

# Additional Conceptual Short Questions with Answers

1. The length of a spaceship is measured to be exactly half its proper length. Find the velocity of spaceship.

**Ans.**  $l = l_0 \sqrt{1 - \frac{v^2}{c^2}}$

As  $l = \frac{l_0}{2}$

$$\frac{l_0}{2} = l_0 \sqrt{1 - \frac{v^2}{c^2}}$$

$$\frac{1}{2} = \sqrt{1 - \frac{v^2}{c^2}}$$

Squaring both sides

$$\frac{1}{4} = 1 - \frac{v^2}{c^2}$$

$$\frac{v^2}{c^2} = 1 - \frac{1}{4}$$

$$\frac{v^2}{c^2} = \frac{4-1}{4}$$

$$\frac{v^2}{c^2} = \frac{3}{4}$$

$$\frac{v^2}{c^2} = 0.75$$

$$v^2 = 0.75c^2$$

Taking square root of both sides

$$v = 0.866c$$

**2. An electron has mass  $\frac{5}{3} m_0$  during motion. Find K.E of electron.**

**Ans.** K.E =  $mc^2 - m_0c^2$

$$m = \frac{5}{3} m_0$$

$$\text{K.E} = \frac{5}{3} m_0c^2 - m_0c^2$$

$$\text{K.E} = \frac{5m_0c^2 - 3m_0c^2}{3}$$

$$\text{K.E} = \frac{2m_0c^2}{3}$$

**3. Two metals A and B have work functions 2eV and 4eV respectively. Which metal have lower threshold wavelength for photoelectric effect?**

**Ans.** Work function of metal A

$$\phi_A = \frac{hc}{\lambda_0} = 2\text{eV}$$

Work function of metal B

$$\phi_B = \frac{hc}{\lambda'_0} = 4\text{eV}$$

$$\text{As } \phi_A \propto \frac{1}{\lambda_0}$$

$$\text{As } \phi_B > \phi_A$$

Therefore, metal B has shorter threshold wavelength of incident photon than metal A

$$\lambda'_0 < \lambda_0$$

**4. When light from a lamp falls on a wooden table, no photoelectrons are emitted from it. Why?**

**Ans.** The work function of wood is greater than that of energy of the incident photon so electrons cannot be ejected from the wood.

**5. If the frequency of incident light on the cathode of photocell is doubled, how will the following change?**

(i) K.E of ejected electrons

(ii) Photoelectric current

(iii) stopping potential

**Ans.** If frequency of incident light is doubled then

(i) K.E of ejected electron will be greater than twice.

(ii) The current will not change

(iii) The stopping potential will also be greater than twice, because it depends on K.E.

**6. What are dimensions of Plank's constant h?**

**Ans.**  $E = hf$

$$h = \frac{E}{f}$$

dimension of energy is  $E = [ML^2T^{-2}]$

dimension of frequency  $f = [T^{-1}]$

Dimension of h

$$h = \frac{[ML^2T^{-2}]}{[T^{-1}]}$$

$$h = [ML^2T^{-1}]$$

**7. Calculate the Compton's wavelength for electron and a proton.**

**Ans.**  $\Delta\lambda = \frac{h}{m_0c}$

(i) For electron: Putting  $m_0 = 9.11 \times 10^{-31}$  kg,

So  $\Delta\lambda = \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 3 \times 10^8} = 2.43 \times 10^{-12} \text{m}$

(ii) For proton: Putting  $m_0 = 1.67 \times 10^{-27}$  kg,

So  $\Delta\lambda = \frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 3 \times 10^8}$   
 $= 3.31 \times 10^{-6} \text{m}$

**8. What is a positron?**

**Ans.** An anti-particle of electron is called Positron. Positron has the same mass as that of electron but it carries positive charge.

**9. Does the dilation means that time really passes more slowly in moving system or that it only seems to pass more slowly?**

**Ans.** According to time dilation formula

$$t = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

This result shows that the time dilation means that time really passes more slowly for relativistic motion.

**10. A beam of red light and a beam of blue light have exactly the same energy. Which beam contains the greater number of photons?**

**Ans.** As energy of single photon is

$$E = hf$$

For a photon, energy is

$$E = nhf$$

$$c = f\lambda$$

$$E = \frac{nhc}{\lambda} \quad \text{and} \quad f = \frac{c}{\lambda}$$

$$\text{or} \quad n = \frac{E\lambda}{hc}$$

As red and blue have the same energies, so  $E$ ,  $h$  and  $c$  have constant values, thus

$$n = \text{constant} \times \lambda$$

$$\text{or} \quad n \propto \lambda$$

That relation shows that greater wavelength will have a large number of photons.

As wavelength of red-light is greater than that of blue light (i.e.,  $\lambda_{\text{red}} > \lambda_{\text{blue}}$ ), so beam of red light will contain a greater number of photons.

**11. Will bright light eject more electrons from a metal surface than dimmer light of the same colour?**

**Ans.** Yes, as in photoelectric effect, the number of photoelectrons emitted from the surface of metal is directly proportional to the intensity of light, therefore, bright light being more intense will emit more electrons from a metal surface than the dimmer light of same color.

### Self-Assessment Paper 1

**Q.No.2 Write Short Answers any SIX of the following questions. (6 x 2 = 12)**

1. If the speed of light were infinite, what would the equations of special theory of relativity reduce to?

2. What happens to total radiation from a black body if its absolute temperature is doubled?
3. When ultraviolet light falls on a certain dye, visible light is emitted. Why does this not happen when infrared light falls on these dyes?
4. Can pair production take place in vacuum? Explain.
5. If electrons behaved only like particles, what pattern would you expect on the screen after the electrons pass through the double slit?
6. What is the difference between photoelectric effect and Compton's effect?
7. What is a photo cell, give some of its uses.
8. What advantages does an electron microscope have over an optical microscope.

**Q.No.3 Extensive Question.**

Q. (a) Explain intensity distribution diagram of black body radiation.

(b) An electron is placed in a box about the size of an atom that is about  $1 \times 10^{-10}$  m. What is the velocity of the electron?

## Self-Assessment Paper 2

**Q.No.2 Write Short Answers any SIX of the following questions. (6 x 2 = 12)**

1. Since mass is a form of energy, can we conclude that a compressed spring has more mass than the same spring when it is not compressed?
2. Give the postulates of special theory of relativity.
3. A solid is heated and begins to glow, why does it first appear red?
4. Why do we not observe the Compton's effect with visible light?
5. Write down the principle of complementarity to describe the nature of light?
6. Is it possible to create a single electron from energy? Example

7. Does the brightness of a beam of light primarily depend on the frequency of photons or on the number of photons?

8. What are the two main frontiers of modern physics?

**Q.No.3 Extensive Questions.**

**(5 + 3 = 8)**

Q. (a) Explain Davison-Germer experiment.

(b) At what fraction of the speed of light must a particle move so that kinetic energy is one half times its rest energy?

