

## **UNIT-7 DUAL NATURE OF MATTER AND RADIATION**

### **VERY SHORT ANSWER QUESTIONS (1 Mark)**

1. What is the rest mass of photon?
2. A good mirror reflects 80% of light incident on it. Which of the following is correct.
  - (a) Energy of each reflected photon decreases by 20%.
  - (b) Total no. of reflected photons decreases by 20%. Justify your answer.
3. Why in a photocell the cathode is coated with alkali metals.?
4. Name the phenomenon which shows quantum nature of electromagnetic radiation.
5. Write Einstein's photoelectric equations and specify each term.
6. Which of the following radiations is more effective for electron emission from the surface of sodium?
  - (i) Microwave
  - (ii) Infrared
  - (iii) Ultraviolet.
7. A metal emits photoelectrons when red light falls on it. Will this metal emit photoelectrons when blue light falls on it?

8. Name any two phenomena which show the particle nature of radiation.
9. The photoelectric cut off voltage in a certain photoelectric experiment is 1.5V. What is the max kinetic energy of photoelectrons emitted?
10. What is the de-Broglie wavelength of a 3 kg object moving with a speed of 2m/s?
11. What factors determine the maximum velocity of the photoelectrons from a surface?
12. What is the stopping potential applied to a photocell, in which electrons with a maximum kinetic energy of 5.6 eV are emitted. **Ans. : 5.6 V**
13. Work functions of caesium and lead are 2.14 eV and 4.25 eV respectively. Which of the two has a higher threshold wavelength?

**Ans. :** Work function,  $\phi_0 = h\nu_0 = h\frac{c}{\lambda_0}$  or  $\lambda_0 \propto \frac{1}{\phi_0}$

Hence caesium has a higher threshold wavelength for photoelectric emission.

14. What is the de-Broglie wavelength of a neutron at absolute temperature T K ?

**Ans. :**

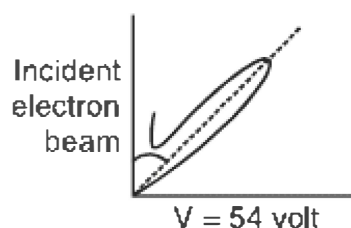
$$\lambda = \frac{h}{\sqrt{2m_n E_k}} = \frac{h}{\sqrt{2m_n \frac{3}{2} k_B T}} = \frac{h}{\sqrt{3m_n k_B T}} \quad K_B \rightarrow \text{Boltzmann's Constant}$$

### SHORT ANSWER QUESTIONS (2 Mark)

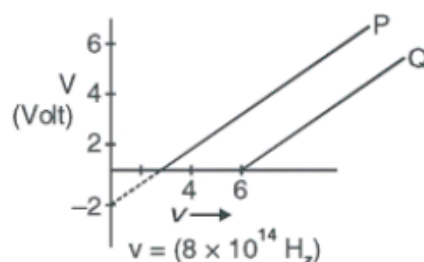
1. Write one similarity and one difference between matter wave and an electromagnetic wave.
2. Does a photon have a de Broglie wavelength? Explain.
3. A photon and an electron have energy 200 eV each. Which one of these has greater de-Broglie wavelength?
4. The work function of the following metal is given Na = 2.75 eV, K = 2.3 eV, Mo = 4.14 eV, Ni = 5.15 eV which of these metal will not give a photoelectric emission for radiation of wave length 3300 Å from a laser

source placed at 1m away from the metal. What happens if the laser is brought nearer and placed 50 cm away.

5. Name the experiment for which the followings graph, showing the variation of intensity of scattered electron with the angle of scattering, was obtained. Also name the important hypothesis that was confirmed by this experiment.



6. In a photoelectric effect experiment the graph between the stopping potential  $V$  and frequency of the incident radiation on two different metals P and Q are shown in Fig.



- (i) Which of the two metals has greater value of work function?
  - (ii) Find maximum K.E. of electron emitted by light of frequency  $\nu = 8 \times 10^{14}$  Hz for metal P.
7. Do all the photons have same dynamic mass? If not, why?
8. Why photoelectrons ejected from a metal surface have different kinetic energies although the frequency of incident photons are same?
9. Find the ratio of de-Broglie wavelengths associated with two electrons 'A' and 'B' which are accelerated through 8V and 64 volts respectively.

10. The photoelectric current at distances  $r_1$  and  $r_2$  of light source from photoelectric cell are  $I_1$  and  $I_2$  respectively. Find the value of  $\frac{I_2}{I_1}$ .

**Ans. :**  $I \propto \frac{1}{r^2} \quad \frac{I_2}{I_1} = \left(\frac{r_1}{r_2}\right)^2$

11. How does the maximum kinetic energy of emitted electrons vary with the increase in work function of metals?

**Ans. :**  $KE_{\max} = h\nu - W_0 \Rightarrow KE_{\max}$  decreases with increase in  $W_0$ .

### SHORT ANSWER QUESTIONS (3 Marks)

1. Explain the working of a photocell? Give its two uses.
2. Find the de Broglie wavelength associated with an electron accelerated through a potential difference  $V$ .
3. What is Einstein's explanation of photo electric effect? Explain the laws of photo electric emission on the basis of quantum nature of light.
4. If kinetic energy of thermal neutron is  $\frac{3}{2} kT$  then show that de-Broglie wavelength of waves associated with a thermal neutron of mass  $m$  at temperature  $T$  kelvin is  $\frac{h}{\sqrt{3mkT}}$  where  $k$  is boltz mann constant.
5. Explain Davisson and Germer experiment to verify the wave nature of electrons.
6. Explain the effect of increase of (i) frequency (ii) intensity of the incident radiation on photo electrons emitted by a metal.
7. X-rays of wave length  $\lambda$  fall on a photo sensitive surface emitting electrons. Assuming that the work function of the surface can be neglected, prove that the de-Broglie wavelength of electrons emitted will be .
8. A particle of mass  $M$  at rest decays into two particles of masses  $m_1$  and  $m_2$  having velocities  $V_1$  and  $V_2$  respectively. Find the ratio of de-broglie Wavelengths of the two particles. **Ans. : 1 : 1**