Assignment 3 - Answer Key

Q.40(b)

Q.41(b) Less work function means less energy is required for ejecting out the electrons

Q.42.(a) When a light of single frequency falls on the electrons of inner layer of metal, then this electron comes out of the metal surface after a large number of collisions with atom of it's upper layer.

Q.43 (a)

Q.44. $2\sqrt{2}$:1

Q.45. electron wave

Q.46 (c) (iii) only

Q.47. (a) UV radiations

Q.48. (b) 1.23 Å

Explanation: The value of V is given 100 volts.

Equation of de Broglie wavelength of electron λ=h/2meV

$\lambda=6.6\times10^{-34}/2(9.1\times10^{-31})(1.6\times10^{-19})(100)$

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$\lambda = 6.6 \times10^{-34} / 5.4 \times10^{-10}$m

$\lambda=1.277\times10^{10}$m=1.23Å

Q.49. (c) Blue light

Explanation: Einstein's photoelectric equation is given by $E_k = hv – \phi_\phi$

Where, E_k is the maximum kinetic energy of the ejected electron.

Energy of the photon of the blue light $(hv)_{blue}$ is higher compared to red light $(hv)_{red}$. In photoelectric emission, E_k a (hv). Therefore, blue light emits electrons of greater kinetic energy than that of red light.

Q.50. (a) increasing the potential difference between the anode and filament

Explanation: if, e is the charge on electron, V is the potential difference, m is the mass of the particle and v is the velocity of the particle then, $eV = ½ mv^2$

Therefore, in the Davisson and Germer experiment, velocity of electrons emitted from electron guns can be increased by increasing the potential difference between anode and filament.

Q.51. (iii) 3000 Å

Q.52. (I)b (ii) a (III) a (IV) b (V) b

Q.53. Electron diffraction.

Q.54. de-Broglie wavelength

$\lambda = h/mv$=h/p

Kinetic Energy= $p^2/2m = \frac{1}{2m}\left(\frac{h}{\lambda}\right)^2 = (6.626\text{x}10^{-34})^2/2\text{x}9.11\text{x}10^{-31}\text{x}(1\text{x}10^{-10})^2$

$= 2.409\text{x}10^{-17}\text{J}$

Q.55.(i)For a given metal and frequency of incident radiation, the number of photoelectrons ejected per second is directly proportional to the intensity of incident radiation.

(ii) Maximum kinetic energy of the emitted photo electron is independent of the intensity of incident radiations.

(iii) Emission of photoelectrons is instantaneous

TWO MARK's QUESTIONS

Q.56. de-broglie wavelength of a particle of mass m and kinetic energy E is

$\lambda = \boldsymbol{h}\ \sqrt{\boldsymbol{2mE}}$

or $E = h^2/2m\,\lambda^2$

for particle having same λ, Eα 1/m

As mass of electron as smaller than that of proton, so the electron has a higher kinetic energy and it is moving faster.

Q.57.

According to de-Broglie wavelength, $\lambda = \frac{h}{\sqrt{2meV}}$

$$\frac{\lambda}{1/\sqrt{V}} = \frac{h}{\sqrt{2me}} \quad \Rightarrow \quad \frac{\lambda}{1/\sqrt{V}} = \frac{1}{\sqrt{m}} \times \frac{h}{\sqrt{2e}}$$

The slope is given by slope $\propto \frac{1}{\sqrt{m}}$

Slope of B > slope of A

$$\frac{1}{\sqrt{m}_B} > \frac{1}{\sqrt{m}_A} \quad \Rightarrow \quad \sqrt{m}_B < \sqrt{m}_A$$

$\therefore \quad m_B < m_A$

$\therefore$ **B represents a particle of smaller mass**

THREE MARK's QUESTIONS

Q.58 (i) The de -Broglie wavelength of a particle is given by

$\lambda = 12.27/ V$ Å where, V is the accelerating potential of the particle.

It is given that

$\lambda_{proton} = \lambda_{alpha}$

12.27 / proton = 12.27 / alpha

$V_{proton} / V_{alpha} = 1$

(ii) The de – Broglie wavelength (λ) of a particle is also given by

$\lambda = h /mv$

$\lambda_{proton} = h/m_{proton} v_{proton}$

λ alpha $= h/ m_{alpha} v_{alpha}$

We known $m_{alpha} = 4m_{proton}$

$\lambda_{alpha} = h / 4m_{proton} v_{alpha}$

$\lambda_{proton} = \lambda_{alpha}$

$h / m_{proton} v_{proton} = h / 4 m_{proton} v_{alpha}$

$v_{proton} / v_{alpha} = 4$

Q.59. (i) The threshold frequency for metal X is less and hence threshold wavelength of metal X will be larger.

(ii) As threshold frequency for X is less than that of Y and work function $\phi_0 = h \nu_0$, hence work function for X is less than that of Y. Lesser the work function, more will be its K.E.

$(K.E.)_{max} = h \nu - \phi_0$, K.E. of X will be more.

(iii)If the distance between the light source and metal X is halved, intensity of incident light becomes four times its previous value but frequency of light remains unchanged. Therefore, the K.E. of ejected electron remains unchanged.

Q.60.(a)

Basic features of photon picture of electromagnetic radiation:

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

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

(iv) 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 = $h(v - v_0)$.

(b) (i) Stopping potential or cut-off potential. The minimum value of the negative potential 'V_0', which should be applied to the anode in a photo cell so that the photo electric current becomes zero, is called stopping potential.

The maximum kinetic energy (K_{max}) of photoelectrons is given by,

$$K_{max} = eV_0 \quad \text{or} \quad \frac{1}{2}mv^2_{max} = eV_0$$

(ii) Threshold frequency. The minimum frequency V_0, which the incident light must possess so as to eject photoelectrons from a metal surface, is called threshold frequency of the metal.

Mathematically $\phi_0 = hv_0$,

where [ϕ_0 is work function and h is plank's constant.]