ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

path to success

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PRE-MEDICAL

PHYSICS

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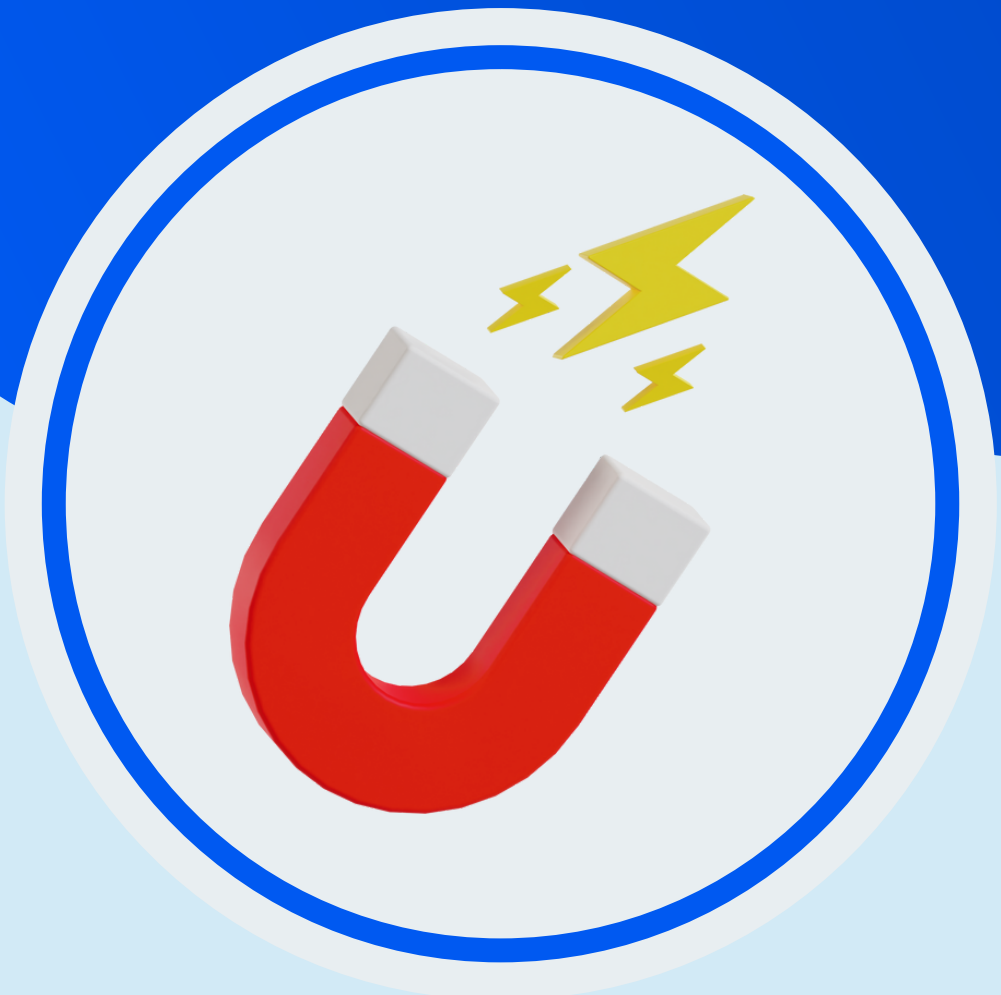

EXERCISE

Electromagnetic Waves (EMW)

ENGLISH MEDIUM

EXERCISE-I (Conceptual Questions) Build Up Your Understanding

1. If $\vec{E}$ and $\vec{B}$ are the electric and magnetic field vectors of electromagnetic waves then the direction of propagation of electromagnetic wave is along the direction of –

(1) $\vec{E}$ (2) $\vec{B}$

(3) $\vec{E} \times \vec{B}$ (4) none of these

EM0178

2. The electromagnetic waves do not transport -

(1) energy (2) charge

(3) momentum (4) information

EM0179

3. The wave function (in S.I.units) for an electromagnetic wave is given as –

$\psi(x,t) = 10^3 \sin\pi(3\times10^6 x - 9\times10^{14} t)$

The speed of the wave is –

(1) 9×10^{14} m/s (2) 3×10^8 m/s

(3) 3×10^6 m/s (4) 3×10^7 m/s

EM0180

4. In the above problem, wavelength of the wave is –

(1) 666 nm (2) 666 Å

(3) 666 μm (4) 6.66 nm

EM0181

5. In an electromagnetic wave the average energy density is associated with –

(1) electric field only

(2) magnetic field only

(3) equally with electric and magnetic fields

(4) average energy density is zero

EM0182

6. In an electromagnetic wave the energy density associated with magnetic field will be

(1) $\frac{1}{2}LI^2$ (2) $\frac{B^2}{2\mu_0}$

(3) $\frac{1}{2}\mu_0 B^2$ (4) $\frac{1}{2}\frac{\mu_0}{B^2}$

EM0183

7. In the above problem, the energy density associated with the electric field will be –

(1) $\frac{1}{2}CV^2$ (2) $\frac{1}{2}\frac{q^2}{C}$

(3) $\frac{1}{2}\frac{\varepsilon^2}{E}$ (4) $\frac{1}{2}\varepsilon_0 E^2$

EM0184

8. If there were no atmosphere, the average temperature on earth surface would be –

(1) lower (2) higher

(3) same (4) 0° C

EM0185

9. In which part of earth's atmosphere is the ozone layer present ?

(1) troposphere (2) stratosphere

(3) ionosphere (4) mesosphere

EM0186

10. The ozone layer is earth's atmosphere is crucial for human survival because it –

(1) contains ions

(2) reflects radio signals

(3) reflects ultraviolet rays

(4) reflects infra red rays

EM0187

11. The frequency from 3×10^9 Hz to 3×10^{10} Hz is–
(1) high frequency band
(2) super high frequency band
(3) ultra high frequency band
(4) very high frequency band

EM0188

12. The frequency from 3MHz to 30 MHz is known as –
(1) audio band
(2) medium frequency band
(3) very high frequency band
(4) high frequency band

EM0189

13. The AM range of radiowaves have frequency –
(1) less than 30 MHz
(2) more than 30 MHz
(3) less than 20000Hz
(4) more than 20000Hz

EM0190

14. Select wrong statement from the following for EMW-
(1) are transverse
(2) travel with same speed in all medium
(3) travel with the speed of light
(4) are produced by accelerating charge

EM0191

15. The waves related to tele-communication are -
(1) infrared (2) visible light
(3) microwaves (4) ultraviolet rays

EM0192

16. The nature of electromagnetic wave is –
(1) longitudinal
(2) longitudinal stationary
(3) transverse
(4) transverse stationary

EM0193

17. Greenhouse effect keeps the earth surface –
(1) cold at night (2) dusty and cold
(3) warm at night (4) moist

EM0194

18. The speed of electromagnetic radiation in vacuum is :-
(1) $\mu_0 \in_0$ (2) $\sqrt{\mu_0 \in_0}$
(3) $\frac{1}{\mu_0 \in_0}$ (4) $\frac{1}{\sqrt{\mu_0 \in_0}}$

EM0195

19. What is the cause of greenhouse effect ?
(1) Infrared rays (2) Ultraviolet rays
(3) X-rays (4) Radio waves

EM0196

20. The conduction current is the same as displacement current when source is :-
(1) ac only
(2) dc only
(3) both ac and dc
(4) neither dc nor ac

EM0197

EXERCISE-I (Conceptual Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**3**	**2**	**2**	**1**	**3**	**2**	**4**	**1**	**2**	**3**	**2**	**4**	**1**	**2**	**3**
Que.	16	17	18	19	20										
Ans.	**3**	**3**	**4**	**1**	**3**										

EXERCISE-II (Previous Year Questions) AIPMT/NEET

AIPMT 2009

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

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

$E_z = 0$. The wave is :

(1) Moving along –x direction with frequency 10^6 Hz and wave length 200 m.

(2) Moving along y direction with frequency $2\pi \times 10^6$ Hz and wave length 200 m.

(3) Moving along x direction with frequency 10^6 Hz and wave length 100 m.

(4) Moving along x direction with frequency 10^6 Hz and wave length 200 m.

EM0200

AIPMT (Pre) 2010

2. Which of the following statement is false for the properties of electromagnetic waves ?

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

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

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

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

EM0201

AIPMT (Pre) 2011

3. The dimensions of $(\mu_0 \in_0)^{-1/2}$ are :

(1) $[L^{1/2}T^{-1/2}]$ (2) $[L^{-1}T]$

(3) $[LT^{-1}]$ (4) $[L^{-1/2}T^{1/2}]$

EM0202

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

(1) $\left[\vec{E} = E_0\hat{i}, \vec{B} = B_0\hat{j}\right]$

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

(3) $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{i}\right]$

(4) $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{k}\right]$

EM0203

5. The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is :

(1) microwave, infrared, ultraviolet, gamma rays

(2) gamma rays, ultraviolet, infrared, microwaves

(3) microwaves, gamma rays, infrared, ultraviolet

(4) infrared, microwave, ultraviolet, gamma rays

EM0204

AIPMT (Pre) 2012

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

(1) $6m^{-1}$ (2) $3m^{-1}$

(3) $2m^{-1}$ (4) $0.5m^{-1}$

EM0205

NEET-UG 2013

7. The condition under which a microwave oven heats up a food item containing water molecules most efficiently is :-

(1) Infra-red waves produce heating in a microwave oven

(2) The frequency of the microwaves must match the resonant frequency of the water molecules

(3) The frequency of the microwaves has no relation with natural frequency of water molecules

(4) Microwaves are heat waves, so always produce heating

EM0206

Re-AIPMT 2015

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

(1) γ-rays (2) X-rays

(3) Infra-red rays (4) Ultraviolet rays

EM0207

AIPMT 2015

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

(1) $\frac{2E}{C}$ (2) $\frac{2E}{C^2}$ (3) $\frac{E}{C^2}$ (4) $\frac{E}{C}$

EM0208

NEET-I 2016

10. Out of the following options which one can be used to produce a propagating electromagnetic wave ?

(1) A charge moving at constant velocity

(2) A stationary charge

(3) A chargeless particle

(4) An accelerating charge

EM0214

11. 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 :-

(1) 4.4 A (2) $11\sqrt{2}$ A

(3) 2.2 A (4) 11 A

EM0215

NEET (UG) 2017

12. In an electromagnetic wave in free space the root mean square value of the electric field is E_{rms} = 6V/m. The peak value of the magnetic field is :-

(1) 2.83×10^{-8} T

(2) 0.70×10^{-8} T

(3) 4.23×10^{-8} T

(4) 1.41×10^{-8} T

EM0219

NEET (UG) 2018

13. 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 :-

(1) –z direction

(2) +z direction

(3) –y direction

(4) –x direction

EM0224

NEET (UG) 2019 (Odisha)

14. 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,

(1) 2.5×10^8 m/s (2) 3×10^8 m/s

(3) 2.08×10^8 m/s (4) 4.32×10^8 m/s

EM0253

NEET (UG) 2020

15. 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 minute is :

(1) 48×10^3 J (2) 10×10^3 J

(3) 12×10^3 J (4) 24×10^3 J

EM0254

16. 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)

(1) 1 : c^2 (2) c : 1

(3) 1 : 1 (4) 1 : c

EM0255

NEET (UG) 2020 (COVID-19)

17. The E.M. wave with shortest wavelength among the following is

(1) Ultraviolet rays (2) X-rays

(3) Gamma-rays (4) Microwaves

EM0256

18. The magnetic field in a plane electromagnetic wave is given by :

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

Calculate the wavelength.

(1) $\pi \times 10^3$ m

(2) 2×10^{-3} m

(3) 2×10^3 m

(4) $\pi \times 10^{-3}$ m

EM0257

NEET (UG) 2021

19. 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 :

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

(2) $I_d = \frac{V_0}{\omega C}\cos\omega t$

(3) $I_d = \frac{V_0}{\omega C}\sin\omega t$

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

EM0258

20. 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?

(1) $\hat{j}+\hat{k}, \hat{j}+\hat{k}$

(2) $-\hat{j}+\hat{k}, -\hat{j}-\hat{k}$

(3) $\hat{j}+\hat{k}, -\hat{j}-\hat{k}$

(4) $-\hat{j}+\hat{k}, -\hat{j}+\hat{k}$

EM0259

NEET (UG) 2022

21. When light propagates through a material medium of relative permittivity ϵ_r and relative permeability μ_r, the velocity of light, ν is given by: (c-velocity of light in vacuum)

(1) $\nu = \sqrt{\frac{\mu_r}{\epsilon_r}}$

(2) $\nu = \sqrt{\frac{\epsilon_r}{\mu_r}}$

(3) $\nu = \frac{c}{\sqrt{\epsilon_r \mu_r}}$

(4) $\nu = c$

EM0271

22. Match List – I with List –II

	List –I (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

Choose the **correct** answer from the options given below :

(1) (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv)

(2) (a) – (iii), (b) – (iv), (c) – (ii), (d) – (i)

(3) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)

(4) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

EM0272

NEET (UG) 2022 (Overseas)

23. An electromagnetic wave is moving along negative z(–z) direction and at any instant of time, at a point, its electric field vector is $3\hat{j}$ V/m. The corresponding magnetic field at that point and instant will be:

(Take $c = 3 \times 10^8$ ms^{-1})

(1) $-10\hat{i}$ nT (2) $\hat{i}$ nT

(3) $-\hat{i}$ nT (4) $10\hat{i}$ nT

EM0273

24. If λ_x, λ_I, λ_M and λ_γ are the wavelengths of X-rays, infrared rays, microwaves and γ rays respectively, then:

(1) $\lambda_M < \lambda_I < \lambda_x < \lambda_\gamma$

(2) $\lambda_x < \lambda_\gamma < \lambda_M < \lambda_I$

(3) $\lambda_x < \lambda_I < \lambda_\gamma < \lambda_M$

(4) $\lambda_\gamma < \lambda_x < \lambda_I < \lambda_M$

EM0274

Re-NEET (UG) 2022

25. The magnetic field of a plane electromagnetic wave is given by

$\vec{B} = 3\times10^{-8}\cos(1.6\times10^{3}x + 48\times10^{10}t)\hat{j}$

then the associated electric field will be :

(1) $3\times10^{-8}\cos(1.6\times10^{3}x + 48\times10^{10}t)\,\hat{i}\ V/m$

(2) $3\times10^{-8}\sin(1.6\times10^{3}x + 48\times10^{10}t)\,\hat{i}\,V/m$

(3) $9\sin(1.6\times10^{3}x - 48\times10^{10}t)\,\hat{k}\,V/m$

(4) $9\cos(1.6\times10^{3}x + 48\times10^{10}t)\hat{k}\,V/m$

EM0275

26. 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)

(1) c

(2) $\frac{1}{c}$

(3) $\frac{c}{\sqrt{\mu_0\varepsilon_0}}$

(4) $\frac{\sqrt{\mu_0\varepsilon_0}}{c}$

EM0276

EXERCISE-II (Previous Year Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	4	3	1	1	3	2	2	1	4	3	1	2	1	4
Que.	16	17	18	19	20	21	22	23	24	25	26				
Ans.	3	3	2	1	2	3	3	4	4	4	2				

EXERCISE-III (Analytical Questions) Master Your Understanding

1. The pressure exerted by an electromagnetic wave of intensity I W/m^2 on a non-reflecting surface is :-
(1) Ic (2) Ic^2 (3) I/c (4) I/c^2
EM0227

2. A plane electromagnetic wave of frequency 40 MHz travels in free space in the X-direction. At some point and at some instant, the electric field $\vec{E}$ has its maximum value of 750 N/C in Y-direction. The wavelength of the wave is –
(1) 3.5 m (2) 5.5 m (3) 7.5 m (4) 9.5 m
EM0228

3. In **Q.2,** the period of the wave will be –
(1) 2.5 μs (2) 0.25 μs
(3) 0.025 μs (4) none of these
EM0229

4. In **Q.2,** the magnitude and direction of magnetic field will be –
(1) 2.5 μT in X-direction
(2) 2.5 μT in Y-direction
(3) 2.5 μT in Z-direction
(4) none of these
EM0230

5. In **Q.2,** the angular frequency of e.m. wave will be– (in rad/s)
(1) $8\pi \times 10^7$ (2) $4\pi \times 10^6$
(3) $2\pi \times 10^5$ (4) $\pi \times 10^4$
EM0231

6. In **Q.2,** the propagation constant of the wave will be –
(1) 8.38 m^{-1} (2) 0.838 m^{-1}
(3) 4.19 m^{-1} (4) 0.419 m^{-1}
EM0232

7. The sun delivers 10^3 W/m^2 of electromagnetic flux to the earth's surface. The total power that is incident on a roof of dimensions 8m × 20m, will be
(1) 6.4×10^3 W (2) 3.4×10^4 W
(3) 1.6×10^5W (4) none of these
EM0233

8. In. **Q.7,** the radiation force on the roof will be –
(1) 3.33×10^{-5} N (2) 5.33×10^{-4} N
(3) 7.33×10^{-3} N (4) 9.33×10^{-2} N
EM0234

9. In. **Q.7,** the solar energy incident on the roof in 1 hour will be –
(1) 5.76×10^8 J (2) 5.76×10^7 J
(3) 5.76×10^6 J (4) 5.76×10^5 J
EM0235

10. The sun radiates electromagnetic energy at the rate of 3.9×10^{26} W. It's radius is 6.96×10^8 m. The intensity of sun light at the solar surface will be – (in W/m^2)
(1) 1.4×10^4 (2) 2.8×10^5
(3) 4.2×10^6 (4) 6.4×10^7
EM0236

11. In. **Q.10,** if the distance from the sun to the earth is 1.5×10^{11} m, then the intensity of sunlight on earth's surface will be – (in W/m^2)
(1) 1.38×10^3 (2) 2.76×10^4
(3) 5.52×10^5 (4) none of these
EM0237

EXERCISE-III (Analytical Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	
Ans.	3	3	3	3	1	2	3	2	1	4	1	