

Electromagnetic Waves — Assignment 1

Class 12 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.
 (2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.
 (3) Universal values: $g = 10 \text{ m/s}^2$ unless stated. Give answers with correct SI units.

Displacement Current and Maxwell's Equations

MCQ Questions (choose the correct option)

- Displacement current arises due to a changing
 - electric field
 - magnetic field
 - current
 - charge
- The displacement current is given by
 - $\epsilon_0 \frac{d\Phi_E}{dt}$
 - $\mu_0 \frac{d\Phi_E}{dt}$
 - $\epsilon_0 \Phi_E$
 - $\mu_0 \frac{d\Phi_B}{dt}$
- Maxwell modified Ampere's law by adding
 - the displacement current
 - a resistance term
 - a charge term
 - a voltage term
- In a charging capacitor, the displacement current
 - equals the conduction current
 - is zero
 - is twice the conduction current
 - opposes the conduction current

1 Mark Questions

- Define displacement current.
- Write the expression for the displacement current.
- How many Maxwell's equations are there?

2 Mark Questions

- Define displacement current and show that it equals the conduction current in a charging capacitor.
- Write the expression for the displacement current and explain its origin.

3 Mark Questions

- Explain the concept of displacement current and why Maxwell introduced it into Ampere's circuital law.
- Show that the displacement current inside a charging parallel-plate capacitor equals the conduction current in the connecting wires.

Properties of Electromagnetic Waves

MCQ Questions (choose the correct option)

- Electromagnetic waves are
 - transverse
 - longitudinal
 - stationary
 - mechanical
- 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 speed of an EM wave in vacuum is
 - $1/\sqrt{(\mu_0\epsilon_0)}$
 - $\sqrt{(\mu_0\epsilon_0)}$
 - $1/(\mu_0\epsilon_0)$
 - $\mu_0\epsilon_0$
- The ratio of the electric to the magnetic field amplitude in an EM wave in vacuum is
 - c
 - $1/c$
 - c^2
 - $\sqrt{c}$

1 Mark Questions

- Are electromagnetic waves transverse or longitudinal?
- Write the expression for the speed of electromagnetic waves in vacuum.
- What is the relation between E_0 and B_0 in an electromagnetic wave in vacuum?

2 Mark Questions

- Write any four properties of electromagnetic waves.
- Write the relation between the electric and magnetic field amplitudes of an EM wave and explain the term.

3 Mark Questions

- State the properties of electromagnetic waves and derive the expression for their speed in vacuum.
- Explain how electromagnetic waves are produced and describe their transverse nature with the help of a diagram.

Energy, Intensity and Momentum

MCQ Questions (choose the correct option)

- 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 intensity of an electromagnetic wave is proportional to

- (A) E_0^2
 - (B) E_0
 - (C) $1/E_0$
 - (D) E_0^3
3. The momentum carried by an EM wave of energy U is
- (A) U/c
 - (B) Uc
 - (C) U/c^2
 - (D) Uc^2
4. The radiation pressure of an EM wave perfectly absorbed is
- (A) I/c
 - (B) Ic
 - (C) I/c^2
 - (D) Ic^2

1 Mark Questions

1. How is the energy of an electromagnetic wave divided between its electric and magnetic fields?
2. Write the expression for the momentum of an electromagnetic wave.
3. Write the expression for the radiation pressure of an EM wave.

2 Mark Questions

1. Show that the average energy density of the electric field equals that of the magnetic field in an EM wave.
2. An EM wave has an intensity of 30 W/m^2 . Find the radiation pressure if it is completely absorbed. (Ans: $1 \times 10^{-7} \text{ Pa}$)

3 Mark Questions

1. Derive the expression for the average energy density of an electromagnetic wave and show that it is shared equally between the electric and magnetic fields.
2. Define intensity of an EM wave and derive the expression for the radiation pressure exerted by it when it is (i) absorbed and (ii) reflected.

The Electromagnetic Spectrum

MCQ Questions (choose the correct option)

1. Which electromagnetic wave has the longest wavelength?
 - (A) radio waves
 - (B) gamma rays
 - (C) X-rays
 - (D) ultraviolet
2. Which electromagnetic wave has the highest frequency?
 - (A) gamma rays
 - (B) radio waves
 - (C) microwaves
 - (D) infrared
3. The order of increasing wavelength of EM waves is
 - (A) gamma < X-ray < UV < visible < IR < microwave < radio

(B) radio < microwave < IR < visible < UV < X-ray < gamma

(C) visible < UV < IR < gamma < radio

(D) IR < visible < UV < X-ray < gamma < microwave

4. Microwaves are used in

(A) radar and microwave ovens

(B) radiography

(C) sterilisation

(D) night vision

1 Mark Questions

1. Name the electromagnetic wave with the longest wavelength.

2. Name the electromagnetic wave with the highest frequency.

3. Arrange gamma rays, X-rays, ultraviolet, visible, infrared, microwaves and radio waves in increasing order of wavelength.

2 Mark Questions

1. Name the parts of the electromagnetic spectrum in increasing order of frequency and give one use of each of X-rays and microwaves.

2. What is the wavelength range of the visible spectrum and to which part of it is the human eye most sensitive?

3 Mark Questions

1. What is the electromagnetic spectrum? Describe its different regions in order of increasing wavelength and mention one use of each.

2. Describe the electromagnetic spectrum and identify the waves used in (i) remote switches, (ii) water purification and (iii) cancer treatment.

Applications of EM Waves

MCQ Questions (choose the correct option)

1. Radio waves are used in

(A) communication

(B) cancer therapy

(C) sterilising water

(D) night vision goggles

2. Infrared waves are used in

(A) remote controls and night vision

(B) radiography

(C) cancer therapy

(D) water sterilisation

3. X-rays are used in

(A) medical imaging and radiography

(B) remote controls

(C) radar

(D) TV broadcasting

4. Gamma rays are used in

(A) cancer treatment and sterilisation

- (B) radar
- (C) TV
- (D) speed guns

1 Mark Questions

1. Name one use of radio waves.
2. Name one use of infrared waves.
3. Name one use of gamma rays.

2 Mark Questions

1. Give two uses each of (i) microwaves and (ii) ultraviolet radiation.
2. Give two uses each of (i) infrared waves and (ii) X-rays.

3 Mark Questions

1. Describe the main applications of the different regions of the electromagnetic spectrum.
2. Name the EM radiation used in (i) a microwave oven, (ii) a television remote, (iii) medical radiography, (iv) sterilising surgical instruments, and give a reason for each choice.