Electromagnetic Waves

Question1

The electromagnetic radiation which has the smallest wavelength are

[NEET 2024 Re]

Options:

A.

X-rays

B.

Gamma rays

C.

Ultraviolet rays

D.

Microwaves

Answer: B

Solution:

Among the given options, γ-rays has the smallest wavelength.

Question2

If the ratio of relative permeability and relative permittivity of a uniform medium is 1 : 4. The ratio of the magnitudes of electric field intensity (E) to the magnetic field intensity (H) of an EM wave propagating in that medium is

(Given that $\sqrt{\frac{\mu_0}{\varepsilon_0}} = 120\pi$) :

[NEET 2024 Re]

Options:

A.

$30\pi : 1$

B.

1 : 120π

C.

60π : 1

D.

120π : 1

Answer: C

Solution:

$$\frac{\mu_r}{E_r} = \frac{1}{4}$$

$$\frac{E}{H} = \frac{E\mu}{B} = v\mu$$

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

$$= \sqrt{\frac{\mu_0}{\varepsilon_0}}\sqrt{\frac{\mu_r}{\varepsilon_r}}$$

$$= 120\pi\left(\frac{1}{2}\right)$$

$$= \frac{60\pi}{1}$$

Question3

The property which is not of an electromagnetic wave travelling in free space is that:

[NEET 2024]

Options:

A.

They are transverse in nature

B.

The energy density in electric field is equal to energy density in magnetic field

C.

They travel with a speed equal to $\frac{1}{\sqrt{\mu_0\varepsilon_0}}$

D.

They originate from charges moving with uniform speed

Answer: D

Solution:

The EM waves originate from an accelerating charge. The charge moving with uniform velocity produces steady state magnetic field.

Question4

In a plane electromagnetic wave travelling in free space, the electric field component oscillates sinusoidally at a frequency of 2.0×10^{10}Hz and amplitude $48 Vm^{-1}$. Then the amplitude of oscillating magnetic field is (Speed of light in free space = $3 \times 10^8 m\ s^{-1}$)

[NEET 2023]

Options:

A.

1.6×10^{-8}T

B.

1.6×10^{-7}T

C.

1.6×10^{-6}T

D.

1.6×10^{-9}T

Answer: B

Solution:

From the properties of electromagnetic wave

we know that, $C = \frac{E_0}{B_0}$

$E_0 \Rightarrow$ Amplitude of oscillating electric field

$B_0 \Rightarrow$ Amplitude of oscillating magnetic field

$\Rightarrow B_0 = \frac{48}{3 \times 10^8} = 1.6 \times 10^{-7}$T

Question5

An ac source is connected to a capacitor C. Due to decrease in its operating frequency

[NEET 2023]

Options:

A.

Displacement current increases

B.

Displacement current decreases

C.

Capacitive reactance remains constant

D.

Capacitive reactance decreases

Answer: B

Solution:

Solution:

$X_C = \frac{1}{\omega C}$

Since ω decreasing Xc will increases hence current will decreases also conduction current = displacement current

Therefore displacement current will decrease.

Question6

The minimum wavelength of X-rays produced by an electron accelerated through a potential difference of V volts is proportional to

[NEET 2023]

Options:

A.

1/V

B.

$1/\sqrt{V}$

C.

V^2

D.

√V

Answer: A

Solution:

$$eV = \frac{hc}{\lambda_{min}}$$

$$\lambda_{min} = \frac{hc}{eV}$$

$$\lambda_{min} \propto \frac{1}{V}$$

Question7

Match List-I with List-II

	List -1 Electromagnetic Waves		List-II Wavelength
(a)	AM radio waves	(i)	$10^{-10} m$
(b)	Microwaves	(ii)	$10^{2} m$
(c)	Infrared radiations	(iii)	$10^{-2} m$
(d)	X-rays	(iv)	$10^{-4} m$

[NEET-2022]

Options:

A. (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

B. (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)

C. (a) - (iii), (b) - (iv), (c) - (ii), (d) - (i)

D. (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)

Answer: D

Solution:

Waves	Wavelengthṁ
AM radio waves	$10^{2} m$
Microwaves	$10^{-2} m$
Infrared radiations	$10^{-4} m$
X-raysṁṁ	$10^{-10} m$

(a) - (ii)

(b) - (iii)

(c) - (iv)

(d) - (i)

Question8

When light propagates through a material medium of relative permittivity ε_r and relative permeability μ_r, the velocity of light, v is given by (c-velocity of light in vacuum)
[NEET-2022]

Options:

A. v = c

B. $v = \sqrt{\frac{\mu_r}{\varepsilon_r}}$

C. $v = \sqrt{\frac{\varepsilon_r}{\mu_r}}$

D. $v = \frac{c}{\sqrt{\varepsilon_r \mu_r}}$

Answer: D

Solution:

Solution:

$$v = \frac{1}{\sqrt{\varepsilon_m \mu_m}}$$

$$v = \frac{1}{\sqrt{\varepsilon_0 \varepsilon_r \mu_0 \mu_r}}$$

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

$$\Rightarrow v = \frac{c}{\sqrt{\varepsilon_r \mu_r}}$$

Question9

The magnetic field of a plane electromagnetic wave is given by $\vec{B} = 3 \times 10^{-5} \cos(1.6 \times 10^3 x + 48 \times 10^{10} t)\,\hat{j}$ then the associated electric field will be:
[NEET Re-2022]

Options:

A. $9 \cos(1.6 \times 10^3 x + 48 \times 10^{10} t)\,\hat{k}$ V / m

B. $3 \times 10^{-8} \cos(1.6 \times 10^3 x + 48 \times 10^{10} t)\,\hat{i}$ V / m

C. $3 \times 10^{-8} \sin(1.6 \times 10^3 x + 48 \times 10^{10} t)\,\hat{i}$ V / m

D. $9 \sin(1.6 \times 10^3 x - 48 \times 10^{10} t)\,\hat{k}$ V / m

Answer: A

Solution:

$$\frac{E_0}{B_0} = C \Rightarrow E_0 = B_0 C$$

$$= 3 \times 10^{-8} \times 3 \times 10^8$$

$$= 9 \text{v/m}$$

Phase of magnetic and electric field is same of travelling EM wave

$$\hat{E} = \hat{B} \times \hat{C}$$

$$= \hat{j} \times (-\hat{i}) = \hat{k}$$

$$\vec{E} = 9 \cos(1.6 \times 10^3 x + 48 \times 10^{10} t)\,\hat{k}\, \text{v/m}$$

Question10

The ratio of the magnitude of the magnetic field and electric field

intensity of a plane electromagnetic wave in free space of permeability μ_0 and permittivity ε_0 is (Given that C - velocity of light in free space) [NEET Re-2022]

Options:

A. $\frac{\sqrt{\mu_0 \varepsilon_0}}{c}$

B. c

C. $\frac{1}{c}$

D. $\frac{c}{\sqrt{\mu_0 \varepsilon_0}}$

Answer: C

Solution:

We know $|E| = C|B|$

$\Rightarrow \frac{|B|}{|E|} = \frac{1}{C}$

Question11

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]

Options:

A. $I_d = V_0 \varepsilon C \cos \omega t$

B. $I_d = \frac{V_0}{\omega C} \cos \omega t$

C. $I_d = \frac{V_0}{\omega C} \sin \omega t$

D. $I_d = V_0 \omega C \sin \omega t$

Answer: A

Solution:

Given $V = v_0 \sin \omega t$ ....(1)
Now displacement current I_d is given by

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

$$= C\frac{d}{dt}(V_0 \sin \omega t) \text{ (using equation 1)}$$

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

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

Question12

An electromagnetic wave of wavelength ' λ ' is incident on a photosensitive surface of negligible work function. If ' m ' mass is of photoelectron emitted from the surface has de-Broglie wavelength λ_d, then
[NEET 2021]

Options:

A. $\lambda = \left(\frac{2m}{hc}\right) \lambda_d{}^2$

B. $\lambda_d = \left(\frac{2mc}{h}\right) \lambda^2$

C. $\lambda = \left(\frac{2mc}{h}\right) \lambda_d{}^2$

D. $\lambda = \left(\frac{2h}{mc}\right) \lambda_d{}^2$

Answer: C

Solution:

As per Einstein's photoelectric equation

$$\frac{hc}{\lambda} = \phi_0 + k$$

ϕ_0 : work function
$k =$ maximum kinetic energy of photoelectrons
As per question, $\phi \to 0$

$$\therefore \frac{hc}{\lambda} = k = \frac{P^2}{2m} \Rightarrow P = \sqrt{\frac{2mhc}{\lambda}}$$

Now De-broglie wavelength,

$$\lambda_d = \frac{h}{P} = \frac{h}{\sqrt{2mhc / \lambda}}$$

$$\Rightarrow \sqrt{\lambda} = \lambda_d \sqrt{\frac{2mc}{h}}$$

$$\Rightarrow \lambda = \left(\frac{2h}{mc}\right) \lambda_d{}^2$$

Question13

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]

Options:

A. $\hat{j} + \hat{k}, \hat{j} + \hat{k}$

B. $-\hat{j} + \hat{k}, -\hat{j} - \hat{k}$

C. $\hat{j} + \hat{k}, -\hat{j} - \hat{k}$

D. $-\hat{j} + \hat{k}, -\hat{j} + \hat{k}$

Answer: B

Solution:

Direction of propagation of electromagnetic waves is along $\vec{E} \times \vec{B}$
Given that direction of propagation is along x-axis
(1) $(\hat{j} + \hat{k}) \times (\hat{j} + \hat{k}) = 0$
(2) $(-\hat{j} + \hat{k}) \times (-\hat{j} - \hat{k}) = 2\hat{i}$
(3) $(\hat{j} + \hat{k}) \times [-(\hat{j} + \hat{k})] = 0$
(4) $(-\hat{j} + \hat{k}) \times (-\hat{j} + \hat{k}) = 0$
∴ Option (2) is correct.

Question14

The ratio of contributions made by the electric field and magnetic field components to the intensity of an electromagnetic wave is :
(c = speed of electromagnetic waves)
(2020)

Options:

A. 1: 1

B. 1 : c

C. 1 : c^2

D. c : 1

Answer: A

Solution:

(a) The energy in electromagnetic wave is divided equally between the electric and magnetic field.
So, in an electromagnetic wave, half of the intensity is provided by the electric field and half by the magnetic field.
Hence, required ratio should be 1 : 1.

Question15

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

Options:

A. zero, zero

B. zero, 60μA

C. 60μA, 60μA

D. 60μA, zero

Answer: C

Solution:

Here ,C = 20μF
The rate of change of potential $= 3\ V/s$
The charge on the capacitor, Q = CV
$\therefore \frac{dQ}{dt} = I_D = C\frac{dV}{dt} = 20\mu F \times \frac{3V}{s} = 60\mu A$
Displacement current is equal to the conduction current.

Question16

For a transparent medium relative permeability and permittivity, μ_r and ε_r are 1.0 and 1.44 respectively. The velocity of light in this medium would be
(OD NEET 2019)

Options:

A. $2.5 \times 10^8 m/s$

B. $3 \times 10^8 m/s$

C. $2.08 \times 10^8 m/s$

D. $4.32 \times 10^{8} m / s$

Answer: A

Solution:

Given, relative permittivity, $\varepsilon_r = 1.44$ and relative permeability, $\mu_r = 1$

Now, as we know that, $\varepsilon_r = \frac{\varepsilon}{\varepsilon_0} \Rightarrow \varepsilon = \varepsilon_r \varepsilon_0$

and $\mu_r = \mu\mu_0 \Rightarrow \mu = \mu_r \mu_0$

where, ε and μ are the permittivity and permeability of the medium.
∴ Velocity of light in the medium will be,

$$v = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{1}{\sqrt{\mu_r \mu_0 \varepsilon_r \varepsilon_0}} = \frac{c}{\sqrt{\mu_r \varepsilon_r}} = \frac{3 \times 10^8}{\sqrt{1 \times 1.44}}$$

$= 2.5 \times 10^{8} m / s$

Question17

An em wave is propagating in a medium with a velocity $\vec{v} = v\hat{i}$. The instantaneous oscillating electric field of this em wave is along +y axis. Then the direction of oscillating magnetic field of the em wave will be along
(NEET 2018)

Options:

A. −z direction

B. +z direction

C. −y direction

D. −x direction

Answer: B

Solution:

Velocity of em wave in a medium is given by $\vec{v} = \vec{E} \times \vec{B}$
$\therefore v\hat{i} = (E\hat{j}) \times (\vec{B})$ [$\because \vec{E} = E\hat{j}$ (Given)]
As $\hat{i} = \hat{j} \times \hat{k}$
so $\vec{B} = B\hat{k}$
Direction of oscillating magnetic field of the em wave will be along +z direction.

Question18

In an electromagnetic wave in free space the root mean square value of

the electric field is $E_{rms} = 6 V m^{-1}$.The peak value of the magnetic field is
(2017 NEET)

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Options:

A. $2.83 \times 10^{-8} T$

B. $0.70 \times 10^{-8} T$

C. $4.23 \times 10^{-8} T$

D. $1.41 \times 10^{-8} T$

Answer: A

Solution:

(a) : Given: $E_{rms} = 6 V m^{-1}$

$\frac{E_{rms}}{B_{rms}} = c$ or $B_{rms} = \frac{E_{rms}}{c}$

$B_{rms} = \frac{6}{3 \times 10^8} = 2 \times 10^{-8} T$

since, $B_{rms} = \frac{B_0}{\sqrt{2}}$

where B_0 is the peak value of magnetic field.

$\therefore B_0 = B_{rms}\sqrt{2} = 2 \times 10^{-8} \times \sqrt{2} T$

$B_0 \approx 2.83 \times 10^{-8} T$

Question19

Out of the following options which one can be used to produce a propagating electromagnetic wave?
(2016 NEET Phase-1)

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Options:

A. A chargeless particle

B. An accelerating charge

C. A charge moving at constant velocity

D. A stationary charge

Answer: B

Solution:

An accelerating charge is used to produce oscillating electric and magnetic fields, hence the electromagnetic wave.

Question20

A 100 Ω resistance and a capacitor of 100 Ω reactance are connected in series across a 220 V source. When the capacitor is 50% charged, the peak value of the displacement current is (2016 NEET Phase-II)

Options:

A. 2.2 A

B. 11 A

C. 4.4 A

D. $11\sqrt{2}$ A

Answer: A

Solution:

Solution:
Here, $R = 100\Omega$, $X_C = 100\Omega$
Net impedance,
$Z = \sqrt{R^2 + X_C^2} = 100\sqrt{2}\Omega$

Peak value of displacement current = Maximum conduction current in the circuit
$\frac{\varepsilon_0}{Z} = \frac{220\sqrt{2}}{100\sqrt{2}} = 2.2A$

Question21

A radiation of energy 'E' falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (C = Velocity of light) (2015 Cancelled)

Options:

A. $\frac{2E}{C^2}$

B. $\frac{E}{C^2}$

C. $\frac{E}{C}$

D. $\frac{2E}{C}$

Answer: D

Solution:

Energy of radiation, $E = h\upsilon = \frac{hC}{\lambda}$

Also, its momentum $p = \frac{h}{\lambda} = \frac{E}{C} = p_i$

$p_r = -p_i = -\frac{E}{C}$

So, momentum transferred to the surface

$= p_i - p_r = \frac{E}{C} - \left(-\frac{E}{C}\right) = \frac{2E}{C}$

Question22

The energy of the em waves is of the order of 15 keV. To which part of the spectrum does it belong?
(2015)

Options:

A. Ultraviolet rays

B. γ- rays

C. X-rays

D. Infrared rays

Answer: C

Solution:

Solution:

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

where the symbols have their usual meanings.

Here, $E = 15\text{keV} = 15 \times 10^3\text{V}$ and $hc = 1240\text{eV nm}$

$\therefore \lambda = \frac{1240\text{eV nm}}{15 \times 10^3\text{eV}} = 0.083\text{nm}$

As the wavelength range of X-rays is from 1 nm to 10^{-3}nm, so this wavelength belongs to X-rays.

Question23

Light with an energy flux of $25 \times 10^4\text{W m}^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is 15cm^2,the average force exerted on the surface is
(2014)

Options:

A. 1.25×10^{-6}N

B. 2.50×10^{-6}N

C. 1.20×10^{-6}N

D. 3.0×10^{-6}N

Answer: B

Solution:

Solution:
Here, Energy flux, $I = 25 \times 10^{4} W\,m^{-2}$
Area $A = 15 cm^{2} = 15 \times 10^{-4} m^{2}$
Speed of light, $c = 3 \times 10^{8} ms^{-1}$
For a perfectly reflecting surface, the average force exerted on the surface is

$$F = \frac{2IA}{c} = \frac{2 \times 25 \times 10^{4} W\,m^{-2} \times 15 \times 10^{-4} m^{2}}{3 \times 10^{8} ms^{-1}}$$

$$= 250 \times 10^{-8} N = 2.50 \times 10^{-6}$$

Question24

The condition under which a microwave oven heats up a food item containing water molecules most efficiently is (2013 NEET)

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Options:

A. Microwaves are heat waves, so always produce heating.

B. Infra-red waves produce heating in a microwave oven.

C. The frequency of the microwaves must match the resonant frequency of the water molecules.

D. The frequency of the microwaves has no relation with natural frequency of water molecules

Answer: C

Solution:

Solution:
In microwave oven the frequency of the microwaves must match the resonant frequency of water molecules so that energy from the waves is transferred efficiently to the kineticenergy of the molecules.

Question25

An electromagnetic wave of frequency v = 3.0 MHz passes from vacuum into a dielectric medium with relative permittivity ε = 4.0. Then

(KN NEET 2013)

Options:

A. Wavelength is doubled and frequency becomes half.

B. Wavelength is halved and frequency remains unchanged.

C. Wavelength and frequency both remain unchanged.

D. Wavelength is doubled and frequency unchanged

Answer: B

Solution:

Solution:
Frequency of electromagnetic wave does not change with change in medium but wavelength and velocity of wave changes with change in medium.
Velocity of electromagnetic wave in vacuum

$c = \frac{1}{\sqrt{\mu_0 \in_0}} = v\lambda_{vacuum}$ .....(i)

Velocity of electromagnetic wave in the medium

$v_{medium} = \frac{1}{\sqrt{\mu_0 \mu_r \in_0 \in_r}} = \frac{c}{\sqrt{\mu_r \in_r}}$

where μ_r and $\in_r$ be relative permeability and relative permittivity of the medium. For dielectric medium, $\mu_r = 1$

$\therefore v_{medium} = \frac{c}{\sqrt{\in_r}}$

Here, $\in_r = 4.0$

$\therefore v_{medium} = \frac{c}{\sqrt{4}} = \frac{c}{2}$ ....(ii)

Wavelength of the wave in medium

$\lambda_{medium} = \frac{v_{medium}}{\upsilon} = \frac{c}{2\upsilon} = \frac{\lambda_{vacuum}}{2}$

(Using (i) and (ii))

Question26

The electric field associated with an em wave in vacuum is given by $\vec{E} = \hat{i}40\cos(kz - 6 \times 10^8 t)$, where E,z and t are in volt/m, meter and seconds respectively. The value of wave vector k is (2012)

Options:

A. $2m^{-1}$

B. $0.5m^{-1}$

C. $6m^{-1}$

D. $3m^{-1}$

Answer: A

Solution:

Compare the given equation with
$E = E_0 \cos(kz - \omega t)$
we get, $\omega = 6 \times 10^8 s^{-1}$
Wave vector, $k = \frac{\omega}{c} = \frac{6 \times 10^8 s^{-1}}{3 \times 10^8 ms^{-1}} = 2m^{-1}$

Question27

The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum is equal to (2012 Mains)

Options:

A. the speed of light in vacuum

B. reciprocal of speed of light in vacuum

C. the ratio of magnetic permeability to the electric susceptibility of vacuum

D. unity

Answer: B

Solution:

Solution:
The amplitude of magnetic field and electric field for an electromagnetic wave propagating in vacuum are related as
$E_0 = B_0 c$
where c is the speed of light in vacuum.
$\therefore \frac{B_0}{E_0} = \frac{1}{c}$

Question28

The electric and the magnetic field, associated with an e.m. wave, propagating along the +z-axis, can be represented by (2011)

Options:

A. $\left[\vec{E} = E_0 \hat{i}, \vec{B} = B_0 \hat{j}\right]$

B. $\left[\vec{E} = E_0 \hat{k}, \vec{B} = B_0 \hat{i}\right]$

C. $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{i}\right]$

D. $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{k}\right]$

Answer: A

Solution:

Solution:
The electromagnetic wave is propagating along the +z-axis.
Since the electric and magnetic fields are perpendicular to each other and also perpendicular to the direction of propagation of wave.
Also $\vec{E} \times \vec{B}$ gives the direction o wave propagation.
$\therefore \vec{E} = E_0\hat{i}, B = B_0\hat{J} \qquad (\because \hat{i} \times \hat{j} = \hat{k})$

Question29

The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is
(2011)

Options:

A. microwave, infrared, ultraviolet, gamma rays

B. gamma rays, ultraviolet, infrared, microwaves

C. microwaves, gamma rays, infrared, ultraviolet

D. infrared, microwave, ultraviolet, gamma rays

Answer: A

Solution:

The decreasing order of wavelength of the given electromagnetic waves is as follows :
$\lambda_{\text{Microwave}} > \lambda_{\text{Infrared}} > \lambda_{\text{Ultraviolet}} > \lambda_{\text{Gamma rays}}$

Question30

Which of the following statement is false for the properties of electromagnetic waves?
(2010)

Options:

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.

Answer: C

Solution:

Solution:
In an electromagnetic wave both electric and magnetic vectors are perpendicular to each other as well as perpendicular to the direction of propagation of wave.

Question31

The electric field of an electromagnetic wave in free space is given by $\vec{E} = 10\cos(10^7 t + kx)\hat{j}$ V/m where t and x are in seconds and metres respectively. It can be inferred that
(1) the wavelength X is 188.4 m.
(2) the wave number k is 0.33 rad/m.
(3) the wave amplitude is 10 V/m.
(4) the wave is propagating along +x direction.
Which one of the following pairs of statements is correct?
(2010 Mains)

Options:

A. (3) and (4)

B. (1) and (2)

C. (2) and (3)

D. (1) and (3)

Answer: D

Solution:

Given
$\vec{E} = 10\cos(10^7 t + kx)\hat{j}$ V/m..........(i)
Comparing it with standard equation of electromagnetic wave,
$E = E_0 \cos\omega t + kx$.........(ii)
We get,
Amplitude $E_0 = 10$V/m and $\omega = 10^7$ rad/s

$\because c = \upsilon\lambda = \frac{\omega\lambda}{2\pi}$

or $\lambda = \frac{2\pi c}{\omega} = \frac{2\pi \times 3 \times 10^8}{10^7} = 188.4\text{m}$

Also, $c = \frac{\omega}{k}$ or $k = \frac{\omega}{c} = \frac{10^7}{3 \times 10^8} = 0.033$ rad/m

The wave is propagating along $-x$ direction.

Question32

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

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

.The wave is

(2009)

Options:

A. moving along x-direction with frequency 10^6 Hz and wavelength 100 m.

B. moving along x-direction with frequency 10^6 Hz and wavelength 200 m.

C. moving along $-$x-direction with frequency 10^6 Hz and wavelength 200 m.

D. moving along y-direction with frequency $2\pi \times 10^6$ Hz and wavelength 200 m.

Answer: B

Solution:

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

$E_z = 0$

The wave is moving in the positive direction of x

This is the form $E_y = E_0(\omega t - kx)$

$\omega = 2\pi \times 10^6 \Rightarrow \upsilon = 10^6$Hz

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

$\Rightarrow \lambda = \frac{2\pi}{\pi \times 10^{-2}} = 2 \times 10^2 = 200\text{m}$

Question33

The velocity of electromagnetic radiation in a medium of permittivity ε_0 and permeability μ_0 is given by

(2008)

Options:

A. $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

B. $\sqrt{\frac{\mu_0}{\varepsilon_0}}$

C. $\sqrt{\frac{\varepsilon_0}{\mu_0}}$

D. $\sqrt{\mu_0 \varepsilon_0}$

Answer: A

Solution:

Solution:
The velocity of electromagnetic radiation in vacuum is $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$,where μ_0 and ε_0 are the permeability and permittivity of vacuum.

Question34

The electric and magnetic field of an electromagnetic wave are (2007, 1994)

Options:

A. in opposite phase and perpendicular to each other

B. in opposite phase and parallel to each other

C. in phase and perpendicular to each other

D. in phase and parallel to each other.

Answer: C

Solution:

Solution:
In electromagnetic wave, electric and magnetic field are in phase and perpendicular to each other and also perpendicular to the direction of the propagation of the wave.

Question35

If λ_v, λ_x and λ_m represent the wavelengths of visible light, X -rays and microwaves respectively, then

(2005)

Options:

A. $\lambda_m > \lambda_x > \lambda_v$

B. $\lambda_m > \lambda_v > \lambda_x$

C. $\lambda_v > \lambda_x > \lambda_m$

D. $\lambda_v > \lambda_m > \lambda_x$

Answer: B

Solution:

$\lambda_m > \lambda_v > \lambda_x$.
In spectrum X -rays has minimum wavelength and microwave has maximum wavelength.

Question36

We consider the radiation emitted by the human body. Which one of the following statements is true?
(2003)

Options:

A. The radiation emitted is in the infraredregion

B. The radiation is emitted only during the day

C. The radiation is emitted during the summers and absorbed during the winters

D. The radiation emitted lies in the ultraviolet region and hence is not visible

Answer: A

Solution:

Solution:
Every body at all time, at all temperatures emit radiation (except at $T = 0$), which fall in the infrared region.

Question37

Which of the following rays are not electromagnetic waves?
(2003)

Options:

A. X -rays

B. γ -rays

C. β -rays

D. heat rays

Answer: C

Solution:

Solution:
Electromagnetic waves are also known as EM waves that are formed when an electric field comes in contact with the magnetic field. These fields are perpendicular to each other. EM waves travel at a speed of 3 × 108 ms-1 in a vacuum. Gamma rays, microwaves, radio waves are examples of EM waves.
Beta rays are not electromagnetic waves
Beta rays also known as beta radiation is obtained through the emission of an electron. Beta rays are not electromagnetic waves because they are charged particles and are capable of getting deflected by the magnetic field. These rays are not pure energy as a photon.

Question38

The velocity of electromagnetic wave is parallel to (2002)

Options:

A. $\vec{B} \times \vec{E}$

B. $\vec{E} \times \vec{B}$

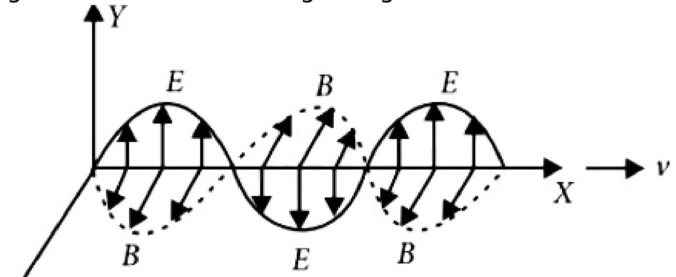
C. $\vec{E}$

D. $\vec{B}$

Answer: B

Solution:

According to Maxwell, the electromagnetic waves are those waves in which there are sinusoidal variation of electric and magnetic field vectors at right angles to each other as well as at right angles to the direction of wave propagation.



Propagation of electromagnetic waves

If the electric field ($\vec{E}$) and magnetic field $(\vec{B})$ are vibrating along Y and Z direction, propagation of electromagnetic wave will be along the X -axis. Therefore, the velocity of electromagnetic wave is parallel to $\vec{E} \times \vec{B}$.

Question39

What is the cause of Green house effect? (2002)

Options:

A. infra-red rays

B. ultra violet rays

C. X -rays

D. radio waves

Answer: A

Solution:

Solution:
As the electromagnetic radiations from Sun pass through the atmosphere, some of them are absorbed by it while other reach the surface of earth. The range of wavelength which reaches earth lies in infrared region. Thispart of the radiation from the sun has shorter wavelength and can penetrate through the layer of gases like CO_2 and reach earth surface. But the radiation from the earth being of longer wavelength can escape through this layer. As a result the earth surface gets warm. This is known as green house effect.

Question40

Biological importance of ozone layer is (2001)

Options:

A. it stops ultraviolet rays

B. ozone layer reduces green house effect

C. ozone layer reflects radio waves

D. ozone layer controls O_2 / H_2 ratio in atmosphere.

Answer: A

Solution:

The ozone layer absorbs the harmful ultraviolet rays coming from sun.

Question41

The frequency order for gamma -rays (B), X -rays (A), UV rays (C) is (2000)

Options:

A. B > A > C

B. A > B > C

C. C > B > A

D. A > C > B.

Answer: A

Question42

Ozone layer blocks the radiations of wavelength (1999)

Options:

A. more than 3×10^{-7} m

B. equal to 3×10^{-7} m

C. less than 3×10^{-7} m

D. all of these

Answer: D

Solution:

Solution:
The range is from 380 nm to even 200nm to 120nm

Question43

Wavelength of light of frequency 100 Hz

(1999)

Options:

A. 4×10^{6} m

B. 3×10^{6} m

C. 2×10^{6} m

D. 5×10^{-5} m

Answer: B

Solution:

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

Question44

If ε_0 and μ_0 are the electric permittivity and magnetic permeability in a free space, ε and μ are the corresponding quantities in medium, the index of refraction of the medium is
(1997)

Options:

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. $\sqrt{\frac{\varepsilon}{\varepsilon_0}}$

Answer: B

Solution:

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \left(\text{ free space } \right)$$

$v = \frac{1}{\sqrt{\mu\varepsilon}}$ (medium) $\therefore \mu = \frac{c}{v} = \sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}}$

Question45

Which of the following electromagnetic radiations have the smaller wavelength?
(1994)

Options:

A. X -rays

B. γ -rays

C. UV waves

D. microwaves.

Answer: B

Question46

A signal emitted by an antenna from a certain point can be received at another point of the surface in the form of
(1993)

Options:

A. sky wave

B. ground wave

C. sea wave

D. both (a) and (b)

Answer: D

Solution:

An antenna is a device used to transform a signal, traveling on a conductor, into an electromagnetic wave in free space and it can be received at the receiver’s place with the help of a receiver and can be decoded into useful information. Sky wave propagation is the method of propagation of a signal which is reflected or refracted back to the earth from the ionosphere. Antenna can do this work very efficiently.In ground wave propagation the signal travels from one place to another in the area between the surface of the earth and the ionosphere and this happens with the aid of antennas.So, both sky wave and ground wave can be propagated using antennas.

The atmosphere plays a very important role in transmission of electromagnetic waves. The Ionosphere extends from 80 km to 400km above the surface of the earth. The ionosphere has charged particles which aids in communication.

Question47

The structure of solids is investigated by using (1992)

Options:

A. cosmic rays

B. X -rays

C. γ -rays

D. infra-red radiations

Answer: B

Solution:

Solution:
X -rays are used for the investigation of structure of solids.

Question48

The frequency of electromagnetic wave, which best suited to observe a particle of radius 3×10^{-4} cm is of the order of (1991)

Options:

A. 10^{15}

B. 10^{14}

C. 10^{13}

D. 10^{12}

Answer: B

Solution:

The wave length of radiation used should be less than the size of the particle

Size of particle $= l = \frac{c}{\upsilon}$

$3 \times 10^{-4} = \frac{3 \times 10^{10}}{\upsilon}$ or $\upsilon = 10^{14}$ hertz

However, when frequency is higher than this, wavelength is still smaller. Resolution becomes better.

Question49

In which of the following, emission of electrons does not take place (1990)

Options:

A. thermionic emission

B. X -rays emission

C. photoelectric emission

D. secondary emission

Answer: B

Solution:

Thermionic emission : When a metal is heated to a high temperature, the free electron gain kinetic energy and escape from the surface of the metal.

Secondary emission : When an electron strikes the surface of a metallic plate, it emits other electrons from the surface.

Photoelectric emission : Emission of electrons from the metal surface on irradiation with radiation of suitable frequency.

X -rays emission : They are due to transitions in the inner energy levels of the atom.

Question50

Which of the following electromagnetic radiations have the longest wavelength ? (1989)

Options:

A. X -rays

B. γ -rays

C. Microwaves

D. Radiowaves

Answer: D

Solution:

Radiations	Wavelength[Range in m]
X − rays	1×10^{-11} to 3×10^{-8}
γ − rays	6×10^{-14} to 1×10^{-11}
Microwaves	10^{-3} to 0.3
Radiowaves	10 to 10^{4}
