

# Electromagnetic Waves

## Question1

Select the 'WRONG' statement out of the following.

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Options:

- A. Electromagnetic waves do not require any medium for their propagation.
- B. Electromagnetic waves can travel through vacuum waves speed of light
- C. Material medium is necessary for propagation of electromagnetic waves.
- D. Electromagnetic waves are transverse in nature.

Answer: C

Solution:

Electromagnetic waves can propagate through vacuum. This can be clearly understood from Maxwell's equations for EM waves. Self-sustaining electric and magnetic fields enable waves to travel through empty space.

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## Question2

An electromagnetic wave, whose wave normal makes an angle of  $45^\circ$  with the vertical, travelling in air strikes a horizontal liquid surface. While travelling through the liquid it gets deviated through  $15^\circ$ . What is the speed of the electromagnetic wave in the liquid, if the speed of electromagnetic wave in air is  $3 \times 10^8$  m/s ?

$$\left( \sin 30^\circ = 0.5, \sin 45^\circ = \frac{1}{\sqrt{2}} \right)$$



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**Options:**

A.  $\frac{\sqrt{2}}{3} \times 10^8 \text{ m/s}$

B.  $1.5 \times 10^8 \text{ m/s}$

C.  $2.1 \times 10^8 \text{ m/s}$

D.  $2.5 \times 10^8 \text{ m/s}$

**Answer: C**

**Solution:**

The angle of incidence is  $i = 45^\circ$

The angle of deviation is  $\delta = 15^\circ$

The angle of refraction is

$$\delta = i - r$$

$$r = i - \delta$$

$$r = 45^\circ - 15^\circ$$

$$r = 30^\circ$$

The relation between the speed of the wave in the medium, the angle of incidence and the angle of refraction is given by the formula:

$$\frac{v_2}{v_1} = \frac{\sin r}{\sin i}$$

$$\frac{v_2}{v_1} = \frac{\sin 30^\circ}{\sin 45^\circ}$$

$$\frac{v_2}{v_1} = \frac{1}{\sqrt{2}}$$

$$v_2 = \frac{v_1}{\sqrt{2}}$$

$$v_2 = \frac{3 \times 10^8}{\sqrt{2}}$$

$$v_2 = 2.1 \times 10^8 \text{ m/s}$$

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### Question3

A charge ' $q$ ' moves with velocity ' $v$ ' through electric ( $E$ ) as well as magnetic field ( $B$ ). Then the force acting on it is

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Options:

A.  $q(\vec{v} \times \vec{B})$

B.  $q(\vec{B} \times \vec{v})$

C.  $q(\vec{E} \times \vec{v})$

D.  $q\vec{E} + q(\vec{v} \times \vec{B})$

**Answer: D**

**Solution:**

Answer: (D)  $q\vec{E} + q(\vec{v} \times \vec{B})$

The force experienced by a charge  $q$  moving with velocity  $\vec{v}$  through both an electric field  $\vec{E}$  and a magnetic field  $\vec{B}$  is given by the Lorentz force law. This law states that the total force is the vector sum of the electric force and the magnetic force.

- The electric force is given by  $\vec{F}_E = q\vec{E}$ .
- The magnetic force is given by  $\vec{F}_B = q(\vec{v} \times \vec{B})$ , which involves a cross product between the velocity and the magnetic field vectors.

Therefore, the total force is  $\vec{F} = \vec{F}_E + \vec{F}_B = q\vec{E} + q(\vec{v} \times \vec{B})$ .

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## Question4

In amplitude modulation,

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### Options:

- A. amplitude remains constant but frequency . changes according to information signal
- B. amplitude of carrier wave changes according to information signal
- C. both amplitude and frequency changes according to information signal
- D. both amplitude and frequency do not change according to information signal

**Answer: B**

### Solution:

Amplitude Modulation (AM) is a modulation technique used in electronic communication, most commonly for transmitting information via a radio carrier wave. In AM, the amplitude (the strength or intensity) of the carrier wave is varied in proportion to that of the message signal, such as an audio signal. This variation in amplitude represents the information or data that is being transmitted.

Given the options:

Option A suggests that only the frequency of the carrier wave changes according to the information signal, which is not true for amplitude modulation. In frequency modulation (FM), it is the frequency that changes according to the information signal, not the amplitude.

Option B correctly describes amplitude modulation. In AM, the amplitude of the carrier wave changes in accordance with the amplitude of the information signal, while the frequency of the carrier wave remains constant.

Option C suggests that both amplitude and frequency of the carrier wave change according to the information signal. This description does not fit AM but rather describes more complex modulation schemes where both amplitude and frequency can be varied, such as amplitude and frequency modulation techniques used together or other forms of digital modulation.

Option D suggests that in amplitude modulation, both the amplitude and frequency of the carrier wave do not change according to the information signal. This option is incorrect because, in AM, it is specifically the amplitude of the carrier wave that changes to encode information.

Therefore, the correct answer is:

**Option B: amplitude of carrier wave changes according to information signal**

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