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Electromagnetic Waves

TOPIC 1

Displacement Current and Properties of EM Waves

01 A capacitor of capacitance *C*, is connected across an AC source of voltage *V*, given by

$$V = V_0 \sin\omega t$$

The displacement current between the plates of the capacitor, would then be given by **[NEET 2021]**

(a) $I_d = V_0 \omega C \cos\omega t$

(b) $I_d = \dfrac{V_0}{\omega C}\cos\omega t$

(c) $I_d = \dfrac{V_0}{\omega C}\sin\omega t$

(d) $I_d = V_0 \omega C \sin\omega t$

Ans. *(a)*

Given, AC source voltage,

$$V = V_0 \sin\omega t \quad \text{...(i)}$$

We know that,

$$Q = CV \quad \text{...(ii)}$$

Here, Q is the charge on the capacitor, C is the capacitance of the capacitor, V is the AC source voltage.

On differentiate Eq. (ii) w.r.t. time, we get

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

$$\Rightarrow \frac{dQ}{dt} = \frac{Cd(V_0 \sin\omega t)}{dt} \quad \text{[from Eq. (i)]}$$

$$\Rightarrow \frac{dQ}{dt} = C\omega V_0 \cos\omega t$$

As we know, the displacement current,

$$I_d = \frac{dQ}{dt}$$

$$\Rightarrow \quad I_d = V_0 \omega C \cos\omega t$$

02 For a plane electromagnetic wave propagating in *x*-direction, which one of the following combination gives the correct possible directions for electric field (*E*) and magnetic field (*B*) respectively? **[NEET 2021]**

(a) $\hat{\mathbf{j}} + \hat{\mathbf{k}}, \hat{\mathbf{j}} + \hat{\mathbf{k}}$ (b) $-\hat{\mathbf{j}} + \hat{\mathbf{k}}, -\hat{\mathbf{j}} - \hat{\mathbf{k}}$

(c) $\hat{\mathbf{j}} + \hat{\mathbf{k}}, -\hat{\mathbf{j}} + \hat{\mathbf{k}}$ (d) $-\hat{\mathbf{j}} + \hat{\mathbf{k}}, -\hat{\mathbf{j}} + \hat{\mathbf{k}}$

Ans. *(b)*

We know that, in electromagnetic wave, the electric field (*E*) and magnetic field (*B*) are perpendicular to each other,

$$\mathbf{E} \cdot \mathbf{B} = 0$$

Consider the option (a);

$$(\hat{\mathbf{j}} + \hat{\mathbf{k}}) \cdot (\hat{\mathbf{j}} + \hat{\mathbf{k}}) = 1 + 1 = 2 \neq 0$$

So, it is incorrect option.

Consider the option (b);

$$(-\hat{\mathbf{j}} + \hat{\mathbf{k}}) \cdot (-\hat{\mathbf{j}} - \hat{\mathbf{k}}) = 1 - 1 = 0$$

Hence, it satisfies the condition $\mathbf{E} \cdot \mathbf{B} = 0$

Similarly, options (c) and (d) are incorrect.

So, the correct option is (b).

03 The magnetic field in a plane electromagnetic wave is given by $B_y = 2 \times 10^{-7} \sin(\pi \times 10^3 x + 3\pi \times 10^{11} t)\,\text{T}$ Calculate the wavelength. **[NEET (Oct.) 2020]**

(a) $\pi \times 10^3$ m (b) 2×10^{-3} m

(c) 2×10^3 m (d) $\pi \times 10^{-3}$ m

Ans. *(b)*

Magnetic field in plane electromagnetic wave is given as

$B_y = 2 \times 10^{-7} \sin(\pi \times 10^3 x + 3\pi \times 10^{11} t)\,\mathbf{T}$

Comparing with, $B_y = B_0 \sin(kx - \omega t)$, we get

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

$$\Rightarrow \quad \lambda = \frac{2}{10^3} = 2 \times 10^{-3}\,\text{m}$$

04 The ratio of contributions made by the electric field and magnetic field components, to the intensity of an electromagnetic wave is (where, c = speed of electromagnetic waves) **[NEET (Sep.) 2020]**

(a) 1 : 1 (b) 1 : c (c) 1 : c^2 (d) c : 1

Ans. *(d)*

We know that,

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

where, E_0 and B_0 are the peak values of electric field and magnetic field, respectively.

$$\therefore \quad E_0 : B_0 = c : 1$$

Hence, correct option is (d).

05 Light with an average flux of 20 W/cm^2 falls on a non-reflecting surface at normal incidence having surface area 20 cm^2. The energy received by the surface during time span of 1 min is **[NEET (Sep.) 2020]**

(a) 12×10^3 J (b) 24×10^3 J

(c) 48×10^3 J (d) 10×10^3 J

Ans. *(b)*

Given, average flux = 20 W/cm^2

Surface area = 20 cm^2

Time = 1 min = 60 s

For non-reflecting surface,

energy received = average flux × surface area × time

$$= 20 \times 20 \times 60 = 24 \times 10^3 \text{ J}$$

06 A parallel plate capacitor of capacitance 20μF is being charged by a voltage source whose potential is changing at the rate of 3 V/s. The conduction current through the connecting wires and the displacement current through the plates of the capacitor, would be, respectively. **[NEET (National) 2019]**

(a) $60\,\mu A$, $60\,\mu A$ (b) $60\,\mu A$, zero
(c) zero, zero (d) zero, $60\,\mu A$

Ans. ***(a)***

Key Idea The displacement current is precisely equals to the conduction current, when the two are present in different parts of the circuit.

Given, $C = 20\mu F = 20 \times 10^{-6}$ F and

$$\frac{dV}{dt} = 3\text{ V/s}$$

The displacement current in a circuit is given by

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

[from Maxwell's equation)

$$= \varepsilon_0 \frac{d}{dt}(EA) \quad [\because \phi = EA]$$

$$= \varepsilon_0 A \frac{d}{dt}\left(\frac{V}{d}\right) \, [\because V = Ed]$$

$$= \frac{\varepsilon_0 A}{d}\frac{dV}{dt}$$

As the capacitance, $C = \frac{\varepsilon_0 A}{d}$

$$\therefore \quad I_d = C\frac{dV}{dt}$$

Substituting the given values, we get

$$I_d = 20 \times 10^{-6} \times 3$$
$$= 60 \times 10^{-6}\text{ A} = 60\,\mu\text{ A}$$

As displacement current is in between the plates of capacitor and conduction current is in the connecting wires which are equal to each other. So,

$$I_c = I_d = 60\,\mu\text{A}$$

07 An EM wave is propagating in a medium with a velocity $\mathbf{v} = v\hat{\mathbf{i}}$. The instantaneous oscillating electric field of this EM wave is along $+y$-axis. Then, the direction of oscillating magnetic field of EM wave will be along **[NEET 2018]**

(a) $-y$-direction (b) $+z$-direction
(c) $-z$-direction (d) $-x$-direction

Ans. ***(b)***

Here, velocity of EM wave, $\mathbf{v} = v\hat{\mathbf{i}}$

Instantaneous oscillating electric field,

$$\mathbf{E} = E\hat{\mathbf{j}}$$

As we already know that, during the propagation of = EM waves through a medium oscillating electric and magnetic field vectors are mutually perpendicular to each other and to the direction of each other and to the direction of propagation of the wave $(\mathbf{E} \times \mathbf{B})$.

i.e.

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

$$\Rightarrow \quad (E\hat{\mathbf{j}}) \times \mathbf{B} = v\hat{\mathbf{i}} \quad \text{...(i)}$$

As we know that from vector algebra,

$$\hat{\mathbf{j}} \times \hat{\mathbf{k}} = \hat{\mathbf{i}} \quad \text{...(ii)}$$

Comparing Eqs. (i) and (ii), we get

$$\mathbf{B} = B\hat{\mathbf{k}},$$

where B (say) be the magnitude of magnetic field.

Thus, we can say that the direction of oscillating magnetic field of the em wave will be along $+z$ direction.

08 Out of the following options which one can be used to produce a propagating electromagnetic wave? **[NEET 2016]**

(a) A stationary charge
(b) A chargeless particle
(c) An accelerating charge
(d) A charge moving at constant velocity

Ans. ***(c)***

A particle is known that an electric charge at rest has electric field in the region around it, but no magnetic field. A moving charge produces both the electric and magnetic fields. If a charge is moving with a constant velocity, the electric and magnetic fields will not change with time, hence no EM wave will be produced. But if the charge is moving with a non-zero acceleration, both the electric and magnetic field will change with space and time, it then produces EM wave. This shows that accelerated charge emits electromagnetic waves.

09 A radiation of energy 'E' falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (c = velocity of light) **[CBSE AIPMT 2015]**

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

Ans. ***(b)***

The radiation energy is given by

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

Initial momentum of the radiation is

$$\mathbf{P}_i = \frac{h}{\lambda} = \frac{E}{c}$$

The reflected momentum is

$$\mathbf{P}_r = -\frac{h}{\lambda} = -\frac{E}{c}$$

So, the change in momentum of light is

$$\Delta\mathbf{P}_{\text{light}} = \mathbf{P}_r - \mathbf{P}_i = -\frac{2E}{c}$$

Thus, the momentum transferred to the surface is

$$\Delta P_{\text{light}} = \frac{2E}{c}$$

10 Light with an energy flux of $25 \times 10^4\ \mathbf{Wm}^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is $\mathbf{15cm}^2$, the average force exerted on the surface is **[CBSE AIPMT 2014]**

(a) 1.25×10^{-6} N (b) 2.50×10^{-6} N
(c) 1.20×10^{-6} N (d) 3.0×10^{-6} N

Ans. ***(b)***

As $F_{\text{average}} = \frac{2IA}{c}$

where, I = energy flux of light $= 25 \times 10^4\ \text{Wm}^{-2}$

A = Surface area of reflecting surface

and c = speed of light $= 3 \times 10^8$ m/s

$$\therefore \quad F_{\text{average}} = \frac{2 \times 25 \times 10^4 \times 15 \times 10^{-4}}{3 \times 10^8}$$
$$= 2.50 \times 10^{-6}\text{N}$$

11 The electric field associated with an electro magnetic wave in vacuum is given by $\mathbf{E} = \hat{\mathbf{i}}\ 40 \cos(kz - 6 \times 10^8\, t)$, where E, z and t are in volt/m, metre and second respectively. The value of wave vector k is **[CBSE AIPMT 2012]**

(a) 2 m^{-1} (b) 0.5 m^{-1}
(c) 6 m^{-1} (d) 3 m^{-1}

Ans. ***(a)***

Electromagnetic wave equation is given by

$$E = E_0 \cos(kz - \omega t) \quad \text{...(i)}$$

Speed of electromagnetic wave, $v = \frac{\omega}{k}$

Given, equation is

$$\mathbf{E} = \hat{\mathbf{i}} 40 \cos(kz - 6 \times 10^8 t) \quad \text{...(ii)}$$

Comparing Eqs. (i) and (ii), we get

$$\omega = 6 \times 10^8 \quad \text{and} \quad E_0 = 40\,\hat{\mathbf{i}}$$

Here, wave factor,

$$k = \frac{\omega}{v} = \frac{6 \times 10^8}{3 \times 10^8} = 2\ \text{m}^{-1}$$

12 The electric and the magnetic field, associated with an electromagnetic wave, propagating along the +*z*-axis, can be represented by **[CBSE AIPMT 2011]**

(a) $[\mathbf{E} = E_0\hat{\mathbf{k}}, \mathbf{B} = B_0\hat{\mathbf{i}}]$

(b) $[\mathbf{E} = E_0\hat{\mathbf{j}}, \mathbf{E} = B_0\hat{\mathbf{j}}]$

(c) $[\mathbf{E} = E_0\hat{\mathbf{j}}, \text{B} = B_0\hat{\mathbf{k}}]$

(d) $[\mathbf{E} = E_0\hat{\mathbf{i}}, \mathbf{B} = B_0\hat{\mathbf{j}}]$

Ans. *(d)*

As we know that $\mu = \mathbf{E} \times \mathbf{B} = E_0\hat{\mathbf{i}} + B_0\hat{\mathbf{j}}$

$\mathbf{E} \times \mathbf{B}$ points in the direction of wave propagation.

13 Which of the following statement is false for the properties of electromagnetic waves? **[CBSE AIPMT 2010]**

(a) Both electric and magnetic field vectors attain the maxima and minima at the same place and same time

(b) The energy in electromagnetic wave is divided equally between electric and magnetic vectors

(c) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave

(d) These waves do not require any material medium for propagation

Ans. *(c)*

The time varying electric and magnetic fields are mutually perpendicular to each other and also perpendicular to the direction of propagation.

14 The electric field part of an electromagnetic wave in a medium is represented by $E_x = 0$;

$$E_y = 2.5\frac{N}{C}\cos\left[\left(2\pi \times 10^6 \frac{\text{rad}}{\text{m}}\right)t - \left(\pi \times 10^{-2}\frac{\text{rad}}{\text{s}}\right)x\right]; E_z = 0.$$

The wave is **[CBSE AIPMT 2009]**

(a) moving along *y*-direction with frequency $2\pi \times 10^6$ Hz and wavelength 200 m

(b) moving along *x*-direction with frequency 10^6 Hz and wavelength 100 m

(c) moving along *x*-direction with frequency 10^6 Hz and wavelength 200 m

(d) moving along $-x$-direction with frequency 10^6 Hz and wavelength 200 m

Ans. *(c)*

Comparing the given equation

$$E_y = 2.5\frac{\text{N}}{\text{C}}\cos\left[\left(2\pi \times 10^6\frac{\text{rad}}{\text{m}}\right)t - \left(\pi \times 10^{-2}\frac{\text{rad}}{\text{sec}}\right)x\right]$$

With the standard equation

$$E_y = E_0\cos(\omega t - kx)$$

we get $\omega = 2\pi f = 2\pi \times 10^6$

$\therefore \quad f = 10^6$ Hz

Moreover, we know that

$$\frac{2\pi}{\lambda} = k = \pi \times 10^{-2}\ \text{m}^{-1}$$

$\Rightarrow \quad \lambda = 200\text{m}$

As direction of field $\mathbf{E}$ of electromagnetic wave is in *y* direction so, the wave is moving along positive *x*-direction with frequency 10^6 Hz and wavelength 200 m.

15 The velocity of electromagnetic wave is along the direction of **[CBSE AIPMT 2002]**

(a) $\mathbf{B} \times \mathbf{E}$ (b) $\mathbf{E} \times \mathbf{B}$

(c) $\mathbf{E}$ (d) $\mathbf{B}$

Ans. *(b)*

An electromagnetic wave is the wave composed of the oscillations of electric and magnetic fields in mutually perpendicular planes and these oscillations are perpendicular to the direction of propagation of wave.

The direction of propagation of electromagnetic wave is given by poynting vector

$$\mathbf{S} = \mathbf{E} \times \mathbf{H} = \frac{\mathbf{E} \times \mathbf{B}}{\mu_0}$$

This is parallel to $\mathbf{E} \times \mathbf{B}$.

16 In a certain region of space electric field **E** and magnetic field **B** are perpendicular to each other and an electron enters in region perpendicular to the direction of **B** and **E** both and moves undeflected, then velocity of electron is **[CBSE AIPMT 2001]**

(a) $\frac{|\mathbf{E}|}{|\mathbf{B}|}$ (b) $\mathbf{E} \times \mathbf{B}$ (c) $\frac{|\mathbf{B}|}{|\mathbf{E}|}$ (d) $\mathbf{E} \cdot \mathbf{B}$

Ans. *(a)*

For electron to pass undeflected, electric force on electron

= magnetic force on electron

i.e. $eE = evB$

or $v = \frac{E}{B}$ or $v = \frac{|\mathbf{E}|}{|\mathbf{B}|}$

17 The electromagnetic radiations are caused by **[CBSE AIPMT 1999]**

(a) a stationary charge

(b) uniformly moving charges

(c) accelerated charges

(d) All of the above

Ans. *(c)*

A stationary charge produces electric field only; a uniformly moving charge produces localised electromagnetic field.

An accelerated charge produces electro- magnetic radiations. The reason is that due to accelerated charges, magnetic field is produced around accelerating charges. As the velocity of charge changes, the magnetic field produced due to it also changes with time. This varying magnetic field produces the electric field.

The electric field so produced also changes with time. These two varying fields are mutually perpendicular and also perpendicular to the direction of propagation of wave and both the fields are in same phase and of same frequency. The frequency of these fields is same as the frequency of oscillations of the charged particle. The wave associated with these oscillations is called the electromagnetic wave.

18 The wavelength of light of frequency 100 Hz is **[CBSE AIPMT 1999]**

(a) 2×10^6 m (b) 3×10^6 m

(c) 4×10^6 m (d) 5×10^6 m

Ans. *(b)*

The relation between velocity of light (*c*), frequency (ν) and wavelength (λ) is

$$c = \nu\lambda$$

Thus, wavelength $\lambda = \frac{c}{\nu}$

Given, $c = 3 \times 10^8$ m/s, $\nu = 100$ Hz

$$\therefore \quad \lambda = \frac{3 \times 10^8}{100} = 3 \times 10^6\ \text{m}$$

19 If ε_0 and μ_0 are respectively the electric permittivity and magnetic permeability of free space, ε and μ are the corresponding quantities in a medium, the index of refraction of the medium is **[CBSE AIPMT 1997]**

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

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

Ans. ***(b)***

Refractive index of medium is given by

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

Here, $\mu = \mu_0 \mu_r \Rightarrow \mu_r = \frac{\mu}{\mu_0}$

and $\varepsilon = \varepsilon_0 \varepsilon_r \Rightarrow \varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$

$\therefore \quad n = \sqrt{\frac{\mu}{\mu_0} \cdot \frac{\varepsilon}{\varepsilon_0}} = \sqrt{\frac{\varepsilon\mu}{\varepsilon_0 \mu_0}}$

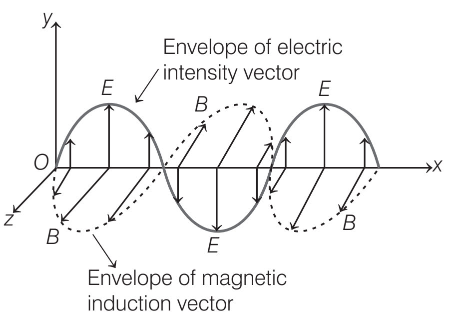
20 The oscillating electric and magnetic field vectors of electromagnetic wave are oriented along **[CBSE AIPMT 1995]**

(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°

Ans. ***(c)***

According to Maxwell, the electromagnetic waves are those waves in which there are sinusoidal variations of electric and magnetic field vectors at right angles to each other as well as right angles to the direction of wave propagation. Both these fields vary with time and space and have the same frequency.

In figure, the electric field vector (**E**) and magnetic field vector (**B**) are vibrating along *y* and *z*-directions and propagation of electromagnetic wave is shown in *x*-direction.



From figure it is clear that electric and magnetic fields oscillate in same phase.

TOPIC 2
EM Spectrum

21 The electromagnetic wave with shortest wavelength among the following is **[NEET (Oct.) 2020]**

(a) UV-rays (b) X-rays
(c) γ-rays (d) microwaves

Ans. ***(c)***

Gamma-rays has the shortest wavelength because it has higher frequency than UV-rays, microwaves and X-rays.

22 The energy of the EM waves is of the order of 15 keV. To which part of the spectrum does it belong? **[CBSE AIPMT 2015]**

(a) X-rays (b) Infrared rays
(c) Ultravioiet rays (d) γ-rays

Ans. ***(a)***

Given, energy of EM waves is of the order of 15 keV

i.e. $E = h\nu = h \times \frac{c}{\lambda}$

$\Rightarrow \lambda = \frac{h \times c}{E} = \frac{6.624 \times 10^{-34} \times 3 \times 10^{18}}{15 \times 10^3 \times 1.6 \times 10^{-19}}$

$= \frac{1.3248 \times 10^{-29}}{1.6 \times 10^{-19}} = 0.828 \times 10^{-10}$ m

$= 0.828$ Å [$\because$ 1Å $= 10^{-10}$ m]

$\lambda = 0.828$ Å

Thus, this spectrum is a part of *X*-rays.

23 The condition under which a microwave oven heats up a food item containing water molecules most efficiently is **[NEET 2013]**

(a) the frequency of the microwave must match the resonant frequency of the water molecules
(b) the frequency of the microwave has no relation with natural frequency of water molecules
(c) microwave are heat waves, so always produce heating
(d) infra-red waves produce heating in a microwave oven

Ans. ***(a)***

It is an electromagnetic wave. The frequency of the microwave oven must match the resonant frequency of the water molecules.

Note In the presence of microwaves, water molecules oscillate with frequency of microwaves and large heat is developed.

24 The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is **[CBSE AIPMT 2011]**

(a) gamma rays, ultraviolet, infrared, microwaves
(b) microwaves, gamma rays, infrared, ultraviolet
(c) infrared, microwave, ultraviolet, gamma rays
(d) microwave, infrared, ultraviolet, gamma rays

Ans. ***(d)***

Decreasing order of wavelength of various rays is Microwave > Infrared > Ultraviolet > Gamma rays

25 The velocity of electromagnetic radiation in a medium of permittivity ε_0 and permeability μ_0 is given by **[CBSE AIPMT 2008]**

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

Ans. ***(c)***

The velocity of electromagnetic waves in free space is given by

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

26 If λ_v, λ_x and λ_m represent the wavelengths of visible light, X-rays and microwaves respectively, then **[CBSE AIPMT 2005]**

(a) $\lambda_m > \lambda_x > \lambda_v$ (b) $\lambda_v > \lambda_m > \lambda_x$
(c) $\lambda_m > \lambda_v > \lambda_x$ (d) $\lambda_v > \lambda_x > \lambda_m$

Ans. ***(c)***

Wavelength order of given rays are listed below

Waves	Wavelength (in Å)
Visible light	4000–7000
X-rays	$10^{-3} - 10^2$
Microwaves	$10^7 - 10^9$

So, $\lambda_x < \lambda_v < \lambda_m$

27 Which of the following rays are not electromagnetic waves? **[CBSE AIPMT 2003]**

(a) β-rays (b) Heat rays
(c) X-rays (d) γ-rays

Ans. *(a)*

(a) β-rays are fast moving electrons. So, they are not electromagnetic waves.

(b) Heat rays can travel through vaccum *via* radiation process. They are electromagnetic waves.

(c) X-rays are electromagnetic waves having wavelengths from about 10^{-8} m to 10^{-12} m.

(d) γ-rays are electromagnetic waves having wavelengths ranging from about 10^{-16} m to 10^{-14} m.

Hence, choice (a) is correct.

28 Which of the following has minimum wavelength ? **[CBSE AIPMT 2002]**

(a) X-rays (b) Ultraviolet rays
(c) γ-rays (d) Cosmic rays

Ans. *(d)*

The wavelength order of waves are given below

Waves	Wavelength (in Å)
(a) X-rays	0.001 Å to 100 Å
(b) Ultraviolet rays	10 Å to 4000 Å
(c) γ-rays	0.0001 Å to 1 Å
(d) Cosmic rays	upto 4×10^{-3} Å

Thus, cosmic rays have the minimum wavelength.

29 What is the cause of "Green house effect"? **[CBSE AIPMT 2002]**

(a) Infrared rays (b) Ultraviolet rays
(c) X-rays (d) Radio-waves

Ans. *(a)*

The green house is a room made of glass which is constructed to grow plants in open space. The glass transmits the infrared radiations of short wavelength and the visible light, but it absorbs the infrared radiations of long wavelength. During the day time, the light and the infrared radiations of short wavelength enter inside the green house through the roof and the walls and they are absorbed by the plants.

At night, plants emit the infrared radiations through the glass walls and roof. As a result, green house remains warm. This is called green house effect.

30 The frequency of γ-rays, X-rays and ultraviolet rays are *a*, *b* and *c* respectively. Then, **[CBSE AIPMT 2000]**

(a) $a>b>c$ (b) $a<b<c$
(c) $a=b=c$ (d) $a>c>b$

Ans. *(a)*

Frequency of radiations given are listed below.

	Waves		Frequency (in Hz)
1.	γ-rays	(a)	3×10^{21} to 3×10^{18}
2.	X-rays	(b)	3×10^{18} to 3×10^{16}
3.	Ultraviolet radiation	(c)	3×10^{16} to 7.5×10^{14}

Thus, correct order is $a>b>c$.

31 Ozone layer blocks the radiations of wave length **[CBSE AIPMT 1999]**

(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

Ans. *(a)*

Ozone layer extends from 30 km to nearly 50 km above the earth's surface in ozone sphere. This layer absorbs the major part of ultraviolet radiations coming from the sun and does not allow them to reach the earth's surface.

The range of ultraviolet radiations is 100 Å to 4000 Å. Thus, it blocks the radiations of wavelength less than 3×10^{-7} m (or 3000 Å).

32 A signal emitted by an antenna from a certain point can be received at another point of the surface in the form of **[CBSE AIPMT 1993]**

(a) sky wave
(b) ground wave
(c) sea wave
(d) Both (a) and (b)

Ans. *(d)*

Space communication refers to sending, receiving and processing of information through space. Following are the modes of space communication

(i) round or surface wave propagation
(ii) Space wave or tropospheric wave propagation
(iii) Sky wave propagation
(iv) Satellite communication

33 The structure of solids is investigated by using **[CBSE AIPMT 1992]**

(a) cosmic rays
(b) X-rays
(c) γ-rays
(d) infrared radiations

Ans. *(b)*

Due to high penetrating power of X-rays, X-rays are used for investigation of structure of solids. Lane spot method and rotating cylinder method are used for this purpose. X-rays fall on solid under investigation and their structure is received on photographic plate.

34 The frequency of electromagnetic wave, which is best suited to observe a particle of radius 3×10^{-4} cm, is of the order of **[CBSE AIPMT 1991]**

(a) 10^{15} (b) 10^{14} (c) 10^{13} (d) 10^{12}

Ans. *(b)*

Size of particle of any wave is given in terms of wavelength

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

Here, $\lambda=3\times10^{-4}$ cm,

Velocity of light in vacuum, $c=3\times10^{10}$ cm/s

$$\therefore \quad 3\times10^{-4}=\frac{3\times10^{10}}{\nu}$$

$\therefore$ Frequency of electromagnetic wave

$$\nu=10^{14}\text{ Hz}$$

35 Pick out the longest wavelength from the following types of radiations **[CBSE AIPMT 1990]**

(a) blue light (b) gamma rays
(c) X-rays (d) red light

Ans. *(d)*

Gamma rays have wavelength range 6×10^{-14} m to 1×10^{-10} m, X-rays have wavelength range 1×10^{-13} m to 3×10^{-8} m. Blue light and red light lies in visible range of spectrum which extends from 4000Å to 7800 Å. Hence, wavelength of red light is longest.

36 Which of the following is the longest wave ? **[CBSE AIPMT 1989]**

(a) X-rays (b) γ-rays
(c) Microwaves (d) Radiowaves

Ans. *(d)*

Wavelength range of various waves are as follows

Name	Wavelength range (m)
Gamma rays	6×10^{-14} to 1×10^{-10}
X-rays	1×10^{-13} to 3×10^{-8}
Radio waves	greater than 0.1
Microwaves	10^{-3} to 0.3

So, radiowaves are the longest waves.