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CLASS 12 PHYSICS · NCERT CHAPTER 8 · IMU CET PRACTICE

Electromagnetic Waves

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Questions: 44 MCQs

Each question has exactly one correct option. Attempt all questions first, then check the Answer Key and Solutions at the end.

- 1 The displacement current was introduced by
(A) Maxwell (B) Faraday
(C) Hertz (D) Ampere
- 2 Displacement current is given by
(A) $\epsilon_0 d\Phi_E/dt$ (B) $\epsilon_0 \Phi_E$
(C) dQ/dV (D) $\mu_0 d\Phi_B/dt$
- 3 Displacement current exists
(A) only in vacuum
(B) wherever the electric field (flux) changes with time
(C) only in a steady electric field
(D) only in conductors
- 4 Electromagnetic waves are
(A) transverse
(B) mechanical
(C) longitudinal
(D) partly transverse and partly longitudinal
- 5 In an electromagnetic wave, the electric and magnetic fields are
(A) parallel to each other
(B) out of phase by π
(C) out of phase by $\pi/2$
(D) in phase and perpendicular to each other
- 6 The speed of electromagnetic waves in vacuum is
(A) $\sqrt{(\mu_0\epsilon_0)}$ (B) $\sqrt{(\mu_0/\epsilon_0)}$
(C) $\mu_0\epsilon_0$ (D) $1/\sqrt{(\mu_0\epsilon_0)}$
- 7 The ratio of amplitudes of electric to magnetic field (E_0/B_0) in an EM wave in vacuum is
(A) c^2 (B) c
(C) 1 (D) $1/c$



- 8 The magnetic field amplitude of an EM wave is 2×10^{-8} T. The electric field amplitude is
(A) 60 V/m (B) 6.67×10^{-17} V/m
(C) 0.6 V/m (D) 6 V/m
- 9 Electromagnetic waves are produced by
(A) charges moving with constant velocity (B) accelerated charges
(C) neutral particles only (D) charges at rest
- 10 The direction of propagation of an EM wave is along
(A) B (B) E
(C) $B \times E$ (D) $E \times B$
- 11 An EM wave travels along +z with E along +x. The magnetic field is along
(A) -y (B) -x
(C) +z (D) +y
- 12 Which of the following has the longest wavelength?
(A) Radio waves (B) X-rays
(C) Visible light (D) Microwaves
- 13 Which of the following has the highest frequency?
(A) X-rays (B) Ultraviolet rays
(C) Gamma rays (D) Microwaves
- 14 The wavelength range of visible light is approximately
(A) 700 μm to 1 mm (B) 1 nm to 100 nm
(C) 1 mm to 1 m (D) 400 nm to 700 nm
- 15 Infrared radiation is also called
(A) heat waves (B) Hertzian waves
(C) cosmic rays (D) Röntgen rays
- 16 Ultraviolet radiation from the Sun is largely absorbed by
(A) the ozone layer (B) carbon dioxide
(C) water vapour in the troposphere (D) the ionosphere
- 17 X-rays are used in medicine to
(A) carry TV signals (B) cook food
(C) measure temperature remotely (D) image bones and diagnose fractures
- 18 Microwaves are used in
(A) radar and microwave ovens (B) medical X-ray imaging
(C) sterilising water by ionisation (D) nuclear reactions
- 19 The frequency of microwaves used in microwave ovens is chosen to match the resonant frequency of
(A) carbon atoms (B) water molecules
(C) iron atoms (D) air molecules



- 20 Gamma rays originate from
(A) outer electron transitions (B) oscillating LC circuits
(C) nuclear transitions (D) hot bodies
- 21 Radio waves are produced by
(A) inner shell electron transitions
(B) nuclear decay
(C) hot bodies only
(D) accelerated motion of charges in antennas (oscillating circuits)
- 22 The frequency of an EM wave of wavelength 3 m is
(A) 10^7 Hz (B) 10^8 Hz
(C) 9×10^8 Hz (D) 10^9 Hz
- 23 The speed of EM waves in a medium of relative permittivity $\epsilon_r = 4$ and $\mu_r = 1$ is
(A) 6×10^8 m/s (B) 1.5×10^8 m/s
(C) 3×10^8 m/s (D) 0.75×10^8 m/s
- 24 Electromagnetic waves carry
(A) only energy (B) only mass
(C) energy and momentum (D) only charge
- 25 Which of the following is NOT an electromagnetic wave?
(A) X-rays (B) Radio waves
(C) Gamma rays (D) Sound waves
- 26 The waves used for remote controls of TVs are
(A) infrared (B) gamma rays
(C) X-rays (D) ultraviolet
- 27 The waves used in LASIK eye surgery and to kill germs in water purifiers are
(A) radio waves (B) microwaves
(C) infrared (D) ultraviolet
- 28 The average energy density of an EM wave is shared between electric and magnetic fields
(A) entirely in the magnetic field (B) equally
(C) in the ratio $c : 1$ (D) entirely in the electric field
- 29 The order of magnitude of wavelength of X-rays is
(A) 1 m (B) 10^{-6} m
(C) 10^{-10} m (D) 10^{-3} m
- 30 The Earth's greenhouse effect is mainly due to trapping of
(A) radio waves (B) ultraviolet radiation
(C) infrared radiation (D) X-rays
- 31 Which experiment first demonstrated the existence of EM waves?
(A) Young's double-slit experiment (B) Hertz's experiment
(C) Michelson–Morley experiment (D) Rutherford's experiment



- 32 The electric field of an EM wave is $E = 30 \sin(2 \times 10^6 t - kx)$ V/m. The value of k is about
(A) 1.5×10^2 rad/m (B) 2×10^6 rad/m
(C) 6.67×10^{-3} rad/m (D) 6×10^{14} rad/m
- 33 The charging current in a capacitor connecting wire is 2 A. The displacement current between the plates is
(A) zero (B) 1 A
(C) 2 A (D) 4 A
- 34 Short-wave radio communication via the ionosphere uses
(A) line of sight only (B) sky wave propagation
(C) ground wave only (D) satellite only
- 35 The intensity of an EM wave is related to its electric field amplitude E_0 as
(A) $I = c\epsilon_0 E_0$ (B) $I = E_0^2/c$
(C) $I = \epsilon_0 E_0^2/2c$ (D) $I = \frac{1}{2}c\epsilon_0 E_0^2$
- 36 EM waves do not require
(A) an accelerating source (B) a frequency
(C) a material medium for propagation (D) energy
- 37 Which part of the EM spectrum is used for night vision devices?
(A) X-rays (B) Ultraviolet
(C) Infrared (D) Gamma rays
- 38 Arrange in increasing order of frequency: microwaves (M), X-rays (X), visible (V), radio (R)
(A) $R < V < M < X$ (B) $R < M < V < X$
(C) $X < V < M < R$ (D) $M < R < V < X$
- 39 In an EM wave, the energy carried by the electric field compared to that by the magnetic field is
(A) equal (B) c times
(C) less (D) more
- 40 The momentum delivered by an EM wave of energy U completely absorbed by a surface is
(A) Uc (B) $2U/c$
(C) U/c (D) U/c^2
- 41 The amplitude of the magnetic field in an EM wave in vacuum with $E_0 = 120$ V/m is
(A) 4×10^{-5} T (B) 3.6×10^{10} T
(C) 4×10^{-7} T (D) 120 T
- 42 Which radiation is used to study crystal structure?
(A) X-rays (B) Infrared
(C) Microwaves (D) Radio waves
- 43 The modified Ampere–Maxwell law is
(A) $\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0(I_c + \epsilon_0 d\Phi_E/dt)$ (B) $\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 I_c$ only
(C) $\oint \mathbf{B} \cdot d\mathbf{A} = 0$ (D) $\oint \mathbf{E} \cdot d\mathbf{l} = -d\Phi_B/dt$



44 An LC oscillator circuit is used to generate

(A) X-rays

(C) gamma rays

(B) radio frequency EM waves

(D) visible light

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Answer Key

1	2	3	4	5	6	7	8	9	10
A	A	B	A	D	D	B	D	B	D
11	12	13	14	15	16	17	18	19	20
D	A	C	D	A	A	D	A	B	C
21	22	23	24	25	26	27	28	29	30
D	B	B	C	D	A	D	B	C	C
31	32	33	34	35	36	37	38	39	40
B	C	C	B	D	C	C	B	A	C
41	42	43	44						
C	A	A	B						

Hints & Solutions

- (A) Maxwell added the displacement current to make Ampere's law consistent for time-varying fields.
- (A) $I_d = \epsilon_0 (d\Phi_E/dt)$.
- (B) It arises from a time-varying electric flux, e.g., between capacitor plates while charging.
- (A) E and B oscillate perpendicular to each other and to the direction of propagation.
- (D) E and B oscillate in phase, mutually perpendicular.
- (D) $c = 1/\sqrt{\mu_0\epsilon_0} \approx 3 \times 10^8$ m/s.
- (B) $E_0 = cB_0$.
- (D) $E_0 = cB_0 = 3 \times 10^8 \times 2 \times 10^{-8} = 6$ V/m.
- (B) An oscillating (accelerated) charge produces time-varying E and B fields that propagate.
- (D) The Poynting vector $S = (E \times B)/\mu_0$ gives the direction of energy flow.
- (D) $E \times B$ must point along +z: $\hat{x} \times \hat{y} = \hat{z} \rightarrow B$ along +y.
- (A) Order (decreasing λ): radio > microwave > IR > visible > UV > X-ray > gamma.
- (C) Gamma rays have the shortest wavelength, hence the highest frequency.
- (D) Visible spectrum ≈ 400 (violet) to 700 nm (red).
- (A) IR radiation is readily absorbed as heat by most materials.
- (A) The stratospheric ozone layer absorbs most harmful UV.
- (D) X-rays penetrate soft tissue but are absorbed more by bones.
- (A) Microwaves suit radar (short λ) and heat food by agitating water molecules.
- (B) Microwaves at ~ 2.45 GHz efficiently transfer energy to water molecules.
- (C) Gamma rays are emitted when an excited nucleus de-excites.
- (D) Oscillating currents in antennas radiate radio waves.
- (B) $f = c/\lambda = 3 \times 10^8/3 = 10^8$ Hz.
- (B) $v = c/\sqrt{\epsilon_r\mu_r} = 3 \times 10^8/2$.



24. (C) EM waves transport energy and momentum and exert radiation pressure.
25. (D) Sound is a mechanical wave that needs a medium.
26. (A) Remote controls use IR LEDs.
27. (D) UV lasers are used in LASIK, and UV lamps kill bacteria.
28. (B) $\frac{1}{2}\epsilon_0 E^2 = B^2/2\mu_0$ on average, so energy is equally divided.
29. (C) X-rays span ~ 10 nm to 10^{-4} nm; typical $\sim 1 \text{ \AA} = 10^{-10}$ m.
30. (C) Greenhouse gases absorb the IR re-emitted by the Earth's surface.
31. (B) Heinrich Hertz produced and detected EM waves in 1887.
32. (C) $k = \omega/c = 2 \times 10^6 / (3 \times 10^8) \approx 6.67 \times 10^{-3} \text{ rad/m}$.
33. (C) Displacement current between plates equals the conduction current in the wires (continuity of current).
34. (B) The ionosphere reflects short-wave radio signals back to Earth.
35. (D) $I = \text{average energy density} \times c = \frac{1}{2}\epsilon_0 E_0^2 c$.
36. (C) EM waves can travel through vacuum.
37. (C) Warm bodies emit IR, detected by night vision cameras.
38. (B) Frequency increases from radio $\rightarrow$ microwave $\rightarrow$ visible $\rightarrow$ X-rays.
39. (A) $u_E = u_B$ in an EM wave.
40. (C) $p = U/c$ for complete absorption ($2U/c$ for complete reflection).
41. (C) $B_0 = E_0/c = 120 / (3 \times 10^8) = 4 \times 10^{-7} \text{ T}$.
42. (A) X-ray wavelengths are comparable to interatomic spacings, giving diffraction.
43. (A) Maxwell added the displacement current term $\epsilon_0 d\Phi_E/dt$.
44. (B) LC circuits produce oscillations at radio frequencies, radiated by antennas.

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