$

$\Rightarrow C' = \frac{3\varepsilon_0 A}{4d} + \frac{\varepsilon_0 AK}{4d} = \frac{\varepsilon_0 A}{4}\left[\frac{3}{4}+\frac{K}{4}\right] = \frac{C}{4}(K+3)$

$\Rightarrow C' = \frac{C}{4}(K+3)$

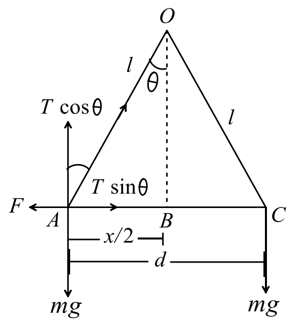
656 **(c)**

Electric line force due to negative charge are radially inward



657 **(a)**

$T\sin\theta = F = \frac{q^2}{4\pi\varepsilon_0 d^2}$



$$T\cos\theta = mg$$

$$\tan\theta = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{x^2mg}$$

$$\frac{x}{2l} = \frac{1.q^2}{4\pi\varepsilon_0 x^2 mg}$$

or $\frac{x}{2l} \propto \frac{q^2}{x^2}$, or $q^2 \propto x^3 \Rightarrow q \propto x^{\frac{3}{2}}$

$$\frac{dq}{dt} \propto \frac{3}{2}x^{\frac{1}{2}}\frac{dx}{dt}$$

$$v \propto x^{\frac{1}{2}} \qquad \left[\frac{dq}{dt} = cons.\right]$$

658 **(b)**

$$K = \frac{t}{t-d'} = \frac{4\times10^{-3}}{4\times10^{-3} - 3.5\times10^{-3}} = 8$$

659 **(a)**

By the concept of electrical image, it is considered that an equal but opposite charge present on the other side of the plate at equal distance. Hence force

$$F = \frac{40\times40}{4^2} = 100\ dynes$$

660 **(a)**

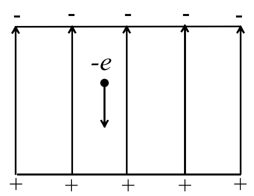
$$F = QE = \frac{QV}{d} \Rightarrow 5000\ \frac{5\times V}{10^{-2}} \Rightarrow V = 10\ volt$$

661 **(d)**

$V = \frac{p\cos\theta}{r^2}$ If $\theta = 0^o$ then $V_a = \max$

If $\theta = 180^o$ then $V_e = \min$

663 **(d)**



As the field is upward, so the negatively charged electron experiences a downward force of the magnitude of eE where E is the magnitude of the electric field.

The acceleration of the electron is $a_e = \frac{eE}{m_e}$

Where, m_e is the mass of the electron

Starting from rest, the time taken by the electron to fall through a distance h is given by

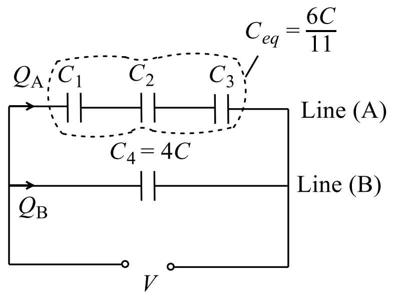
$$t_e = \sqrt{\frac{2h}{a_e}} = \sqrt{\frac{2hm_e}{eE}}$$

$$= \sqrt{\frac{2\times1.5\times10^{-2}\times9.1\times10^{-31}}{1.6\times10^{-19}\times2\times10^4}}$$

$$= 2.9\times10^{-9}s$$

664 **(b)**

The given circuit can be redrawn as follow



$$C_{eq} = \frac{C_1C_2C_3}{C_1C_2 + C_2C_3 + C_3C_1} = \frac{6C}{11}$$

$$\frac{Q_A}{Q_B} = \frac{C_A}{C_B} = \frac{6C/11}{4C} = \frac{3}{22}$$

665 **(c)**

$$C_{PR} = \frac{C}{2} + \frac{C}{3} = \frac{5C}{6}$$

$$C_{PQ} = C + \frac{C}{4} = \frac{5C}{4} \Rightarrow \frac{C_1}{C_2} = \frac{2}{3}$$

666 **(b)**

$$QE = mg \Rightarrow Q = \frac{mg}{E} = \frac{5\times10^{-5}\times10}{10^7}$$

$$= 5\times10^{-5}\mu C$$

Since electric field is acting downward so for balance charge must be negative

667 **(d)**

Torque, $\tau = pE\sin\theta$

or $\qquad p = \frac{\tau}{E\sin\theta}$

Potential energy, $U = pE\ cos\ \theta$

$$= \frac{\tau}{E\sin\theta}.E\cos\theta$$

$$= \frac{\tau}{E\sin\theta} = \frac{10\sqrt{2}}{10^4\tan 30°}$$

$$= 24.5\times10^{-4}J$$

668 **(c)**

Using $C = n^{1/3}c \Rightarrow c = \frac{C}{n^{1/3}} = \frac{C}{(8)^{1/3}} = \frac{C}{2} = \frac{1}{2}\mu F$

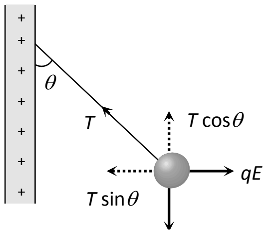
669 **(b)**

$T\sin\theta = qE$

And $T\cos\theta = mg$

$\Rightarrow \tan\theta = \frac{qE}{mg} = \frac{q}{mg}\left(\frac{\sigma}{2\varepsilon_0}\right)$

$\Rightarrow \sigma \propto \tan\theta$



670 **(b)**

$W = q.\Delta V$

$= q(V_{surface} - V_{centre})$

$= q \times \left(\frac{1}{4\pi\varepsilon_0} \times \frac{Q}{R} - \frac{1}{4\pi\varepsilon_0} \times \frac{Q}{R}\right) = 0$

671 **(d)**

If the charges are arranged according to the option (d), the electric fields due to P and S and due to Q and T add to zero, while due to U and R will be added up

672 **(a)**

Since $W = qV \Rightarrow 20 = 5 \times V \Rightarrow V = 2\ volts$

673 **(a)**

$V = \frac{kq}{R}\ i.e. V \propto \frac{1}{R}$

∴ Potential on smaller sphere will be more

674 **(a)**

Potential energy of the system

$U = k\frac{Qq}{l} + \frac{kq^2}{l} + \frac{kqQ}{l} = 0$

$\Rightarrow \frac{kq}{l}(Q + q + Q) = 0 \Rightarrow Q = -\frac{q}{2}$

676 **(d)**

Momentum $p = \sqrt{2mk}$; where K = kinetic energy $= Q.V$

$\Rightarrow p = \sqrt{2mQV} \Rightarrow p \propto \sqrt{mQ} \Rightarrow \frac{p_e}{p_\alpha} = \sqrt{\frac{m_e Q_e}{m_\alpha Q_\alpha}}$

$= \sqrt{\frac{m_e}{2m_\alpha}}$

677 **(b)**

After initial contact and separation, each sphere will be having $-2\mu C$ each

$\therefore n = \frac{-2 \times 10^{-6}}{-1.6 \times 10^{-19}} = 1.25 \times 10^{13}$

$i.e.$ 1.25×10^{13} electrons in excess

678 **(d)**

If r is the distance between q and $(Q - q)$, the Coulomb force between them is

$F = \frac{1}{4\pi\varepsilon_0}.\frac{q(Q-q)}{r^2}$

$= \frac{1}{4\pi\varepsilon_0}.\frac{(qQ-q^2)}{r^2}$

For F to be maximum dF/dq=0 and Q and r are constants,

ie $\quad \frac{d}{dq}\left[\frac{1}{4\pi\varepsilon_0}(qQ - q^2)\right] = 0$

$i.e, \quad Q - 2_q = 0 \qquad \left(\text{as} \frac{1}{4\pi\varepsilon_0} \neq 0\right)$

or $\quad \frac{q}{Q} = \frac{1}{2}$

$\Rightarrow \quad q = \frac{Q}{2}$

679 **(d)**

By using $C_{air} = \frac{\varepsilon_0 A}{d}, C_{medium} = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}}$

For $K = \infty$ $C_{medium} = \frac{\varepsilon_0 A}{d-t}$

$\Rightarrow \frac{C_m}{C_a} = \frac{d}{d-t} \Rightarrow \frac{C_m}{15} = \frac{6}{6-3} \Rightarrow C_m = 30\mu\, C$

680 **(a)**

Potential difference across the condenser

$V = V_1 + V_2 = E_1 t_1 + E_2 t_2 = \frac{\sigma}{K_1\varepsilon_0}t_1 + \frac{\sigma}{K_2\varepsilon_0}t_2$

$\Rightarrow V = \frac{\sigma}{\varepsilon_0}\left(\frac{t_1}{K_1} + \frac{t_2}{K_2}\right) = \frac{Q}{A\varepsilon_0}\left(\frac{t_1}{K_1} + \frac{t_2}{K_2}\right)$

681 **(a)**

In air the potential difference between the plates

$V_{air} = \frac{\sigma}{\varepsilon_0}.d$ ...(i)

In the presence of partially filled medium potential difference between the plates

$V_m = \frac{\sigma}{\varepsilon_0}(d - t + \frac{t}{K}$ ...(ii)

Potential difference between the plates with dielectric medium and increased distance is

$V_m' = \frac{\sigma}{\varepsilon_0}\left\{(d + d') - t + \frac{t}{K}\right\}$ ...(iii)

According to question $V_{air} = V_m{}'$ which gives $K = \frac{t}{t-d'}$

Hence $K = \frac{2}{2-1.6} = 5$

683 **(c)**

Potential energy as well as force are positive if there is repulsion between the particles and negative if there is attraction.

We take of only the magnitude of values when discussing decrease or increase of energy.

As $\text{P. E.} = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r}$,

Plus or minus, i.e., whether both are of the same sign or different, if r decreases, the value increase, Therefore (c) is wrong

684 **(b)**

In series $V' = nV = 10\ V$

685 **(d)**

Force exerted by an electric dipole on a charge is inversely proportional to the cube of distance of the charge from the centre of the dipole

$$F \propto \frac{1}{r^3}$$

$$\therefore \frac{F}{F'} = \left(\frac{r'}{r}\right)^3$$

$$\frac{F}{F'} = \left(\frac{2}{1}\right)^3$$

$$F' = \frac{F}{8}$$

686 **(c)**

$$a = \frac{qE}{m} \Rightarrow \frac{a_e}{a_p} = \frac{m_p}{m_e}$$

687 **(b)**

$$\phi_{net} = \frac{1}{\varepsilon_0} \times Q_{enc} \Rightarrow Q_{enc} = (\phi_2 - \phi_1)\varepsilon_0$$

688 **(a)**

As the dipole will feel two forces which are although opposite but not equal.

$\therefore$ A net force will be there and as these forces act at different points of a body. A torque is also present

689 **(a)**

Electrical force per unit area

$$= \frac{1}{2}\varepsilon_0 E^2$$

$$= \frac{1}{2}\varepsilon_0 \left(\frac{\sigma}{\varepsilon_0}\right)^2 = \frac{\sigma^2}{2\varepsilon_0}$$

Projected area $= \pi R^2$

$\therefore$ Net electrical force

$$= \left(\frac{\sigma^2}{2\varepsilon_0}\right)(\pi R^2)$$

In equilibrium, this force should be equal to the applied force.

$$\therefore \quad F = \frac{\pi\sigma^2 R^2}{2\varepsilon_0}$$

Or $F \propto \frac{\sigma^2 R^2}{\varepsilon_0}$

690 **(d)**

In steady state current flows through 4Ω resistance only and it is $i = \frac{10}{(4+1)} = 2amp$.

Potential difference across 4Ω resistance is $V = 2 \times 4 = 8\ volt$

Hence, potential difference across each capacitor is $4V$

So charge on each capacitor $Q = 3 \times 4 = 12\mu C$

691 **(d)**

After inserting the dielectric slab

New capacitance $C' = K.C = \frac{K\varepsilon_0 A}{d}$

New potential difference $V' = \frac{V}{K}$

New charge $Q' = C'V' = \frac{\varepsilon_0 AV}{d}$

New electric field $E' = \frac{V'}{d} = \frac{V}{Kd}$

Work done (W) = Final energy – Initial energy

$$W = \frac{1}{2}C'V'^2 - \frac{1}{2}CV^2 = \frac{1}{2}(KC)\left(\frac{V}{K}\right)^2 - \frac{1}{2}CV^2$$

$$= \frac{1}{2}CV^2\left(\frac{1}{K} - 1\right) = -\frac{1}{2}CV^2\left(1 - \frac{1}{K}\right)$$

$$= -\frac{\varepsilon_0 AV^2}{2d}\left(1 - \frac{1}{K}\right) \text{ so } |W| = \frac{\varepsilon_0 AV^2}{2d}\left(1 - \frac{1}{K}\right)$$

692 **(c)**

We know that $m = 9.11 \times 10^{-31}$ kg and $M = 75.0$kg

So, $N = \frac{M}{m} = \frac{75.0}{9.11 \times 10^{-31}}$

$= 8.23 \times 10^{31}$ electrons

Hence, total charge on the collection is

$$q = -Ne$$

$$= -(8.23 \times 10^{31})(1.60 \times 10^{-19})$$

$$= -1.32 \times 10^{13}\ \text{C}$$

693 **(b)**

Here, $F_1 = \frac{k(+10)(-20)}{R^2} = \frac{-k\times 200}{R^2}$

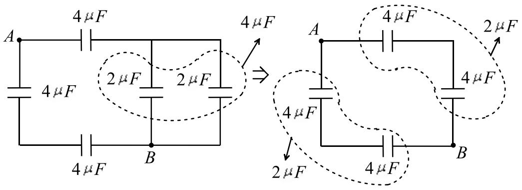
As spheres are of equal radius, their capacities are same. On touching, the net charge $+10 - 20 = -10\ \mu C$ is shared equally between them *ie*, each sphere carries $-5\ \mu C$ charge.

$F_2 = \frac{k(-5)(-5)}{R^2} = \frac{k\times 25}{R^2}$

$\therefore \frac{F_1}{F_2} = \frac{-8}{1}$

694 **(c)**

The given circuit can be simplified as follows



Equivalent capacitance between A and B is $C_{AB} = 4\ \mu F$

695 **(d)**

For discharging of an RC circuit,

$V = V_0 e^{-t/\tau}$

So, when $V = \frac{V_0}{2}$

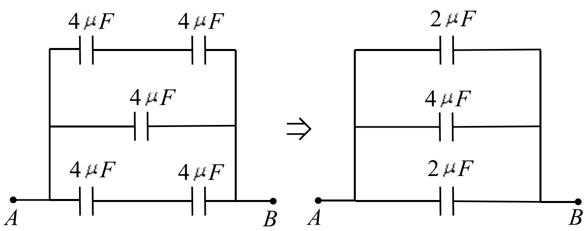
$\frac{V_0}{2} = V_0 e^{-t/\tau}$

$\ell n \frac{1}{2} = -\frac{t}{\tau} \Rightarrow \tau = \frac{1}{\ell n 2}$

From graph when $V = \frac{V_0}{2}, t = 100 s$

$\therefore \tau = \frac{100}{\ell n 2} = 144.3$ sec

696 **(a)**



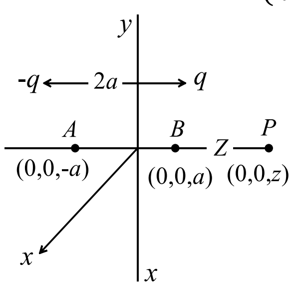
$\Rightarrow C_{AB} = 8\ \mu F$

697 **(c)**

S.I. unit of electric flux is $\frac{N\times m^2}{C} = \frac{J\times m}{C} = volt \times m$

698 **(c)**

Potential at P due to $(+q)$ charge



$$V_1 = \frac{1}{4\pi\varepsilon_0}.\frac{q}{(z-a)}$$

Potential at P due to $(-q)$ charge

$$V_2 = \frac{1}{4\pi\varepsilon_0}.\frac{-q}{(z+a)}$$

Total potential at P due (AB) electric dipole

$V = V_1 + V_2$

$$= \frac{1}{4\pi\varepsilon_0}.\frac{q}{(z-a)} - \frac{1}{4\pi\varepsilon_0}\frac{q}{(z+a)} = \frac{2qa}{4\pi\varepsilon_0(z^2-a^2)}$$

699 **(c)**

By using $W = Q.\Delta V \Rightarrow \Delta V = \frac{2}{20} = 0.1\ volt$

700 **(d)**

Work done in rotating an electric dipole in an uniform electric field (E) through an angle θ from the direction of field is

$W = pE(1 - \cos\theta)$

Where p is electric dipole moment.

If the dipole is to be rotated to be and anti-parallel to the field (θ − 180°), then

$W = pE(1 - \cos 180°)$

$= pE[1 - (-1)] = 2pE$

701 **(d)**

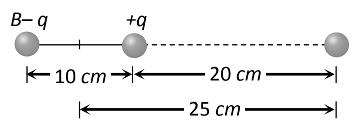
The flux passing through the square of 1 m placed in xy plane inside the electric field is zero because by Gauss theorem we can say have closed circuit not formed.

702 **(b)**

$E = \frac{f}{q} = \frac{mg}{q} = \frac{3.2\times10^{-27}\times9.8}{1.6\times10^{-19}}$

$= 19.6 \times 10^{-8}\ NC^{-1}$

703 **(a)**



By using $E = 9\times10^9.\frac{2pr}{(r^2-l^2)^2}$; where

$p = (500\times10^{-6})\times(10\times10^{-2})$

$= 5\times10^{-5} c\times m,$

$r = 25\ cm = 0.25\ m, l = 5\ cm = 0.05\ m$

$$E = \frac{9\times10^9\times2\times5\times10^{-5}\times0.25}{\{(0.25)^2-(0.05)^2\}^2}$$

$= 6.25\times10^7 N/C$

704 **(a)**

Initial energy of body of capacitance 4 μF is

$U_i = \frac{1}{2} \times (4 \times 10^{-6})(80)^2 = 0.0128J$

Final potential on this body after connection is $V = \frac{4\times80+6\times30}{4+6} = 50V$. So final energy on it

$U_f = \frac{1}{2} \times 4 \times 10^{-6}(50)^2 = 0.005\,J$

Energy lost by this body $= U_i - U_f = 7.8\,mJ$

705 **(b)**

$$E = \frac{1}{4\pi\varepsilon_0} . \frac{q}{r^2}$$

706 **(d)**

$$V_x = \frac{20}{x^2 - 4}$$

$$E = \frac{-dV}{dx} = \frac{20}{(x^2-4)^2}(2x - 0) = \frac{160}{144} = \frac{10}{9}$$

707 **(a)**

Force on one plate due to another is

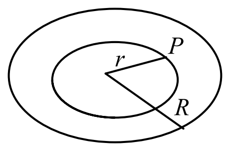
$$F = qE = q \times \frac{\sigma}{2\varepsilon_0 K} = q\left(\frac{q}{2AK\varepsilon_0}\right) = \frac{q^2}{2AK\varepsilon_0}$$

[where $\frac{\sigma}{2\varepsilon_0 K}$ is the electric field produced by one plate at the location of other]

708 **(c)**

$$E \times 4\pi r_1^2 = \frac{\int_0^{r_1} \frac{Q}{\pi R^4} r 4\pi r^2 dr}{\varepsilon_0}$$

$$\Rightarrow E = \frac{Qr_1^2}{4\pi\varepsilon_0 R^4}$$

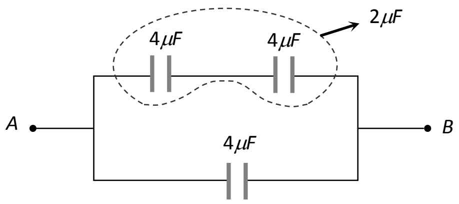


709 **(c)**

$$E = \frac{1}{4\pi\varepsilon_0} . \frac{Qr}{R^3} \Rightarrow E \propto \frac{1}{R^3}$$

710 **(b)**

The given circuit can be drawn as follows



$\Rightarrow C_{AB} = 2 + 4 = 6\mu F$

711 **(b)**

$$V = \frac{Q}{C} = \frac{Qd}{\varepsilon_0 KA} \Rightarrow V \propto d$$

712 **(c)**

Electric field outside of the sphere $E_{out} = \frac{kQ}{r^2}$ …(i)

Electric field inside the dielectric sphere $E_{in} = \frac{kQx}{R^3}$ …(ii)

From (i) and (ii), $E_{in} = E_{out} \times \frac{r^2 x}{R^3}$

$$\Rightarrow \text{At } 3\,cm, E = 100 \times \frac{3(20)^2}{10^3} = 120V/m$$

713 **(d)**

Loss of energy $= \frac{1}{2}\frac{C_1 C_2}{(C_1+C_2)}(V_1 - V_2)^2$

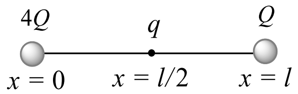
$$\frac{1}{2}\frac{5 \times 5 \times 10^{-12}}{(5+5) \times 10^{-6}}(2000 - 1000)^2$$

$$= \frac{5 \times 5 \times 1}{2 \times 10} = \frac{5}{4} = 1.25\,J$$

714 **(d)**

The total force on Q

$$\frac{Qq}{4\pi\varepsilon_0 \left(\frac{l}{2}\right)^2} + \frac{4Q^2}{4\pi\varepsilon_0 l^2} = 0$$

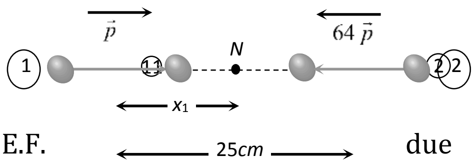


$$\frac{Qq}{4\pi\varepsilon_0 \left(\frac{l}{2}\right)^2} = -\frac{4Q^2}{4\pi\varepsilon_0 l^2} \Rightarrow q = -Q$$

715 **(a)**

Suppose neutral point N lies at a distance x from dipole of moment p or at a distance (25-x) from dipole of 64 p

At N |E.F. due to dipole | =|E.F. due to dipole |



$$\Rightarrow \frac{1}{4\pi\varepsilon_0} . \frac{2p}{x^3} = \frac{1}{4\pi\varepsilon_0} . \frac{2(64p)}{(25-x)^3}$$

$$\Rightarrow \frac{1}{x^3} = \frac{64}{(25-x)^3} \Rightarrow x = 5\,cm$$

717 **(c)**

Electric flux, $\phi = \mathbf{E}.\mathbf{S}$

Or $\phi = ES\cos\theta$

Here, θ is the angle between **E** and **S**. In this question$\theta = 45°$, because **S** is perpendicular to surface.

$E = E_0$

$S = (\sqrt{2a})(a) = \sqrt{2a^2}$

$\therefore \phi = (E_0)\left(\sqrt{2a^2}\right)\cos 45° = E_0 a^2$

$\therefore$ Correct option is (C).

718 **(d)**

Inside hollow sphere, $E = 0$. on the surface of hollow sphere, $E =$ maximum and outside the sphere, $E \propto 1/r^2$. this is shown in figure (d).

719 **(c)**

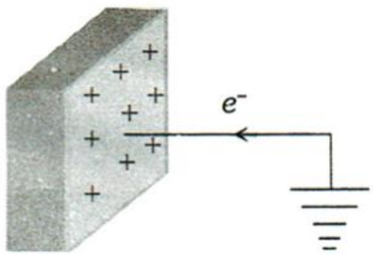
Initially charge on the capacitor $Q = 10 \times 12 = 120\mu C$

Finally charge on the capacitor $Q' = (5 \times 10) \times 12 = 600\mu C$

So charge supplied by the battery later $= Q' - Q = 480\mu C$

720 **(b)**

When a positively charged body connected to earth, electrons flows from each to body and body becomes neutral



722 **(d)**

If the charge of an electron is taken as elementary unit *ie*, quanta of charge, the charge on anybody will be some integral multiple of e *ie*, $q = n\,e$ with $n = 1,2,3 \ldots$

723 **(d)**

Electric field due to a charged conducting sheet of surface charge density σ is given by

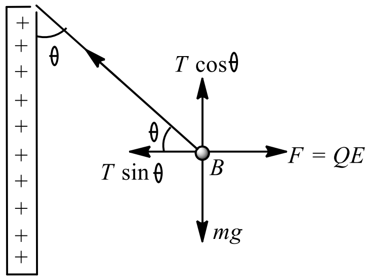
$$E = \frac{\sigma}{\varepsilon_0 \varepsilon_r}$$

Where, ε_0=permittivity in vacuum and $\varepsilon_r$relative permittivity of medium.

Here, electrostatics force on B

$$QE = \frac{Q\sigma}{\varepsilon_0 \varepsilon_r}$$

FBD of B is shown in figure.



In equilibrium, $T\cos\theta = mg$

And $\qquad T\sin\theta = \frac{Q\sigma}{\varepsilon_0\varepsilon_r}$

Thus, $\quad \tan\theta = \frac{Q\sigma}{\varepsilon_0\varepsilon_r mg}$

$\therefore \quad \tan\theta \propto \sigma$

or $\quad \sigma \propto \tan\theta$

726 **(c)**

$$C = \frac{\varepsilon_0 A}{\left(\frac{t_1}{k_1} + \frac{t_2}{k_2}\right)} = \frac{\varepsilon_0 A}{\frac{6\times10^{-3}}{10} + \frac{4\times10^{-3}}{5}} = \frac{5000}{7}\varepsilon_0 A$$

727 **(c)**

For spherical conductor

$C = 4\pi\varepsilon_0 R$

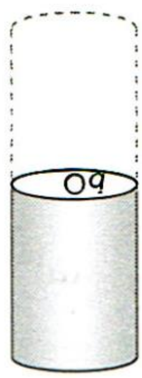
$\because V = \frac{4}{3}\pi R^3 \;\&\; A = 4\pi R^2$

$\because R = \frac{3V}{A}$

$\therefore C = 12\pi\varepsilon_0 \frac{V}{A}$

728 **(c)**

To apply Gauss's theorem it is essential that charge should be placed inside a closed surface. So imagine another similar cylindrical vessel above it as shown in figure (dotted)



729 **(c)**

$$F_{net} = F_{AC} + F_D = \sqrt{F_A^2 + F_C^2} + F_D$$

Since $F_A = F_C = \frac{kq^2}{a^2}$ and $F_D = \frac{kq^2}{(a\sqrt{2})^2}$

$$F_{net} = \frac{\sqrt{2}kq^2}{a^2} + \frac{kq^2}{2a^2} = \frac{kq^2}{a^2}\left(\sqrt{2} + \frac{1}{2}\right)$$

$$= \frac{q^2}{4\pi\varepsilon_0 a^2}\left(\frac{1+2\sqrt{2}}{2}\right)$$

730 **(d)**

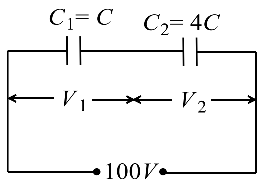
By using

$Q = nq \Rightarrow Q = 64\,q$

731 **(b)**

$$C_{eq} = \frac{C \times 4C}{(C + 4C)} = \frac{4C}{5}$$

$$Q = C_{eq}.V = \frac{4C}{5} \times 100 = 80C$$

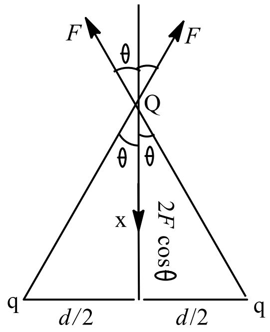


Hence $V_1 = \frac{Q}{C_1} = \frac{80C}{C} = 80V$

and $V_2 = \frac{80C}{4C} = 20V$

732 **(c)**

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$



Taking the net force, we have

$$F_{\text{net}} = 2F\cos\theta = 2\left[\frac{1}{4\pi\varepsilon_0}\frac{Qqx}{\left(x^2 + \frac{d^2}{4}\right)^{\frac{3}{2}}}\right]$$

For maximum, $\frac{dF_{\text{net}}}{dx} = 0$

$$\therefore \left(x^2 + \frac{d^2}{4}\right)^{3/2} - \frac{3}{2}x\left[x^2 + \frac{d^2}{4}\right]^{1/2}(2x) = 0$$

$$\therefore \left(x^2 + \frac{d^2}{4}\right)^{\frac{1}{2}}\left(x^2 + \frac{d^2}{4} - 3x^2\right) = 0$$

or $\quad 2x^2 = \frac{d^2}{4}$

$$x = \frac{d}{2\sqrt{2}}$$

734 **(b)**

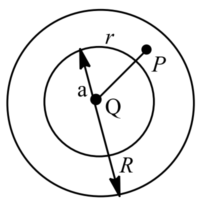
Capacitance of a parallel plate capacitor $C = \frac{\varepsilon_0 A}{d}$

$\because$ Potential difference $= \frac{\text{Charge}}{\text{Capacitance}}$

$\therefore$ Potential difference increases

736 **(b)**

The solid conductor with a cavity is shown in figure.



The inner surface of cavity will be $-Q$due to induction. At outer surface, the charge will be $+Q$ and at a point between$P$ at a position $r(a < r < R)$ will be zero

737 **(c)**

Kinetic energy = Force × Displacement = qEy

738 **(b)**

Potential energy of electric dipole

$U = -pE\cos\theta = -(q \times 2)E\cos\theta$

$U = -(3.2 \times 10^{-19} \times 2.4 \times 10^{-10})4 \times 10^5 \cos\theta$

$U = -3 \times 10^{-23}$ (approx.)

739 **(c)**

In the given condition angle between $\vec{p}$ and $\vec{E}$ is zero.

Hence potential energy $U = -pE\cos 0 = -pE =$ min

Also in uniform electric field $F_{net} = 0$

741 **(a)**

Total electric flux through enclosed surface

$$\phi = \frac{q}{\varepsilon_0}\left(\frac{-q}{\varepsilon_0}\right) = 0$$

742 **(b)**

On rubbing glass rod with silk, excess electron transferred from glass to silk. So glass rod becomes positive and silk becomes negative

743 **(d)**

From Coulomb's law the force (F) between two charges is

$$F = \frac{1}{4\pi\varepsilon_0 k}\frac{q^2}{r^2}$$

First case $k = 1$

$$F = \frac{1}{4\pi\varepsilon_0}.\frac{q^2}{r^2} \quad \text{....(i)}$$

Second case $k = 4$

$$F' = \frac{1}{4\pi\varepsilon_0 \times 4}\frac{q^2}{r^2} \quad \text{...(ii)}$$

$$\Rightarrow \frac{F}{F'} = 4$$

$$F' = \frac{F}{4}$$

744 **(c)**

$E_1 = E_2 = \frac{q\times 1}{4\pi\varepsilon_0 a^2}$, acting at 60^0.

∴ Resultant intensity

$$E = \sqrt{E_1^2 + E_2^2 + 2E_1E_2\cos\theta}$$

$$= \sqrt{E_1^2 + E_1^2 + 2E_1^2\cos 60^0}$$

$$= E_1\sqrt{3} = \frac{q\sqrt{3}}{4\pi\varepsilon_0 a^2}$$

745 **(a)**

The intensity of electric field inside a hollow conducting sphere is zero

746 **(a)**

Maximum potential difference

$$= 19\frac{kV}{mm} \times 0.01mm = 0.19kV = 190V$$

747 **(a)**

The electric potential $V(x, y, z) = 4x^2 volt$

Now $\vec{E} = -\left(\hat{\imath}\frac{\partial V}{\partial x} + \hat{\jmath}\frac{\partial V}{\partial y} + \hat{k}\frac{\partial V}{\partial z}\right)$

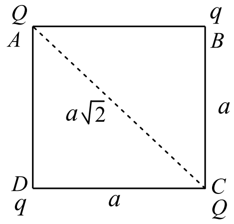
Now $\frac{\partial V}{\partial x} = 8x, \frac{\partial V}{\partial y} = 0$ and $\frac{\partial V}{\partial z} = 0$

Hence $\vec{E} = -8x\hat{\imath}$, so at point $(1m, 0, 2m)$

$E = -8\hat{\imath}\ volt/metre$ or 8 along negative X-axis

748 **(a)**

It is given that $\overrightarrow{F_A} + \overrightarrow{F_B} + \overrightarrow{F_D} = 0$ where $\overrightarrow{F_A}, \overrightarrow{F_B}$ and $\overrightarrow{F_D}$ are the forces applied by charges placed at A, B and D on the charge placed at C



$\Rightarrow \overrightarrow{F_B} + \overrightarrow{F_D} = -\overrightarrow{F_A}$

$\left|\overrightarrow{F_B} + \overrightarrow{F_D}\right| = \sqrt{2}\frac{kqQ}{a^2}$ &

$\left|\overrightarrow{F_A}\right| = \frac{kQ^2}{2a^2}$

$\therefore \sqrt{2}\frac{kqQ}{a^2} = \frac{kQ^2}{2a^2} \Rightarrow \frac{Q}{q} = -2\sqrt{2}$

750 **(a)**

By using $W = Q(\vec{E}.\Delta\vec{r})$

$\Rightarrow W = Q\left[\left(e_1\hat{\imath} + e_2\hat{\jmath} + e_3\hat{k}\right).(a\hat{\imath} + b\hat{\jmath})\right]$

$= Q(e_1 a + e_2 b)$

751 **(d)**

$C_{air} = \frac{\varepsilon_0 A}{d}$, with dielectric slab $C' = \frac{\varepsilon_0 A}{\left(d - t + \frac{t}{K}\right)}$

Given $C' = \frac{4}{3}C \Rightarrow \frac{\varepsilon_0 A}{\left(d-t+\frac{t}{K}\right)} = \frac{4}{3} \times \frac{\varepsilon_0 A}{d}$

$\Rightarrow K = \frac{4t}{4t - d} = \frac{4(d/2)}{4[(d/2) - d]} = 2$

752 **(c)**

$Q_1 = Q_2 + Q_3$ because in series combination charge is same on both condenser and $V = V_1 + V_2$ because in parallel combination $V_2 = V_3$

Hence $V = V_1 + V_2$

753 **(b)**

By using $\frac{1}{2}mv^2 = QV$

$\Rightarrow \frac{1}{2} \times 2 \times 10^{-3} \times (10)^2 = 2 \times 10^{-6}V \Rightarrow V$

$= 50\ kV$

754 **(d)**

When $\frac{Q_1}{R_1} \neq \frac{Q_2}{R_2}$; current will flow in connecting wire so that energy decreases in the form of heat through the connecting wire

755 **(a)**

When the two conducting spheres are connected by a conducting wire, charge will flow from one sphere (having higher potential) to other (having lower potential) till both acquire the same potential.

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$$

So,

$$\frac{E_1}{E_2} = \left(\frac{r_2}{r_1}\right)^2 = 4:1$$

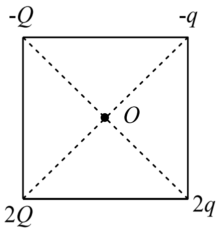
756 **(d)**

Dipole moment $p = 4 \times 10^{-8} \times 2 \times 10^{-4} = 8 \times 10^{-12} m$

Maximum torque $= pE = 8 \times 10^{-12} \times 4 \times 10^8$
$= 32 \times 10^{-4} Nm$

Work done in rotating through $180^o = 2pE$
$= 2 \times 32 \times 10^{-4} = 64 \times 10^{-4} J$

757 **(a)**



Let the side length of square be $''a''$ then potential at centre O is

$$V = \frac{K(-Q)}{\left(\frac{a}{\sqrt{2}}\right)} + \frac{k(-q)}{\frac{a}{\sqrt{2}}} + \frac{k(2q)}{\frac{a}{\sqrt{2}}} + \frac{k(2Q)}{\frac{a}{\sqrt{2}}} = 0$$

$= -Q - q + 2q + 2Q = 0 \Rightarrow Q + q = 0 \Rightarrow Q = -q$

758 **(d)**

$$C_{PQ} = \frac{1}{3}\mu F + 1\mu F = \frac{4}{3}\mu F$$

759 **(a)**

Parallel plate capacitor

$C = K\varepsilon_0 A/d$

As given in fig., for series combination

$$\frac{1}{C'} = \frac{1}{\frac{\varepsilon_0 A}{\frac{d}{2}}} + \frac{1}{\frac{2\varepsilon_0 A}{\frac{d}{2}}} \Rightarrow C = \frac{4}{3}\frac{\varepsilon_0 A}{d}$$

761 **(c)**

When the dipole is rotated through at an angle of 90^o about it's perpendicular axis then given point comes out to be on equator. So field will become $E/2$ at the given point

762 **(c)**

In balance condition $QE = mg = \left(\frac{4}{3}\pi r^3 \rho\right) g$

$$\Rightarrow E = \frac{4 \times (3.14)(0.1 \times 10^{-6})^3 \times 10^3 \times 10}{3 \times 1.6 \times 10^{-19}}$$
$$= 262 N/C$$

763 **(b)**

Total capacitance of given system $C_{eq} = \frac{8}{5}\mu F$

$$U = \frac{1}{2}C_{eq}V^2 = \frac{1}{2} \times \frac{8}{5} \times 10^{-6} \times 225$$
$$= 180 \times 10^{-6} J$$

$= 180 \times 10^{-6} \times 10^7 erg = 1800\ erg$

764 **(d)**

$$\tau_1 = RC\left(\frac{1 \times 2}{1+2}\right) \times \left(\frac{2 \times 4}{2+4}\right) = \frac{2}{3} \times \frac{8}{6} = 8/9\ \mu s$$

$\tau_2 = RC = (1+2)(2+4) = 3 \times 6 = 18\ \mu s$

$$\tau_3 = \left(\frac{1 \times 2}{1+2}\right)(2+4) = \frac{2}{3} \times 6 = 4\ \mu s$$

765 **(a)**

Metal plate acts as an equipotential surface, therefore the field lines should enter normal to the surface of the metal plate

766 **(d)**

Conducting surface behaves as equipotential surface

767 **(d)**

At mid point, $E = 0$

Before mid point, E is positive. This is maximum near the charge and decreases towards mid point

After mid point, E is negative. The curve crosses x-axis at x-axis at $x = d/2$. From centre to end, E decreases

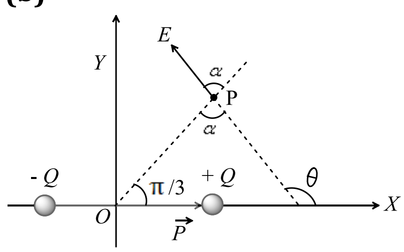
The variation is shown by curve d

768 **(a)**

$$V = n^{2/3}v \Rightarrow V = (64)^{2/3} \times 9 \times 10^9 \times \frac{10^{-9}}{(2 \times 10^{-2})}$$

$= 7.2 \times 10^3\ V$

769 **(b)**



$\theta = \frac{\pi}{3} + \alpha$ where $\tan\alpha = \frac{1}{2}\tan\frac{\pi}{3}$

$\Rightarrow \alpha = \tan^{-1}\sqrt{3}/2$ so, $\theta = \frac{\pi}{3} + \tan^{-1}\sqrt{3}/2$

770 **(a)**

From the given figure, total capacitance is

$$\frac{1}{1} = \frac{1}{C} + \frac{1}{(1+2.5)} \Rightarrow 1 = \frac{1}{C} + \frac{1}{3.5} \Rightarrow C = \frac{3.5}{2.5}$$
$$= 1.4\ \mu F$$

771 **(c)**

$C = \frac{\varepsilon_0 A}{d}$ and $C' = \frac{\varepsilon_0 A}{\left(d-t+\frac{t}{K}\right)} \Rightarrow \frac{C}{C'} = \frac{\left(d-t+\frac{t}{K}\right)}{d}$

$$\Rightarrow \frac{20}{C'} = \frac{\left(2 \times 10^{-3} - 1 \times 10^{-3} + \frac{1\times10^{-3}}{2}\right)}{2 \times 10^{-3}} \Rightarrow C'$$

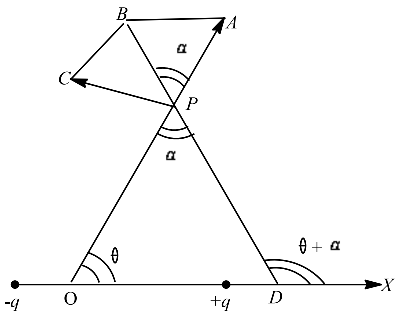
$$= 26.6\mu F$$

772 **(b)**

Some energy lost in the form of heat in resistance also

773 **(b)**

On producing the rays backwards, we get $\angle PDX = (\theta + \alpha)$ is required angle.



775 **(d)**

$q_1 + q_2 = Q$ and $\frac{q_1}{4\pi r^2} = \frac{q_2}{4\pi R^2}$ [Given]

$q_1 = \frac{Qr^2}{R^2+r^2}$ and $q_2 = \frac{QR^2}{R^2+r^2}$

Potential at common centre

$$\frac{1}{4\pi\varepsilon_0}\left(\frac{Qr^2}{(R^2+r^2)r} + \frac{QR^2}{(R^2+r^2)R}\right)$$

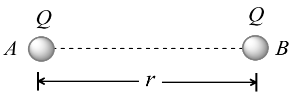
$$= \frac{Q(R+r)}{4\pi\varepsilon_0(R^2+r^2)}$$

776 **(b)**

$$C = \frac{(C_1+C_2)\times C_3}{(C_1+C_2)+C_3} = \frac{(5+10)\times 4}{5+10+4} = \frac{60}{19} = 3.2\mu F$$

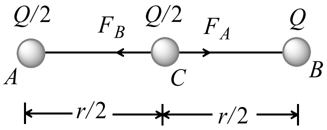
777 **(a)**

Initially



$F = k\frac{Q^2}{r^2}$ ...(i)

Finally



Force on C due to $A, F_A = \frac{k(Q/2)^2}{(r/2)^2} = \frac{kQ^2}{r^2}$

Force on C due to $B, F_B = \frac{KQ(Q/2)}{(r/2)^2} = \frac{2kQ^2}{r^2}$

$\therefore$ Net force on $C, F_{net} = F_B - F_A = \frac{kQ^2}{r^2}$

778 **(c)**

Potential at $C = \left(9 \times 10^9 \times \frac{4\times10^{-6}}{0.2}\right) \times 2 = 36 \times 10^4\ V$

779 **(c)**

$V = Q/C$

$Q =$ the amount of charge

$C =$ capacitance which depends on geometry and size of conductor

780 **(c)**

The total positive charge on the inner solid sphere

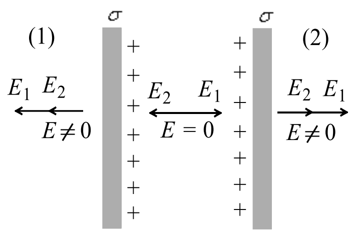
$$\int_0^{R_1} 4\pi\, r^2\, dr\,.\frac{\rho_0}{r} = +4\pi\frac{R_1^2}{2}\rho_0$$

The total negative charge on the outer shell $= -4\pi R_2^2\sigma$. But both are equal in magnitude as the sum is zero.

$$\frac{R_2^2}{R_1^2} = \frac{\rho_0}{2\sigma} \quad \therefore \frac{R_2}{R_1} = \sqrt{\frac{\rho_0}{2\sigma}}$$

781 **(c)**

Electric field between sheets $E = \frac{1}{2\varepsilon_0}(\sigma - \sigma) = 0$



782 **(d)**

Electric field between the plates of parallel plate capacitor is uniform and it doesn't depend upon distance

783 **(a)**

Torque about Q of charge $-q$ is zero, so angular momentum charge $-q$ is constant, but distance between charges is changing, so force is changing, so speed and velocity are changing

784 **(c)**

At any point over the spherical Gaussian surface, net electric field is the vector sum of electric fields due to $+q_1, -q_1$ *and* q_2. Don't confuse with the electric flux which is zero (net) passing over the Gaussian surface as the net charge enclosing the surface is zero.

785 **(b)**

Potential inside the sphere will be same as that on its surface $i.e. V = V_{surface} = \frac{q}{10} stat\ volt, V_{out} = \frac{q}{15} stat\ volt$

$\therefore \frac{V_{out}}{V} = \frac{2}{3} \Rightarrow V_{out} = \frac{2}{3}V$

786 **(b)**

The charge flowing through C_4 is

$q_4 = C_4 \times V = 4CV$

The series combination of C_1, C_2 and C_3 given

$$\frac{1}{C'} = \frac{1}{C} + \frac{1}{2C} + \frac{1}{3C}$$

$$\frac{1}{C'} = \frac{6+3+2}{6C} = \frac{11}{6C} \Rightarrow C' = \frac{6C}{11}$$

Now, C' and C_4 form parallel combination giving

$$C'' = C' + C_4 = \frac{6C}{11} + 4C = \frac{50C}{11}$$

Net charge $q = C''V = \frac{50}{11}CV$

Total charge flowing through C_1, C_2, C_3 will be

$$q' = q - q_4 = \frac{50}{11}CV - 4CV = \frac{6CV}{11}$$

Since, C_1, C_2, C_3 are in series combination hence, charge flowing through these will be same

Hence, $q_2 = q_1 = q_3 = q' = \frac{6CV}{11}$

Thus, $\frac{q_2}{q_4} = \frac{6CV/11}{4CV} = \frac{3}{22}$

789 **(c)**

After redistribution new charges on spheres are

$$Q_1' = \left(\frac{10}{10+20}\right) \times 10 = \frac{10}{3}\mu C$$

And $Q_2' = \left(\frac{20}{10+20}\right) \times 10 = \frac{20}{3}\mu C$

Ratio of charge densities $\frac{\sigma_1}{\sigma_2} = \frac{Q_1'}{Q_2'} \times \frac{r_2^2}{r_1^2}$

$$= \frac{10/3}{20/3} \times \left(\frac{20}{10}\right)^2 = \frac{2}{1} \quad \left[\sigma = \frac{Q}{4\pi r^2}\right]$$

790 **(d)**

The charge inside the closed surface is given by

q=net electric flux pass through the surface $\times \varepsilon_0$

$q = (4 \times 10^3 - 8 \times 10^3)\varepsilon_0$

Therefore,

$q = -4 \times 10^3 \varepsilon_0 C$

791 **(b)**

$C_{medium} = K \times C_{air}$

792 **(b)**

For balance $mg = eE \Rightarrow E = \frac{mg}{e}$

Also $m = \frac{4}{3}\pi r^3 d = \frac{4}{3} \times \frac{22}{7} \times (10^{-7})^3 \times 1000\ kg$

$$\Rightarrow E = \frac{4/3 \times 22/7 \times (10^{-7})^3 \times 1000 \times 10}{1.6 \times 10^{-19}}$$
$$= 260\ N/C$$

794 **(c)**

$$V = 9 \times 10^9 \times \frac{Q}{r} = 9 \times 10^9 \times \frac{(+1.6 \times 10^{-19})}{0.53 \times 10^{-10}}$$
$$= 27.2V$$

795 **(b)**

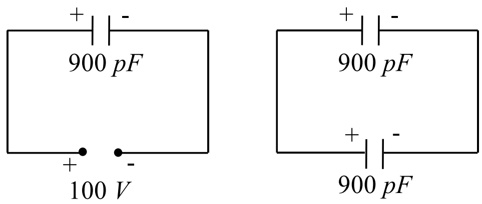
Energy stored in the capacitor $= \frac{1}{2}\frac{Q^2}{C}$

$Q = CV = 900 \times 10^{-12}F \times 100V$

$\therefore Q = 9 \times 10^{-8}C$

Energy of the capacitor when fully charged

$= \frac{1}{2}\frac{Q^2}{C} = 4.5 \times 10^{-6}\ J$



(a) (b)

The total charge is conserved. In figure (b), total capacitance

$= C'' = 2 \times C = 2 \times 900\ pF$

$\therefore$ Final energy $= \frac{1}{2}\frac{Q^2}{C''} = \frac{1}{2} \cdot \frac{Q^2}{2C}$

$\therefore$ Final energy $= \frac{4.5 \times 10^{-6}\ J}{2} = 2.25 \times 10^{-6}\ J$

796 **(d)**

$C = \frac{\varepsilon_0 A}{d}$ As $A \to \frac{1}{2}$ times and $d \to 2$ times

So $C \to \frac{1}{4}$ times $i.e. C' = \frac{1}{4}C = \frac{12}{4} = 3\ \mu F$

797 **(d)**

Frequency or time period of SHM depends on variable forces. It does not depend on constant external force. Constant external force can only change the mean position. For example, in the given question mean position is at natural length of spring in the absence of electric field. Whereas in the presence of electric field mean position will be obtained after a compression of x_0. Where x_0 is given by

$kx_0 = QE$

$$x_0 = \frac{QE}{k}$$

798 **(b)**

In charging half of energy supplied by the battery is lost in the form of heat

799 **(c)**

In parallel, $C = C_1 + C_2 + C_3 = 20\mu F$

800 **(d)**

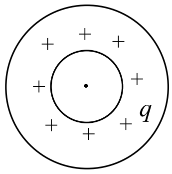
The force is perpendicular to this displacement

801 **(a)**

$$C = 4\pi \in_0 R = \frac{1}{9 \times 10^9} \times 1 = 1.1 \times 10^{-10} F$$

802 **(a)**

When a charge density is given to inner cylinder an electric field will be produced between the inner and outer cylinder. Hence a potential difference will appear between the two cylinders



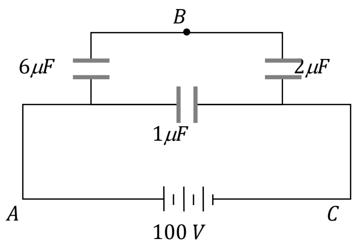
803 **(c)**

$$C_{eq} = \frac{(3+3)\times(1+1)}{(3+3)+(1+1)} + 1 = \left(\frac{6\times 2}{6+2}\right) + 1$$

$$= \frac{5}{2}\mu F$$

$$\therefore Q = C \times V = \frac{5}{2} \times 100 = 250 \mu C$$

Charge in $6\mu F$ branch $= VC = \left(\frac{6\times2}{6+2}\right) 100 = 150\ \mu C$



$V_{AB} = \frac{150}{6} = 25V$ and $V_{BC} = 100 - V_{AB} = 75V$

804 **(c)**

As $Q = CV, (Q_1)_{\max} = 10^{-6} \times 6 \times 10^3 = 6mC$

While $(Q_2)_{\max} = 3 \times 10^{-6} \times 4 \times 10^3 = 12mC$

However in series charge is same so maximum charge on C_2 will also be 6 mC (and not 12 mC) and potential difference across it $V_2 = 6mC/3\ \mu F = 2KV$ and as in series $V = V_1 + V_2$ so $V_{\max} = 6KV + 2KV = 8KV$

805 **(a)**

Here, $u = 0, a = \frac{F}{m} = \frac{qE}{m}$

$$v = u + at = 0 + \frac{qE}{m} t$$

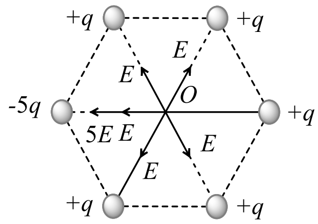
KE $\frac{1}{2}mv^2 = \frac{mq^2E^2t^2}{2m^2} = \frac{E^2q^2t^2}{2m}$

807 **(a)**

$q = CV$ and $U = \frac{1}{2}CV^2 = \frac{q^2}{2C}$

809 **(d)**

To obtained net field $6E$ at centre O, the charge to be placed at remaining sixth corner is $-5q$. (see following figure)



810 **(b)**

Spheres have same potential

$i.e. k\frac{Q_1}{R_1} = k\frac{Q_2}{R_2} \Rightarrow \frac{Q_1}{Q_2} = \frac{R_1}{R_2}$

811 **(d)**

$Q_1 = CV$ and $Q_2 = CV$

Applying charge conservation $CV_1 + CV_2 = Q_1 + Q_2$

$CV_1 + CV_2 = 2CV \Rightarrow V_1 + V_2 = 2V$

813 **(b)**

Given system is a spherical capacitor

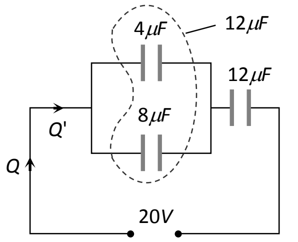
So capacitance of system $C = K \times 4\pi\varepsilon_0 \left(\frac{r_1 r_2}{r_2 - r_1}\right)$

$$= \frac{6}{9\times10^9}\left(\frac{9\times10}{1}\right) \times 10^{-2} = 6 \times 10^{-10} Farad$$

Now potential of inner sphere will be equal to potential difference of the capacitor. So $V = \frac{q}{C} = \frac{18\times10^{-9}}{6\times10^{-10}} = 30V$

814 **(b)**

Equivalent capacitance of the circuit $C_{eq} = 6\mu F$



Charge supplied from source $Q = 6 \times 20 = 120\mu C$

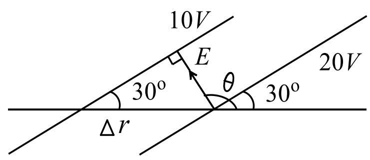
Hence charge on the plates of 4 μF capacitor

$$= Q' = \frac{4}{(4+8)} \times 120 = 40\mu C$$

816 **(c)**

Using $dV = -\vec{E}.d\vec{r}$

$\Rightarrow \Delta V = -E.\Delta r \cos\theta$



$$\Rightarrow E = \frac{-\Delta V}{\Delta r \cos\theta}$$

$$\Rightarrow E = \frac{-(20-10)}{10 \times 10^{-2} \cos 120°}$$
$$= \frac{-10}{10 \times 10^{-2}(-\sin 30°)}$$
$$= \frac{-10^2}{-1/2} = 200V/m$$
Direction of E be perpendicular to the equipotential surface $i.e.$ at 120° with x-axis

817 **(a)**

$$V = Ed = \frac{3000}{3} \times 10^{-2} = 10V$$

818 **(a)**

Electric flux, $\phi_E = \int \vec{E}.\overrightarrow{dS}$
$$= \int EdS \cos\theta = \int EdS \cos 90° = 0$$
The lines are parallel to the surface

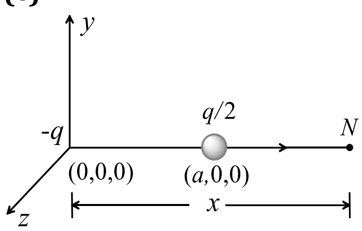
819 **(b)**

For a charged cylinder

$$E = \frac{\lambda}{2\pi\varepsilon_0 r} = \frac{4 \times 10^{-6} \times 18 \times 10^9}{3.6 \times 10^{-2}}$$

$$= 2 \times 10^6 \text{NC}^{-1}$$

820 **(c)**

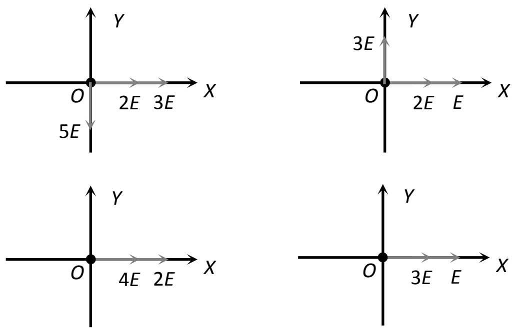


Suppose the field vanishes at distance x, we have $\frac{kq}{x^2} = \frac{kq/2}{(x-a)^2}$ or $2(x-a)^2 = x^2$ or $\sqrt{2}(x-a) = x$

or $(\sqrt{2}-1)x = \sqrt{2}a$ or $x = \left(\frac{\sqrt{2}a}{\sqrt{2}-1}\right)$

821 **(c)**

If electric field due to charge $|q|$ at origin is E then electric field due to charges $|2q|, |3q|, |4q|$ and $|5q|$ are respectively $2E, 3E, 4E$ and $5E$



$E_{(i)} = \sqrt{(5E)^2 + (5E)^2} = 5\sqrt{2}E,$

$E_{(ii)} = \sqrt{(3E)^2 + (3E)^2} = 3\sqrt{2}E,$

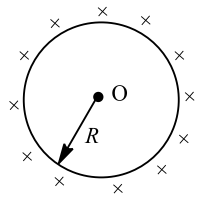
$E_{(iii)} = 4E + 2E = 6E$ and $E_{(iv)} = 3E + E = 4E$

$\Rightarrow E_{(i)} > E_{(iii)} > E_{(ii)} > E_{(iv)}$

822 **(a)**

Electric field at any point inside a spherical charge is zero everywhere E=0.

Therefore, if we take any other charge from one point to another inside a charged spherical shell, then no work will be done.



823 **(d)**

The negative charge distributed over the surface of earth is about $5 \times 10^5 C$. The surface charge density of earth is
$$\sigma = \frac{Q}{4\pi r_e^2} = \frac{-5 \times 10^5 C}{4\pi(6.37 \times 10^6 m)^2} \sim -10^{-9} C/m^2$$

824 **(c)**

64 small spheres have formed have formed a single large spheres of radius R

$\therefore \frac{4}{3}\pi R^3 = 64 \times \frac{4}{3}\pi r^3 \Rightarrow R = 4r$

$Q_{\text{total}} = 64q$

As $C' = \frac{Q}{V}$ and $V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$;

$C' = 4\pi\varepsilon_0 R$

$C' = (4\pi\varepsilon_0).4r \Rightarrow C' = 4C$

825 **(c)**

Since the two charges (spheres) attract, they will be opposite in sing, ie, q_1 and $-q_2$.

Force, $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 \times -q_2}{d^2}$

After touching, charge on each will be $\frac{q_1 - q_2}{2}$.

New force, $F' = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1-q_2}{2}\right)^2 \times \frac{1}{d^2}$

Given |F|=|F'|

On solving by quadratic equations, we get

$\frac{q_1}{q_2} = -(3+\sqrt{8})or(-3+\sqrt{8})$

826 **(c)**

For pair of change $U = \frac{1}{4\pi\varepsilon_0}.\frac{q_1 q_2}{r}$

$$U_{system} = \frac{1}{4\pi\varepsilon_0}\left[\frac{10\times10^{-6}\times10\times10^{-6}}{10/100} + \frac{10\times10^{-6}\times10\times10^{-6}}{10/100} + \frac{10\times10^{-6}\times10\times10^{-6}}{10/100}\right]$$

$$= 3\times9\times10^9\times\frac{100\times10^{-12}\times100}{10} = 27J$$

827 **(b)**

Force on electron $F = QE = Q\left(\frac{V}{d}\right)$

$$\Rightarrow F = (1.6\times10^{-19})\left(\frac{1000}{2\times10^{-3}}\right) = 8\times10^{-14}N$$

828 **(d)**

Here, $q = -3\times10^{-7}C$

Number of electrons transferred to the conductor is

$$n = \frac{q}{e} = \frac{-3\times10^{-7}C}{-1.6\times10^{-19}C} \approx 2\times10^{12}$$

Mass of one electron, $m_e = 9.1\times10^{-31}kg$

Mass increase of the conductor $= m_e\times n$

$= 9.1\times10^{-31}\times2\times10^{12} = 18.2\times10^{-19}kg$

$\approx 2\times10^{-18}kg$

829 **(a)**

Electric lines of force usually start (*ie*, diverge out) from positive charge and end (*i.e.*, converge) on negative charge or extends to infinity.

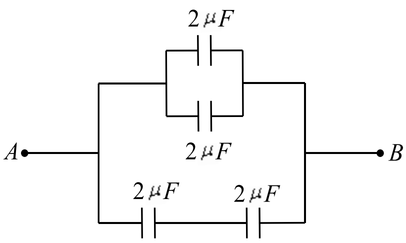
Thus, A is positive charge and B is negative charge. Also density of lines at A is more than that of B, *i.e.*, $|A| > |B|$.

830 **(d)**

Minimum when connected in series and maximum when connected in parallel

831 **(b)**

The possible arrangement may be



832 **(c)**

Given $\Rightarrow V = 200\ volt, Q = 0.1\ C$

As energy $U = \frac{QV}{2}, U = \frac{0.1\times200}{2} = 10\ Joule$

833 **(a)**

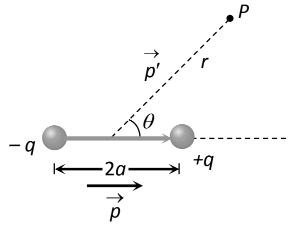
$$E_{medium} = \frac{E_{air}}{k}$$

835 **(d)**

Total charge $Q = 80 + 40 = 120\mu C$. By using the formula $Q_1' = Q\left[\frac{r_1}{r_1+r_2}\right]$. New charge on sphere A is $Q_A' = Q\left[\frac{r_A}{r_A+r_B}\right] = 120\left[\frac{4}{4+6}\right] = 48\mu C$. Initially it was $80\mu C$ *i.e.*, $32\mu C$ charge flows from A to B

836 **(a)**

For the given situation, diagram can be drawn as follows



As shown in figure component of dipole moment along the line OP will be $p' = p\cos\theta$

Hence electric potential at point P will be

$$V = \frac{1}{4\pi\varepsilon_0}.\frac{p\cos\theta}{r^2}$$

837 **(a)**

$$F \propto \frac{1}{K}\ i.e.\frac{F_{\text{air}}}{F_{\text{medium}}} = K$$

838 **(b)**

It is assumed that charge on earth is 10^6C hence by taking away a negative charge from the earth, potential energy will increase

839 **(b)**

There are 8 capacitor in this gang and all of them are in parallel combination

$$C_{eq} = 8.C = \frac{8\varepsilon_0 A}{d}$$

$$= \frac{8\times8.85\times10^{-12}\times5\times10^{-4}}{0.885\times10^{-2}} = 4\times10^{-12}$$

$$= 4\ pF$$

840 **(a)**

Loss of energy during sharing $= \frac{C_1C_2(V_1-V_2)^2}{2(C_1+C_2)}$

In the equation, put $V_2 = 0, V_1 = V_0$

$\therefore$ Loss of energy $= \frac{C_1C_2V_0^2}{2(C_1+C_2)}$

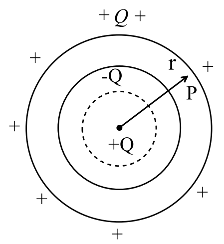
$$= \frac{C_2U_0}{C_1+C_2}\quad\left[\because U_0 = \frac{1}{2}C_1V_0^2\right]$$

841 **(d)**

Energy $= \frac{10\times40}{2} + \frac{10\times20}{4} = 250\ erg$

842 **(b)**

The charge at the inner surface, outer surface and inside the conductor at $P = (-Q, +Q, 0)$ as shown in the figure



843 **(b)**
According to Gauss's theorem Electric flux through a closed surface $S = q/\varepsilon_0$
Where $q =$ total charge enclosed by S
Electric flux pass through the spherical Gaussian surface is independent on the radius of a gaussian surface but depends on the charge enclosed by a gaussian surface. On increasing the radius of gaussian surface remain the same. Therefore, the electric flux pass through the gaussian surface remains the same

844 **(c)**
Initial energy of the system
$$U_i = \frac{1}{2}CV_1^2 + \frac{1}{2}CV_2^2$$
When the capacitors are joined, common potential
$$V = \frac{CV_1 + CV_2}{2C} = \frac{V_1 + V_2}{2}$$
Final energy of the system
$$U_f = \frac{1}{2}(2C)V^2 = \frac{1}{2}2C\left(\frac{V_1+V_2}{2}\right)^2 = \frac{1}{4}C(V_1+V_2)^2$$
Decrease in energy $= U_i - U_f = \frac{1}{4}C(V_1 - V_2)^2$

845 **(d)**
Inside the sphere at any point, $E = 0$.

846 **(d)**
$$V = 6 \times \left[\frac{1}{4\pi\varepsilon_0} \times \frac{Q}{a}\right]$$
$$V = 6 \times \frac{k.Q}{a}$$

847 **(b)**
In the direction of electric field potential decreases

848 **(a)**
$$U = \frac{1}{2}CV^2 = \frac{1}{2} \times 10 \times 10^{-12} \times (50)^2$$
$$= 1.25 \times 10^{-8}\,J$$

849 **(b)**
$V_{Big} = n^{2/3}v_{small} = (1000)^{2/3}v_{small} = 100v_{small}$

852 **(a)**
In second case, charges will be $-2\mu C$ and $+3\mu C$
Since $F \propto Q_1Q_2$ $i.e. \frac{F}{F'} = \frac{Q_1Q_2}{Q_1'\,Q_2'}$
$\therefore \frac{40}{F'} = \frac{3\times8}{-2\times3} = -4 \Rightarrow F' = 10N$ (Attractive)

853 **(b)**
$E = \sum\frac{dq}{4\pi\varepsilon_0 a^2} = \sum\frac{\lambda dl}{4\pi\varepsilon_0 a^2} = \frac{\lambda(\pi a)}{4\pi\varepsilon_0 a^2} = \frac{\lambda}{4\varepsilon_0 a}$.

855 **(c)**
Gauss's law is based on the inverse square dependence on distance contained in the Coulomb's law. Any violation of Gauss's law will indicate departure from the inverse square law

856 **(d)**
Number of electrons added to the conductor
$$n = \frac{q}{e}$$
$$= \frac{-3\times10^{-7}}{1.6\times10^{-19}} = 1.8\times10^{12}$$
Mass increase of the conductor
$$= 1.8\times10^{12}\times9.1\times10^{-31}$$
$$\approx 20\times10^{-19} = 2\times10^{-18}$$

858 **(c)**
$U_{Big} = n^{5/3}u_{small}$

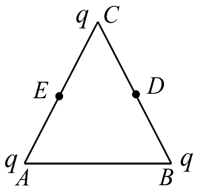
859 **(c)**
By Gauss's law
$$\varepsilon_0\phi = q$$
$$\phi = \frac{q}{\varepsilon_0}$$
$$= \frac{1.8\times10^{-6}}{8.85\times10^{-12}}$$
$$= 2.0\times10^5\,\mathrm{N-m^2C^{-1}}$$

860 **(c)**
Volume of 8 small drops = Volume of big drop
$$8\times\frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow R = 2r$$
As capacity is proportional to r, hence capacity becomes 2 times

861 **(d)**
$$E = \frac{q}{4\pi\varepsilon_0 r^2} = 9\times10^9\times\frac{1.6\times10^{-19}}{(10^{-10})^2}$$
$$= 1.44\times10^{11}N/C$$

862 **(c)**
Electric field at any interior point of a metallic sphere is zero. When a test charge q_0 is moved along the equipotential surface, it follows that **E** must be perpendicular to the surface at every point, so that the electric force $q_0\mathbf{E}$ will always be perpendicular to the displacement of a charge moving on the surface, so work done by the electric force is zero.

863 **(a)**



$AC = BC$

$V_D = V_E$

$W = Q(V_E - V_D)$

$W = 0$

864 **(d)**

$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{d^2}$

$\therefore (10 \times 10^{-3}) \times 10 = \frac{(9 \times 10^9) \times q^2}{(0.6)^2}$

$\Rightarrow q^2 = 4 \times 10^{-12}$

$\Rightarrow q = 2 \times 10^{-6}C = 2\mu C$

865 **(c)**

$C_R = C_1 + C_2 = \frac{k_1\varepsilon_0A_1}{d} + \frac{k_2\varepsilon_0A_2}{d}$

$= \frac{2 \times \varepsilon_0\frac{A}{2}}{d} + \frac{4 \times \varepsilon_0\frac{A}{2}}{d} = 2 \times \frac{10}{2} + 4 \times \frac{10}{2} = 30\mu F$

866 **(b)**

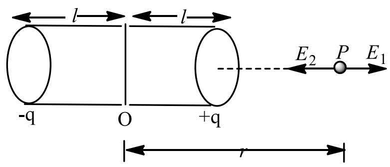
Total potential at the centre $V_c = \frac{6q}{4\pi\varepsilon_0 r}$

Required work done $= q = (V_c - V_\infty)$

$= qV_c = \frac{6q^2}{4\pi\varepsilon_0 r}[V_\infty = 0]$

867 **(c)**

Intensity of electric field at a point on the axis of dipole is given by

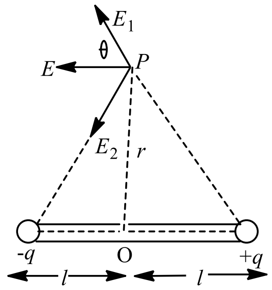


$E_a = \frac{1}{4\pi\varepsilon_0}.\frac{2p}{r^3}\frac{N}{C} \ldots..(\text{i})$

Where, p is dipole moment.

Intensity of electric field at a point on the

Equatorial line of dipole is given by



$E_q = \frac{1}{4\pi\varepsilon_0}.\frac{p}{r^3}\frac{N}{C} \ldots..(\text{ii})$

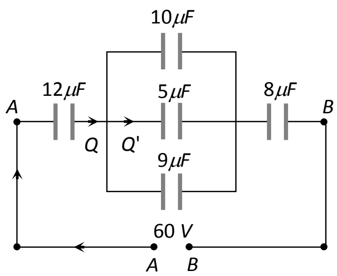
Dividing Eq. (i) by Eq. (ii), we get

$\frac{E_a}{E_q} = \frac{2}{1}$

$\Longrightarrow E_a = 2E_q$

868 **(d)**

The given circuit can be redrawn as follows



Equivalent capacitance of the circuit $C_{AB} = 4\mu F$

Charge given by the battery $Q = C_{eq}V = 4 \times 60 = 240\mu C$

Charge in $5\mu F$ capacitor $Q' = \frac{5}{(10+5+9)} \times 240 = 50\mu C$

869 **(a)**

In steady state potential difference a cross capacitor $= 2V$

So charge on capacitor $Q = 10 \times 2 = 20\ \mu C$

870 **(b)**

$\because E = -\frac{dV}{dX} \Rightarrow V_x = -xE_0$

871 **(a)**

$\tau = pE\sin\theta$

$U = -pE\cos\theta$

872 **(b)**

$\text{K.E.} = q_0(V_A - V_B) = 1.6 \times 10^{-19}(70 - 50)$

$= 3.2 \times 10^{-18}\ J$

873 **(c)**

$$U = \frac{1}{2}CV^2 = \frac{1}{2} \times 6 \times 10^{-6}(100)^2 = 0.03J$$

874 **(a)**

Electric flux $= \frac{q}{\varepsilon_0}$

$$= \frac{(-14 + 78.85 - 56) \times 10^9}{8.85 \times 10^{-12}}$$

$$= \frac{8.85 \times 10^{-9}}{8.85 \times 10^{-12}} = 1000 \text{ Nm}^2\text{C}^{-1}$$

875 **(d)**

Extra charge $Q = (2CV - CV) = CV$ flows through potential V of the battery. Thus $W = QV = CV^2$

876 **(c)**

The Gaussian surface for calculating the electric field due to a charge distribution is a symmetrical closed surface containing the charge distribution, at every point of which electric field has a single fixed value.

878 **(b)**

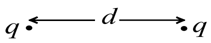
$F_{12} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{a^2}$ and $F_{13} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{(a\sqrt{2})^2} \Rightarrow \frac{F_{12}}{F_{13}} = 2$

879 **(d)**

$$K = \frac{\rho}{\rho - \sigma} = \frac{1.6}{1.6 - 0.8} = 2$$

$\rho \rightarrow$ density of sphere, $\sigma \rightarrow$ density of liquid

880 **(d)**



$$F = \frac{(ne)^2}{4\pi \epsilon_0 d^2} \Rightarrow n = \sqrt{\frac{4\pi \epsilon_0 d^2}{e^2}}$$

881 **(a)**

Work done in moving a charge q into a uniform electric field E through a distance Y is

work done= Force $\times$ distance

$$= (qE) \times r = qEY$$

882 **(d)**

Let the spherical conductors B and C have same charge as q. The electric force between them is

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q^2}{r^2}$$

r, being the distance between them.

When third uncharged conductor A is brought in contact with B, then charge on each conductor

$$q_A = q_B = \frac{q_A + q_B}{2}$$

$$= \frac{0 + q}{2} = \frac{q}{2}$$

When this conductor A is now brought in contact with C, then charge on each conductor

$$q_A = q_C = \frac{q_A + q_c}{2}$$

$$= \frac{\left(\frac{q}{2}\right) + q}{2} = \frac{3q}{4}$$

Hence, electric force acting between B and C is

$$F' = \frac{1}{4\pi\varepsilon_0} \frac{q_B q_c}{r^2}$$

$$F' = \frac{1}{4\pi\varepsilon_0} \frac{(q/2)(3q/4)}{r^2}$$

$$= \frac{3}{8}\left[\frac{1}{4\pi\varepsilon_0} \frac{q^2}{r^2}\right] = \frac{3F}{8}$$

883 **(c)**

Let tension in the thread is T, then force of repulsion between the charges.

$$F = T\cos 60°$$

Or $= \frac{9 \times 10^9 \times 10 \times 10^{-6} \times 10 \times 10^{-6}}{(1)^2}$

$$= T\cos 60°$$

Or $T \times \frac{1}{2} = 0.9$

$\therefore$ $T = 2 \times 0.9 = 1.8$ N

884 **(a)**

Electric field inside shell is zero

885 **(a)**

Gauss's law is valid for any closed surface, no matter what its shape or size

886 **(b)**

In the presence of battery potential difference remains constant. Also $E = \frac{V}{d}$, so E remains same

888 **(b)**

$$Q_1 = \frac{C_1}{C_1 + C_2} Q_n \quad \& \quad Q_2 = \frac{C_2}{C_1 + C_2} Q_n$$

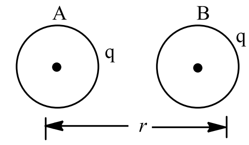
$$\Rightarrow Q_1 = \frac{6c}{6c + 3c} \times 9q \quad \& \Rightarrow Q_2 = \frac{3c}{6c + 3c} \times 9q$$

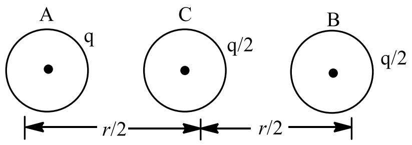
$$= 6q \quad \& = 3q$$

889 **(c)**

From Coulomb's law, the force of attraction between two charged particles (q), kept at a distance r apart is

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q^2}{r^2}$$





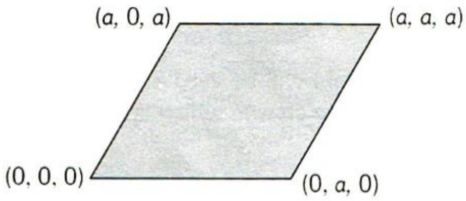
When two identical spheres are brought in contact, charge on them is equalised, hence total charge on C is equally shared when brought in contact with sphere B having a charge q.

Therefore, charge on B and C is $\frac{q}{2}$.

From Coulomb's law, the force on C is

$$F_c = \frac{q \times q/2}{4\pi\varepsilon_0 (r/2)^2} - \frac{(q/2)(q/2)}{4\pi\varepsilon_0 (r/2)^2}$$
$$= \frac{qq}{4\pi\varepsilon_0 r^2}(2-1) = F$$

890 **(c)**



Flux $= [E_0 \cos 45^o] \times$ area

$$= \frac{E_0}{\sqrt{2}} \times a \times \sqrt{2}a = E_0 a^2$$

891 **(c)**

Electric field due to a hollow spherical conductor is gonerned by following equation $E = 0$ for $r < R$ ....(i)

and $E = \frac{Q}{4\pi\varepsilon_0 r^2}$ for $r \geq R$

i.e., inside the conductor field will be zero and outside the conductor will vary according to

$$E \propto \frac{1}{r^2}$$

892 **(a)**

If there are n point charges $q_1, q_2, \dots . q_n$, then each of them will produce the same intensity at any point which it would have produced in the absence of other point charges. Hence, total intensity will be vector sum of $\mathbf{E}_1, \mathbf{E}_2 \dots\dots, \mathbf{E}_n$ produced at a point.

$$\sum E = \frac{q}{4\pi\varepsilon_0 r_1^2} + \frac{q}{4\varepsilon_0 r_2^2} + \cdots + \frac{q}{4\pi\varepsilon_0 r_n^2}$$

$$\therefore E = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{4^2} + \frac{1}{8^2} + \cdots\right]$$

The given series is a geometric progression.

Hence,

$$\text{sum } (S) = \frac{a}{1-r}$$

Where a is first term of series and r the common difference

$$r = \frac{1}{4}, a = 1$$

$$\therefore S = \frac{1}{1 - \frac{1}{4}} = \frac{4}{3}$$

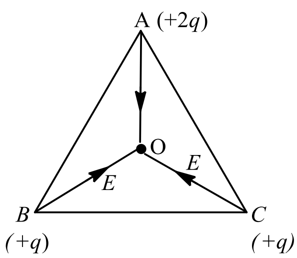
$$\therefore \text{Total intensity} = \frac{q \times 4}{4\pi\varepsilon_0 \times 3}$$

$$= \frac{9 \times 10^9 \times 4q}{3}$$

$$= 12 \times 10^9 q\text{NC}^{-1}$$

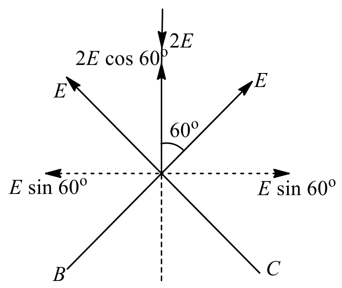
894 **(a)**

The situation is as shown below. As shown, we resolve E along CO and also BO into two perpendicular components.



The horizontal components cancel each other.

The vertical (cosine) components add up along OA to give $2E \cos 60°$.



Resultant field along AO

$= 2E - 2E\cos 60°$

$= 2E - 2E \times \frac{1}{2}$

$= 2E - E = E$

Hence, resultant field is E along AO.

895 **(b)**

$\oint E.ds = \frac{\rho}{\varepsilon_0}$, assuming ρ as charge

896 **(a)**

$F' = \frac{1}{4\pi\varepsilon_0 K}\frac{q_1q_2}{r^2} = \frac{F}{K}$

If F is the force in air, then F' is less than F since $K > 1$

897 **(c)**

$F = F'$ or $\frac{Q_1Q_2}{4\pi\varepsilon_0 r^2} = \frac{Q_1Q_2}{4\pi\varepsilon_0 r'^2 K} \Rightarrow r' = \frac{r}{\sqrt{K}}$

898 **(d)**

Work done $W = U_f - U_i$

$U_i = \frac{1}{2}CV_0^2$ and $U_f = \frac{1}{3}\frac{(C)}{3}.(3V_0)^2 = 3 \times \frac{1}{2}CV_0^2$

So $W = \frac{\varepsilon_0 AV_0^2}{d}$

899 **(b)**

Electrostatic energy density $\frac{dU}{dV} = \frac{1}{2}K\varepsilon_0 E^2$

$\therefore \frac{dU}{dV} \propto E^2$

901 **(a)**

We have $C = \frac{\varepsilon_0 A}{d} \Rightarrow A = \frac{Cd}{\varepsilon_0} = \frac{3\times5\times10^{-3}}{8.85\times10^{-12}}$

$= 1.69 \times 10^9 m^2$

902 **(d)**

Equivalent capacitance $= \frac{2\times3}{2+3} = \frac{6}{5}\mu F$

Total charge by $Q = CV = \frac{6}{5} \times 1000 = 1200\mu C$

Potential (V) across $2\mu F$ is $V = \frac{Q}{C} = \frac{1200}{2} = 600 volt$

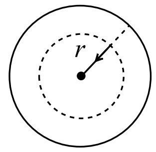
$\therefore$ Potential on internal plates $= 1000 - 600 = 400\ V$

903 **(a)**

In the following figure since $|\vec{F_A}| = |\vec{F_B}| = |\vec{F_C}|$ and they are equally inclined with each other, so their resultant will be zero

904 **(d)**

$\phi = ar^2 + b$



$E = -\frac{d\phi}{dt} = -2ar$

$\oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$

$-2ar.4\pi r^2 = \frac{q}{\varepsilon_0}$

$q = -8\varepsilon_0 a\pi r^3$

$\rho = \frac{q}{\frac{4}{3}\pi r^3} \Rightarrow \rho = -6a\varepsilon_0$

905 **(b)**

Original charges on spheres A and B be q_1 and q_2 respectively.

Distance between the two spheres $= r$

Since, both the spheres are of same size, they will possess equal charges on being brought in contact.

$\therefore \quad q_1' = \frac{q_1 + q_2}{2}$

Similarly $q_2' = \frac{q_1+q_2}{2}$

Therefore, new force of repulsion between spheres A and B is

$F' = \frac{1}{4\pi\varepsilon_0}\frac{\left[\frac{q_1+q_2}{2}\right]\left[\frac{q_1+q_2}{2}\right]}{r^2}$

$= \frac{\left[\frac{q_1+q_2}{2}\right]^2}{4\pi\varepsilon_0 r^2}$

As $\left[\frac{q_1+q_2}{2}\right]^2 > q_1q_2$

$\therefore \quad F' > F$

906 **(d)**

$12\mu F$ and $6\mu F$ are in series and again are in parallel with $4\mu F$.

Therefore, resultant of these three will be

$= \frac{12 \times 6}{12 + 6} + 4 = 4 + 4 = 8\mu F$

This equivalent system is in series with $1\ \mu F$

Its equivalent capacitance $= \frac{8\times1}{8+1} = \frac{8}{9}\mu F$ ...(i)

Equivalent of $8\mu F, 2\mu F$ and $2\mu F$

$= \frac{4\times8}{4+8} = \frac{32}{12} = \frac{8}{3}\mu F$ ...(ii)

(i) and (ii) are in parallel and are in series with C

$\therefore \frac{8}{9}+\frac{8}{3}=\frac{32}{9}$ and $C_{eq}=1=\frac{\frac{32}{9}\times C}{\frac{32}{9}+C} \Rightarrow C=\frac{32}{23}\mu F$

907 **(a)**

Electric field,

$$E=\frac{q}{4\pi\varepsilon_0 r^2}$$

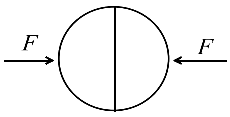
$$q=4\pi\varepsilon_0\, r^2 E$$

$$=\frac{(0.25)^2\times 2}{9\times 10^9}$$

$$q=1.39\times 10^{-11}\text{C}$$

909 **(a)**

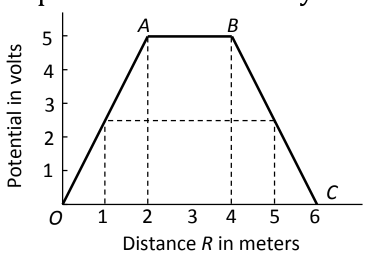
Electrostatic repulsive force;



$$F_{ele}=\left(\frac{\sigma^2}{2\varepsilon_0}\right)\pi R^2; F=F_{ele}=\frac{\sigma^2\pi R^2}{2\varepsilon_0}$$

910 **(a)**

Intensity at $5m$ is same as at any point between B and C because the slope of BC is same throughout ($i.e$, electric field between B and C is uniform). Therefore electric field at $R=5m$ is equal to the slope of line BC hence by

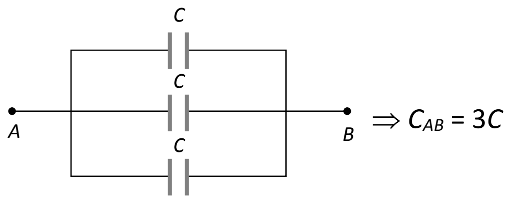


$$E=\frac{-dV}{dr};$$

$$E=-\frac{(0-5)}{6-4}=2.5\frac{V}{m}$$

911 **(b)**

The given circuit be redrawn as follows

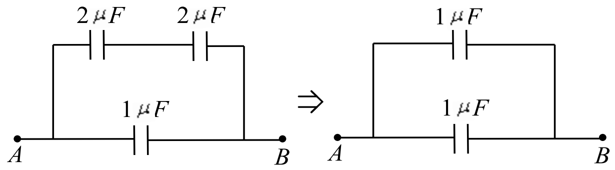


912 **(c)**

Work done appears in the form of energy which is given by $\frac{q^2}{2C}$

913 **(b)**

The given circuit can be redrawn as shown below



$\Rightarrow C_{AB}=2\mu F$

914 **(d)**

Initial charge on sphere of radius $R=q$

Charge on this sphere after joining

$$q'=\frac{(q+(-2q))\times R}{R+2R}=\frac{-q\times R}{3R}=-\frac{q}{3}$$

Now charge flowing between them $=q-\left(-\frac{q}{3}\right)=\frac{4q}{3}$

915 **(b)**

Work done $=\frac{1}{2}q\,V=\frac{1}{2}\times 4\times 4\times 10^{-6}$

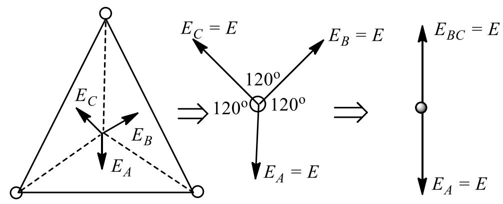
Power $=\frac{8\times 10^6}{0.1}=80\ MW$

916 **(c)**

$V=N^{2/3}V \Rightarrow 40=N^{2/3}\times 10$

$N^{2/3}=4 \Rightarrow N^2=64 \Rightarrow N=8$

917 **(a)**



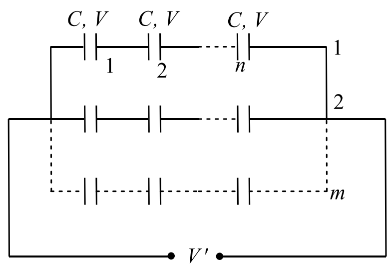
Hence, the electric field at the centroid of triangle will be zero.

$E_{\text{net}}=0$

918 **(b)**

Suppose $C=8\ \mu F, C''=16\mu F$

And $V=250V, V''=1000V$



Suppose m rows of given capacitors are connected in parallel and each row contains n capacitors then potential difference across each capacitor $V=\frac{V''}{n}$ and equivalent capacitance of network $C''=\frac{mC}{n}$ on putting the values we get $n=4$ and $m=8$

$\therefore$ Total capacitors $= n \times m = 4 \times 8 = 32$

Short Trick : For such type of problems number of capacitors

$$= \frac{C''}{C} \times \left(\frac{V''}{V}\right)^2 = \frac{15}{8}\left(\frac{1000}{250}\right)^2 = 32$$

919 **(b)**

Initially potential difference across each capacitor

$$V_1 = \frac{20}{(10+20)} \times 200 = \frac{400}{3} V$$

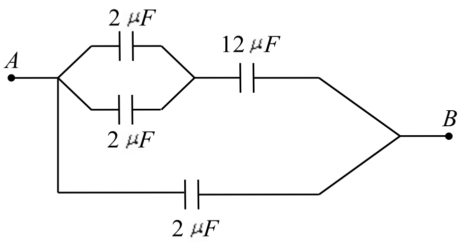
and $V_2 = \frac{10}{(10+20)} \times 200 = \frac{200}{3} V$

finally common potential $V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$$V = \frac{10 \times \frac{400}{3} + 20 \times \frac{200}{3}}{(10+20)} = \frac{800}{9} V$$

920 **(c)**

The circuit can be rearranged as



Net capacitance between $AB = \frac{4 \times 12}{4+12} + 2 = 5\ \mu F$

921 **(c)**

$$W = U_f - U_i = 9 \times 10^9 \times Q_1\ Q_2 \left[\frac{1}{r_2} - \frac{1}{r_1}\right]$$

$$\Rightarrow W = 9 \times 10^9 \times 12 \times 10^{-6} \times 8 \times 10^{-6} \left[\frac{1}{4 \times 10^{-2}} - \frac{1}{10 \times 10^{-2}}\right]$$

$= 12.96\ J = 13\ J$

922 **(a)**

Torque of an electric dipole

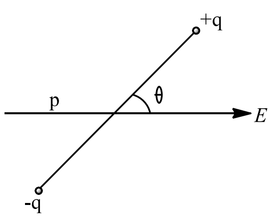
$\tau = pE \sin\theta$

Torque is maximum when dipole is perpendicular to the field.

Hence,

$\tau_{\max} = pE$

$(\theta = 90°)$



923 **(d)**

The electric field between the spheres of a charged capacitor is non-uniform and it decreases with distance from the Centre as $E \propto \frac{1}{r^2}$

924 **(d)**

Total capacitance $\frac{1}{C} = \frac{1}{20} + \frac{1}{8} + \frac{1}{12} \Rightarrow C = \frac{120}{31} \mu F$

Total charge $Q = CV = \frac{120}{31} \times 300 = 1161 \mu C$

Charge, through 4 μF condenser $= \frac{1161}{2} = 580 \mu C$

And potential difference across it $= \frac{580}{4} = 145 V$

925 **(d)**

Charge q will momentarily come to rest at a distance r from charge Q when all it's kinetic energy converted to potential energy

$i.e.\ \frac{1}{2}mv^2 = \frac{1}{4\pi\varepsilon_0} . \frac{qQ}{r}$

Therefore the distance of closest approach is given by

$$r = \frac{qQ}{4\pi\varepsilon_0} . \frac{2}{mv^2} \Rightarrow r \propto \frac{1}{v^2}$$

Hence if v is doubled, r becomes one fourth

926 **(a)**

A magnetic dipole placed in an external magnetic field on acted upon by a torque which tends to align the dipole in the direction of the field. Therefore, work must be done to charge the orientation of the dipole against the torque. This work is stored as potential energy (U) in the dipole, given by

$U = \boldsymbol{M} . \boldsymbol{B}$

$U = -MB \cos\theta$

Where M is magnetic moment, B the magnetic field and θ the angle between them.

Thus, a magnetic dipole has minimum potential energy when

M and **B** are parallel $(\theta = 0)$ that is,

$U_{\min} = -pE$

927 **(a)**

Common potential $= \frac{C_1V_0 + C_2 \times 0}{C_1 + C_2} = \frac{C_1V_0}{C_1 + C_2}$

$$U_{\text{before}} = \frac{1}{2} C_1 V_0^2$$

$$U_{\text{after}} = \frac{1}{2}C_1\left(\frac{C_1V_0}{C_1+C_2}\right)^2 + \frac{1}{2}\left(\frac{C_1V_0}{C_1+C_2}\right)^2$$

$$= \frac{1}{2}\left(\frac{C_1V_0}{C_1+C_2}\right)^2(C_1+C_2) \Rightarrow \frac{U_{Before}}{U_{After}} = \frac{C_1+C_2}{C_1}$$

928 **(b)**

The schematic diagram of distribution of charges on x —axis is shown in figure below:

Total force acting on $1C$ charge is given by

$$F = \frac{1}{4\pi\varepsilon_0}\left[\frac{1\times1\times10^{-6}}{(1)^2} + \frac{1\times1\times10^{-6}}{(2)^2} + \frac{1\times1\times10^{-6}}{(4)^2} + \frac{1\times1\times10^{-6}}{(8)^2} + \ldots.\infty\right]$$

$$= \frac{10^{-6}}{4\pi\varepsilon_0}\left(\frac{1}{1}+\frac{1}{4}+\frac{1}{16}+\frac{1}{64}+\cdots\infty\right)$$

$$= 9\times10^9\times10^{-6}\left(\frac{1}{1-\frac{1}{4}}\right)$$

$$= 9\times10^9\times10^{-6}\times\frac{4}{3} = 9\times\frac{4}{3}\times10^3 = 12000\ N$$

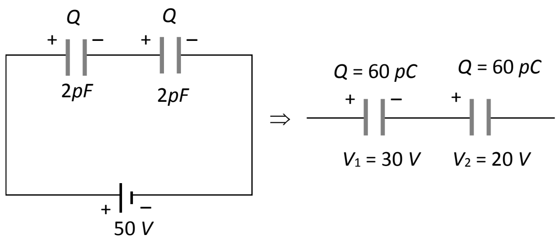
929 **(d)**

$$C = \frac{\varepsilon_0KA}{d} \Rightarrow C \propto K, Q = CV \Rightarrow Q \propto C\ [\because V = \text{constant}]$$

930 **(d)**

Charges on capacitors are $Q_1 = 30\times2 = 60pC$ and $Q_2 = 20\times3 = 60pC$ or $Q_1 = Q_2 = Q$ (say)

The situation is similar as the two capacitors in series are first charged with a battery of emf 50 V and then disconnected



$\therefore$ when S_3 is closed $V_1 = 30V$ and $V_2 = 20V$

931 **(d)**

In series combination, charge is same on each capacitor

932 **(d)**

$W = qV = qE.d$

$\Rightarrow 4 = 0.2\times E\times(2\cos60°)$

$= 0.2\ E\times(2\times0.5)$

$\therefore E = \frac{4}{0.2} = 20\ NC^{-1}$

933 **(c)**

Force on $-q_1$ due to q_2 is

$F_2 = \frac{kq_1q_2}{b^2}$ along X-axis

Force on $-q_1$ due to $-q_2$ is

$F_{13} = \frac{kq_1q_3}{a^2}$ at $\angle\theta$ With negative direction of Y-axis.

$\therefore$ x component of force on $-q_1$ is

$F_x = F_{12} + F_{13}\sin\theta = kq_1\left[\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta\right]$

$ie,\ F_x \propto \left[\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta\right]$

934 **(a)**

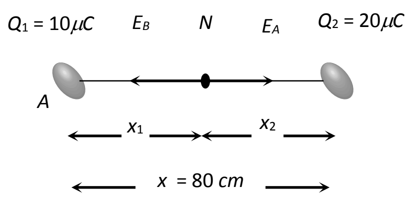
$$C = \frac{\varepsilon_0A}{d}$$

$$C_N = \frac{C_1C_2}{C_1+C_2} = \frac{\frac{\varepsilon_0A}{d/2}\cdot\frac{\varepsilon_0\varepsilon_rA}{d/2}}{\frac{\varepsilon_0A}{d/2}+\frac{\varepsilon_0\varepsilon_rA}{d/2}}$$

$$= \frac{2\varepsilon_0A\varepsilon_r}{d(1+\varepsilon_r)} = \frac{2C\varepsilon_r}{(1+\varepsilon_r)}$$

935 **(c)**

Suppose electric field is zero at N. Hence $|E_A| = |E_B|$



Which gives $x_1 = \frac{x}{\sqrt{\frac{Q_2}{Q_1}}+1} = \frac{80}{\sqrt{\frac{20}{10}}+1} = 33\ cm$

936 **(c)**

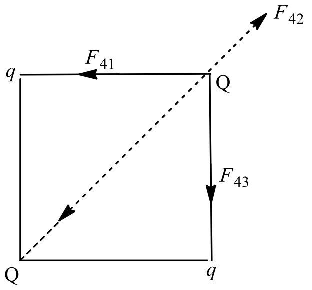
When charge enters perpendicularly in electric field, it describe parabolic path

937 **(a)**

Three forces F_{41}, F_{42} and F_{43}acting on Qas shown resultant of

$F_{41}$and $F_{43} = \sqrt{2}F_{\text{each}}$

$$= \sqrt{2}\,\frac{1}{4\pi\varepsilon_0}\frac{Qq}{d^2}$$



Resultant on Q becomes zero only when q charges are of negative nature.

$$F_{42} = \frac{1}{4\pi\varepsilon_0}\frac{Q\times Q}{(\sqrt{2}d)^2}$$

$$\Rightarrow \frac{\sqrt{2}qQ}{d^2} = \frac{Q\times Q}{2d^2}$$

$$\Rightarrow \sqrt{2}\times q = \frac{Q}{2}$$

$$\therefore \quad q = \frac{Q}{2\sqrt{2}}$$

Or $Q = -2\sqrt{2}\,q$

938 **(d)**

∵ charge 8q is placed at one corner of the cube, it can be imagined to be placed at the centre of a large cube which can be formed using 8 similar cubes and arranging them

Now 8q is at centre of the 8 cubes arranged to form a closed box

Total flux through the bigger cube

$= \frac{8q}{\varepsilon_0}$ [Gauss's law]

$\Rightarrow$ Flux through one small cube $= \frac{1}{8}\times\frac{8q}{\varepsilon_0} = \frac{q}{\varepsilon_0}$

939 **(b)**

Initially $F = qE$ and $E = \frac{\sigma}{\varepsilon_0}$ $\therefore F = \frac{q\sigma}{\varepsilon_0}$

If one plate is removed, then E becomes $\frac{\sigma}{2\varepsilon_0}$

So $F' = \frac{q\sigma}{2\varepsilon_0} = \frac{F}{2}$

941 **(a)**

Electron is moving is opposite direction of field so field will produce an accelerating effect on electron

942 **(a)**

$V = 9\times 10^9 . \frac{p}{r^2}$

$$= 9\times 10^9 \times \frac{(1.6\times 10^{-19})\times 1.28\times 10^{-10}}{(12\times 10^{-10})^2}$$
$$= 0.13V$$

943 **(d)**

Electric field due to an electric dipole at axial point

$$E_{\text{axial}} = \frac{2kpr}{(r^2-l^2)^2}$$

$$If\ r \gg l, E_a = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3}$$

$$\Rightarrow E \propto \frac{1}{r^3}$$

(directed from −q to +q)

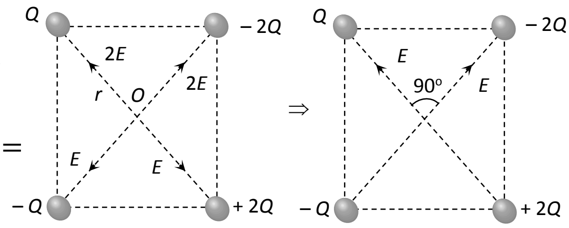
944 **(a)**

Side $a = 5\times 10^{-2}m$

Half of the diagonal of the square $r = \frac{a}{\sqrt{2}}$

Electric field at centre due to charge Q $E = \frac{kQ}{\left(\frac{a}{\sqrt{2}}\right)^2}$

Now field at O =



$\sqrt{E^2+E^2} = E\sqrt{2} = \frac{kq}{\left(\frac{a}{\sqrt{2}}\right)^2}.\sqrt{2}$

$= \frac{9\times 10^9\times 10^{-6}\times\sqrt{2}\times 2}{(5\times 10^{-2})^2} = 1.02\times 10^7 N/C$ [upward]

945 **(b)**

Coulomb's law is appliable for charged particles, it is not responsible to bind the protons and neutrons in the nucleus of an atom.

946 **(a)**

When a lamp is connected to D.C. line with a capacitor. If will form an open circuit. Hence, the lamp will not glow

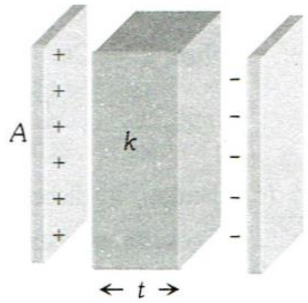
947 **(c)**

Potential difference between the plates $V = V_{air} + V_{medium}$

$= \frac{\sigma}{\varepsilon_0} \times (d - t) + \frac{\sigma}{K\varepsilon_0} \times t$

$\Rightarrow V = \frac{\sigma}{\varepsilon_0}(d - t + \frac{t}{K})$

$= \frac{Q}{A\varepsilon_0}(d - t + \frac{t}{K})$



Hence capacitance $C = \frac{Q}{V} = \frac{Q}{\frac{Q}{A\varepsilon_0}(d-t+\frac{t}{K})}$

$= \frac{\varepsilon_0 A}{(d - t + \frac{t}{K})} = \frac{\varepsilon_0 A}{d - t\left(1 - \frac{1}{K}\right)}$

948 **(d)**

If charge q is placed at a corner of cube, it will be divided into 8 such cubes. Therefore, electric flux through the cube is

$$\phi' = \frac{1}{8}\left(\frac{q}{\varepsilon_0}\right)$$

949 **(a)**

$$E = \frac{F}{q} = \frac{2.25}{15 \times 10^{-4}} = 1500\text{NC}^{-1}$$

952 **(a)**

$$\frac{1}{2}\left(\frac{C_1}{n_1}\right)(4V)^2 = \frac{1}{2}(n_2 C_2)V^2 \Rightarrow C_2 = \frac{16C_1}{n_1 n_2}$$

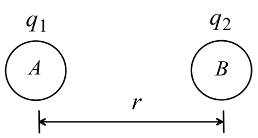
953 **(b)**

$E_{inside} = \frac{\rho}{3\varepsilon_0} r \quad [r < R]$

$E_{outside} = \frac{\rho R^3}{3\varepsilon_0 r^2} \quad [r \geq R]$

$i.e.$ inside the uniformly charged sphere field varies linearly ($E \propto r$) with distance and outside varies according to $E \propto \frac{1}{r^2}$

954 **(b)**



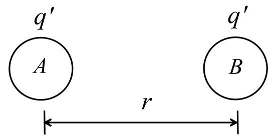
According to coulomb's law, the force of repulsion between them is

$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$

When the charged spheres A and B are brought in contact, each sphere will attain equal charge q'''''''

$q''''''' = \frac{q_1 + q_2}{2}$

Now, the force of repulsion between them at the same distance r is

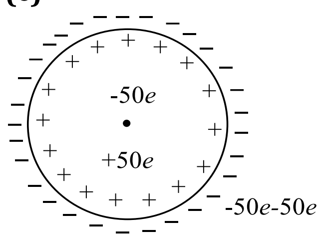


$$F''''''' = \frac{q''''''' \times q'''''''}{4\pi\varepsilon_0 r^2} = \frac{1}{4\pi\varepsilon_0} \frac{\left(\frac{q_1+q_2}{2}\right)\left(\frac{q_1+q_2}{2}\right)}{r^2}$$

$$= \frac{\left(\frac{q_1+q_2}{2}\right)^2}{4\pi\varepsilon_0 r^2}$$

As $\left(\frac{q_1+q_2}{2}\right)^2 > q_1 q_2 \;\therefore F''''''' > F$

955 **(c)**



Charge on outer surface $= -50e - 50e$
$= -100e$

956 **(a)**

$$V = E \times r \Rightarrow r = \frac{V}{E} = \frac{3000}{500} = 6\,m$$

957 **(a)**

The point 10 cm from centre of sphere will be inside the sphere. Hence,

$$E_{\text{inside}} = \frac{1}{4\pi\varepsilon_0} . \frac{qr}{R^3}$$

Here,

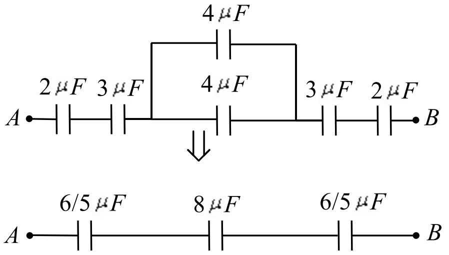
$q = 500 \times 10^{-6}\text{C}, r = 10\text{cm} = 0.1\text{m},$

$R = 60 \text{ cm} = 0.60\text{m}$

$$\therefore E_{\text{inside}} = (9.0 \times 10^9) \times \frac{500 \times 10^{-6} \times 0.1}{(0.60)^3}$$

$= 2 \times 10^6\text{NC}^{-1}$

958 **(b)**



$$\frac{1}{C_{eq}}=\frac{5}{6}+\frac{1}{8}+\frac{5}{6}=\frac{20+3+20}{24}\Rightarrow C_{eq}=\frac{24}{43}\mu F$$

959 **(b)**

$$\vec{E}=-\frac{dV}{dx}\hat{\imath}=-8x\hat{\imath}\text{ volt/meter}$$

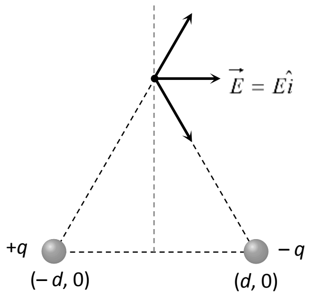
$$E_{(1,0,2)}=-8\hat{\imath}\,V/m$$

960 **(a)**

Since A and B are at equal potential so potential difference between A and B is zero. Hence $W=Q.\Delta V=0$

961 **(a)**

From figure, it is clear that $\vec{E}$ at all points on the y-axis is along $\hat{\imath}$. Here $\vec{E}$ of all points on x-axis cannot have the same direction



Here electric potential at origin is zero so no work is done in bringing a test charge from infinity to origin.

Here dipole moment is in $-x$ direction ($-q$ to $+q$)

Hence only option (a) is correct

962 **(c)**

Electric potential at a distance r due to point charge Q is $V=\frac{kQ}{r}$ and electric field at the same point $E=\frac{kQ}{r^2}$

$$\Rightarrow E=\frac{kQ}{(kQ/V)^2}=\frac{V^2}{kQ}=\frac{(Q\times 10^{11})^2}{kQ}$$

$$=4\pi\varepsilon_0\,Q\times 10^{22}V/m$$

$$\left[\because k=\frac{1}{4\pi\varepsilon_0}\right]$$

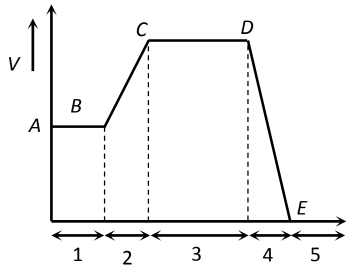
964 **(b)**

Electric field in the region 1, 3 and 5 is zero

$i.e. E_1=E_3=E_5$

Slope of the line BC < Slope of the line DE

$i.e. E_2<E_4$



965 **(b)**

Given electric potential of spheres are same $i.e$

$V_A=V_B$

$\Rightarrow \frac{1}{4\pi\varepsilon_0}.\frac{Q_1}{a}=\frac{1}{4\pi\varepsilon_0}.\frac{Q_2}{b}\Rightarrow\frac{Q_1}{Q_2}=\frac{a}{b}$ ...(i)

As surface charge density $\sigma=\frac{Q}{4\pi r^2}$

$$\Rightarrow\frac{\sigma_1}{\sigma_2}=\frac{Q_1}{Q_2}\times\frac{b^2}{a^2}=\frac{a}{b}\times\frac{b^2}{a^2}=\frac{b}{a}$$

966 **(b)**

In equilibrium $QE=mg\Rightarrow Q.\frac{V}{d}=mg=\left(\frac{4}{3}\pi r^3\rho\right)g$

$$\Rightarrow 2\times1.6\times10^{-19}\times\frac{12000}{2\times10^{-2}}$$

$$=\frac{4}{3}\pi r^3\times900\times10$$

$$\Rightarrow r=1.7\times10^{-6}m$$

967 **(a)**

Direct formula : (energy density $=\frac{1}{2}\varepsilon_0E^2$) × volume

969 **(c)**

$$C\propto\frac{1}{d}\Rightarrow\frac{C_1}{C_2}=\frac{d_2}{d_1}\Rightarrow\frac{15}{C_2}=\frac{2}{6}\Rightarrow C_2=45\mu F$$

970 **(b)**

The two capacitors are in parallel so $C=\frac{\varepsilon_0A}{t\times2}(k_1+k_2)$

972 **(d)**

$V_{\text{bigdrop}}=n^{2/3}\,V_{\text{small}}$

973 **(c)**

If dipole be rotated from an initial orientation $\theta=\theta_1$ to final orientation $\theta=\theta_2$, the total work required is

$$W=\int_{\theta_1}^{\theta_2}pE\sin\theta\,d\theta$$

$$W=pE[-\cos\theta]_{\theta_1}^{\theta_2}$$

Where p is dipole moment and E the electric field.

In first case.

$$W = pE(1 - \cos 60°)$$

$$W = pE\left(1 - \frac{1}{2}\right) = \frac{pE}{2}$$

$$\Rightarrow pE = 2W$$

In second case,

$$W_2 = pE(1 - \cos 180°)$$

$$W_2 = 2W(1 + 1) = 4W$$

974 **(a)**

Charge enclosed in the sphere of radius r

$$q = \frac{4}{3}\pi r^3 \rho$$

$$E = \frac{q}{4\pi\varepsilon_0 r^2} = \frac{\frac{4}{3}\pi r^3 \rho}{4\pi\varepsilon_0 r^2} = \frac{r\rho}{3\varepsilon_0}$$

975 **(c)**

Since aluminium is a metal, therefore field inside this will be zero. Hence it would not affect the field in between the two plates, so capacity $= \frac{q}{V} = \frac{q}{Ed}$ remains unchanged

976 **(d)**

Given, $q = 0.05\mu C = 5 \times 10^{-8} C$

$$2a = 30 mm = 0.03 m$$

$$E = 10^6 NC^{-1}$$

Torque acting on an electric dipole placed in an uniform electric field

$$\tau = pE \sin\theta$$

For maximum torque $\theta = 90°$

$$\therefore \quad \tau_{max} = pE = E(q \times 2a)$$

$$= 10^6 \times 5 \times 10^{-8} \times 0.03$$

$$= 1.5 \times 10^{-3} N - m$$

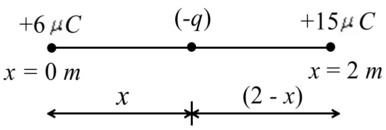
977 **(b)**

In steady state charge on C_1 is

$$Q_1 = \left(\frac{C_1}{C_1 + C_2}\right) \times Q = \frac{Q}{3}$$

and charge on C_2 is $Q_2 = \left(\frac{C_2}{C_1 + C_2}\right).Q = \frac{2}{3}Q$

978 **(a)**



Let the charge $(-q)$ be placed at a distance x from $+6\mu C$. As the resultant force on $(-q)$ is zero

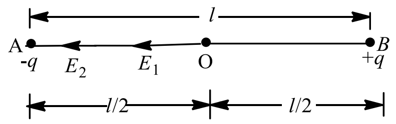
$$\therefore \frac{(-q) \times 6 \times 10^{-6}}{4\pi\varepsilon_0 \times x^2} = \frac{(-q) \times 15 \times 10^{-6}}{4\pi\varepsilon_0 \times (2 - x)^2}$$

$$\frac{6}{x^2} = \frac{15}{(2 - x)^2} \Rightarrow \frac{1}{x} = \pm\frac{\sqrt{5}}{\sqrt{2}(2 - x)}$$

On solving, we get $x = 0.775m$ or $x = -3.44m$

980 **(d)**

Let AB be a dipole of length l. Hence O be the midpoint of the dipole.



Then the electric field at point O, due to $+q$ charge

$$E_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{\left(\frac{l}{2}\right)^2}$$

$$\Rightarrow E_1 = \frac{1}{4\pi\varepsilon_0}\frac{4q}{l^2} \qquad \text{(along } OA\text{)}$$

and the electric field at point O, due to −q charge

$$E_2 = \frac{1}{4\pi\varepsilon_0}\frac{q}{\left(\frac{l}{2}\right)^2}$$

$$\Rightarrow E_2 = \frac{1}{4\pi\varepsilon_0}\frac{4q}{l^2} \qquad \text{(along } OA\text{)}$$

Hence, the total electric field at point O

$$E = E_1 + E_2$$

$$E = 2.\frac{1}{4\pi\varepsilon_0}\frac{4q}{l^2}$$

$$\Rightarrow \quad E = \frac{1}{4\pi\varepsilon_0}\frac{8q}{l^2} \quad \text{....(i)}$$

Now, potential at O, due to $+q$ charge

$$V_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{l/2}$$

$$\Rightarrow V_1 = \frac{1}{4\pi\varepsilon_0}\frac{2q}{l}$$

and potential at point O, due to $-q$ charge

$$V_2 = \frac{1}{4\pi\varepsilon_0} \frac{-q}{l/2}$$

$$\Rightarrow \ V_2 = -\frac{1}{4\pi\varepsilon_0} \frac{2q}{l}$$

Hence, total potential at point O,

$V = 0$ …………………(ii)

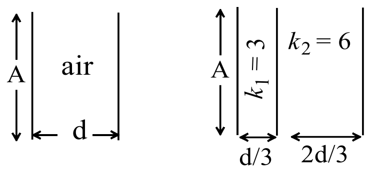
On dividing Eq. (i) by Eq. (ii), we get

$$\frac{E}{V} = \infty$$

982 **(b)**

$$U = \int_0^V CV\, dV = \frac{1}{2} CV^2$$

983 **(b)**



$$C_{air} = \frac{\varepsilon_{0A}}{d} = 9, \frac{1}{C_{\text{med}}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{d_1}{k_1\varepsilon_0 A} + \frac{d_2}{k_2 \varepsilon_0 A}$$

$$\Rightarrow C_{\text{med}} = \frac{k_1 k_2 \varepsilon_0 A}{k_1 d_2 + k_2 d_1}$$

$$= \frac{3 \times 6 \times \varepsilon_0 A}{3 \times 2d/3 + 6 \times d/3} = \frac{18}{4} \times 9 = 40.5\ pF$$

984 **(a)**

Energy $U = \frac{1}{2}\frac{Q^2}{C}$ for a charged capacitor charge Q is costant and with the increase in separation C will decrease $\left(C \propto \frac{1}{d}\right)$, so overall U will increase

985 **(a)**

Common potential $V = \frac{\text{Total charge}}{\text{Total capacitance}}$

$$V = \frac{150 \times 10^{-6} \times 2}{4\pi\varepsilon_0 (10 \times 10^{-2} + 20 \times 10^{-2})} = 9 \times 10^6\ V$$

986 **(c)**

Coulombic force on electron, $F_e = a_e m_e$

Similarly, for proton $F_p = a_p m_p$

Here $\quad F_e = F_p$

$\therefore \quad a_e m_e = a_P m_p$

$$\Rightarrow \quad a_p = \frac{a_e m_e}{m_p}$$

$$= \frac{(2.5 \times 10^{22})(9.1 \times 10^{-31})}{1.6 \times 10^{-27}}$$

$= 1.42 \times 10^{19}$

$= 1.5 \times 10^{19}\ \text{m/s}^2$

987 **(d)**

The electric field intensity at a point lying outside the sphere (non-conducting) is

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$$

Where r is the distance of that point from centre of sphere.

$$E \propto \frac{1}{r^2} \quad \ldots.(i)$$

The electric field intensity at surface of sphere

$$E = \frac{q}{4\pi\varepsilon_0 R^2}$$

Or

$$E \propto \frac{1}{R^2} \quad \ldots.(\text{ii})$$

R, being the radius of sphere.

The electric field intensity at a point lying inside the sphere is

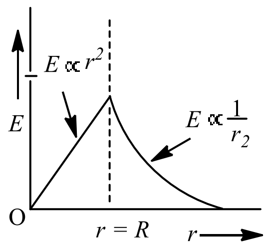
$$E = \frac{qr}{4\pi\varepsilon_0 R^3}$$

Or $E \propto r \quad \ldots\ldots(\text{iii})$

Also at the centre of sphere r=0.

Hence,

The graphical distribution is shown below



988 **(a)**

In equilibrium

$$QE = mg \Rightarrow n = \frac{mg}{Ee} = \frac{9.6 \times 10^{-16} \times 10}{20{,}000 \times 1.6 \times 10^{-19}} = 3$$

990 **(c)**

ABCDE is an equipotential surface, on equipotential surface no work is done in shifting a charge from one place to another

991 **(b)**

$$E = \frac{V}{d} = \frac{10}{2 \times 10^{-2}} = 500\ N/C$$

992 **(b)**

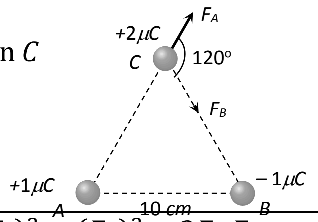
F_A = Force on C due to charge placed at A

$= 9 \times 10^9 \times \frac{10^{-6} \times 2 \times 10^{-6}}{(10 \times 10^{-2})^2} = 1.8N$

F_B = Force on C due to charge placed at B

$= 9 \times 10^9 \times \frac{10^{-6} \times 2 \times 10^{-6}}{(0.1)^2} = 1.8N$

Net force on C



$F_{net} = \sqrt{(F_A)^2 + (F_B)^2 + 2F_A\, F_B \cos 120°} = 1.8N$

993 **(d)**

$U = \frac{1}{2}QV$ = Area of triangle OAB

995 **(b)**

$\Delta E = 2e \times 5V = 10eV \Rightarrow$ Final kinetic energy = $10eV$

996 **(c)**

Electric potential inside a conductor is constant and it is equal to that on the surface of conductor

997 **(d)**

$C = \frac{\varepsilon_0 A}{d}$ ...(i)

$C' = \frac{\varepsilon_0 K A}{2d}$ ...(ii)

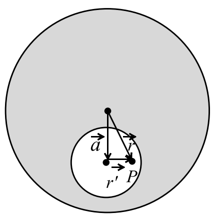
From equation (i) and (ii)

$\frac{C'}{C} = \frac{K}{2} \Rightarrow 2 = \frac{K}{2} \Rightarrow K = 4$

998 **(b)**

a = distance between centre of both spheres

By principle of superposition the net electric field at point P



$\vec{E} = \frac{\rho \vec{r}}{3\,\epsilon_0} - \frac{\rho \vec{r}''}{3\,\epsilon_0}$

$\therefore \vec{r} - \vec{r}'' = \vec{a}$

$\therefore \vec{E} = \frac{\rho \vec{a}}{3\epsilon_0}$ = uniform

999 **(d)**

Electric charge is quantised. It is an integral multiple of $e = 1.60 \times 10^{-19}C$

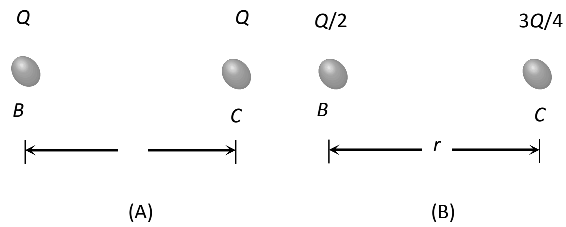
1000 **(a)**

Half disk (charge $3C$), and fourth part of rod (charge $2C$) and charge of $-7C$ are inside the cubical surface, so net charge inside the surface = $3 + 2 - 7 = -2C$

$\therefore$ Flux through the surface $\phi = \frac{1}{\varepsilon_0}(Q) = \frac{-2C}{\varepsilon_0}$

1001 **(d)**

Initially $F = k.\frac{Q^2}{r^2}$ (fig. A). Finally when a third spherical conductor comes in contact alternately with B and C then removed, so charges on B and C are $Q/2$ and $3Q/4$ respectively (fig. B)



Now force $F' = k.\frac{\left(\frac{Q}{2}\right)\left(\frac{3Q}{4}\right)}{r^2} = \frac{3}{8}F$

1002 **(a)**

$q_1 = 2CV, q_2 = CV$

Now condenser of capacity C is filled with dielectric K,

therefore $C_2 = KC$

As charge is conserved

$\therefore q_1 + q_2 = (C_2' + 2C)V' \Rightarrow V' = \frac{3CV}{(K+2)C}$

$= \frac{3V}{K+2}$

1003 **(c)**

Because there is no source of charge

1004 **(b)**

$C_1 = \frac{C}{4}$ (series); $C_2 = 4C$ (parallel)

$\therefore \frac{C_1}{C_2} = \frac{C/4}{4C} = \frac{1}{16}$

1005 **(a)**

$P.E.\, U_o = \frac{Q^2}{2C}$

When a slab of dielectric constant k is inserted,

Then $C' = Ck$

$U' = \frac{Q^2}{2C'} = \frac{Q^2}{2Ck} = \frac{U_o}{k}$

1006 **(c)**

Torque,

$\tau = p \times E$

$\tau_{\max} = pE = 6 \times 10^{-30} \times 3 \times 10^{4}$

$= 18 \times 10^{-26}\text{Nm}$

1007 **(c)**

Capacitance with dielectric $C_{medium} = \frac{K\varepsilon_0 A}{d}$

$\Rightarrow C_{medium} \propto \frac{K}{d}$

1008 **(c)**

Charge enclosed by the sphere of radius r_1 is

$$Q' = \int_0^{r_1} \delta(4\pi r^2)dr = \int_0^{r_1} \frac{Q}{\pi R^4} r(4\pi r^2)dr$$

$$Q' = \frac{Q}{\pi R^4}(4\pi)\left[\frac{r^4}{4}\right]_0^{r_1} = \frac{Qr_1^4}{R^4}$$

$\therefore E.F.$ at p is $E = \frac{1}{4\pi\varepsilon_0}.\frac{Q'}{r_1^2} = \frac{1}{4\pi\varepsilon_0}.\frac{Qr_1^4/R^4}{r_1^2}$

$$E = \frac{Qr_1^2}{4\pi\varepsilon_0 R^4}$$

1009 **(a)**

As $E \propto \frac{1}{r^3} \quad \therefore n = -3$

1011 **(d)**

Charge on capacitor for when it's potential becomes 10 V

$Q = CV = 500 \times 10^{-6} \times 10 = 5000 \times 10^{-6}\mu C$

$\therefore$ Required time $= \frac{5000\times10^{-6}}{100\times10^{-6}} = 50$ sec

1013 **(c)**

$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$ (110/100) (90/100) times

$ie, \frac{99}{100}$ times

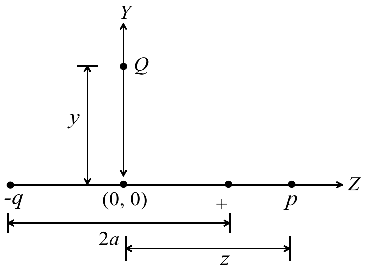
$\therefore$ net force $= \frac{99}{100} \times 100 = 99\text{N}$

1014 **(a)**

By using $KE = QV \Rightarrow KE = 1.6 \times 10^{-19} \times 100$ $= 1.6 \times 10^{-17}\, J$

1015 **(d)**

The magnitude of electric field at a axial point P at a distance z from the origin is given by



$$|\vec{E}_{(z)}| \frac{4qaz}{4\pi\varepsilon_0(z^2 - a^2)^2} = \frac{2pz}{4\pi\varepsilon_0(z^2 - a^2)^2}$$

Where $p = 2qa$ is the electric dipole moment

For $z >> a, |\vec{E}_{(z)}| = \frac{2p}{4\pi\varepsilon_0 z^3}$

The magnitude of electric field at a equatorial point Q at a distance y from the origin is given by

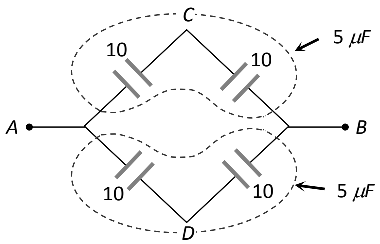
$$|\vec{E}_{(y)}| = \frac{1}{4\pi\varepsilon_0}\frac{2qa}{(y^2 + a^2)^{3/2}} = \frac{p}{4\pi\varepsilon_0(y^2 + a^2)^{3/2}}$$

For $y >> a, |\vec{E}_{(y)}| = \frac{p}{4\pi\varepsilon_0 y^3}$

For $z = y >> a, \therefore \frac{|\vec{E}_{(z)}|}{|E_{(y)}|} = 2$

1016 **(d)**

In the given system, no current will flow through the branch CD so it can be removed



Effective capacitance of the system $= 5 + 5 = 10\mu F$

1017 **(b)**

Potential energy of charges Q_1 and Q_2 at 10cm apart

$$= \frac{1}{4\pi\varepsilon_0}\frac{12 \times 10^{-6} \times 5 \times 10^{-6}}{0.1}$$

$$= \frac{9 \times 10^9 \times 60 \times 10^{-12}}{0.1} = 54 \times 10^{-1} = 5.4\, J$$

At 6 cm apart,

$$\text{P. E.} = \frac{9 \times 10^9 \times 60 \times 10^{-12}}{0.06} = 9\, J$$

$\therefore$ Work done $= (9 - 5.4)\text{J} = 3.6$ J

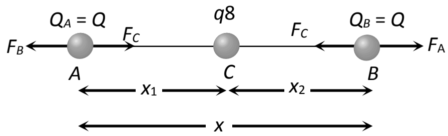
1018 **(c)**

By Gauss Law

1019 **(b)**

Suppose in the following figure, equilibrium of charge B is considered. Hence for it's equilibrium $|F_A| = |F_C|$

$$\Rightarrow \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{4x^2} = \frac{1}{4\pi\varepsilon_0}\frac{qQ}{x^2} \Rightarrow q = \frac{-Q}{4}$$



Short trick : For such type of problem the magnitude of middle charge can be determined if either of the extreme charge is in equilibrium by using the following formula

If charge A is in equilibrium then $q = -Q_B\left(\frac{x_1}{x}\right)^2$

If charge B is in equilibrium then $q = -Q_A\left(\frac{x_2}{x}\right)^2$

If the whole system is in equilibrium then use either of the above formula

Session : 2025-26 **AS PER NEW NTA SYLLABUS**

Total Questions : 1053

PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 1 to 0. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

1

Statement 1: When charges are shared between any two bodies, no charge is really lost, but some loss of energy does occur

Statement 2: Some energy disappears in the form of heat, sparking *etc*

2

Statement 1: Dielectric breakdown occurs under the influence of an intense light beam

Statement 2: Electromagnetic radiations exert pressure

3

Statement 1: Electrons move away from a low potential to high potential region

Statement 2: Because electrons have negative charge

4

Statement 1: The surface charge densities of two spherical conductors of different radii are equal. Then the electric field intensities near their surface are also equal

Statement 2: Surface charge density is equal to charge per unit area

5

Statement 1: Electric lines of force cross each other

Statement 2: Electric field at a point superimposes to give one resultant electric field

6

Statement 1: A parallel plate capacitor is connected across battery through a key. A dielectric slab of constant K is introduced between the plates. The energy which is stored becomes K times

Statement 2: The surface density of charge on the plate remains constant or unchanged

7

Statement 1: If three capacitors of capacitance $C_1 < C_2 < C_3$ are connected in parallel then their equivalent capacitance $C_p > C_3$

Statement 2: $\frac{1}{C_p} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

8

Statement 1: A point charge is brought in an electric field. The field at a nearby point will increase, whatever be the nature of the charge

Statement 2: The electric field is independent of the nature of charge

9

Statement 1: Mass of ion is slightly differed from its element

Statement 2: Ion is formed, when some electrons are removed or added so mass changes

10

Statement 1: For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q

Statement 2: The net work done by a conservative force on an object moving along a closed loop is zero

11

Statement 1: If a proton and an electron are placed in the same uniform electric field. They experience different acceleration

Statement 2: Electric force on a test charge is independent of its mass

12

Statement 1: If the distance between parallel plates of a capacitor is halved and dielectric constant is made three times, then the capacitance becomes 6 times

Statement 2: Capacity of the capacitor does not depend upon the nature of the material

13

Statement 1: A charged capacitor is disconnected from a battery. Now if its plate are separated farther, the potential energy will fall

Statement 2: Energy stored in a capacitor is equal to the work done in charging it

14

Statement 1: A number of capacitors are connected in series with each other. If U_1 U_2 U_3 be the energy stored in them respectively then total energy stored is $U_1 + U_2 + U_3 + ...$

Statement 2: Potential energy is the scalar quantity.

15

Statement 1: The force with which one plate of a parallel plate capacitor is attracted towards the other plate is equal to square of surface density per ε_0 per unit area

Statement 2: The electric field due to one charged plate of the capacitor at the location of the other is equal to surface density per ε_0

16

Statement 1: The tyres of aircraft's are slightly conducting

Statement 2: If a conductor is connected to ground, the extra charge induced on conductor will flow to ground

17

Statement 1: On going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases

Statement 2: Electric field is inversely proportional to square of distance from the charge or an electric dipole

18

Statement 1: For practical purpose, the earth is used as a reference at zero potential in electrical circuits

Statement 2: The electrical potential of a sphere of radius R with charge Q uniformly distributed on the surface is given by $\frac{Q}{4\pi\varepsilon_0 R}$

19

Statement 1: A and B are two conducting spheres of same radius A being solid and B hollow. Both are charged to the same potential. Then charge A =charge B

Statement 2: Potentials on both are same.

20

Statement 1: A metallic shield in form of a hollow shell may be built to block an electric field

Statement 2: In a hollow spherical shield, the electric field inside it is zero at every point

21

Statement 1: Conductors having equal positive charge and volume, must also have same potential

Statement 2: Potential depends only on charge and volume of conductor

22

Statement 1: Annihilation of electron and positron is an example of decay of charges

Statement 2: In the process of annihilation an electron and a positron combine to give gamma ray

23

Statement 1: The coulomb's force is the dominating force in the universe.

Statement 2: The coulomb's force is the weaker than the gravitational force.

24

Statement 1: A small metal ball of mass m is suspended from a thread of length I between the plates of a large capacitor. If a charge +q is placed on the ball and the upper plate is positively charged then time period of the ball increases.

Statement 2: Time period of the ball is given by T= $2\pi \frac{\sqrt{l}}{g-1e/m}$

25

Statement 1: The coulomb face is the dominating force in the universe

Statement 2: The coulomb force is weaker than the gravitational force

26

Statement 1: A molecule having intrinsic dipole moment is called polar molecule.

Statement 2: Centre of positive charge does not coincide with the negative charge in a polar molecule.

27

Statement 1: Surface of a symmetrical conductor can be treated as equipotential surface

Statement 2: Charges can easily flow in a conductor

28

Statement 1: If three capacitors of capacitances $C_1 < C_2 < C_3$ are connected in parallel and in series then their equivalent capacitance $C_p > C_s$.

Statement 2: $\frac{1}{Cp} = \frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3}$ and $C_s = C_1 + C_2 + C_3$

29

Statement 1: A bird perches on a high power line and nothing happens to the bird

Statement 2: The level of bird is very high from the ground

30

Statement 1: If a point charge q is placed in front of an infinite grounded conducting plane surface, the point charge will experience a force

Statement 2: This force is due to the induced charge on the conducting surface which is at zero potential

31

Statement 1: Displacement current goes through the gap between the plates of a capacitor when the charge of the capacitor does not change

Statement 2: The displacement current arises in the region in which the electric field and hence the electric flux does not change with time

32

Statement 1: When a charge $'q'$ is take from the centre of the surface of the sphere its potential energy changes by $\frac{q\rho}{3\varepsilon_0}$

Statement 2: The electric field at a distance $r(r < R)$ from the centre of the sphere is $\frac{\rho r}{3\varepsilon_0}$

33

Statement 1: The electric field due to a dipole on its axis line at a distance r is E. then, electric field due to the same dipole on the equatorial line and a the same distance will be $\frac{E}{2}$

Statement 2: Electric field due to dipole varies inversely as the squares of distance.

PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

: ANSWER KEY :

1)	b	2)	b	3)	a	4)	b
5)	d	6)	c	7)	c	8)	d
9)	a	10)	b	11)	b	12)	b
13)	d	14)	b	15)	d	16)	b
17)	d	18)	b	19)	a	20)	a
21)	d	22)	d	23)	d	24)	d
25)	d	26)	a	27)	a	28)	a
29)	c	30)	a	31)	d	32)	d
33)	c						

PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

: HINTS AND SOLUTIONS :

1 **(b)**
Charge is always conserved but energy is lost in the term of heat

3 **(a)**
Electron has negative charge, in electric field negative charge moves from lower potential to higher potential

4 **(b)**
As $\sigma_1 = \sigma_2$ [Given]

$\therefore \frac{q_1}{4\pi r_1^2} = \frac{q_2}{4\pi r_2^2}$, or $\frac{q_1}{q_2} = \frac{r_1^2}{r_2^2}$ [Let r_1 and r_2 be two different radii]

Then the ratio of electric field intensities near the surface of spherical conductor,

$$\frac{E_1}{E_2} = \frac{q_1}{4\pi\varepsilon_0 r_1^2} \times \frac{4\pi\varepsilon_0 r_2^2}{q_2} = \frac{q_1}{q_2} \times \frac{r_2^2}{r_1^2} = 1 \ i.e. E_1 = E_2$$

5 **(d)**
If electric lines of forces cross each other, then the electric field at the point of intersection will have two direction simultaneously which is not possible physically

6 **(c)**
In the given case $V = V_0$ [constant]

Energy stored in the capacitor $= \frac{1}{2}CV^2$

$C \rightarrow KC$, so energy stored will become A times

$Q = CV$, so Q will become K times

$\therefore$ Surface charge density $\sigma' = \frac{Kq}{A} = K\sigma_0$

7 **(c)**
Equivalent capacitance of parallel combination is $C_p = C_1 + C_2 + C_3$

8 **(d)**
Electric field at the nearby point will be resultant of existing field and field due to the charge brought. It may increase or decrease if the charge is positive or negative depending on the position of the point with respect to the charge brought

11 **(b)**
Electron and proton have same amount of charge so they have same coulomb force. They have different accelerations because they have different masses $\left[a = \frac{F}{m}\right]$

Therefore, both assertion and reason are true and reason is not the correct explanation of the assertion

12 **(b)**
By the formula capacitance of a capacitor

$$C_1 = \varepsilon_0 \times \frac{KA}{d} \propto \frac{K}{d}$$

Hence, $\frac{C_1}{C_2} = \frac{K_1}{d_1} \times \frac{d_2}{K_2} = \frac{K}{d} \times \frac{d/2}{3K} = \frac{1}{6}$ or $C_2 = 6C_1$

Again for capacity of a capacitor $C = \frac{Q}{V}$

Therefore, capacity of a capacitor does not depend upon the nature of the material of the capacitor

13 **(d)**
Battery is disconnected from the capacitor

So $Q =$ constant. Energy $= \frac{Q^2}{2C} = \frac{Q^2 d}{2\varepsilon_0 A}$

$\Rightarrow$ Energy $\propto d$

14 **(b)**
The total energy stored in series combination of capacitors is the sum of energies stored in the individual capacitors i.e., U=$U_1 + U_2 + U_3 + \cdots$is also true that potential energy is the scalar quantity.

15 **(d)**
The electric field due to one charged plate at the location of the other is $E = \sigma/2\varepsilon_0$ and the force per unit area is $F = \sigma$ E $= \sigma^2/2\varepsilon_0$

16 **(b)**
During take off and landing, the friction between tyres and the run way may cause electrification of tyres. Due to conducting nature of tyre, the charge so collected is conducted to a ground and electrical sparking is avoided

17 **(d)**
The rate of decrease of electric field is different in the two cases. In case of a point charge, it decreases as $1/r^2$ but in the case of electric dipole it decreases more rapidly, as $E \propto 1/r^3$

18 **(b)**
Statement 1 is true by information

Statement 2 is true by formula. But statement 2 is not the explanation of statement 1

19 **(a)**
Let Q_A andQ_B be the charges on the solid and the hollow conducting spheres respectively and R be the radius of each sphere. When charge is given to a solid conducting sphere, it appears on the outer surface. For the calculation of electric field or potential due to a sphere (Whether hollow or solid) at a point on or outside the sphere, the charge behaves as if it is concentrated at the center of the sphere. If $V_A andd\ V_B$ are potential of two spheres, then

$$V_A = \frac{1}{4\pi\epsilon_o}\frac{Q_A}{R}\ or\ V_B = \frac{1}{4\pi\epsilon_o}\frac{Q_B}{R}$$

Since, $V_A = V_B$

$\Rightarrow \quad Q_A = Q_B$

20 **(a)**
In a hollow spherical shield, the charge is present only on its surface but charge is zero at every point inside the hollow sphere. Hence, the metallic shield in form of hollow shell may be built to block an electric field

21 **(d)**
Electric potential of a charged conductor depends not only on the amount of charge and volume but also on the shape of the conductor. Hence if their shapes are different, they may have different electric potential

22 **(d)**
It is an example of conversation of charges

23 **(d)**
Gravitational force is the dominating force in nature not coulomb's force. Gravitational force is the weakest force.

24 **(d)**
Figure shows the forces on the metal ball, when the upper plate of the capacitor is positively charged.

If E is strength of the electric field between the plates, then apparent weight of the ball

Diagram

$$mg' = mg + qE$$

$$or \qquad g' = g + \frac{qE}{m}$$

The period of oscillation of the ball is given by

$$T = 2\pi\sqrt{\frac{1}{g}} = 2\pi\sqrt{\frac{1}{g + qE/m}}$$

Since, g + qE /m>g, the time period of the ball will decrease.

25 **(d)**
Gravitational force is the dominating force in nature and not coulomb's force. Gravitational force is the weakest force. Also, Coulomb's force >> gravitational force

26 **(a)**
A polar molecular has intrinsic dipole moment or permanent dipole moment, so it is called an electric dipole. In a polar molecule, the centers of positive and negative charges do not coincide

with each other because of asymmetric shape of molecule.

27 **(a)**
Potential is constant on the surface of a sphere so it behaves as an equipotential surface

28 **(a)**
In series combination

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

In parallel combination

$$C_p = C_1 + C_2 + C_3$$

Thus, it is obvious that

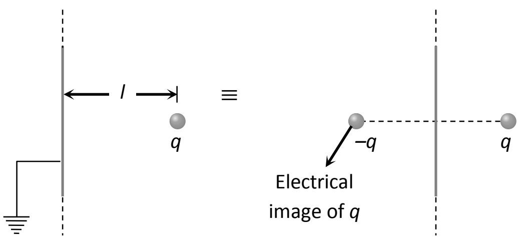
$$C_p > C_s$$

29 **(c)**
When the bird perches on a single high power line, no current passes through its body because its body is at equipotential surface $i.e.$, there is no potential difference. While when man touches the same line, standing bare foot on ground the electrical circuit is completed through the ground. The hands of man are at high potential and his feet's are at low potential. Hence large amount of current flows through the body of the man and person therefore gets a fatal shock

30 **(a)**
This is the concept of electric image

If we are asked to find the force between an infinite earthed conductor and a point charge q placed at perpendicular distance l from the earthed conductor (see figure), than we proceed as follows

Firstly, the conductor being earthed implies $V = 0$



So, we redraw the situation in which we replace the conductor and introduce an **IMAGE** charge $-q$ as shown

The force between the two charges (object charge q and image charge $-q$) is the electrostatic force between the infinite grounded conductor and q

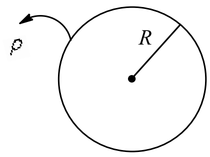
So, $F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{(2l)^2} \Rightarrow F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{4l^2}$ [attractive in nature]

31 **(d)**
Displacement current is not the current produced due to charge carries but it is due to varying electric flux with time. It is the current in the sense that it produces a magnetic field. The displacement current is given by

$$I_d = \varepsilon_0 \frac{d\phi_\varepsilon}{dt}$$

It will happen when charge on capacitor does not remain constant but changes with time

32 **(d)**



$$U_c = \frac{3}{2}\frac{KQ}{R}q, U_S = \frac{KQ}{R}q$$

$$\therefore \Delta U = \frac{KQ}{2R}q$$

$$= \frac{1}{4\pi\varepsilon_0}.\frac{1}{2R}\rho\frac{4\pi R^3}{3}q = \frac{\rho R^2 q}{6\varepsilon_0}$$

33 **(c)**
We know that for an electric dipole,

$$E_{axial} = \frac{1}{4\pi\epsilon_o}\left(\frac{2p}{r^3}\right) \qquad \text{... ...}(i)$$

And $E_{equatorial} = \frac{1}{4\pi\epsilon_o}\left(\frac{p}{r^3}\right)$ ... ...(ii)

Hence, from Eqs. (i) and (ii)

$$\frac{E_{axial}}{2} = E_{equatorial}$$

Hence. $E_{equatorial} = \frac{E}{2}$

Reason is false as electric field due to dipole varies inversely as cube of distance i.e., $E \propto \frac{1}{r^3}$.

Session : 2025-26 **AS PER NEW NTA SYLLABUS**

Total Questions : 1053

PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

1. Six point charges, each of the same magnitude q, are arranged in different manners as shown in Column II. In each case, a point M and a line PQ passing through M are shown. Let E be the electric field and V be the electric potential at M (potential at infinity is zero) due to the given charge distribution when it is at rest. Now, the whole system is set into rotation with a constant angular velocity about the line PQ. Let B be the magnetic field at M and μ be the magnetic moment of the system in this condition. Assume each rotation charge to be equivalent to a steady current

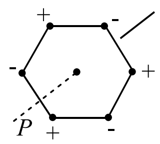
Column-I

(A) $E = 0$

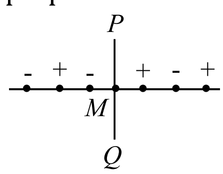
(B) $V \neq 0$

(C) $B = 0$

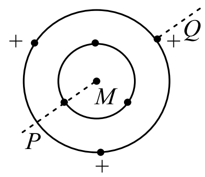
Column- II

(p) 

Charge are at the corners of a regular hexagon. M is at the centre of the hexagon. PQ is perpendicular to the plane of the hexagon

(q) 

Charges are on a line perpendicular to PQ at equal intervals. M is the mid-point between the two innermost charges

(r) 

Charges are placed on two coplanar insulating rings at equal intervals. M is the common

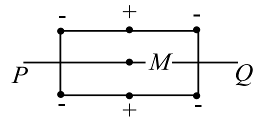
(D) $\mu \neq 0$

CODES :

	A	**B**	**C**	**D**
a)	P,r,s	r,s	p,q,t	r,s
b)	r,s	p,q,t	r,s	p,r,
c)	p,q,t	r,s	r,s	p,r,s
d)	r,s	p,r,s	r,s	p,q,t

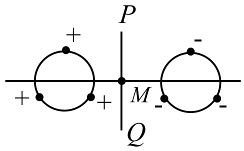
centre of the rings. PQ is perpendicular to the plane of the rings

(s)



Charges are placed at the corners of a rectangle of sides a and $2a$ and at the mid points of the longer sides. M is at the centre of the rectangle. PQ is parallel to the longer sides

(t)



Charges are placed on two coplanar, identical insulating rings at equal intervals. M is the mid-point between the centres of the rings. PQ is perpendicular to the line joining the centres and coplanar to the rings

PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

: ANSWER KEY :

1)	**a**

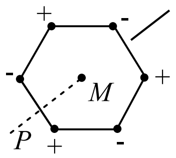
PHYSICS (QUESTION BANK)

1.ELECTRIC CHARGES AND FIELDS

: HINTS AND SOLUTIONS :

1 **(a)**

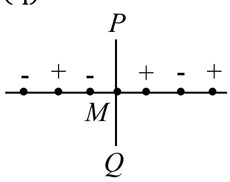
(p)



By symmetry an $E=0, V=0, B=0$

$\mu=$ NIA but $I_{\text{effective}}=0$, So, $\mu=0$

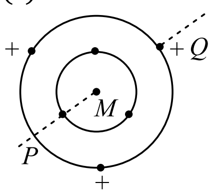
(q)



$E \neq 0, V=0$ Since $I_{\text{effective}}=0$

$\Rightarrow B=0$ and $\mu=0$

(r)



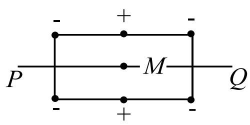
$E=0$ (By Symmetry)

$V \neq 0$ (Since distances are different)

$B \neq 0$ (Since Radius is different)

$\mu \neq 0$

(s)



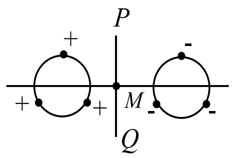
$E=0$ (By Symmetry)

$V \neq 0$ (Since distances are different)

$B \neq 0$

$\mu \neq 0$

(t)



$E \neq 0, V=0, \mu=0, B=0$ and given each rotating charge to be equivalent to a steady current so $B=0$ so $(t \rightarrow C)$ and it was not given that each rotating charge to be equivalent to steady current then $B \neq 0$