Short Answer Questions – I (PYQ)

Q. 1. State two properties of electromagnetic waves. How can we show that em waves carry momentum? [CBSE South 2016]

Ans. Properties of electromagnetic waves:

(i) Transverse nature.

(ii) Does not get deflected by electric or magnetic fields.

(iii) Same speed in vacuum for all waves.

(iv) No material medium required for propagation.

(v) They get refracted, diffracted and polarised.

Electric charges present on a plane, kept normal to the direction of propagation of an em wave can be set and sustained in motion by the electric and magnetic field of the electromagnetic wave. The charges thus acquire energy and momentum from the waves.

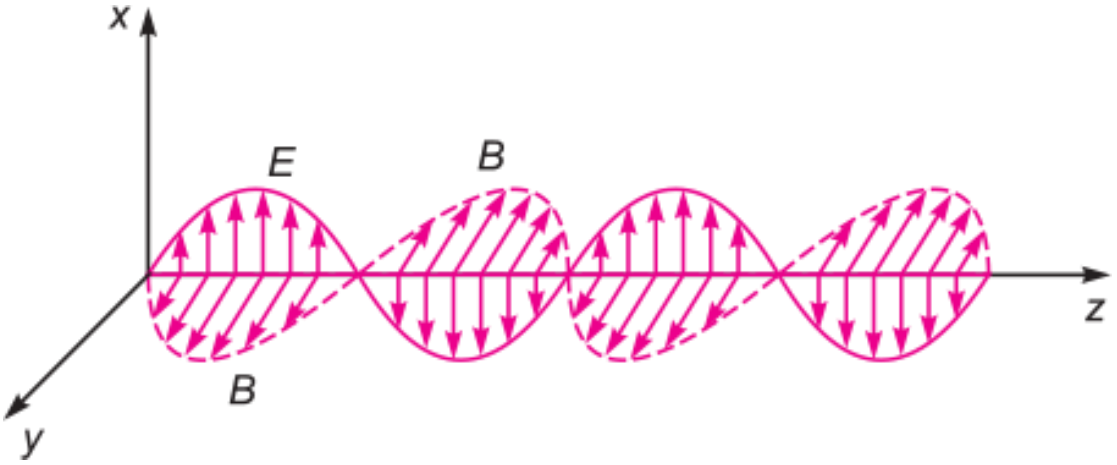
Q. 2. Answer the following questions:

(i) How does oscillating charge produce electromagnetic waves?

(ii) Sketch a schematic diagram depicting oscillating electric and magnetic fields of an em wave propagating along + z-direction. [CBSE (F) 2014, Delhi 2016]

Ans. (i) An oscillating charge produces an oscillating electric field in space, which produces an oscillating magnetic field. The oscillating electric and magnetic fields regenerate each other, and this results in the production of em waves in space.

(ii) Electric field is along x-axis and magnetic field is along y-axis.



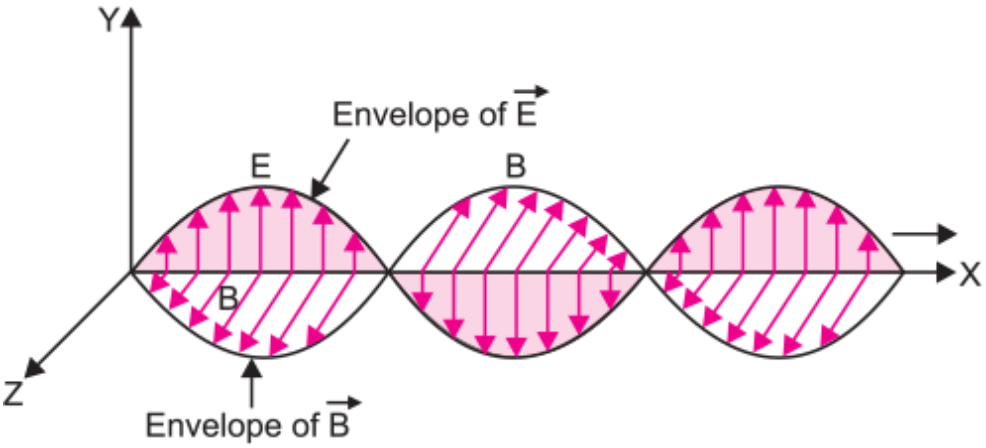
Q. 3. Answer the following questions:

(i) An em wave is travelling in a medium with a velocity $\vec{v} = v\,\hat{i}$. Draw a sketch showing the propagation of the em wave, indicating the direction of the oscillating electric and magnetic fields.

(ii) How are the magnitudes of the electric and magnetic fields related to the velocity of the em wave? [CBSE Delhi 2013]

Ans. (i) $\hat{i} = \hat{j} \times \hat{k}$.

The direction of propagation of electromagnetic wave is given by $\vec{E} \times \vec{B}$



(ii) The speed of electromagnetic wave |c|= $\frac{|E_0|}{|B_0|}$

Q. 4. Name the part of the electromagnetic spectrum whose wavelength lies in the range 10^{-10} m. Give its one use. [CBSE (AI) 2010]

Ans. The electromagnetic waves having wavelength 10^{-10} m are X-rays.

X-rays are used to study crystal structure.

Q. 5. Answer the following questions:

(i) How are infrared waves produced? Write their one important use.

(ii) The thin Ozone layer on top of the stratosphere is crucial for human survival. Why?
[CBSE East 2016]

Ans. (i) Infrared waves are produced by hot bodies and molecules.

Important use:

(a) To treat muscular strains. (b) To reveal the secret writings on the ancient walls. (c) For producing dehydrated fruits (d) Solar heater (e) Solar cooker. (Any one)

(ii) Ozone layer protects us from harmful U–V rays.

Q. 6. Answer the following questions:

(i) Which segment of electromagnetic waves has highest frequency? How are these waves produced? Give one use of these waves.

(ii) Which EM waves lie near the high frequency end of visible part of EM spectrum? Give its one use. In what way this component of light has harmful effects on humans?
[CBSE (F) 2016]

Ans. (i) Gamma rays have the highest frequency. These are produced during nuclear reactions and also emitted by radioactive nuclei. They are used in medicine to destroy cancer cells.

(ii) Ultraviolet rays lie near the high frequency end of visible part of EM spectrum. They are used to sterlise drinking water and surgical instruments. Exposure to UV radiation induces the production of more melanin, causing tanning of the skin.

Q. 7. Explain briefly how electromagnetic waves are produced by an oscillating charge. How is the frequency of em waves produced related to that of the oscillating charge?
[CBSE (F) 2012]

Ans. An oscillating or accelerated charge is supposed to be source of an electromagnetic wave. An oscillating charge produces an oscillating electric field in space which further produces an oscillating magnetic field which in turn is a source of electric field. These oscillating electric and magnetic field, hence, keep on regenerating each other and an electromagnetic wave is produced The frequency of em wave = Frequency of oscillating charge.

Q. 8. Identify the electromagnetic waves whose wavelengths vary as

(a) 10^{-12}m < λ < 10^{-8} m
(b) 10^{-3} m < λ < 10^{-1} m

Write one use for each. [CBSE (AI) 2017]

Ans. (a) X-rays: Used as a diagnostic tool in medicine and as a treatment for certain forms of cancer.

(b) Microwaves: Used in radar systems for aircraft navigation.

Q. 9. Identify the electromagnetic waves whose wavelengths lie in the range

(a) 10^{-11}m < λ < 10^{-8} m

(b) 10^{-4} m < λ < 10^{-1} m

Write one use of each. **[CBSE (AI) 2017]**

Ans. (a) X-rays / Gamma rays

(b) Infrared / Visible rays / Microwaves

(i) X-rays are used as a diagnostic tool in medicine.

(ii) Gamma rays are used in medicine to destroy cancer cells.

(iii) Infrared are used in green houses to warm plants.

(iv) Visible rays provide us information about the world.

(v) Microwaves are used in RADAR system for aircraft navigation.

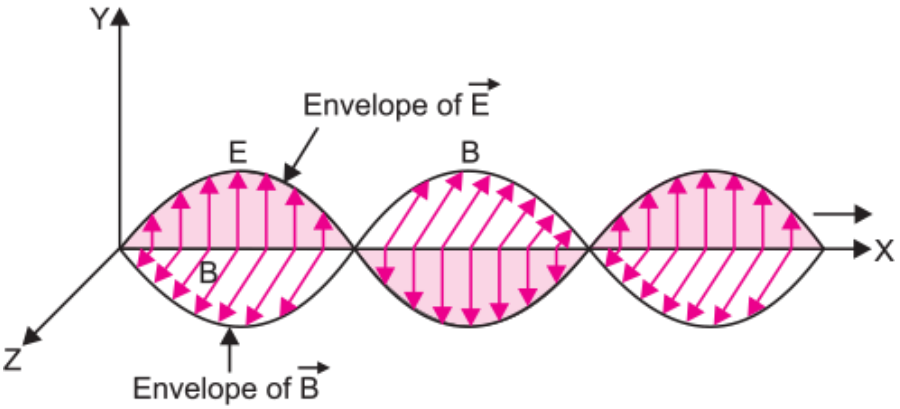
Short Answer Questions – I (OIQ)

Q. 1. What is meant by the transverse nature of electromagnetic waves? Draw a diagram showing the propagation of an electromagnetic wave along X-direction, indicating clearly the directions of oscillating electric and magnetic fields associated with it.

Ans. Transverse Nature of Electromagnetic Waves :

In an electromagnetic wave, the electric and magnetic field vectors oscillate, perpendicular to the direction of propagation of wave. This is called transverse nature of electromagnetic wave.

In an electromagnetic wave, the three vectors $\rightarrow_{E}, \rightarrow_{B}$ and $\rightarrow_{K}$ form a right handed system. Accordingly if a wave is propagating along X-axis, the electric field vector oscillates along Y-axis and magnetic field vector oscillates along Z-axis. Diagram is shown in figure.



Q. 2. What do electromagnetic waves consist of ? Explain on what factors does its velocity in vacuum depend?

Ans. Electromagnetic waves consist of mutually perpendicular electric and magnetic field vectors. Its velocity in vacuum is given by

$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ is same for all electromagnetic waves.

In other words its velocity in vacuum does not depend on any factor.

Q. 3. A plane electromagnetic wave travels in vacuum, along the Y-direction. Write down the

(i) ratio of the magnitudes and
(ii) the direction, of its electric and magnetic field vectors.

Ans. (i) $\frac{B}{E}$ = speed of light (c = 3 × 10^8 m/s)

(ii) $\vec{K}, \vec{E}, \vec{B}$ form a right handed system. As wave propagation vector ($\vec{K}$) is along Y-axis; electric field ($\vec{E}$) must be along Z-axis and magnetic field $\vec{B}$ along X-axis.

Q. 4. When can a charge act as a source of electromagnetic wave? How are the directions of electric and magnetic field vectors, in an electromagnetic wave related to each other and to the direction of propagation of the wave?

Which physical quantity, if any, has the same value for waves belonging to the different parts of the electromagnetic spectrum?

Ans. Source of Electromagnetic Waves: The source of electromagnetic waves is an accelerated (or decelerated) charge or an oscillating LC circuit. In an electromagnetic wave, the electric field vector $\vec{E}$ and magnetic field vector $\vec{B}$ are mutually perpendicular and also perpendicular to direction of wave propagation such that wave propagation vector $\vec{K}$, electric field vector $\vec{E}$ and magnetic field vector $\vec{B}$ form a right handed orthogonal system.

The speed of waves in vacuum is the same for different parts of electromagnetic spectrum.

Q. 5. To which regions of the electromagnetic spectrum, the following wavelengths belong? 2,000 Å, 5,000 Å, 10,000 Å and 1.0 Å.

Ans. 2,000 Å — Ultraviolet radiation 5,000 Å — Visible light

10,000 Å — Infrared radiation 1.0 Å — X-rays

Q. 6. Write the following in descending order of wavelength:

Gamma rays, Hertzian waves, yellow light, blue light, infrared radiation, ultraviolet radiation, X-rays, γ–rays.

Ans. Hertzian waves, infrared radiation, yellow light, blue light, ultraviolet radiation, X-rays, γ–rays.

Q. 7. Find the wavelength of electromagnetic waves of frequency 5× 1019 Hz in free space. Give its two applications.

Ans.

$$\text{Wavelength, } \lambda = \frac{c}{\nu} = \frac{3\times10^8}{5\times10^{19}} = 6\times10^{-12} m$$

These are gamma rays.

These are used for : (i) Nuclear reactions (ii) Radiotherapy.

Q. 8. Find the wavelength of electromagnetic waves of frequency 4 × 109 Hz in free space. Give its two applications.

Ans.

$$\text{Wavelength, } \lambda = \frac{c}{\nu} = \frac{3\times10^8}{4\times10^9} = \frac{3}{40}\ m = \frac{300}{40}\ \text{cm} = 7.5\ \text{cm}.$$

This wavelength corresponds to microwave region (or short radio waves).

These are used in (i) RADAR (ii) Microwave ovens.