Assignment 1

Answer Key

Q.1 (e) If electron is moving parallel to the magnetic field, then the electron is not deflected i.e., if electron is not deflected, we cannot be sure that there is no magnetic field in that region.

Q.2 (a)

Q3. (d) Photoelectric effect demonstrates the particle nature of light. Number of emitted photoelectrons depends upon the intensity of light.

Q.4 material body, packet of energy

Q5. Work function

Q.6. (b) The photocurrent increases with the intensity of light

Q.7. (a) dual nature

Q.8. d) the least amount of energy required to remove an electron from a metal surface

Q.9. d) Frequency

Q.10. c) quantum theory of light

Q.11. CASE STUDY

I. B II. C III. C IV. A V. D

Q.12. Features of the photons: (i)Photons are particles of light having energy $E = h\nu$ and momentum $p = h/\lambda$

(ii) Photons travel with the speed of light in vacuum, independent of the frame of reference.

(iii) Intensity of light depends on the number of photons crossing unit area in a unit time.

Q.13. The minimum retarding (negative) potential of anode of a photoelectric tube for which photoelectric current stops or becomes zero is called the stopping potential.

Threshold frequency is defined as the minimum frequency of incident radiation which can cause photoelectric emission. It is different for different metal.

Q.14. The photoelectric current increases proportionally with the increase in intensity of incident radiation. Larger the intensity of incident radiation, larger is the number of incident photons and hence larger is the number of electrons ejected from the photosensitive surface

Q.15. Metal B will yield more photo electrons. work function of Metal B is lower than that of A for the same wavelength of light. Hence metal B will give more electrons

Q.16. (i) Given, $h = 6.63\ 10^{-34}$ J/s, $c = 3 \times 10^{8}$ m/s and $p = 3.3 \times 10^{-29}$ - kg m/s

Momentum, p= $h\nu/c$ or $\nu = pc/h$ = 3.3 x 10^{-29} x3 x 10^{8} /6.63 x 10^{-34} = 1.5 x 10^{13} Hz

$\lambda = c/\nu$ = 3 x10^{8} /1.5 x 10^{13} = 2 x 10^{-5} m

Q.17. Work Function: The minimum energy required to free an electron from metallic surface is called the work function. Smaller the work function, larger the kinetic energy of emitted electron.

Q.18. Photoelectric emission is possible only if the energy of the incident photon (hv) is greater than the work function ($\omega_0 = h\nu_0$) of the metal. Hence the frequency v of the incident radiation must be greater than the threshold frequency ν_0.

Q.19. Threshold frequency (ν_0) : It is the minimum frequency below which below which no emission of photoelectron takes place is known as threshold frequency (ν_0) .

Stopping potential (V_0) : Its is the minimum negative potential at which the photoelectric current becomes zero.

(i) On increasing the frequency of incident radiation, the magnitude of photoelectric current remains unchanged because increased frequency means increased energy of photon but number of photon remains unchanged.

(ii) On increasing the intensity of incident radiation, the photoelectric current increases in the same ratio, because increased intensity means increased number of incident photons which results in increased number of ejected photoelectrons and hence increased photoelectric current.

Q.20. (i) Important features of photoelectric effect:

(a) Radiation behaves as if it is made of particles like photons. Each photon has energy E = hv and momentum p = h/λ.

(b) Intensity of radiation can be understood in terms of number of photons falling per second on the surface. Photon energy depends only on frequency and is independent of intensity.

(c) Photoelectric effect can be understood as the result of the one to one collision between an electron and a photon.

(d) When a photon of frequency v is incident on a metal surface, a part of its energy is used in overcoming the work function and other part is used in imparting kinetic energy, so

KE = h(v– ν_0)

(ii) Since no photoelectric emission takes place from P, it means frequency of incident radiation (10^{15} Hz) is less than its threshold frequency $(\nu_0)_p$. Photo emission takes place from Q but kinetic energy of photoelectrons is zero. This implies that frequency of incident radiation is just equal to the threshold frequency of Q.

For Q, work function $\phi_0 = hv_0$

$$= \frac{(6.6 \times 10^{-34}) \times (10^{15})}{(1.6 \times 10^{-19})} \text{ eV} = \mathbf{4.125\ eV}$$

Q21. (a) The collision of a photon can cause emission of a photoelectron (above the thresholdfrequency). As the intensity increases, number of photons increases. Hence, the current increases.

(*b*) We have, $eV_s = h(v - v_0)$

$\therefore \quad V_s = \frac{h}{e}(v) + \left(-\frac{hv_0}{e}\right)$

$\therefore$ Graph of V_s with v is a straight line and slope $\left(\frac{h}{e}\right)$ is a constant.

(c) Since maximum kinetic energy for different surfaces is given by $(\text{K.E.})_{\max} = h(v - v_0)$,

hence, it depends on the frequency and not on the intensity of the incident radiation.