Answer Key

Assignment 2

1 Mark's Questions

Q22. (b) Both statement I and II are true; but even it radiation of single wavelength is incident on photosensitive surface, electrons of different KE will be emitted.

Q.23(b)

Q.24 (d) Photoelectric saturation current is independent of frequency. It only depends on intensity of light

Q.25. inversely

Q.26. Heinrich Hertz, 1887

Q.27 (d) All of these

Q.28 (a) 5.47 Å

Q.29. (b) $\lambda/2$

Q.30. (b)

Q.31. (a) frequency

CASE STUDY BASED QUESTIONS

Q.32. I. d II. C III. A IV. B V. d

Two Mark's Questions

Q.33. Calculating (i) Energy of a photon = $h\nu = 6.63 \times 10^{-34} \times 6.0 \times 10^{14}$ J = 3.978×10^{-19} J

(ii) Number of photons emitted per second = Power x Energy of photon

= 2×10^{-3} x 3.978×10^{-19}

= 5.03×10^{15} photons/second

Q.34. If radiation of frequency (ν) greater than threshold frequency (ν_0) irradiate the metal surface, electrons are emitted out from the metal. So Einstein's photoelectric equation can be given as

$$K_{max} = \frac{1}{2} m v^2 = h\nu - h\nu_0$$

Characteristic properties of photons:

(Q) Energy of photon is directly proportional to the frequency (or inversely proportional to the wavelength.

(ii) In photon-electron collision, total energy and momentum of the system of two constituents remains constant.

Q.35.

Given : $\lambda = 5460 \text{ nm} = 5460 \times 10^{-9} \text{ m}$ $\quad \lambda_B = ?$

Energy of the photon (K) $= \dfrac{hc}{\lambda}$ $\quad \ldots(i)$

de-Broglie wavelength, $(\lambda_B) = \dfrac{h}{p} = \dfrac{h}{\sqrt{2mk}} \ldots(ii)$

$$\therefore \quad \lambda_B = \frac{h}{\sqrt{2m.\frac{hc}{\lambda}}} = \sqrt{\frac{h\lambda}{2mc}}$$

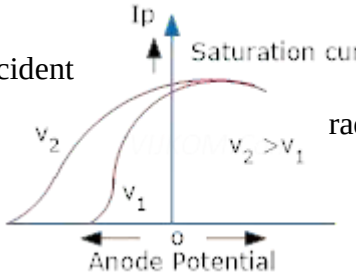
$$= \left[\frac{(6.63\times10^{-34})\times(5460\times10^{-9})}{2\times(9.1\times10^{-31})\times(3\times10^{8})}\right]^{\frac{1}{2}}$$

$$= \mathbf{25.75 \times 10^{-10} \text{ m}}$$

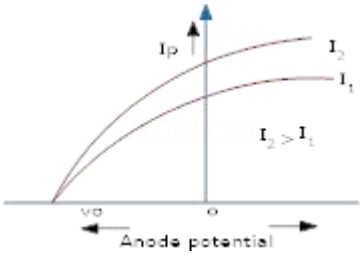
3 Mark's Questions

Q.36 (a) The minimum amount of energy required to take out an electron from the surface of metal. It is measured in electron volt (eV).

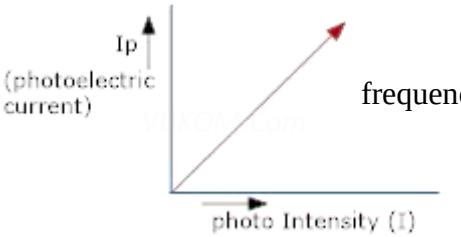
(b) (i) Saturation current depends only on the intensity of incident radiation but is independent of the frequency of incident radiation.



(ii) Stopping potential does not depend on the intensity of incident radiations.



(iii) Photoelectric current is directly proportional to the intensity of incident radiations, provided the given frequency is greater than the threshold frequency.

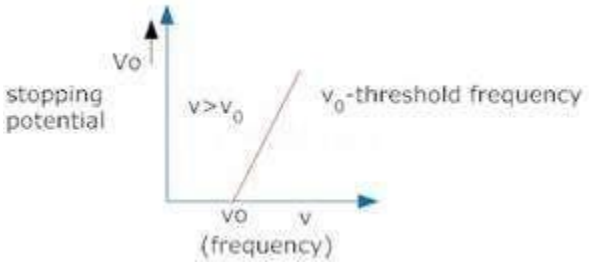


Q.37

Slope of the graph

$$= \frac{\Delta v_o}{\Delta v}$$

Einstein photoelectric equation



$$eV_o = hv - \phi_o \text{ ------(1)}$$

Differentiating equation (1)

$$e\Delta V_o = h\Delta v$$

$$\frac{\Delta V_o}{\Delta v} = \frac{h}{e}$$

Thus slope is equal to the ratio of Planck's constant to the charge on electron. Threshold frequency – The minimum values of frequency of the incident light below which photoelectric emission is not possible is called as threshold frequency.

Q.38 (a) Wave nature of radiation cannot explain the following:

(i) The instantaneous ejection of photoelectrons.

(ii) The existence of threshold frequency for a metal surface.

(iii) The fact that kinetic energy of the emitted electrons is independent of the intensity of light and dependence upon its frequency.

Thus, the photoelectric effect cannot be explained on the basis of wave nature of light.

(b) Photon picture of electromagnetic equation is based on particle nature of light. Its basic features are:

(i) In interaction with matter, radiation behaves as if it is made up of particles called photons.

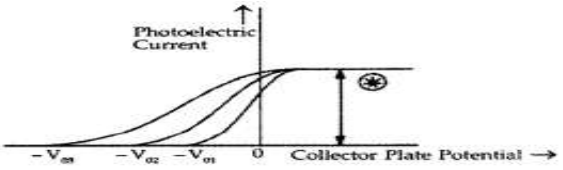
(ii) Each photon has energy E = h v and momentum p = h v/c and c, the speed of light

Q.39.

(a) ‘X’ is a collector plate potential. (b)

‘A’ represents the stopping potential. (c)

Graph for different frequencies



(*d*) Graph for different intensites :