CBSE Test Paper-04

Class - 12 Physics (Electromagnetic Waves)

1. It is necessary to use satellites for long distance TV transmission because
   a. Television signals are attenuated by ionosphere
   b. Satellites transmit the signals all over the earth
   c. Television signals are absorbed by ionosphere
   d. Television signals are not properly reflected by the ionosphere. Therefore, reflection is effected by satellites.
2. State the part of the electromagnetic spectrum to which 21 cm wavelength emitted by atomic hydrogen in interstellar space, belongs to
   a. Microwave
   b. Ultraviolet
   c. Visible
   d. Radio
3. A parallel plate capacitor made of circular plates each of radius R = 6.0 cm has a capacitance C = 100 pF. The capacitor is connected to a 230 V ac supply with a (angular) frequency of 300 rad s^{-1}. rms value of the conduction current is
   a. 7.1 μA
   b. 7.9 μA
   c. 6.9 μA
   d. 7.3 μA
4. Electromagnetic radiation-
   a. is neither a wave nor a particle but pure energy
   b. has both a wave and particle
   c. natureis pure waves
   d. is only particles
5. When white light is split into its component colors by a prism
   a. You are not looking at electromagnetic spectrum but at colored light.
   b. All of the electromagnetic spectrum
   c. You are looking at a part of the electromagnetic spectrum
   d. None of these

6. Why is ozone layer on top of the stratosphere crucial for human survival?
7. In which directions do the electric and magnetic field vectors oscillate in an electromagnetic wave propagating along the X-axis?
8. How are infrared waves produced? What is the range of their wavelength?
9. Name the electromagnetic radiation to which waves of wavelength in the range of 10^{-2} m belongs. Give one use of this part of electromagnetic spectrum.
10. Why are microwaves considered suitable for radar systems used in aircraft navigation?
11. A compound microscope with an objective of 1.0 cm focal length and an eyepiece of 2.0 cm focal length has a tube length of 20 cm. Calculate the magnitude power of microscope, if the final image is formed at the near point of the eye.
12. Explain the following terms: (i) Ground waves (ii) Spacewaves (iii) Sky waves
13. Draw a sketch of a plane electromagnetic wave propagating along the Z-direction. Depict clearly the directions of electric and magnetic fields varying sinusoidally with *Z*.
14. i. Which segment of electromagnetic waves has the 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?
15. Electromagnetic waves travel in a medium at a speed of $2 \times 10^8 ms^{-1}$. The relative permeability of the medium is 1.0. Calculate the relative permittivity.

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Answers

1. d. Television signals are not properly reflected by the ionosphere. Therefore, reflection is effected by satellites.
   Explanation: Television signals are of high frequencies and high energies. Thus, these signals are not reflected by the ionosphere hence satellites are necessary for television transmission.
2. d. Radio
   Explanation: Wavelength range of radio waves is 0.1 m to 600m
3. c. 6.9 μA
   Explanation: $I_{rms} = V/X_C = V/(1/\omega C) = V\omega C)$
   $= 230 \times 300 \times 100 \times 10^{-12} = 6.9\mu A$
4. b. has both a wave and particle nature
   Explanation: It has dual nature. It shows wave nature as well as particle nature(photon).
5. c. You are looking at a part of the electromagnetic spectrum
   Explanation: Components of white light (VIBGYOR) falls in visible region of em spectrum.
6. Because ozone layer residing on top of stratosphere behaves like a filter and traps most of ultraviolet rays(hazardous ultraviolet radiation with shorter wavelength) coming from the sun and prevent its harmful impact.
7. Electric field vector, $\vec{E}$ and magnetic field vector, $\vec{B}$ are always perpendicular to each other and also to direction of propagation of an electromagnetic wave or light. Also, the direction of propagation is parallel to the vector product, $\vec{E} \times \vec{B}$.
   As, the wave is propagating along $\hat{i}$ or X-axis. Hence, electirc filed E is vibrating along $\hat{j}$ or +Y-axis and magnetic field B is vibrating along $\hat{k}$ or +Z-axis.
8. Hot objects and vibration of atoms and molecules are the sources of infrared waves. For example, a hot charcoal may not give off light, but radiate infrared waves. Range

of infrared wavelength is 7×10^{-7} m to $I0^{-3}$ m.

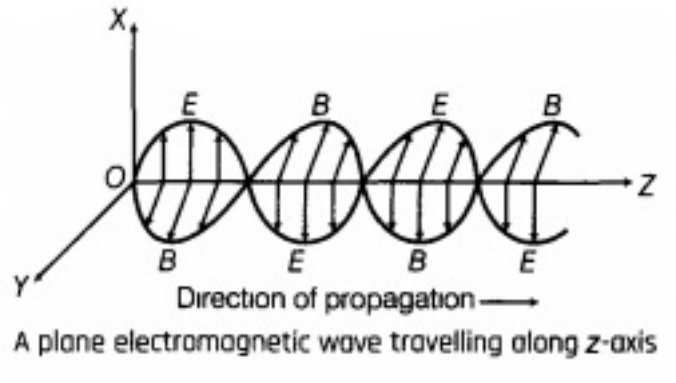
9. Microwaves have their wavelength in the range 0.1 m to 1 mm. These waves are used in RADAR communication, microwave oven for cooking etc.

10. Microwaves make up the majority of the spectrum of radio frequencies.The term microwave refers to any frequency between 300 MHz and 300 GHz, corresponding to wavelengths of 1 m to 1 mm, respectively.
    On account of smaller wavelengths of microwaves, they can be transmitted as beam signals in a particular direction. They also do not bend around the corners of the obstacles coming in their way. Thus, it is considered suitable for radar systems used in aircraft navigation system

11. Given:
    l = 20 cm
    D= 25 cm,
    f_0 = 1cm
    f_e = 2
    As per formula ,
    $m_0 = \frac{1}{f_0} = \frac{20}{1} = 20$
    $m_e = \frac{D}{f_0} = \frac{25}{2}$
    $m = m_0 m_e = 20 \times \frac{25}{2} = 250$

12. i. Ground waves: A radio wave that travels directly from one point to another following the surface of the earth is called ground wave or surface wave.
    ii. Space waves: A radio wave that travels directly from a high transmitting antenna to the receiving station is called space wave.
    iii. Sky waves: A radio wave transmitted towards the sky and reflected by the ionosphere towards the desired location of the earth is called a sky wave.

13. The direction of propagation of the electromagnetic wave is perpendicular to both electric field vector $\vec{E}$ and magnetic field vector $\vec{B}$, i.e. in the direction of the cross product of the electric and magnetic field vectors i.e. $\vec{E} \times \vec{B}$.



A plane electromagnetic wave travelling along z-axis

Here, electromagnetic wave is propagating along the Z-direction with electric and magnetic field vectors along positive X and Y axes respectively.

14. i. Gamma(γ) rays have the highest frequency(as these waves have the highest energy) in the electromagnetic waves. These rays are of the nuclear origin and are produced during the disintegration of radioactive atomic nuclei and during the decay of certain subatomic radioactive particles, associated with the decay of alpha(α) and beta(β) rays. They are used in the treatment of cancer and tumors i.e. in radiotherapy/chemotherapy.
    ii. Ultraviolet(UV) rays lie near the high-frequency end of visible part of EM spectrum. These rays are used to preserve food stuff and in water purifiers to kill the germs for giving pure drinking water. The harmful effect from exposure to ultraviolet (UV) radiation can be life-threatening and include premature ageing of the skin, suppression of the immune systems, damage to the eyes and skin cancer.

15. Given, $v = 2 \times 10^8 ms^{-1}, \mu_r = 1$
    $C = 3 \times 10^8 m/s$
    Using the formula,
    $v = \frac{1}{\sqrt{\mu\varepsilon}}$ (speed of electromagnetic wave in a medium)
    or $v = \frac{1}{\sqrt{\mu_0\mu_r(\varepsilon_0\varepsilon_r)}}$
    or $v = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \times \frac{1}{\sqrt{\mu_r\varepsilon_r}}$
    or $\varepsilon_r = \frac{c^2}{\nu^2\mu_r} = \frac{(3\times10^8)^2}{(2\times10^8)^2\times1}$ = 2.25