Solution

CET25P8 CET25P7 ALTERNATING CURRENT

Class 12 - Physics

1.

(c) +z direction

Explanation: $\vec{E} \times \vec{B} = \vec{V}$

$(E\hat{j}) \times (\vec{B}) = V\hat{i}$

$\Rightarrow \vec{B} = B\hat{k}$, because $\hat{j} \times k = \hat{i}$

Thus the magnetic field oscillates along +z direction.

2.

(c) reciprocal of speed of light in vacuum

Explanation: $\frac{E_0}{B_0} = c \Rightarrow \frac{B_0}{E_0} = \frac{1}{c}$

3.

(d) 2.26 × 10^4

Explanation: Displacement current,

$I_d = \varepsilon_0 \frac{d\phi_E}{dt}$

$\therefore \frac{d\phi}{dt} = \frac{I_d}{\varepsilon_0} = \frac{2 \times 10^{-7}}{8.85 \times 10^{-12}}$

= 2.26 × 10^4 Wb/s

4. **(a)** 361 m, 0.0174 /m

Explanation: $\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{830 \times 10^3} = 361m$

Angular wave number, $k = \frac{2\pi}{\lambda} = \frac{2\pi}{361} = 0.0174/m$

5.

(c) 1.8 × 10^8 m/s

Explanation: $\nu = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$

$= \frac{3 \times 10^8}{\sqrt{1.2 \times 2.14}} = \frac{3 \times 10^8}{1.67}$

= 1.8 × 10^8 ms^{-1}

6.

(b) higher than 0 K

Explanation: Any object having a temperature higher than 0 K emits em radiation in the infrared region.

7.

(b) 3×10^{15}kHz, 3.3×10^{-17}s

Explanation: $\nu = \frac{c}{\lambda} = \frac{3 \times 10^8}{0.1 \times 10^{-9}} = 3 \times 10^{18} Hz = 3 \times 10^{15} kHz$

$T = \frac{1}{\nu} = \frac{1}{3 \times 10^{18} Hz} = 3.33 \times 10^{-17} s$

8.

(d) $\frac{1}{\sqrt{\varepsilon_0 \mu_0}}$

Explanation: $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

9. **(a)** An accelerating charge

Explanation: An accelerating charge produces a propagating electromagnetic wave.

10.

(c) 153 N/C

Explanation: $E_o = c \times B_o = 3 \times 10^8 \times 510 \times 10^{-9}$

= 153 N/C

11.

(b) moving with an acceleration

Explanation: moving with an acceleration

12.

(d) magnetic field

Explanation: A changing electric field gives rise to a magnetic field.

13.

(d) wavelength is halved and the frequency remains unchanged

Explanation: The frequency of electromagnetic waves does not change, when it goes from one medium to another medium.

Now, refractive index of the medium,

$n = \sqrt{\frac{\varepsilon}{\varepsilon_0}} = \sqrt{\frac{4}{1}} = 2$

Therefore, wavelength of the electromagnetic waves in the medium,

$\lambda_{med} = \frac{\lambda}{\mu} = \frac{\lambda}{2}$

14.

(b) a > b > c

Explanation: As the wavelength of γ-rays is least and that of ultraviolet rays is maximum, so the frequency of γ-rays is maximum and that of ultraviolet rays is least.

15.

(c) $10^9 Hz$

Explanation: Frequency of em-wave produced by oscillating charge is equal to frequency of oscillation of charged particle.

16.

(c) Radiowaves, X-rays, Visible rays

Explanation: Radiowaves have wavelength > 0.1m

X-rays have wavelength 1nm to 10^{-3} nm

visible rays have wavelength 400nm to 700nm

17.

(c) None of these

Explanation: Velocity of light in any medium depends only on electrical and magnetic properties of medium and is independent of frequency, amplitude or wavelength.

18. **(a)** Polarization

Explanation: Only transverse waves can be polarized. Longitudinal waves do not undergo polarization.

Whereas both, transverse and longitudinal waves can undergo interference, diffraction and reflection.

19. **(a)** None of these

Explanation: Ultraviolet rays are used for water purification and eye surgery.

20. **(a)** Electric field squared

Explanation: $I = \epsilon_o E_{rms}^2 c$

21.

(b) $E_r = E_0 \hat{i} \cos(kz + \omega t)$

Explanation: $E_r = E_0 \hat{i} \cos(kz + \omega t)$

22.

(b) 2.50×10^{-6} N

Explanation: $F_{av} = \frac{2IA}{c} = \frac{2 \times 25 \times 10^4 \times 15 \times 10^{-4}}{3 \times 10^8}$ N

$= 250 \times 10^{-8}$ N $= 2.5 \times 10^{-6}$ N

23.

(b) Gamma rays

Explanation: Gamma rays

24.

(c) 3.0×10^{-19} J

Explanation: 3.0×10^{-19} J

25.

(c) 2

Explanation: 2

26.

(d) 10^{14}

Explanation: Size of particle $= \lambda = \frac{c}{v}$

$\therefore \nu = \frac{c}{\lambda}$

$= \frac{3\times10^{10}\text{cms}^{-1}}{3\times10^{-4}\text{ cm}}$ = 3 × 10^{14} Hz

27. **(a)** $\lambda_m > \lambda_v > \lambda_x$

Explanation: Since of the given regions, wavelength of microwave is highest and that of x-ray is minimum.

28. **(a)** 10 m

Explanation: $\lambda = \frac{c}{\nu} = \frac{3\times10^8}{30\times10^6} = 10m$

29. **(a)** speed

Explanation: Speed of entire electromagnetic spectrum is same.

30. **(a)** H.R. Hertz

Explanation: H.R. Hertz

31.

(d) $v_g = v_x = v_m$

Explanation: All e.m. waves travel with the speed of light in free space.

32.

(d) $4.58 \times 10^{-6} Jm^{-3}$

Explanation: $Energy\ density = \epsilon_o E^2$

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

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

33.

(c) transverse electromagnetic wave

Explanation: Solar is radiation is transverse e.m. wave.

34.

(c) Magnetic field and electric field

Explanation: Magnetic field and electric field

35.

(b) 25 m - 40 m

Explanation: $\lambda_1 = \frac{c}{\nu_1} = \frac{3\times10^8}{12\times10^6} = 25m$

$\lambda_2 = \frac{c}{\nu_2} = \frac{3\times10^8}{7.5\times10^6} = 40m$

Hence the corresponding wavelength range is 25 m - 40 m.

36.

(c) $E(x, t) = E_{max} \cos\left(5.93 \times 10^5\ x + 1.78 \times 10^{14}\ t\right)$

Explanation: $k = \frac{2\pi}{\lambda} = \frac{2\times3.14}{10.6\times10^{-6}} = 5.93 \times 10^5 rad/m$

$\omega = 2\pi\nu = 2\pi\frac{c}{\lambda} = \frac{2\times3.14\times3\times10^8}{10.6\times10^{-6}} = 1.78 \times 10^{14} rad/s$

Since wave is propagating along -X axis,

$E(x, t) = E_{max} \cos[kx + \omega t]$

$E(x, t) = E_{max} \cos\left(5.93 \times 10^5\ x + 1.78 \times 10^{14}\ t\right)$

37. **(a)** ultraviolet rays, microwaves, radiowaves

Explanation: $\lambda = 10^{-8}$ m $\rightarrow$ ultraviolet rays

$\lambda = 10^{-2}$ m $\rightarrow$ microwaves,

$\lambda = 10^{8}$ m $\rightarrow$ radiowaves.

38.

(c) 35.6 m

Explanation: $\lambda = \frac{c}{\nu} = \frac{3\times10^8}{8.2\times10^6}$ = 35.6 m

39.

(b) transition of electrons from higher to lower electronic orbits of an atom

Explanation: Characteristic X-rays are produced due to transfer of electrons from higher to lower electronic orbits of an atom.

40. **(a)** 2.25

Explanation: 2.25

41. **(a)** $\frac{1}{r}$

Explanation: A diode antenna radiates the electromagnetic waves outwards. The amplitude of electric field vector (E_0) is inversely proportional as the distance (r) from the antenna,

i.e., $E_0 \propto \frac{1}{r}$

42.

(d) a < b, b > c

Explanation: Of the given region, frequency of γ- rays is maximum and that of UV is minimum, hence a < b, b > c

43. **(a)** Ultraviolet rays

Explanation: Ultraviolet rays

44. **(a)** electrons

Explanation: X-rays are produced when an element of high atomic weight is bombarded by high energy electrons.

45.

(c) $\frac{q^2}{2\epsilon_0 A^2}$

Explanation: Energy density $= \frac{\epsilon_o E^2}{2} = \frac{q^2}{2\epsilon_0 A^2}$

as $E = \frac{\sigma}{\epsilon_o}$ and $\sigma = \frac{q}{A}$

46.

(b) zero

Explanation: Peaks of magnetic and electric waves of electromagnetic wave form at the same time. Hence, there is no phase difference between these two waves.

47.

(d) frequency

Explanation: Frequency ν remains unchanged when a wave propagates from one medium to another. Both wavelength and velocity get changed.

48.

(c) all of these

Explanation: The ozone layer absorbs e.m. radiation of wavelength range from 120 nm to 380 nm.

49. **(a)** $2 \times 10^{-7}T$

Explanation: $B_o = \frac{E_o}{c} = \frac{60}{(3\times10^8)} = 2 \times 10^{-7}T$

50.

(c) infrared

Explanation: Infrared radiations are used in the treatment of muscles ache.

51.

(c) Atmosphere absorbs X-rays, while visible and radio waves can penetrate it.

Explanation: Optical and radio waves can penetrate the atmosphere whereas x- rays, are of very short wavelength and hence absorbed by the atmosphere. This is the reason why we can work with optical and radio telescopes on earth's surface, but x-rays astronomical telescopes must be used on the satellite orbiting above the earth's atmosphere.

52. **(a)** ultraviolet rays

Explanation: ultraviolet rays

53.

(d) 8.15 $\times 10^{13}$ km

Explanation: distance = speed $\times$ time = $3 \times 10^8 \times 8.61 \times 365 \times 24 \times 3600 = 8.15 \times 10^{16}$ m = 8.15×10^{13} km

54.

(d) Infrared waves

Explanation: Infrared waves

55.

(d) Microwave

Explanation: Microwave frequency ranges from 10^{13} to 10^{9}Hz.

56. **(a)** 2 m^{-1}

Explanation: $k = \frac{\omega}{c} = \frac{6\times10^8}{3\times10^8} = 2\ \mathrm{m}^{-1}$

57. **(a)** Speed

Explanation: All types of electromagnetic waves travel with speed of light in vacuum.

58.

(c) Infrared waves

Explanation: Infrared rays can be converted into electric energy as in solar cells.

59.

(c) 0.4 W/m^2, 0.004 W/m^2

Explanation: The bulb, as a point source, radiates light in all directions uniformly.

At a distance of 1 m, the surface area of the surrounding sphere is $4\pi r^2 = 12.56m^2$

The intensity at this distance is, $I = \frac{power}{area} = \frac{100}{12.56} \times \frac{5}{100} \approx 0.4W/m^2$

Similarly, at a distance of 10 m, intensity is 0.004 W/m^{-2}

60.

(c) Speed

Explanation: Speed of all em waves is same in a medium.

61.

(c) 2.2 A

Explanation: $Z = \sqrt{R^2 + X_C^2}$

$= \sqrt{100^2 + 100^2}$

$= 100\sqrt{2}\Omega$

$I_d^{\max} = \frac{V_{\max}}{Z}$

$= \frac{220\sqrt{2}}{100\sqrt{2}}$ = 2.2 A

62. **(a)** $\lambda_{\text{radio wave}} > \lambda_{\text{micro waves}} > \lambda_{\text{visible}} > \lambda_{\text{x.rays}}$

Explanation: $\lambda_{\text{radio wave}} > \lambda_{\text{micro waves}} > \lambda_{\text{visible}} > \lambda_{\text{x.rays}}$

63.

(d) electric field is changing

Explanation:

i. Displaced current is defined as the change in the rate of the flow of current or the flow of current changes in the direction.

ii. When the electric field changes with time, then there is a possibility of the occurrence of displaced current.

iii. The current value will also change when the electric field changes.

iv. If there is a steady motion of the electric field, then the current conduction will be also in a steady manner.

64.

(b) $\frac{1}{\sqrt{\mu\varepsilon}}$

Explanation: In a material medium, $v = \frac{1}{\sqrt{\mu\varepsilon}}$ for an em wave.

65.

(c) X-rays

Explanation: The X-rays are the most widely used electromagnetic waves as a diagnostic tool in medicine. The X-rays penetrate through the skin and produce the image of the inner parts of the body and X-rays are used to obtain images of the structures inside the human body, like bones, unwanted stones, etc

66. **(a)** 7.14 $\times 10^{14}$Hz

Explanation: $\nu = \frac{c}{\lambda} = \frac{3\times10^8}{4.2\times10^{-7}} = 7.14 \times 10^{14} Hz$

67.

(b) X-rays

Explanation: As E lies between 100 eV to 100 keV, so the e.m. waves are X-rays.

Aliter. $X = \frac{12400}{E}\text{eV}\overset{\circ}{\text{A}}$

$= \frac{12400\text{eV}\overset{\circ}{\text{A}}}{15\times10^3\text{eV}} = 0.826\overset{\circ}{\text{A}}$

λ lies between 0.01$\overset{\circ}{\text{A}}$ to 100 $\overset{\circ}{\text{A}}$, so the em waves are X-rays.

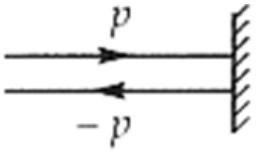
68.

(c) both a.c. and d.c.

Explanation: Conduction current is the same as displacement whether the source is a.c. or d.c.

69. **(a)** $\frac{2E}{c}$

Explanation:



For complete absorption of energy E, momentum transferred is

$p = \frac{E}{c}$

When the radiation is totally reflected, momentum transferred is

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

70.

(d) $\frac{1}{r}$

Explanation: $\frac{1}{r}$

71.

(b) $v_s = v_x = v_m$

Explanation: All electromagnetic waves travel in a vacuum with the same speed c.

72. **(a)** the frequency of the microwaves must match the resonant frequency of the water molecules

Explanation: Energy from the microwaves is transferred efficiently to the kinetic energy of water molecules at their resonant frequency.

73.

(c) Microwaves

Explanation: Microwaves

74.

(c) 1.5$\times10^{-2}$m, 1.6 $\times10^{-7}$T

Explanation: $\lambda = \frac{c}{\nu} = \frac{3\times10^8}{2\times10^{10}} = 1.5 \times 10^{-2} m$

$B_o = \frac{E_o}{c} = \frac{48}{3\times10^8} = 1.6 \times 10^{-7} T$

75. **(a)** 5800 K

Explanation: $T = \frac{0.29\times10^{-2} mK}{\lambda} = \frac{0.29\times10^{-2} mK}{5\times10^{-7}}$ = 5800K