CBSE Test Paper-03

Class - 12 Physics (Electromagnetic Waves)

1. If, λ_v, λ_x and λ_m represent the wavelengths of visible light, x-rays and microwaves respectively in the free space then_____
   a. $\lambda_m > \lambda_v > \lambda_x$
   b. $\lambda_v > \lambda_x > \lambda_m$
   c. $\lambda_m > \lambda_x > \lambda_v$
   d. $\lambda_v > \lambda_m > \lambda_x$
2. Electromagnetic waves for TV and FM radio have a frequency about
   a. 750 KHz
   b. 750 Hz
   c. 750 MHz
   d. 750 GHz
3. High intensities of UV light
   a. are low in energy
   b. kills dangerous bacteria and therefore good
   c. are hazardous to the eyes
   d. is useful to good health
4. The velocity of light is maximum in:
   a. Vacuum
   b. Diamond
   c. Glass
   d. Water
5. Without the concept of displacement current it is not possible to correctly apply Ampere's law on a path parallel to the plates of parallel plate capacitor C in
   a. the region between source and the plates
   b. the region leading to plate 1
   c. the region between the plates
   d. the region leading to plate 2
6. Arrange the following in descending order of wavelength : X-rays, radio waves, blue light, infrared light.

7. Write the expression for speed of electromagnetic waves in free space.

8. Name the electromagnetic radiation used to destroy cancer cells and write its frequency range.

9. How are X-rays produced? Write their two important uses.

10. i. How are electromagnetic waves produced?
    ii. How do you convince yourself that electromagnetic waves carry energy and momentum?

11. State two applications of Infrared radiations.

12. Name the parts of the electromagnetic spectrum which is

    i. suitable for RADAR systems in aircraft navigations.
    ii. used to treat muscular strain.
    iii. used as a diagnostic tool in medicine.

    Write in brief, how these waves can be produced.

13. A plane electromagnetic wave of angular frequency ω is propagating with velocity C along the Z-axis. Write to vector equations of oscillating electric and magnetic fields and show those fields diagrametically.

14. Draw a diagram showing the propagation of an electromagnetic wave along the x direction indicating clearly the directions of the oscillating electric and magnetic fields associated with it.

15. Given:
    Wavelength of Light in mercury is $5.5 \times 10^{-5} cm$
    (a) Calculate its frequency and period
    (b) What is the wavelength of the light in glass, if the refractive index of glass is 1.5?
    Velocity of light = $3 \times 10^{8} ms^{-1}$.

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Answers

1. a. $\lambda_m > \lambda_v > \lambda_x$

   Explanation: Since of the given regions, wavelength of microwave is highest and that of x-ray is minimum.

2. c. 750 MHz

   Explanation: Frequency range for TV and FM radio is 54 - 890 MHz.

3. c. are hazardous to the eyes

   Explanation: UV rays has harmful effects on humans.

4. a. Vacuum

   Explanation: Velocity of light is maximum in Vacuum and that is 3×10^8m/s.

5. c. the region between the plates

   Explanation: In the region between the plates no conducting current flows, hence Ampere's circuital law $\oint \vec{B}.\vec{dl} = \mu_o I$ does'nt hold correct.

6. Since blue ray lies in visible light series, hence Radio wave > Infrared > Blue light > X-ray, is the descending order of wavelength.

7. The expression for speed of electromagnetic waves in free space,
   $v = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$
   where, μ_0 = absolute permeability and ε_0 is the absolute permeability of the free space.

8. γ-rays are used to destroy cancer cells and its frequency range is 10^{18} to 10^{22} Hz.

9. X-rays can be produced in an X-ray tube by colliding fast moving accelerated electron beam emitted from cathode on the anode i.e. the metal target of the tube.
   Uses of X-rays:

   i. In medical diagnosis as they can pass through the muscles but not through the bones.

ii. In detecting faults, cracks, etc. in metal products, huge bridges etc.

10. i. The oscillating charge produces an oscillating or time varying electric field and an oscillating electric field produces a time varying magnetic field which then produces an oscillating emf. An oscillating voltage (emf) produces an oscillating magnetic field and so on. This in turn produces an oscillating electric field and so on. Thus oscillating electric and magnetic fields regenerate each other and as a result an electromagnetic wave is produced and the wave propagates through space. In this way, the oscillating charges produce an electromagnetic wave. Vibrations of electric and magnetic fields are mutually perpendicular to each other and also perpendicular to the direction of propagation of the wave

ii. According to the quantum theory, electromagnetic radiation is made up of mass less particles called photons. Momentum of the photon is expressed as
$p = \frac{E}{c}$
Where, p and E are momentum and energy carried by the electromagnetic radiation or photons respectively.
and c = speed of light.
Thus, I am convinced that electromagnetic waves carry energy and momentum.

11. Infrared radiations are used for;

i. to treat muscular strain,

ii. for taking photographs during the conditions of fog, smoke etc.

12. i. The EM waves suitable for radar systems is microwaves. These rays are produced by special vacuum tubes, namely klystrons, magnetrons and Gunn diodes.

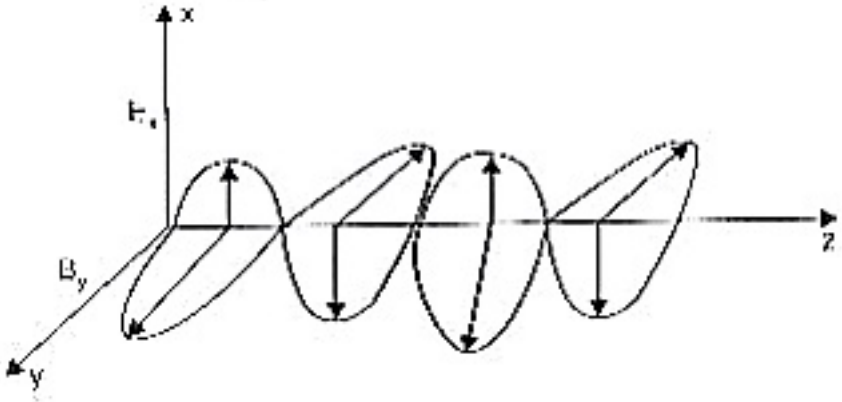
ii. Infrared waves are used to treat muscular strain. These rays are produced by hot bodies and vibration of molecules and atoms. For an example, a hot charcoal emits infrared radiation not the visible light to give the sensation of heat.

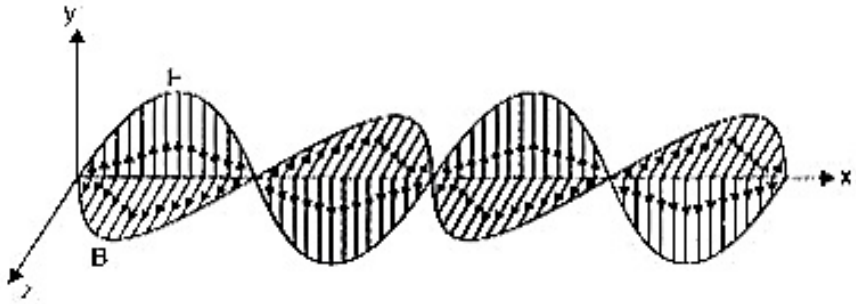
iii. X-rays are used as a diagnostic tool in medicine. These rays are produced when high energy electrons emitted from cathode are stopped suddenly on a metal(anode) of high atomic number in an X-ray tube.

13. Given: Angular frequency = ω
Velocity = C
As per vector deduction, vector in X-axis direction is $E_x = E_0 \ \sin(kz - \omega t)$;
vector in Y-axis direction is $B_y = E_0 \ \sin(kz - \omega t)$

Where $k = \frac{2\pi}{\lambda}$

14.





15. a. $\nu = \frac{c}{\lambda} = \frac{3\times10^8 m/s}{5.5\times10^{-7}m}$

$\nu = \frac{3\times10^8}{5.5\times10^{-7}\times10^6} MHz = 5.45\times10^8 MHz$

$T = \frac{1}{\nu} = \frac{5.5\times10^{-7}m}{3\times10^8 m/s} = \frac{5.5\times10^{-7}}{3\times10^8}\times10^6\mu s$

$= 1.83\times10^{-9}\mu s$

b. $\mu = \frac{c}{\nu}$ or $\nu = \frac{c}{\mu} = \frac{3\times10^8}{1.5} = 2\times10^8 m/s$

$\lambda = \frac{C_g}{\nu_g}$

$\lambda = \frac{2\times10^8}{5.45\times10^8}$

$\lambda = \frac{200}{545}$

= 0.36 m = 36 cm