

Electromagnetic Waves — CBSE Pattern Test 2

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 2 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Electromagnetic Waves · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- Maxwell modified Ampere's law by adding
 - the displacement current
 - a resistance term
 - a charge term
 - a voltage term
- In an EM wave, the electric and magnetic fields are
 - mutually perpendicular and perpendicular to the direction of propagation
 - parallel to each other
 - parallel to the direction of propagation
 - always at 45°
- The ratio of the electric to the magnetic field amplitude in an EM wave in vacuum is
 - c
 - $1/c$
 - c^2
 - $\sqrt{c}$
- The energy of an electromagnetic wave is shared equally between
 - the electric and magnetic fields
 - the electric field only
 - the magnetic field only
 - neither field
- The momentum carried by an EM wave of energy U is
 - U/c
 - Uc
 - U/c^2
 - Uc^2
- The radiation pressure of an EM wave perfectly absorbed is
 - I/c
 - Ic
 - I/c^2
 - Ic^2
- X-rays are used in
 - medical imaging and radiography

- (B) remote controls
 (C) radar
 (D) TV broadcasting
8. Gamma rays are used in
 (A) cancer treatment and sterilisation
 (B) radar
 (C) TV
 (D) speed guns
9. Write the expression for the speed of electromagnetic waves in vacuum.
10. Name the electromagnetic wave with the highest frequency.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. The electric field of an EM wave is $E = 30 \sin(6 \times 10^8 t - 2x)$ V/m. Find its frequency and wavelength.
12. An EM wave has an intensity of 1.5 W/m^2 and falls on a perfectly reflecting surface. Find the radiation pressure.
13. Give two uses each of microwaves and ultraviolet radiation.
14. Write the relation between E_0 and B_0 in an EM wave in vacuum.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. Explain the transverse nature of electromagnetic waves and describe how they are produced.
16. Define the intensity of an EM wave and derive the expressions for the radiation pressure when it is absorbed and when it is reflected.
17. Describe the different regions of the electromagnetic spectrum in order of increasing frequency and give one use of each.
18. In a charging capacitor, show that the displacement current equals the conduction current.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Draw and explain the electromagnetic spectrum in order of increasing wavelength. Name the radiation used in (i) remote switches, (ii) water purification and (iii) cancer treatment, giving a reason for each.
20. Show that the average energy density of an electromagnetic wave is shared equally between its electric and magnetic fields, and derive the expression for the intensity in terms of E_0 .

Answer Key (Marking Scheme)

- Q1 — (A) the displacement current. Q2 — (A) mutually perpendicular and perpendicular to propagation. Q3 — (A) c. Q4 — (A) the electric and magnetic fields.
- Q5 — (A) U/c . Q6 — (A) I/c . Q7 — (A) medical imaging and radiography. Q8 — (A) cancer treatment and sterilisation.
- Q9 — $c = 1/\sqrt{\mu_0 \epsilon_0} \approx 3 \times 10^8 \text{ m/s}$.
- Q10 — gamma rays.
- Q11 — $\omega = 6 \times 10^8 \text{ rad/s} \approx 9.5 \times 10^7 \text{ Hz}$; $k = 2\pi/\lambda = \pi \approx 3.14 \text{ m}^{-1}$.
- Q12 — $P = 2I/c = 1 \times 10^{-8} \text{ Pa}$.
- Q13 — Microwaves: radar, microwave ovens. UV: sterilisation, water purification.
- Q14 — $E_0 = cB_0$.

Q15 — E and B are mutually perpendicular and perpendicular to propagation; produced by accelerating charges.

Q16 — $I = u_{\text{avg}} c$; $P = I/c$ for absorption and $P = 2I/c$ for reflection (momentum reversal).

Q17 — Radio, microwave, IR, visible, UV, X-ray, gamma (increasing frequency) with uses as in the notes.

Q18 — $\Phi_E = EA$, $E = q/(\epsilon_0 A)$, so $\epsilon_0 d\Phi_E/dt = dq/dt = I$.

Q19 — Remote: infrared; water purification: ultraviolet; cancer treatment: gamma rays — each chosen for its specific interaction with matter.

Q20 — $u_E = \frac{1}{2}\epsilon_0 E^2$ and $u_B = B^2/2\mu_0$ with $E = cB$ give $u_E = u_B$; total energy density $u = \epsilon_0 E_{\text{rms}}^2$, and $I = \epsilon_0 E_{\text{rms}}^2 c = \frac{1}{2}\epsilon_0 E_0^2 c$.