

CBSE Test Paper-01
Class - 12 Physics (Electromagnetic waves)

1. Radio station WCCO in Minneapolis broadcasts at a frequency of 830 kHz. Wavelength and angular wave number are
 - a. 361 m, 0.0174 /m
 - b. 381 m, 0.0174 rad/m
 - c. 391 m, 0.0174 rad/m
 - d. 371 m, 0.0174 rad/m

 2. The direction of propagation of an electromagnetic plane wave is
 - a. parallel to both electric field vector and the magnetic field vector
 - b. only perpendicular to electric field vector
 - c. perpendicular to both electric field vector and the magnetic field vector
 - d. only perpendicular to magnetic field vector

 3. An electromagnetic wave with frequency 5.70×10^{14} propagates with a speed of 2.17×10^8 in a certain piece of glass. Find
 - (a) the wavelength of the wave in the glass;
 - (b) the wavelength of a wave of the same frequency propagating in air.
 - a. (a) $0.401 \mu\text{m}$
(b) $0.546 \mu\text{m}$
 - b. (a) $0.391 \mu\text{m}$
(b) $0.536 \mu\text{m}$
 - c. (a) $0.381 \mu\text{m}$
(b) $0.526 \mu\text{m}$
 - d. (a) $0.411 \mu\text{m}$
(b) $0.556 \mu\text{m}$

 4. Comparing X-rays and Gamma rays
 - a. Gamma rays have more energy than X-rays
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- b. Gamma rays have larger wavelength than X-rays
 - c. Gamma rays have more speed than X-rays
 - d. Gamma rays are less penetrating than X-rays
5. The speed of plane electromagnetic waves is maximum in
 - a. glass
 - b. vacuum
 - c. tourmaline
 - d. water
 6. If the earth did not have an atmosphere, would its average surface temperature be higher or lower than what it is now?
 7. Which of the following has the shortest wavelength? Microwaves, ultraviolet rays, X-rays.
 8. Name the electromagnetic waves used for studying crystal structure of solids. What is its frequency range?
 9. Special devices like the klystron valve or the magnetron valve, are used for production of electromagnetic waves. Name these waves and also write one of their applications.
 10. Identify the different types of electromagnetic radiations, which are used (i) to kill germs, (ii) for physical therapy
 11. Welders wear special goggles or face masks with glass windows to protect their eyes from electromagnetic radiation. Name the radiations and write the range of their frequency.
 12. Name the electromagnetic waves used for the following and arrange them in increasing order of their penetrating power.
 - a. Water purification
 - b. Remote sensing
 - c. Treatment of cancer

13. What is intensity of electromagnetic wave? Give its relation in terms of electric field E and magnetic field B .

14. Answer the following questions.

- i. Name the waves which are produced during radioactive decay of a nucleus. Write their frequency range.
- ii. Welders wear special glass goggles while working. Why? Explain.
- iii. Why are infrared waves often called as heat waves? Give their one application

15. An electromagnetic wave travels in vacuum along z -direction.

1. What can you say about the directions of its electric and magnetic field vectors?
2. If the frequency of the wave is 30 MHz, what is its wavelength?

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Answers

1. a. 361 m, 0.0174 /m

Explanation: $\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{830 \times 10^3} = 361m$

Angular wave number, $k = \frac{2\pi}{\lambda} = \frac{2\pi}{361} = 0.0174/m$

2. c. perpendicular to both electric field vector and the magnetic field vector

Explanation: Direction of propagation of em wave is given by Pointing vector which is given by $\vec{E} \times \vec{B}$. Hence, it is perpendicular to both the field vectors.

3. c. a. 0.381 μm

- b. 0.526 μm

Explanation: $\lambda_{glass} = \frac{v_{glass}}{\nu} = \frac{2.17 \times 10^8}{5.7 \times 10^{14}} = 0.381 \mu\text{m}$

$\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{5.7 \times 10^{14}} = 0.526 \mu\text{m}$

4. a. Gamma rays have more energy than X-rays

Explanation: Since frequency (ν) of gamma rays is more than that of x-rays and energy = $h\nu$, where h is planck's constant.

5. b. vacuum

Explanation: $v = \frac{1}{\sqrt{\mu_o \mu_r \epsilon_o \epsilon_r}} = \frac{c}{\sqrt{\epsilon_r \mu_r}}$

since $\epsilon_r \mu_r > 1$, c (speed of light in vacuum) > v (speed of light in any other medium)

Hence it is maximum in vacuum.

6. The temperature of the earth would be lower because the green house effect of the atmosphere would be absent.

7. X-ray has shortest wavelength. Since energy of X-ray has maximum frequency and wavelength is inversely proportional to the frequency.

8. X-rays are used to study the crystal structure of solids and the process to do so is named XRD i.e. X-Ray powder Diffraction.

Frequency range of X-rays is 10^{16}Hz to 10^{21} Hz .

9. Klystron valve or magnetron valve are used for production of micro waves.
Microwaves are used in Microwave Ovens.

10. i. γ -rays(kills bacteria by breaking bacterial DNA) or UV rays(in water purifier)
ii. Infrared waves

11. Welders wear special goggles or face mask with glass windows to protect their eyes from impact, dust and radiation hazards as ultraviolet rays (UV rays).

The frequency range of UV rays is 8×10^{14} Hz to 3×10^{16} Hz.

12. Following are the electromagnetic waves used for;

- a. Water purification - Ultra violet waves
- b. Remote sensing - Micro waves
- c. Treatment of cancer - Gamma rays

In increasing order of penetration of given waves can be written as, (b) remote sensing < (a) water purification < (c) treatment of cancer.

13. Intensity of electromagnetic wave is defined as the energy crossing per second per unit area perpendicular to the direction of propagation of electromagnetic waves.

The intensity of electromagnetic wave at a point is;

$$I = U_{av}c$$

$$\text{where } U_{av} = \frac{1}{2}\epsilon_0 E_0^2 = \frac{1}{2} \frac{B_0^2}{\mu_0}$$

and c is the velocity of electromagnetic wave,

$$\therefore I = \frac{1}{2}\epsilon_0 E_0^2 c = \frac{1}{2} \frac{B_0^2}{\mu_0} c$$

Here E_0 and B_0 are maximum values of electric field and magnetic field respectively.

14. i. γ -rays are produced during radioactive decay of a nucleus. Its frequency range is from 3×10^{18} Hz to 5×10^{22} Hz.
- ii. Welders wear special glass goggles while working to protect their eyes from radiation hazards of ultraviolet rays(UV rays). The range of UV rays is 10^{15} Hz to 10^{17} Hz. Because the radiation hazards are harmful to human eyes.
- iii. Infrared waves are called heat waves because they cause the atoms and molecules

to vibrate when they encounter a substance. This increases the velocity and hence internal energy of atoms and molecules. Thereby, increasing the temperature of the substance (As, heat produced in matter is directly proportional to the internal energy of atoms and molecules). They are used in physical therapy and weather forecasting.

15. \vec{E} and \vec{B} lie in x-y plane and are mutually perpendicular,

Since;

$$C = \nu\lambda$$

$$\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{30 \times 10^6} = 10m$$

Wavelength of the wave is 10m