Session : 2025-26 **AS PER NEW NTA SYLLABUS**

Total Questions : 143

PHYSICS (QUESTION BANK)

8.ELECTROMAGNETIC WAVES

Single Correct Answer Type

1. In an electromagnetic wave, the electric and magnetizing fields are 100 Vm^{-1} and 0.265 Am^{-1}. The maximum energy flow is
a) 26.5 Wm^{-2} b) 36.5 Wm^{-2} c) 46.7 Wm^{-2} d) 765 Wm^{-2}
2. X-ray are not used for radar purpose, because they are not
a) Reflected by target b) Partly absorbed by target
c) Electromagnetic waves d) Completely absorbed by target
3. If an electromagnetic wave is propagation in a medium with permittivity ε and permittivity μ, then $\sqrt{\frac{\mu}{\varepsilon}}$ is the
a) Intrinsic impedance of the medium b) Square of the refractive index of the medium
c) Refractive index of the medium d) Energy density of the medium
4. An earth orbiting satellite has solar energy collecting panel with total area 5 m^2. If solar radiations are perpendicular and completely absorbed, the average force associated with the radiation pressure is (Solar constant= 1.4 kWm^{-2})
a) 2.33×10^{-3} N b) 2.33×10^{-4} N c) 2.33×10^{-5} N d) 2.33×10^{-6} N
5. For EM wave prorogating along x-axis, $E_{\text{max}} = 30 \text{ Vm}^{-1}$. what is maximum value of magnetic field?
a) 10^{-7} T b) 10^{-8} T c) 10^{-9} T d) 10^{-6} T
6. A parallel plate capacitor is charged to60μC. Due to a radioactive source, the plate loss charge at the rate of $1.8 \times 10^{-8} \text{ Cs}^{-1}$. The magnitude of displacement current is
a) $1.8 \times 10^{-8} \text{ Cs}^{-1}$ b) $3.6 \times 10^{-8} \text{Cs}^{-1}$ c) $4.1 \times 10^{-11} \text{Cs}^{-1}$ d) $5.7 \times 10^{-12} \text{ Cs}^{-1}$
7. If ε_0 and μ_0 are the electric permittivity and magnetic permeability of free space and ε and μ are the corresponding quantities in the medium, the index of refraction of the medium in terms of above parameter is
a) $\frac{\varepsilon\mu}{\varepsilon_0\mu_0}$ b) $\left(\frac{\varepsilon\mu}{\varepsilon_0\mu_0}\right)^{1/2}$ c) $\left(\frac{\varepsilon_0\mu_0}{\varepsilon\mu}\right)$ d) $\left(\frac{\varepsilon_0\mu_0}{\varepsilon\mu}\right)^{1/2}$
8. According to Maxwell's hypothesis, a changing electric field gives rise to
a) An emf b) Electric current c) Magnetic field d) Pressure radiant
9. Electric fields induced by changing magnetic fields are
a) Conservation b) Non-conservation
c) May be conservative or non-conservation depending on the conditions d) Nothing can be said
10. The electric field of a plane electromagnetic wave varies with time of amplitude 2 Vm^{-1} propagating along z-axis. The average energy density of the magnetic field is (in Jm^{-3})
a) 13.29×10^{-12} b) 8.86×10^{-12} c) 17.72×10^{-12} d) 4.43×10^{-12}
11. The sun delivers 10^4 Wm^{-2} of electromagnetic flux to the earth's surface. The total power that in incident on a roof of dimensions 10m square will be
a) 10^4W b) 10^5 W c) 10^6 W d) 10^7 W
12. Infrared radiation is detected by
a) Spectrometer b) Pyrometer c) Nanometer d) Photometer
13. Ground waves have wavelength

a) Less than 200 m b) Equal to 200 m c) More than 200 m d) All of these

14. A plane Electromagnetic Waves travelling along the X-direction has a wavelength of 3 mm. The variation in the electric field occurs in the Y-direction with an amplitude 66 Vm^{-1}. The equations for the electric and magnetic fields as a function of x and t are respectively

a) $E_y = 33 \cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_z = 1.1 \times 10^{-7} \cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$

b) $E_y = 11 \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_y = 11 \times 10^{-7} \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

c) $E_x = 33 \cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_x = 11 \times 10^{-7} \cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$

d) $E_y = 66 \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$, $B_z = 2.2 \times 10^{-7} \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

15. The frequency 1057 MHz of radiation arising from two close energy levels in hydrogen belongs to

a) Radio waves b) Infrared waves c) Micro waves d) $\gamma -$ rays

16. Maxwell in his famous equation of electromagnetism introduced the concept

a) AC current b) DC current c) Displacement current d) Impedance

17. In a plane electromagnetic wave electric field varies with time having an amplitude 1 Vm^{-1}. The frequency of wave is 0.5×10^{15} Hz. The wave is propagation along X-axis. What is the average energy density of magnetic field?

a) $1.1 \times 10^{-12} \text{J m}^{-3}$ b) $2.2 \times 10^{-12} \text{J m}^{-3}$ c) $3.3 \times 10^{-12} \text{J m}^{-3}$ d) $4.4 \times 10^{-12} \text{J m}^{-3}$

18. An Electromagnetic Wave of frequency v = 3.0 MHz passes from vacuum into a dielectric medium with permittivity $\varepsilon = 4.0$. Them

a) Wavelength is doubled and the frequency remains unchanged

b) Wavelength is doubled and frequency becomes half

c) Wavelength is halved and frequency remains unchanged

d) Wavelength and frequency both become unchanged

19. The amplitude of electric field in a parallel beam of light of intensity 4 Wm^{-2} is

a) 40.5 NC^{-1} b) 45.5 NC^{-1} c) 50.5 NC^{-1} d) 55.5 NC^{-1}

20. Assume that a lamp radiates power P uniformly in all directions. What is the magnitude of electric field strength at a distance r from the lamp?

a) $\frac{P}{\pi c \varepsilon_0 r^2}$ b) $\frac{P}{2\pi c \varepsilon r^2}$ c) $\sqrt{\frac{P}{2\pi \varepsilon_0 r^2 c}}$ d) $\sqrt{\frac{P}{\pi \varepsilon_0 c r^2}}$

21. The wavelength of infrared rays is of the order of

a) 5×10^{-7}m b) 10^{-3}m c) Diverge more d) None of these

22. Molybdenum is used as a target element for the production of X-rays because it is

a) Light and can easily defect electrons b) Light and can absorb electrons

c) A heavy element with a high melting point d) An element having high thermal conductivity

23. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields **E** and **B** with a velocity **v** perpendicular to both **E** and **B**, and comes out without any change in magnitude or direction of **v**. Then

a) $\mathbf{v} = \mathbf{E} \times \mathbf{B}/\text{B}^2$ b) $\mathbf{v} = \mathbf{B} \times \mathbf{E}/\text{B}^2$ c) $\mathbf{v} = \mathbf{E} \times \mathbf{B}/\text{E}^2$ d) $\mathbf{v} = \mathbf{B} \times \mathbf{E}/\text{E}^2$

24. If v_s, v_x and v_m are the speeds of gamma rays, X-rays and microwaves respectively in vacuum, then

a) $v_s > v_x > v_m$ b) $v_s < v_x < v_m$ c) $v_s < v_x < v_m$ d) $v_s = v_x = v_m$

25. The small ozone layer on top of the atmosphere is crucial for human survival because it

a) Has ions b) Reflects radio signals c) Absorbs UV rays d) Reflects IR rays

26. Television signals reach us only through the ground waves. The range R related with the transmitter height h is in proportion to

a) h b) $h^{1/2}$ c) $h^{-1/2}$ d) h^{-1}

27. In a plane electromagnetic wave propagating in space has an electric field of amplitude 9×10^3 Vm^{-1}, then the amplitude of the magnetic field is

a) 2.7×10^{12} T b) 9.0×10^{-3} T c) 3.0×10^{-4} T d) 3.0×10^{-5} T

28. A capacitor having a capacity of 2 pF. Electric field across the capacitor is changing with a value of 10^{12} Vs^{-1}. The displacement current is

a) 2 A b) 4 A c) 6 A d) 10 A

29. If 150 J of energy is incident on area 2 m^2. If $Q_r = 15$ J, coefficient of absorption is 0.6, then amount of energy transmitted is

a) 50 J b) 45 J c) 40 J d) 30 J

30. Radiations of intensity 0.5 Wm^{-2} are striking a metal plate. The pressure on the plate is

a) 0.166×10^{-8} Nm^{-2} b) 0.332×10^{-8} Nm^{-2} c) 0.111×10^{-8} Nm^{-2} d) 0.083×10^{-8} Nm^{-2}

31. A charged particles oscillates about its mean equilibrium position with a frequency of 10^9 Hz. Frequency of the Electromagnetic Waves produced by the oscillator is

a) 10 Hz b) 10^5 Hz c) 10^9 Hz d) 10^{10} Hz

32. The unit of expression $\mu_0\varepsilon_0$ are

a) ms^{-1} b) m^{2}s^{-2} c) s^{2}m^{-2} d) sm^{-1}

33. A layer of ionosphere does not reflect waves with frequencies greater than 10 MHz; then maximum electron density in this layer is

a) 1.23×10^{11} m^{-3} b) 1.23×10^{10} m^{-3} c) 12.3×10^{10} m^{-3} d) 1.23×10^{12} m^{-3}

34. A point source of Electromagnetic radiation has an average power output of 1500 W. The maximum value of electric field at a distance of 3 m from this source in Vm^{-1} is

a) 500 b) 100 c) $\frac{500}{3}$ d) $\frac{250}{3}$

35. A. The wavelength of microwaves is greater than that of UV-rays.

B. The wavelength of IR rays is lesser than that of UV-rays.

C. The wavelength of microwaves is lesser than that of IR-rays.

D. Gamma rays have shortest wavelength in the Electromagnetic Spectrum.

Of the above statements

a) A and B are true b) B and C are true

c) C and D are true d) A and D are true

36. If μ_0 is permeability of free space and ε_0 is permittivity of free space, the speed of light in vacuum is given by

a) $\sqrt{\mu_0\varepsilon_0}$ b) $\sqrt{\frac{\mu_0}{\varepsilon_0}}$ c) $\sqrt{\frac{1}{\mu_0\varepsilon_0}}$ d) $\sqrt{\frac{\varepsilon_0}{\mu_0}}$

37. A plane electromagnetic wave of intensity 10 Wm^{-2} strikes a small mirror of area 20 cm^2, held perpendicular to the approaching wave. The radiation force on the mirror will be

a) 6.6×10^{-11} N b) 1.33×10^{-11} N c) 1.33×10^{-10} N d) 6.6×10^{-10} N

38. A plane Electromagnetic Waves travels in free space along x-axis. At a particular point in space, the electric field along y-axis is 9.3 Vm^{-1}. The magnetic induction is

a) $3.1 \times 10^{-8}\,T$ b) $3 \times 10^{-5}\,T$ c) $3 \times 10^{-6}\,T$ d) $9.3 \times 10^{-6}\,T$

39. Clouds are contained in a layer from the earth's surface, which is called

a) Troposphere b) Stratosphere c) Mesosphere d) Ionosphere

40. The correct sequence of the increasing wavelength of the given radiation sources is

a) Radioactive sources, X-ray tube, crystal oscillator, sodium vapour lamp
b) Radioactive source, X-ray tube, sodium vapour lamp, crystal oscillator
c) X-ray tube, radioactive source, crystal oscillator, sodium vapour lamp
d) X-ray tube, crystal oscillator, radioactive source, sodium vapour lamp

41. An electromagnetic wave going through vacuum is described by
$E = E_0 \sin(kx - \omega t)$; $B = B_0 \sin(kx - \omega t)$
Which of the following equation is true?
a) $E_0 k = B_0 \omega$ b) $E_0 \omega = B_0 k$ c) $E_0 B_0 = \omega k$ d) None of these

42. If alpha, beta and gamma rays carry same momentum, which has the longest wavelength?
a) Alpha rays b) Beta rays
c) Gamma rays d) None, all have same wavelength

43. The curve drawn between velocity and frequency of a photon in vacuum will be
a) Straight line parallel to frequency axis b) Straight line parallel to velocity axis
c) Straight line passing through origin and making and angle of 45° with frequency axis d) Hyperbola

44. An Electromagnetic Wave has
a) Electric vector only
b) Magnetic vector only
c) Electric and Magnetic vector Perpendicular to each other
d) Neither the Electric vector nor the Magnetic vector

45. An electromagnetic radiation has an energy of 13.2 keV. Then the radiation belongs to the region of
a) Visible light b) Ultraviolet c) Infrared d) X-ray

46. The electric field of plane electromagnetic wave in vacuum is represented by $\vec{\mathbf{E}}_x = 0$; $\vec{\mathbf{E}}_y = 0.5 \cos[2\pi \times 10^8 (t - x/c)]$: $\vec{\mathbf{E}}_z = 0$
What is the direction of propagation of electromagnetic waves?
a) Along $x - z$ direction b) Along y-direction
c) Along x-direction d) A long $y - z$ direction

47. An expression for the magnetic field strength B at the point between the capacitor plates indicates in figure express B in terms of the rate of change of the electric field strength $ie, dE/dt$ between the plates
a) $\frac{\mu_0 i}{2\pi r}$ b) $\frac{\varepsilon_0 \mu_0 r}{2} dE/dt$ c) Zero d) $\frac{\mu_0 i}{2r}$

48. The temperature variation in the region of stratosphere lies from
a) 290 K to 220 K b) 220 K to 280 K c) 220 K to 380 K d) 180 K to 700 K

49. Which is having minimum wavelength?
a) X-rays b) Ultraviolet rays c) γ-rays d) Cosmic rays

50. The voltage applied across an X-ray tube is nearly equal to
a) 10 V b) 100 V c) 1000 V d) 10, 000 V

51. Given the wavefunction (in SI units) for a wave to be $\psi_{(x,t)} = 10^3 \sin \pi(3 \times 10^6\ x - 9 \times 10^{14}\ t)$ The speed of the wave is
a) $9 \times 10^{14}\ \text{ms}^{-1}$ b) $3 \times 10^8\ \text{ms}^{-1}$ c) $3 \times 10^6\ \text{ms}^{-1}$ d) $3 \times 10^7\ \text{ms}^{-1}$

52. The ozone layer of the atmosphere lies in the region called
a) Troposphere b) Stratosphere c) Mesosphere d) Ionosphere

53. Solar radiation is
a) Transverse Electromagnetic wave b) Longitudinal Electromagnetic wave
c) Stationary wave d) None of the above

54. Dimensions of $\frac{1}{\mu_0 \varepsilon_0}$, where symbols have their usual meanings, are
a) $[L^{-1}T]$ b) $[L^{-2}T^2]$ c) $[L^2T^{-2}]$ d) $[LT^{-1}]$

55. Which of the following shows green house effect?
a) Ultraviolet rays b) Infrared rays c) X-rays d) None of these

56. The speed of electromagnetic Wave in vacuum depends upon the source radiation. It

a) Increases as we move from $\gamma - rays$ to radio waves

b) Decreases as we move from $\gamma - rays$ to radio waves

c) Is same for all of them

d) None of the above

57. The wave of wavelength 5900 Å emitted by any atom or molecule must have some finite total length which is known as the coherence length. For sodium light, this length is 2.4 cm. The number of oscillations in this length will be

a) 4.068×10^8 b) 4.068×10^7 c) 4.068×10^6 d) 4.068×10^5

58. The average value of electric energy density in an Electromagnetic Waves is (E_0 is peak value)

a) $\frac{1}{2}\varepsilon_0 E_0^2$ b) $\frac{E_0^2}{2\varepsilon_0}$ c) $\varepsilon_0 E_0^2$ d) $\frac{1}{4}\varepsilon_0 E_0^2$

59. The maximum distance upto which TV transmission from a TV tower of height h can be received is proportional to

a) $h^{1/2}$ b) h c) $h^{3/2}$ d) h^2

60. The dielectric constant of air is 1.006. The speed of Electromagnetic Wave travelling in air is $a \times 10^8$ ms^{-1}, where a is about

a) 3 b) 3.88 c) 2.5 d) 3.2

61. If ε_0 and μ_0 represent the permittivity and permeability of vacuum and ε and μ represent the permittivity and permeability of medium, then refractive index of the medium is given by

a) $\sqrt{\frac{\mu_0\varepsilon_0}{\mu\varepsilon}}$ b) $\sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}}$ c) $\sqrt{\frac{\mu}{\mu_0\varepsilon_0}}$ d) $\sqrt{\frac{\mu_0\varepsilon_0}{\mu}}$

62. The magnetic field between the plate of a capacitor where $r > R$ is given by (where r is the distance from the axis of plates and R is the radius of each plate of capacitor)

a) $\frac{\mu_0 i_D r}{2\pi R^2}$ b) $\frac{\mu_0 i_D}{2\pi R}$ c) $\frac{\mu_0 i_D}{2\pi r}$ d) Zero

63. The amplitude of the magnetic field part of a harmonic Electromagnetic Wave in vacuum is B_0=510 nT. What is the amplitude of the electric field part of the wave?

a) 140 NC^{-1} b) 153 NC^{-1} c) 163 NC^{-1} d) 133 NC^{-1}

64. In an Electromagnetic Wave, direction of propagation is in the direction of

a) **E** b) **B** c) **E** × **B** d) None of these

65. Consider the following two statements regarding a linearly polarized plane electromagnetic wave

(i)Electric field and the magnetic field have equal average values

(ii)Electric energy and the magnetic energy have equal average values

a) (i)is true b) (ii)is true c) Both are true d) Both are false

66. A radiation of 200 W is incident on a surface which is 60% reflecting and 40% absorbing. The total force on the surface is

a) 1.07×10^{-6}N b) 1.3×10^{-6}N c) 1.07×10^{-7}N d) 1.03×10^{-7}N

67. An electric field $\vec{\mathbf{E}}$ and magnetic filed $\vec{\mathbf{B}}$ exist in a region. If these fields are not perpendicular to each other, then the electromagnetic wave

a) Will not pass through the region b) Will pass through region

c) May pass through the region d) Nothing is definite

68. A radiowave has a maximum magnetic field induction of 10^{-4} T on arrival at a receiving antenna. The maximum electric field intensity of such a wave is

a) Zero b) 3×10^4 Vm^{-1} c) 5.8×10^{-4} T d) 3.0×10^{-5} T

69. According to Maxwell's hypothesis, changing electric field gives rise to

a) Magnetic field b) Pressure gradient c) Charge d) Voltage

70. The rms value of the electric field of the light coming from the sun is 720 NC^{-1}. The average total energy density of the Electromagnetic Wave is

a) 4.58×10^{-6} Jm^{-3} b) 6.37×10^{-9} Jm^{-3} c) 81.35×10^{-12} Jm^{-3} d) 3.3×10^{-3}Jm^{-3}

71. The magnetic field of an Electromagnetic Wave is given by
$B_Y = 3 \times 10^{-7} \sin(10^3 x + 6.29 \times 10^{12} t)$.
The wavelength of the Electromagnetic Wave is
a) 6.28 cm b) 3.14 cm c) 0.63 cm d) 0.32 cm

72. The shortest wavelength of X-rays emitted from an X-rays tube depends upon
a) Nature of the gas in the tube b) Voltage applied to tube
c) Current in the tube d) Nature of target of the tube

73. Hydrogen atom does not emit X-rays because
a) It has signal electron b) It has no neutron
c) It has single neutron d) Its energy levels are too close to each other

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

75. The wavelength of X-rays lies between
a) Maximum to finite limits b) Minimum to certain limits
c) Minimum to infinite limits d) Infinite to finite limits

76. The electric field (in NC^{-1}) in an electromagnetic wave is given by $E = 50 \sin \omega (t - x/c)$.
The energy stored in a cylinder of cross-section 10 cm^2 and length 100 cm, along the x-axis will be
a) 5.5×60^{-12} J b) 1.1×10^{-11} J c) 2.2×10^{-11} J d) 1.65×10^{-11} J

77. All components of the Electromagnetic Spectrum in vacuum have the same
a) Energy b) Velocity c) Wavelength d) Frequency

78. Which of the following has zero average value in a plane electromagnetic wave?
a) Kinetic energy b) Magnetic field c) Electric field d) Both (b) and (c)

79. A large parallel plate capacitor, whose plates have an area of 1 m^2 and are separated from each other by 1 mm, is being charged at a rate of 25 Vs^{-1}. If the dielectric between the plates has the dielectric constant 10, then the displacement current at this instant is
a) 25 μA b) 11 μA c) 2.2 μA d) 1.1 μA

80. The atmosphere between the heights of 50 km and 80 km is called
a) Mesosphere b) Ozonosphere c) Ionosphere d) Troposphere

81. Instantaneous displacement current of 1.0 A in the space between the parallel plate of 1 μF capacitor can be estabilished by changing potential difference of
a) 10^{-6}Vs^{-1} b) 10^{6}Vs^{-1} c) 1 Vs^{-1} d) 0.1 Vs^{-1}

82. In a phase electromagnetic wave, the electric filed oscillates sinusoidally at a frequency of 2.0×10^{10} Hz and amplitude 48 Vm^{-1}. The wavelength of the wave is
a) 24×10^{-10} m b) 1.5×10^{-2} m c) 4.16×10^{8} m d) 3×10^{8} m

83. Velocity of Electromagnetic Waves in a medium depends upon
a) Thermal properties of medium
b) Mechanical and electrical properties of medium
c) electrical and magnetic properties of the medium
d) Mechanical and magnetic properties of the medium

84. The electric field for a plane electromagnetic wave travelling in the positive z-direction is represented by which one of the following?
a) $\hat{\mathbf{k}}_1 E_0 e^{i}(kz - \omega t + \phi)$ b) $\hat{\mathbf{i}}_1 E_0 e^{i}(kx - \omega t + \phi)$
c) $\hat{\mathbf{i}}_1 E_0 e^{i}(kz + \omega t + \phi)$ d) $\hat{\mathbf{k}}_1 E_0 e^{i}(kz + \omega t + \phi)$

85. The fact that radiosignals reach the earth from outside the atmosphere, was discovered accidently by
a) K. G. Jansky b) Millikan c) Aryabhatta d) Prof. Kanu

86. The electric field of an electromagnetic wave travelling through vacuum is given by the equation$E = E_0 \sin(kx - \omega t)$. The quantity that is independent of wavelength is

a) $\frac{k}{\omega}$ b) $k\omega$ c) ω d) k

87. X-rays are produced by jumping of
a) Electrons from lower to higher energy orbit of atom
b) Electrons from higher to lower energy orbit of atom
c) Protons from lower to higher energy orbit of nucleus
d) Proton from higher to lower energy orbit of nucleus

88. The magnetic field between the plates of radius 12 cm separated by distance of 4 mm of a parallel plate capacitor of capacitance 100 pF along the axis of plates having conduction current of 0.15 A is
a) Zero b) 1.5 T c) 15 T d) 0.15 T

89. The magnetic field between the plate of a capacitor when $r < R$ is given by
a) $\frac{\mu_0 i_D r}{2\pi R^2}$ b) $\frac{\mu_0 i_D}{2\pi R}$ c) $\frac{\mu_0 i_D}{2\pi r}$ d) Zero

90. The ozone layer absorbs
a) Infrared radiations
b) Ultraviolet radiations
c) X-rays
d) γ-rays

91. Out of the following electromagnetic radiation, which has the shortest wavelength?
a) Radiowaves b) Infrared c) Ultraviolet d) X-rays

92. A circular ring of radius r is placed in a homogenous magnetic field perpendicular to the plane of the ring. The field B chnages with time according to the equation $B = kt$, where k is a constant and t is the time. The electric field in the ring is
a) $\frac{kr}{4}$ b) $\frac{kr}{3}$ c) $\frac{kr}{2}$ d) $\frac{k}{2r}$

93. A cube of edge a has its edges parallel to x, y and z-axis of rectangular coordinate system. A uniform electric field $\vec{E}$ is parallel to y-axis and a uniform magnetic field is $\vec{E}$ parallel to x-axis. The rate at which flows through each face of the cube is
a) $\frac{a^2.EB}{2\mu_0}$ parallel to $x - y$ plane and zero in others
b) $\frac{a^2EB}{\mu_0}$ parallel to $x - y$ plane and zero in others
c) $\frac{a^2EB}{2\mu_0}$ from all faces
d) $\frac{a^2EB}{2\mu_0}$ parallel; to $y - z$ faces and zero in others

94. A radar sends the waves towards a distant object and receives the signal reflected by object. These waves are
a) Sound waves b) Light waves c) Radio waves d) Micro waves

95. A lasser beam is sent to the moon and reflected back to earth by ay mirror placed on the moon by an astronaut. If the moon is 384000 km from earth, how long does it take the light to make the round trip?
a) 5 min b) 2.5 min c) 2.5 s d) 500 s

96. A particles of mass 1×10^{-26}kg and charge 1.6×10^{-19}C travelling with a velocity 1.28×10^6 ms^{-1} along the positive X-axis enters a region in which a uniform electric field **E** and a uniform magnetic field of induction **B** are present. If $\boldsymbol{E} = -10.24 \times 10^3\, \hat{\mathbf{k}}$ NC^{-1} and $B = 8 \times 10^{-2} \hat{\mathbf{j}}$ Wbm^{-2}, the direction of motion of the particles is
a) Along the positive X-axis
b) Along the negative X-axis
c) At 45^0 to the positive X-axis
d) At 135^0 to the positive X-axis

97. A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface is
a) $\frac{E}{c}$ b) $\frac{2E}{c}$ c) Ec d) $\frac{E}{c^2}$

98. Which of the following rays is emitted by a human body?
a) X-rays b) UV rays c) Visible rays d) IR rays

99. A TV tower has a height of 100 m. How much population is covered by the TV broadcast if the average population density around the tower is 100 km^{-2} (radius of the earth= 6.37×10^6 m)
a) 4 lakh b) 4 billion c) 40,000 d) 40 lakh

100. Radio wave diffract around building although light waves do not. The reason is that radio waves
a) Travel with speed target than c
b) Have much larger wavelength than light
c) Carry news
d) Are not electromagnetic waves

101. The density of air at the top of mesosphere in comparison to that of near the earth's surface is
a) 10^{-3}times
b) 10^{-5} times
c) 10^{3} times
d) 10^{5} times

102. A point source of electromagnetic radiation has an average power output of 800 W. The maximum value of electric filed at a distance 4.0 m from the source is
a) 64.7 Vm^{-1}
b) 57.8 Vm^{-1}
c) 56.72 Vm^{-1}
d) 54.77 Vm^{-1}

103. The atmosphere above the height of 80 km is called
a) Stratosphere
b) Troposphere
c) Mesosphere
d) Ionosphere

104. Height h of transmitter antenna when R is radius of earth to have range d is
a) $d^2/2R$
b) $\sqrt{2dR}$
c) $2d^2/R$
d) $2R^2/d$

105. Maxwell in his famous equation of electromagnetism introduced the concept of
a) AC current
b) DC current
c) Displacement current
d) Impedance

106. The waves which have revolutionized telecommunication in more recent time, are
a) Micro wave
b) Radio waves
c) Light waves
d) TV waves

107. The charge of a parallel plate capacitor is varying as $q = q_0 \sin 2\pi f t$. The plates are very large and close together (area= A, separation= d). Neglecting edge effects, the displacement current through the capacitor is
a) $\frac{d}{A\varepsilon_0}$
b) $\frac{d}{\varepsilon_0} \sin 2\pi f t$
c) $2\pi f q_0 \cos 2\pi f t$
d) $\frac{2\pi f q_0}{\varepsilon_0} \cos 2\pi f t$

108. If a source is transmitting electromagnetic wave of frequency 8.2×10^6 Hz, then wavelength of the electromagnetic waves transmitted from the source will be
a) 36.6 m
b) 40.5 m
c) 42.3 m
d) 50.9 m

109. An electric field of 1500 Vm^{-1} and a magnetic field of 0.40 Wbm^{-2} act on a moving electron. The minimum uniform speed along a straight line the electron could have is
a) 1.6×10^{15} ms^{-1}
b) $6 \times 10^{16}$$\text{ms}^{-1}$
c) $3.75 \times 10^{3}$$\text{ms}^{-1}$
d) $3.75 \times 10^{2}$$\text{ms}^{-1}$

110. The energy of X-ray photon is 3.3×10^{-16} J. Its frequency is
a) 2×10^{19} Hz
b) 5×10^{18} Hz
c) 5×10^{17} Hz
d) 5×10^{16} Hz

111. If a source is transmitting Electromagnetic Waves of frequency 8.196×10^6 Hz, then the wavelength of the Electromagnetic Waves transmitted from the source will be
a) 5090 cm
b) 4050 cm
c) 4230 cm
d) 3660 cm

112. The phase velocity (v_p) of travelling wave is
a) $v_p = \frac{\omega}{k}$
b) $v_p = \frac{d\omega}{dk}$
c) $v_p = c$
d) $v_p = \frac{c}{v_g}$

113. If a free electron is placed in the path of a plane electromagnetic wave, it will start moving along
a) Centre of earth
b) Equator of earth
c) Magnetic field
d) Electric field

114. The energy of X-ray photon is 2200 eV. Its frequency would be
a) 5.3×10^{16} Hz
b) 5.3×10^{17} Hz
c) 5×10^{17} Hz
d) 5×10^{16} Hz

115. Which of the following relation is correct?
a) $\sqrt{\varepsilon_0}E_0 = \sqrt{\mu_0}B_0$
b) $\sqrt{\mu_0\varepsilon_0}E_0 = B_0$
c) $E_0 = \sqrt{\mu_0\varepsilon_0}B_0$
d) $\sqrt{\mu_0}E_0 = \sqrt{\varepsilon_0}B_0$

116. According to Maxwell's equation the velocity of light in any medium is expressed as
a) $\frac{1}{\sqrt{\mu_0\varepsilon_0}}$
b) $\frac{1}{\sqrt{\mu\varepsilon}}$
c) $\sqrt{\mu/\varepsilon}$
d) $\sqrt{\frac{\mu_0}{\varepsilon}}$

117. Electromagnetic Waves of frequencies higher than $9\sqrt{2}$ MHz are found to be reflected by the ionosphere on a particular day at a place. The maximum electron density in the ionosphere is
a) $\sqrt{5} \times 10^{12}$ m^{-3}
b) $\sqrt{2} \times 10^{12}$ m^{-3}
c) 2×10^{12} m^{-3}
d) 5×10^{12} m^{-3}

118. An electromagnetic wave, going through vacuum is described by $E = E_0 \sin(kx - \omega t)$

Which of the following is independent of wavelength?

a) k b) ω c) k/ω d) $k\omega$

119. Which of the following is absorbed by the ozone layer?

a) Only gamma rays b) Visible light c) Radio Waves d) Ultraviolet rays

120. If the earth did not have atmosphere, its surface temperature on a day time would be

a) Higher b) Lower c) Same as now d) Not sure

121. A perfectly reflecting mirror has an area of 1 cm^2 Light energy is allowed to fall on it for 1h at the rate of 10 Wcm^{-2}. The force that acts on the mirror is

a) 3.35×10^{-8}N b) 6.7×10^{-8}N c) 1.34×10^{-7}N d) 2.4×10^{-4}N

122. A radio wave of frequency 90 MHz enters a ferrite rod. If $\varepsilon_r = 10^3$ and $\mu_r = 10$, then the velocity and wavelength of the wave in ferrite are

a) 3×10^8 ms^{-1}; 3.33×10^{-2} m
b) 3×10^6 ms^{-1}; 3.33×10^{-2} m
c) 3×10^8 ms^{-1}; 3.33×10^{-1} m
d) 3×10^7 ms^{-1}; 3.33×10^{-3} m

123. The Electromagnetic theory of light failed to explain

a) Photoelectric effect b) Polarization c) Diffraction d) Interference

124. Which of the following electromagnetic waves have the longest wavelength?

a) Heat waves b) Light waves c) Radio waves d) Ultraviolet waves

125. The oscillating electric and magnetic field vectors of electromagnetic wave are oriented along

a) The same direction and in phase
b) The same direction but have a phase difference of 90°
c) Mutually perpendicular directions and are in phase
d) Mutually perpendicular directions but has a phase difference of 90°

126. Electromagnetic Waves can be deflected by

a) Electric field only
b) Magnetic field only
c) Both (a) and (b)
d) None of these

127. The sun delivers 10^3 Wm^{-2} of Electromagnetic flux on the earth's surface. The total power that is incident on a roof of dimensions 6m × 30m,is

a) 1.8×10^5 W b) 7.2×10^5 W c) 0.9×10^5 W d) 4.5×10^5 W

128. What is order of energy of X-rays (E_X), radio waves (E_R) and microwave (E_M)?

a) $E_X < E_R < E_M$ b) $E_X < E_M > E_R$ c) $E_M > E_X > E_R$ d) $E_M < E_R < E_X$

129. A plane Electromagnetic Wave of frequency 30 MHz travels in free space along the x-direction. The electric field component of the wave at a particular point of space and time E=6 Vm^{-1} along y-direction. Its magnetic field component B at this point would be

a) 2×10^{-8} T along z-direction
b) 6×10^{-8} T along x-direction
c) 2×10^{-8} T along y-direction
d) 6×10^{-8} T along z-direction

130. Ozone layer blocks the radiations of wavelength

a) Less than 3×10^{-7}m
b) Equal to 3×10^{-7}m
c) More than 3×10^{-7}m
d) All of the above

131. If c is the speed of Electromagnetic Waves in vacuum, its speed in a medium of dielectric constant K and relative permeability μ, is

a) $v = \frac{1}{\sqrt{\mu_r, K}}$ b) $v = c\sqrt{\mu_{r_c} K}$ c) $v = \frac{c}{\sqrt{\mu_r, K}}$ d) $v = \frac{K}{\sqrt{\mu_r, c}}$

132. The Maxwell's four equations are written as

(i) $\oint \vec{\mathbf{E}} \cdot \vec{\mathbf{ds}} = q/\varepsilon_0$

(ii) $\oint \vec{\mathbf{B}} \cdot \vec{\mathbf{ds}} = 0$

(iii) $\oint \mathbf{E} \cdot \vec{\mathbf{dl}} = -\frac{d}{dt}\oint_s \vec{\mathbf{B}} \cdot \vec{\mathbf{ds}}$

(iv) $\oint \vec{\mathbf{B}} \cdot \vec{\mathbf{dl}} = \mu_0 I + \mu_0 \varepsilon_0 \frac{d}{dt}\oint_s \vec{\mathbf{E}}.\vec{\mathbf{ds}}$

The equation which have sources of $\vec{\mathbf{E}}$ and $\vec{\mathbf{B}}$ are

a) (i), (ii), (iii) b) (i), (ii) c) (i)and (iii) only d) (i)and (iv) only

133. The waves which are reflected back to the earth by ionosphere is

a) Ground wave b) Sky wave c) Space wave d) All of these

134. The relation between electric field vector **E**, the displacement vector **D** and the polarization vector **P** for a dielectric placed in electric field **E** is given by

a) $\mathbf{P} = \varepsilon_0\mathbf{E} + \mathbf{D}$ b) $\mathbf{P} = \mathbf{D} + \mathbf{E}$ c) $\mathbf{D} = \varepsilon_0\mathbf{E} + \mathbf{P}$ d) $\mathbf{E} = \mathbf{D} + \mathbf{P}$

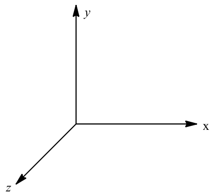
135. The refractive index and the permeability of a medium are respectively 1.5 and $5 \times 10^{-7}\text{Hm}^{-1}$. The relative permittivity of the medium is nearly

a) 25 b) 15 c) 81 d) 6

136. If $\vec{\mathbf{E}}$ is an electric field and $\vec{\mathbf{B}}$ is the magnetic induction then the energy flow per unit area per unit time in an electromagnetic field is given by

a) $\vec{\mathbf{E}} \times \vec{\mathbf{B}}$ b) $\vec{\mathbf{E}} \cdot \vec{\mathbf{B}}$ c) $E^2 + B^2$ d) E/B

137. Light wave is travelling along y-direction. If the corresponding **E** vector at any time is along the x-axis, the direction of **B** vector at that time is along



a) y-axis b) x- axis c) $+z$- axis d) $-z$- axis

Session : 2025-26 AS PER NEW NTA SYLLABUS

Total Questions : 143

PHYSICS (QUESTION BANK)

8.ELECTROMAGNETIC WAVES

: ANSWER KEY :

1)	a	2)	a	3)	a	4)	c	73)	a	74)	d	75)	b	76)	b
5)	a	6)	a	7)	b	8)	c	77)	b	78)	d	79)	c	80)	a
9)	b	10)	b	11)	c	12)	b	81)	b	82)	b	83)	c	84)	b
13)	c	14)	d	15)	b	16)	c	85)	a	86)	a	87)	b	88)	a
17)	b	18)	c	19)	d	20)	c	89)	a	90)	b	91)	d	92)	c
21)	c	22)	c	23)	a	24)	d	93)	b	94)	d	95)	c	96)	a
25)	c	26)	b	27)	d	28)	a	97)	b	98)	d	99)	d	100)	b
29)	b	30)	a	31)	c	32)	c	101)	b	102)	d	103)	d	104)	a
33)	a	34)	a	35)	d	36)	c	105)	c	106)	a	107)	c	108)	a
37)	c	38)	a	39)	a	40)	b	109)	c	110)	c	111)	d	112)	a
41)	a	42)	d	43)	b	44)	c	113)	d	114)	b	115)	b	116)	b
45)	d	46)	c	47)	b	48)	b	117)	d	118)	c	119)	d	120)	a
49)	c	50)	d	51)	b	52)	b	121)	b	122)	b	123)	a	124)	c
53)	a	54)	c	55)	b	56)	c	125)	c	126)	d	127)	a	128)	b
57)	c	58)	d	59)	a	60)	a	129)	a	130)	b	131)	c	132)	d
61)	b	62)	c	63)	b	64)	c	133)	a	134)	c	135)	d	136)	a
65)	c	66)	a	67)	c	68)	b	137)	c						
69)	a	70)	a	71)	c	72)	b								

PHYSICS (QUESTION BANK)

8.ELECTROMAGNETIC WAVES

: HINTS AND SOLUTIONS :

1 **(a)**
Here, amplitude of electric filed, $E_0 = 100\ \mathrm{Vm^{-1}}$; amplitude of magnetic field, $B_0 = 0.265\ \mathrm{Am^{-1}}$. We know that the maximum rate of energy flow
$S = E_0 \times B_0 = 100 \times 0.265 = 26.5\ \mathrm{Wm^{-2}}$

2 **(a)**
X-rays being of high energy radiations, penetrate the target and hence are not reflected back

3 **(a)**
$\sqrt{\frac{\mu}{\varepsilon}}$ = has the dimensions of resistance, hence it is called the intrinsic impedance of the medium

4 **(c)**
Power $= I \times$ area $= (1.4 \times 10^3\ ) \times 5$
Force $F = \frac{\text{Power}}{c} = \frac{1.4\times10^3\times5}{3\times10^8}$
$= 2.33 \times 10^{-5}$ N

5 **(a)**
The amplitude of the electric and magnetic fields in free space are related by $\frac{E_0}{B_0} = c$
Here, $E_0 = 30\ \mathrm{Vm^{-1}}, c = 3 \times 10^8\ \mathrm{ms^{-1}}$
$\therefore \quad B_0 = \frac{E_0}{c} = \frac{30}{3 \times 10^8} = 10^{-7}$ T

6 **(a)**
Displacement current is given by
$I_d = \frac{dq}{dt} = 1.8 \times 10^{-8}\ \mathrm{Cs^{-1}}$

7 **(b)**
Velocity of light in vacuum
$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$
velocity of light in medium
$v = \frac{1}{\sqrt{\mu\,\varepsilon}}$
$\therefore \quad \mu = \frac{c}{v} = \left(\frac{\mu\varepsilon}{\mu_0\varepsilon_0}\right)^{1/2}$

8 **(c)**
According to Maxwell, a changing electric field is a source of magnetic field

9 **(b)**
The electric field induced by changing magnetic field depends upon the rate of change of magnetic flux, hence it is non-conservative

10 **(b)**
$\mathrm{U} = \frac{1}{2} \times \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2} \times \frac{1}{2} \times 8.85 \times 10^{-12} \times (2)^2$
$= 8.85 \times 10^{-12}\mathrm{Jm^{-3}}$

11 **(c)**
Total power=solar constant × area
$= 10^4 \times (10 \times 10) = 10^6$ W

12 **(b)**
Infrared radiations are detected by pyrometer

14 **(d)**
The equation of electric field occurring in Y-direction
$$E_y = 66 \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$$
Therefore, for the magnetic field in Z-direction
$$B_z = \frac{E_y}{c}$$
$$= \left(\frac{66}{3 \times 10^8}\right)\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$$
$$= 22 \times 10^{-8}\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$$
$$= 22 \times 10^{-7}\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$$

17 **(b)**
In an electromagnetic wave, the average energy density of magnetic field μ_B = average energy density of electric filed $v_E = \frac{1}{4}\varepsilon_0 E_0^2$
$= \frac{1}{4} \times (8.85 \times 10^{-12}) \times 1^2$
$= 2.21 \times 10^{-12}\ \mathrm{Jm^{-3}}$

18 **(c)**
In vacuum, ε_0=1
In medium, $\varepsilon = 4$
So, refractive index

$$\mu = \sqrt{\varepsilon/\varepsilon_0} = \sqrt{4/1} = 2$$

wavelength $\lambda' = \frac{\lambda}{\mu} = \frac{\lambda}{2}$

and wave velocity $v = \frac{c}{\mu} = \frac{c}{2}$

Hence, it is clear that wavelength and velocity will become half but frequency remains uncharged when the wave is passing through any medium.

19 **(d)**

$I = \frac{1}{2}\varepsilon_0 E_0^2 c$

or $E_2 = \sqrt{\frac{2I}{\varepsilon_0 c}}$

$= \sqrt{\frac{2 \times 4}{(8.85 \times 10^{-12}) \times (3 \times 10^8)}} = 55.5 \text{ NC}^{-1}$

20 **(c)**

Intensity $I = \frac{\text{pressure}}{\text{area}} = \frac{p}{4\pi r^2}$

=average energy density × velocity

$= \frac{1}{2}\varepsilon_0 E_0^2 c$

$\therefore E_0 = \sqrt{\frac{2P}{4\pi\varepsilon_0 r^2 c}} = \sqrt{\frac{P}{2\pi\varepsilon_0 r^2 c}}$

21 **(c)**

The wavelengths of infrared rays lie between 7800 Å to 0.004 cm

23 **(a)**

As **v** of charged particle is remaining constant, it means force acting on charged particle is zero.

So, $q(\mathbf{v} \times \mathbf{B}) = q\mathbf{E}$

$\Rightarrow \mathbf{v} \times \mathbf{B} = \mathbf{E}$

$\Rightarrow \mathbf{v} = \frac{\boldsymbol{E} \times \boldsymbol{B}}{B^2}$

26 **(b)**

Range, $R = \sqrt{2hr}$ where r is the radius of earth so $R \propto h^{1/2}$

27 **(d)**

$B_0 = \frac{E_0}{c} = \frac{9 \times 10^3}{3 \times 10^8} = 3 \times 10^{-5}$ T

28 **(a)**

$i = \frac{dQ}{dt} = \frac{d}{dt}(CV)$

$= C\frac{dV}{dt} = 2 \times 10^{-12} \times 10^{12} = 2$ A

29 **(b)**

When thermal radiations (Q) fall on a body, they are partly reflected, partly absorbed and partly transmitted.

$Q = Q_a + Q_r + Q_t$

And $\frac{Q_a}{Q} + \frac{Q_r}{Q} + \frac{Q_t}{Q} = a + r + t = 1$

$\Rightarrow \frac{15}{150} + 0.6 + x = 1$

or $0.1 + 0.6 + x = 1$

or $x = 0.3$

Transmitting power, $t = \frac{Q_t}{Q}$

Or $0.3 = \frac{Q_t}{150}$

$\Rightarrow Q_t = 45$ J

30 **(a)**

Intensity or power per unit area of the radiations,

$P = pv$

$\Rightarrow p = \frac{P}{v}$

$= \frac{0.5}{3 \times 10^8} = 0.166 \times 10^{-8} \text{ Nm}^{-2}$

31 **(c)**

The frequency of Electromagnetic Waves produced by the oscillator is equal to the frequency of the oscillating particle *ie*, 10^9 Hz.

32 **(c)**

Velocity of light, $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

or $\mu_0\varepsilon_0 = \frac{1}{c^2} = \frac{1}{(\text{ms}^{-1})^2} = \text{s}^2\text{m}^{-2}$

35 **(d)**

The wavelength order of the given types of waves are given below

Waves	**Wavelength Range (in meter)**
Gamma rays	$10^{-14} - 10^{-10}$
IR-rays	$7 \times 10^{-7} = 10^{-3}$
UV-rays	$10^{-9} - 4 \times 10^{-7}$
Microwave	$10^{-4} - 10^{0}$

Hence, statements (A) and (D) are correct.

36 **(c)**

The speed of light in vacuum is given by $\sqrt{\frac{1}{\mu_0\varepsilon_0}}$, where μ_0 is permeability and ε_0 is permittivity of free space.

37 **(c)**

Radiation force=momentum transferred per sec by electromagnetic wave to the mirror

$= \frac{2S_{\text{av}}A}{c} = \frac{2 \times (10) \times (20 \times 10^{-4})}{(3 \times 10^8)}$

$= 1.33 \times 10^{-10}$ N

38 **(a)**

Using the relation

$c = \frac{E_0}{B_0}$

$B_0 = \frac{E_0}{c}$

$= \frac{9.3}{3 \times 10^8} = 3.1 \times 10^{-8}$ T

40 **(b)**

Radioactive source, X-ray tube, sodium vapour lamp, crystal oscillator

41 **(a)**

Use method of dimensions. Equating the dimensions of two sides we note the relation (a)Is dimensionally correct

42 **(d)**

On the basis of dual nature of light, Lious de-Broglie suggested that the dual nature is not only of light, but each moving material particle has the dual nature. He assumed a wave to be associated with each moving material particle which is called the matter wave. The wavelength of this wave is determined by the momentum of the particle. If p is the momentum of the particle, the wavelength of the wave associated with it is

$$\lambda = \frac{h}{p}$$

Where h is Plank's constant.

Since, it is given that, alpha, beta and gamma rays carry same momentum, so they will have same wavelength.

43 **(b)**

Velocity of photon in vacuum is constant for all frequencies

44 **(c)**

A changing electric field produces a changing magnetic field and $vice - versa$ which gives rise to a transverse wave known as Electromagnetic Wave. The time varying electric and magnetic fields are mutually perpendicular to each other and also perpendicular to the direction of propagation of this wave.

45 **(d)**

Energy of a photon $E = \frac{hc}{\lambda}$

$\therefore$ Wavelength $\lambda = \frac{hc}{E}$

$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{13.2 \times 10^{3} \times 1.6 \times 10^{-19}}$$

$= 0.9375 \times 10^{-10}$ m

$= 1$ Å

Wavelength range of X-rays is from 10^{-11} m to 10^{-8} m (0.1 Å to 100 Å).

Therefore, the given electromagnetic radiation belongs to the X-ray region of electromagnetic spectrum.

46 **(c)**

Equation second shows that the electromagnetic wave travels along the positive x-axis

47 **(b)**

$$B = \frac{\mu_0}{4\pi}\frac{2i_D}{r} = \frac{\mu_0}{4\pi} \times \varepsilon_0 \frac{d\phi_E}{dt}$$

$$= \frac{\mu_0}{2\pi}\frac{2i_D}{r} = \frac{\mu_0}{4\pi}\frac{2}{r} \times \varepsilon_0 \frac{d\phi_E}{dt}$$

$$= \frac{\mu_0\varepsilon_0\pi r^2 dE}{2\pi r dt} = \frac{\mu_0\varepsilon_0 r}{2}\frac{dE}{dt}$$

49 **(c)**

$E = \frac{hc}{\lambda}$; minimum the wavelength, the maximum the energy of a λ ray. Therefore rays have minimum wave length

50 **(d)**

$$V = \frac{hc}{e\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{1.6 \times 10^{-19} \times 10^{-10}} = 10{,}000 \text{ V}$$

51 **(b)**

$\psi_{(x,t)} = 10^3 \sin \pi(3 \times 10^6\, x - 9 \times 10^{14}\, t)$

$= 10^3 \sin 3 \times 10^6\, \pi(x - 3 \times 10^8\, t)$

Comparing it with the relation

$\psi_{(x,t)} = a \sin \frac{2\pi}{\lambda}(x - ct)$; We note that

$c = 3 \times 10^8 \text{ ms}^{-1}$

53 **(a)**

Solar radiations are transverse Electromagnetic waves. The central core of the sun emits a continuous Electromagnetic Spectrum.

54 **(c)**

$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$ or $\frac{1}{\mu_0\varepsilon_0} = c^2$

$= [M^0LT^{-1}]^2 = [M^0L^2T^{-2}]$

56 **(c)**

Speed of Electromagnetic Waves in vacuum

$= \frac{1}{\sqrt{\mu_0\varepsilon_0}} =$ costant

57 **(c)**

Number of oscillator in coherence length

$= \frac{l}{\lambda} = \frac{0.024}{5900 \times 10^{-10}}$

$= 4.068 \times 10^6$

58 **(d)**

Electric energy density

$$u_e = \frac{1}{2}\varepsilon_0 E_{\text{rms}}^2$$

$$E_{\text{rms}} = \frac{E_0}{\sqrt{2}}$$

$$u_e = \frac{1}{4}\varepsilon_0 E_0^2$$

59 **(a)**

$d = \sqrt{2hR}$ or $d \propto h^{1/2}$

60 **(a)**

For an Electromagnetic Wave (in vacuum), Velocity $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = 3 \times 10^8 \text{ ms}^{-1}$

Air acts almost as vacuum, hence

$a = 3$(approx)

61 **(b)**

Refractive index= $\frac{c_0}{c} = \frac{1/\sqrt{\mu_0\varepsilon_0}}{1/\sqrt{\mu\varepsilon}}$

$= \sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}}$

62 **(c)**

Using Ampere circuit law,

$\oint \vec{\mathbf{B}} \cdot \vec{\mathbf{dl}} = \mu_0 i_D$

or $B2\pi r = \mu i_D$

or $B = \mu_0 i_D / 2\pi r$

63 **(b)**

For an EM wave, $\frac{E_0}{B_0} = c$ or $E_0 = cB_0$

$= 3 \times 10^8 \times 510 \times 10^{-9} \text{ NC}^{-1}$

$= 153 \text{ NC}^{-1}$

64 **(c)**

The direction of propagation of Electromagnetic Wave is in the plane perpendicular to both **E** and **B** *ie*, along **E** × **B**.

66 **(a)**

$F_{\text{total}} + F_{\text{ref}} + F_{\text{abs}}$

$= \frac{1.2P}{c} + \frac{0.4P}{c} = \frac{1.6P}{c}$

$= \frac{1.6 \times 200}{3 \times 10^8} = 1.07 \times 10^{-6} \text{ N}$

67 **(c)**

The electromagnetic wave being packets of energy moving with speed of light may pass through the region

68 **(b)**

$E_0 = cB_0 = 3 \times 10^8 \times 10^{-4} = 3 \times 10^4 \text{ Vm}^{-1}$

69 **(a)**

From Maxwell's Electromagnetic theory, the Electromagnetic Wave propagation contains electric and magnetic fields vibrating perpendicularly to each other . Hence, changing of electric field gives rise to magnetic field.

70 **(a)**

Total average energy = $\varepsilon_0 E_{\text{rms}}^2$

$= 8.85 \times 10^{-12} \times (720)^2$

$= 4.58 \times 10^{-6} \text{ Jm}^{-3}$

71 **(c)**

Given, $B_y = 3 \times 10^{-7} \sin(10^3 x + 6.28 \times 10^{12} t)$.

Comparing with the general equation

$B_y = B_0 \sin(kx + \omega t)$

we get $k = 10^3$

or $\frac{2\pi}{\lambda} = 10^3$

$\Rightarrow \lambda = \frac{2\pi}{10^3}$

$= 6.28 \times 10^{-3}\text{m}$

$= 0.63 \text{ cm}$

72 **(b)**

$eV = hc/\lambda$

Or $\lambda = hc/eV$ *ie*, $\lambda \propto 1/V$

74 **(d)**

The electric displacement field is a vector valued **D** that accounts for the effects of bound charges within materials. In general **D** is given by

$\mathbf{D} = \varepsilon_0 \mathbf{E} + \mathbf{P}$

When **E** is electric field, ε_0 the vacuum permittivity and **P** the polarization density of the material.

In most ordinary terms

$\mathbf{D} = \varepsilon_0 \mathbf{E}$

When dielectric is present $\varepsilon = K\varepsilon_0$

$\therefore \quad \mathbf{D} = K\varepsilon_0 \mathbf{E}$

75 **(b)**

According to Daun-Hunt law, the wavelength of X-rays lies between minimum to certain limit

76 **(b)**

Energy contained in a cylinder

U = avearge energy density × volume

$= \frac{1}{2}\varepsilon_0 E_0^2 \times Al$

$= \frac{1}{2} \times (8.85 \times 10^{-12}) \times (50)^2 \times (10 \times 10^{-4}) \times 1$

$= 1.1 \times 10^{-11} \text{ J}$

77 **(b)**

All the component of electromagnetic spectrum have same velocity, *ie*, $3 \times 10^8 \text{ ms}^{-1}$.

78 **(d)**

In electromagnetic wave, the average value of electric filed or magnetic field is zero

79 **(c)**

$C = \frac{\varepsilon_0 KA}{d} = \frac{(8.85 \times 10^{-12}) \times 10 \times 1}{10^{-3}}$

$= 8.85 \times 10^{-8} \text{ F}$

$i = \frac{d}{dt}(CV) = C\frac{dV}{dt} = 8.85 \times 10^{-8} \times 25$

$= 2.2 \times 10^{-6} \text{ A}$

81 **(b)**

$\frac{Q}{t} = \frac{CV}{t}$ or $i_D = C\left(\frac{V}{T}\right)$

or $\frac{V}{t} = \frac{i_D}{C} = \frac{1.0}{10^{-6}} \text{ Vs}^{-1} = 10^6 \text{ Vs}^{-1}$

82 **(b)**

Wavelength, $\lambda = c/v = 3 \times 10^8 / 2 \times 10^{10} = 1.5 \times 10^{-2}$ m

85 **(a)**

K. G. Jansky discovered accidently the radio signals coming from outside the atmosphere and reaching the earth

86 **(a)**

$E = E_0 \sin(kx - \omega t)$

Comparing with standard equation we will get

Wavelength $= \frac{k}{\omega}$

88 **(a)**

As $B \propto r$, since the point is on the axis, where $r = 0$, so $B = 0$

89 **(a)**

Consider a loop of radius $r(< R)$ between the two circular plates, placed coaxially with them. The area of the loop $= \pi r^2$

By symmetry magnetic field is equal in magnetic at all points on the loop. If i'_D is the displacement current crossing the loop and i_D is the total displacement current between plates $i'_D = \frac{i_D r}{\pi R^2} \times \pi r^2$. Using Ampere Maxwell' law we have, $\oint \vec{\mathbf{B}} \cdot \vec{\mathbf{dl}} = \mu_0 i'_D$

or $2\pi r = \mu_0 i_D \frac{\pi r^2}{\pi R^2}$ or $B = \frac{\mu_0 i_D r}{2\pi R^2}$

90 **(b)**

The ozone layer absorbs ultraviolet radiations

91 **(d)**

The X-rays ahs the shortest wavelength among the following radiations

92 **(c)**

$\oint \vec{\mathbf{E}} \cdot \vec{\mathbf{dl}} = -\frac{d\phi B}{dt}$

or $E \times 2\pi r = \frac{d}{dt}(Kt \times \pi r^2) = K\pi r^2$

or $E = \frac{Kr}{2}$

93 **(b)**

Energy flowing per sec per unit area from a face is $= \frac{1}{\mu_0}[\vec{\mathbf{E}} \times \vec{\mathbf{B}}]$. It will be in the negative z-direction. It shows that the energy will be flowing infaces parallel to $x - y$ plane and is zero in all other faces. Total energy flowing per second from a face in $x - y$ plane$= \frac{1}{\mu_0}(EB \sin 90°)a^2 = \frac{EBa^2}{\mu_0}$

94 **(d)**

Now a days microwaves are used to locate the flying objects by radar

95 **(c)**

$$t = \frac{2s}{c} = \frac{2 \times 38400 \times 1000}{3 \times 10^8} = 2.5 \text{ s}$$

96 **(a)**

$m = 1 \times 10^{-26}$kg, $q = 1.6 \times 10^{-19}$ C,

$v = 1.28 \times 10^6$ ms^{-1}

Electric field $\mathbf{E} = -1024 \times 10^3 \,\hat{\mathbf{k}}$ NC^{-1}

Magnetic field $\mathbf{B} = 8 \times 10^{-2} \,\hat{\mathbf{j}}$ Wbm^{-2}

$\frac{|\mathbf{E}|}{|\mathbf{B}|} = \frac{102.4 \times 10^3}{8 \times 10^{-2}} = \frac{10.24 \times 10^6}{8}$

$= 1.28 \times 10^6$

Hence, $|\mathbf{v}| = \frac{|\mathbf{E}|}{|\mathbf{B}|}$

So, particle will remain undeflected, hence direction of motion of particle is along the positive X-axis.

97 **(b)**

Initial momentum of surface

$$P_i = \frac{E}{C}$$

Where, c = velocity of light (constant).

Since, the surface is perfectly, reflecting, so the same momentum will be reflected completely.

Final momentum

$P_f = \frac{E}{c}$ (negative value)

∴Change in momentum

$\Delta p = p_f - p_i$

$$= -\frac{E}{c} - \frac{E}{c} = -\frac{2E}{c}$$

Thus , momentum transferred to the surface is

$\Delta p' = |\Delta p| = \frac{2E}{c}$

98 **(d)**

Generally, temperature of human body is 37°C, corresponding to which IR and microwave radiations are emitted from the human body

99 **(d)**

$d = \sqrt{2hR}$

Population covered

$= \pi d^2$ ×population density

$= 3.114 \times (2 \times 0.1 \times 6.37 \times 10^3) \times 1000 \approx 40$ lakh

100 **(b)**

Diffraction takes places when the wavelength of wave is comparable with the size of the obstacle in path. The wavelength of radio waves is greater than the wavelength of light waves. Therefore, radio waves are diffracted around building

101 **(b)**

The density of air in mesosphere with height decreases from $1/10^3$ to $1/10^5$ times that due to the surface of earth

102 **(d)**

Intensity of electromagnetic wave is $I = \frac{P_{av}}{4\pi\times r^2} = \frac{E_0^2}{2\mu_0 c}$

or $E_0 = \sqrt{\frac{\mu_0 c P_{av}}{2\pi r^2}}$

$= \sqrt{\frac{(4\pi\times10^{-7})\times(3\times10^8)\times800}{2\pi\times(4)^2}}$

$= 54.77\ \text{Vm}^{-1}$

103 **(d)**

The earth's atmosphere above the height of 80 km up to 400 km is called Ionosphere

104 **(a)**

$d = \sqrt{2hR}$ or $h = d^2/2R$

107 **(c)**

$i = \frac{dq}{dt} = \frac{d}{dt}(q_0 \sin 2\pi f t) = q_0 2\pi f \cos 2\pi f t$

108 **(a)**

Here, $\lambda = \frac{c}{v} = \frac{3\times10^8}{8.2\times10^6} = 36.6$ m

109 **(c)**

Here, $E = 1500\ \text{Vm}^{-1}, B = 0.4\ \text{Wbm}^{-2}$

Minimum speed of electron along the straight line

$v = \frac{E}{B} = \frac{1500}{0.4} = 3750$

$= 3.75 \times 10^3\ \text{ms}^{-1}$

110 **(c)**

$v = E/h = 3.3\times10^{-6}/6.6\times10^{-34}$

$= 5\times10^{17}$ Hz

111 **(d)**

Given , frequency of EM waves

$\text{v} = 8.196 \times 10^6$ Hz

Velocity of EM waves $(v) = 3 \times 10^8$ m/s

∴Wavelength of EM waves $\lambda = \frac{v}{V}$

$= \frac{3\times10^8}{8.196\times10^6} =$ 36.60 m

$= 3660$ cm

112 **(a)**

The phase velocity of a wave is rate at which the phase of the wave propagates in space. This is the speed at which the phase of any one frequency component of the wave travels. For such a component, any given phase of the wave will appear to travel at the phase velocity. It is given in terms of wave's angular velocity ω and wave number k by $v_p = \frac{\omega}{k}$.

113 **(d)**

The electron placed in the path of electromagnetic wave will experience force due to electric field vector and not due to magnetic field vector

115 **(b)**

$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$ and $c = E_0/B_0$

116 **(b)**

Velocity of light in a medium,

$c = \frac{1}{\sqrt{\mu_0\varepsilon_0\mu_r\varepsilon_r}} = \frac{1}{\sqrt{\mu\varepsilon}}$

118 **(c)**

Here, $kx = \theta$ or $k = \theta/x$

And $\omega t = \theta_0$ or $\omega = \theta_0/t$

$\therefore\ k/\omega = t/x = 1/(x/t) = \frac{1}{v}$, where v is the velocity of electromagnetic wave, which is independent of wavelength of wave but depends upon the nature of medium of propagation of wave

119 **(d)**

Ultraviolet is absorbed by the ozone layer.

121 **(b)**

Let E = Energy falling on the surface per second = 10 J

Momentum Of photons

$p = \frac{h}{\lambda} = \frac{h}{(c_1 v)}$

$= \frac{hv}{c} = \frac{E}{C}$

On reflection,

Change in momentum per second $= 2p = \frac{2E}{c}$

We know that,

Change in momentum per second = force

$F = \frac{2E}{c} = \frac{2\times10}{3\times10^8}$

$= 6.7 \times 10^{-8}$ N

122 **(b)**

$v_{\text{ferrite}} = \frac{c}{\sqrt{\mu_r\varepsilon_r}} = \frac{3\times10^8}{\sqrt{10\times10^{33}}} = 3\times10^6\ \text{ms}^{-1}$

$\lambda_{\text{ferrite}} = \frac{v_{\text{ferrite}}}{v} = \frac{3\times10^6}{90\times10^6} = 3.33\times10^{-2}$ m

123 **(a)**

The electromagnetic theory of light failed to explain photoelectric effect.

126 **(d)**

Electromagnetic Waves are not deflected in electric and magnetic fields.

128 **(b)**

The wavelength of X-rays is of the order of 1 Å to 100 Å. The wavelength of radiowaves is of the order of 10^9Å to $10^{1.4}$Å. The wavelength of microwaves is of the order of 10^7Å to 10^9Å.

Thus, $\lambda_X < \lambda_M < \lambda_R$

The waves with less wave length will have more energy.

Hence,

$$E_X > E_M > E_R$$

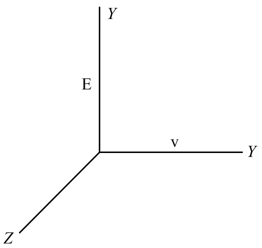
129 **(a)**

The frequency of Electromagnetic Wave along y −direction

$$\text{v} = 30 \text{ MHz}$$

The electric field component of the wave along y-direction.

$$E = 6 \text{ Vm}^{-1}$$



In Electromagnetic, the ratio of the amplitudes of electric and magnetic field is always constant and it is equal to velocity of the Electromagnetic Waves.

ie, $\frac{E}{B} = c$

or $B = \frac{E}{c} = \frac{6}{3 \times 10^8}$

or $B = 2 \times 10^{-8}$ T

130 **(b)**

Ozone layer blocks the high energy radiations like UV (3×10^{-7} m)

134 **(c)**

The relation between electric field vector **E**, the displacement vector **D** and the polarization vector **P** for a dielectric placed in electric field **E** is given by$\mathbf{D} = \varepsilon_0 \mathbf{E} + \mathbf{P}$.

135 **(d)**

Given refractive index

$$n = 1.5$$

Permeability $\mu_0 = 5 \times 10^{-7}$

$$n = \sqrt{\mu_r \varepsilon_r}$$

$$\varepsilon_r = \frac{n^2}{\mu_r}$$

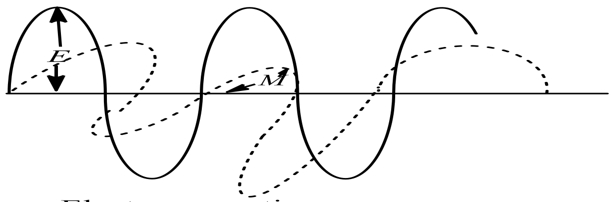
or $\rho = \frac{n^2 \mu_0}{\mu}$ $\left(\because \mu_r = \frac{\mu}{\mu_0}\right)$

or $\varepsilon_r = \frac{(1.5)^2 \times 4\pi \times 10^{-7}}{5 \times 10^{-7}}$

or $\varepsilon_r = 6$

137 **(c)**

The given wave in an Electromagnetic Waves. Electromagnetic radiation is a self propagating wave in space with electric and magnetic components. These components oscillate at right angles to each other and to the direction of propagation.



Electromagnetic wave

Hence, **B** is along the z-axis at that time.

Session : 2025-26 **AS PER NEW NTA SYLLABUS**

Total Questions : 143

PHYSICS (QUESTION BANK)

8.ELECTROMAGNETIC WAVES

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: If earth did not have atmosphere, its average surface temperature would be lower than what is now

Statement 2: Green house effect of the atmosphere would be absent if earth did not have atmosphere

2

Statement 1: The electromagnetic wave is transverse in nature

Statement 2: The waves propagates in straight line

3

Statement 1: X-ray astromy is possible only from satellites orbiting the earth

Statement 2: Efficiency of X-rays telescope is large as compared to any other telescope

4

Statement 1: $X-$ray Astronomy is possible only from satellites orbiting the earth.

Statement 2: Efficiency of $X-$rays telescope is large as compared to any other telescope.

5

Statement 1: Ultraviolet radiations being higher frequency waves are dangerous to human being

Statement 2: Ultraviolet radiations are absorbed by the atmosphere

6

Statement 1: Television signals are received through sky-wave propagation

Statement 2: The ionosphere reflects electromagnetic waves of frequencies greater than a certain critical frequency

7

Statement 1: For cooking in a microwave oven, food is always kept I metal containers.

Statement 2: The energy of microwave is easily transferred to the food in metal container.

8

Statement 1: Electromagnetic waves exert radiation pressure.

Statement 2: Electromagnetic waves carry energy.

PHYSICS (QUESTION BANK)

8.ELECTROMAGNETIC WAVES

: ANSWER KEY :

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

PHYSICS (QUESTION BANK)

8.ELECTROMAGNETIC WAVES

: HINTS AND SOLUTIONS :

1 **(a)**
Earth is heated by sun's infrared radiation. The earth also emits radiation most in infrared region. These radiations are reflected back due to heavy gases like CO_2 by atmosphere. These back radiation keep the earth's surface warm at night. This phenomenon is called green house effect. When the atmosphere were absent then temperature of earth falls

2 **(b)**
The electromagnetic wave contains sinusoidally time varying electric and magnetic fields which act perpendicularly to each other as well as at right angle (90°) to the direction of propagation of waves, so it is quite clear that electromagnetic waves are transverse in nature. The field may be represented as

$$E = E_0 \sin\omega\left(t - \frac{x}{v}\right)$$

$$B = B_0 \sin\omega\left(t - \frac{x}{v}\right)$$

3 **(b)**
The earth's atmosphere is transparent to visible light and radio waves, but absorbs X-rays. Thus, X-rays. Thus, X-rays telescope cannot be used on surface of earth

4 **(d)**
The earth's atmosphere is transparent to visible light and radio waves, but absorbs $X-$rays. Thus, $X-$rays telescope cannot be used on surface of earth.

5 **(b)**
Ultraviolet radiations are electromagnetic waves. The wavelength of these waves ranges between 4000Å to 100Å that is of smaller wavelength and higher frequency. They are absorbed by ozone layer of stratosphere in atmosphere. They cause skin disease and they are harmful to eye and cause permanent blindness

6 **(b)**
In sky wave propagation the radio waves which have frequency between 2 MHz to 30 MHz, are reflected back to the ground by the ionosphere. But radio waves having frequency greater than 30 MHz cannot be reflected by the ionosphere because at this frequency they penetrates the ionosphere. It makes the sky wave propagation less reliable for propagation of TV signal having frequency greater than 30 MHz

Critical frequency is defined as the highest frequency that is returned to the earth by the ionosphere. Thus, above this frequency a wave whether it is electromagnetic will penetrate the ionosphere and in not reflected by it