ATOMIC PHYSICS
PREVIOUS EAMCET QUESTIONS
ENGINEERING

1. The work function of a certain metal is $3.31\times10^{-19}J$. Then the maximum kinetic energy of photoelectrons emitted by incident radiation of wavelength 5000 $\overset{0}{A}$ is: **(2009 E)**

1) 2.48 eV 2) 0.41 eV 3) 2.07 eV 4) 0.82 eV

Ans :2

Sol: From photoelectric equation $\frac{hc}{\lambda} = w_0 + \frac{1}{2}mv^2$

$$\frac{1}{2}mv^2 = \frac{hC}{\lambda} - w_0$$

$$= \frac{\left(6.62\times10^{-34}\right)\left(3\times10^{8}\right)}{500\times10^{-10}} - 3.31\times10^{-19} = 0.41eV$$

2. An X-ray tube produces a continuous spectrum of radiation with its shortest wavelength of 45 x 10^{-2} A°. The maximum energy of a photon in the radiation in eV is (h = 6.62 x 10^{-34} J-sec, c = 3x 10^{8} m/ssec) **(2008 E)**

1) 27, 500 2) 22, 500 3) 17, 500 4) 12, 500

Ans: 1

Sol: $\lambda_{min} = 45\times10^{-2}A^0$

Energy $E = \frac{hc}{\lambda_{min}} = \frac{6.62\times10^{-34}\times3\times10^{8}}{45\times10^{-2}\times10^{-10}} = 27500$

3. X-rays of energy 50KeV. are scattered from a carbon target. The scattered rays are at 90^0 from the incident beam. The percentage of change in wavelength (m_e= 9×10^{-31}Kg, C= 3×10^8m/s.) **(2008 E)**

1) 10% 2) 20% 3) 5% 4) 1%

Ans :1

Sol: $E = \frac{hc}{\lambda}$

$$\lambda = \frac{6.62\times10^{-34}\times3\times10^{8}}{50\times10^{3}\times1.6\times10^{-19}}m$$

$$\lambda^1 = \frac{h}{mc}\left(1-\cos90^0\right) = = \frac{6.62\times10^{-34}}{9\times10^{-31}\times3\times10^{8}}$$

$$\Delta\lambda = \frac{6.62\times10^{-34}}{27\times10^{8}}$$

$\therefore$ Change in wavelength $= \frac{\Delta\lambda}{\lambda}\times100 = 10\%$

4. An electron beam travels with a velocity of 1.6 x 10^{7} ms^{-1} perpendicularly to magnetic field of intensity 0.1 T. The radius of the path of the electron beam (m_e = 9 x10^{-31} kg) **(2007 E)**

1) 9 x 10^{-5} m 2) 9 x 10^{-2} m 3) 9 x 10^{-4} m 4) 9 x 10^{-3} m

Ans :3

Sol: Centripetal force = Magnetic force

$$\frac{mv^2}{r} = Bqv$$

$$r = \frac{mv}{Bq} = \frac{9\times10^{-31}\times1.6\times10^{7}}{0.1\times1.6\times10^{-19}}$$

$$= 9\times10^{-4}\,m$$

5. The work function of nickel is 5eV. When light of wavelength 2000A^0 falls on it, emits photoelectrons in the circuit. Then the potential difference necessary to stop the fastest electrons emitted is (given h=6.67×10^{-34}Js) **[2007 E]**

1) 1.0V 2) 1.75V 3) 1.2V 4) 0.75V

Ans :3

Sol: When wavelength is expressed in A° then $E = \frac{12400}{\lambda} eV$

$$\frac{hc}{\lambda} = \omega_0 + eV_0$$

$$6.2eV = 5eV + eV_0$$

$$V_0 = 1.2V$$

6. In an experiment on photoelectric emission from a metallic surface, wavelength of incident light is 2 x 10^{-7} m and stopping potential is 2.5V. The threshold frequency of the metal (in Hz) approximately (charge of electron e = 1.6 x 10^{-19}C, Plank's constant h = 6.6 x 10^{-34} JS) **(2007 E)**

1) 12 x 10^{15} 2) 9x 10^{15} 3) 9 x 10^{14} 4) 12 x 10^{13}

Ans:3

Sol: $\frac{hc}{\lambda} = hv_0 + ev_0$

$$h\nu_0 = \frac{hc}{\lambda} - ev_0 = \frac{6.6\times10^{-34}\times3\times10^{8}}{2\times10^{-7}} - 2.5\times1.6\times10^{-19} = 9\times10^{14}$$

7. An oil drop having a mass 4.8×10^{-10}g. and charge 2.4×10^{-18}C stands still between two charged horizantal plates seperated by a distance of 1cm. If now the polarity of the plates is changed the instantaneous acceleration of the drop is (in ms^{-2}) (g =10ms^{-2}) **[2006 E]**

1) 5 2)10 3) 20 4) 40

Ans : 3

Sol: Mass m = $4.8\times10^{10}\,g$

$= 4.8\times10^{-13}\,g$

Charge q $= 2.4\times10^{-18}\,C$

Distance d = 10^{-2} m

When the charge is balanced Eq = mg

Eq = mg

When the field is reversed

F = ma = Eq + mg = mg + mg = 2mg

∴ a = 2g = 20 ms^{-2}

8. A proton, a deutron (nucleus of ${}_1\mathrm{H}^2$) and an α- particle with same kinetic energy enter a region of uniform magnetic field moving at right angles to the field. The ratio of the radii of their circular paths is **(2006 E)**

1) 1 : 2 : 4 2) 1 : $\sqrt{2}$: 1 3) 2 : $\sqrt{2}$: 1 4) 1 : 1 : 2

Ans :2

Sol: Proton = ${}_1H^1$

Deuteron = ${}_1H^2$

α particle = ${}_2He^4$

Centripetal force = magfnetic force

$$\frac{mv^2}{r} = qvB$$

$$r = \frac{p}{qB}$$

Radius r = $\sqrt{\frac{2mKE}{qB}} \Rightarrow r \propto \sqrt{\frac{m}{q}}$

$$r_1 : r_2 : r_3 = \sqrt{\frac{m_1}{q_1}} : \sqrt{\frac{m_2}{q_2}} : \sqrt{\frac{m_2}{q_3}}$$

$$= \sqrt{\frac{1}{1}} : \sqrt{\frac{2}{1}} : \sqrt{\frac{4}{1}} = 1 : \sqrt{2} : 1$$

9. A particle of mass 1 x 10^{-26} kg and charge 1.6 x 10^{-19}C travelling with a velocity 1.28 x 10^6 ms^{-1} along the positive X-axis enters a region in which a uniform electric field $\vec{E}$ and a uniform magnetic field of induction $\vec{B}$ are present. If $\vec{E} = -102.4 \times 10^3 \hat{k} NC^{-1}$ and $B = 8 \times 10^{-2} \hat{j} Wbm^{-2}$, the direction of motion of the particles is **(2005 E)**

1) along the positive X-axis 2) along the negative X-axis

3) at 45° to the positive X-axis 4) at 135° to the positive X-axis

Ans :1

Sol : $\vec{E}, \vec{B}$ are acting in Z, Y directions

Here $\frac{E}{B}$ gives velocity of charge particle

$\therefore$ The charged particle is not deviated

10. Light rays of wavelengths 6000 A° and of photon intensity 39.6 watts/m^2 is incident on a metal surface. If only one percent of photons incident on the surface emit photo electrons, then the number of electrons emitted per second per unit area from the surface will be

[Planck constant = 6.64 x 10^{-34} J - S; Velocity of light = 3 x 10^8 ms^{-1}] **[2004E]**

1) 12 x 10^{18} 2) 10 x 10^{18} 3) 12 x 10^{17} 4) 12 x 10^{15}

Ans :3

Sol: Number of electrons emitted per second per unit area from the surface $n = \frac{E\lambda}{hc}$

Photon energy, $h\upsilon = \frac{1240}{600(nm)} = 2.066eV$

I = 39.6 W/m^2 = 39.6 J/s/m^2

$= \frac{39.6}{1.6\times10^{-19}} eV/s/m^2$

Photoelectrons emitted/s/m^2

$= \frac{39.6}{1.6\times10^{-19}}\times\frac{1}{2.066}\times\frac{1}{100} = 12\times10^{17}$

11. $\Delta\lambda$ is the difference between the wavelength of Kα line and the minimum wavelength of the continuous X-ray spectrum when the X-ray tube is operated at a voltage *V*. If the operating voltage is changed to v/3 then the above difference is . Then **[2004E]**

1) $\Delta\lambda^1 = 3\ \Delta\lambda$ 2) $\Delta\lambda^1 = 4\Delta\lambda$ 3) $\Delta\lambda^1 = 3\Delta\lambda$ 4) $\Delta\lambda^1 < 3\Delta\lambda$

Ans : .4

Sol: For continuous X-ray spectrum

$$\lambda_{\min} = \frac{hc}{eV}$$

$$\Delta\lambda = \lambda_k - \frac{hc}{eV} = \lambda_k - x$$

$$\Delta\lambda^1 = \lambda_k - \frac{hc}{eV/3} = \lambda_k - 3x$$

As λ_k does not change with voltage and x=hc/eV.

$$\frac{\Delta\lambda^1}{\Delta\lambda} = \frac{\lambda_k - 3x}{\lambda_k - x} = 3 - \frac{2\lambda_k}{\lambda_k - x}$$

$$\therefore \frac{\Delta\lambda^1}{\Delta\lambda} < 3 \Rightarrow \Delta\lambda^1 < 3\Delta\lambda$$

12. Electrons ejected from the surface of a metal, when light of certain frequency is incident on it, are stopped fully by a retarding potential of 3 volts. Photo electric effect in this metallic surface begins at a frequency 6 x 10^{14}s^{-1}. The frequency of the incident light in s^{-1} is [h=6 x 10^{-34}J-sec; charge on the electron = 1.6 x 10^{-19}C] **[2004E]**

1) 7.5 x 10^{13} 2) 13.5 x 10^{13} 3) 14 x 10^{14} 4) 7.5 x 10^{15}

Ans: 3

Sol: According to Einstein's Photo electric equation,

$$hv = hv_0 + K.E = hv_0 + ev_0$$

$$\Rightarrow v_0 = v_0 + \frac{ev_0}{h}$$

$$\Rightarrow v_0 = 13.5\times10^{14} Js^{-1}$$

13. Match the pairs in two lists given blew **[2004 E]**

List – I	**List- II**
a) Spectra produced by light from incandescent solid	d) Photon
b) Elementary particles with zero mass and with a spin of unity	e) Continuous spectra
c) Photocell in which current changes with	f) Photo-emissive cell

change in intensity of light after gap | g) Photo-conducting cell

h) Neutrino

i) Band spectra

a) a-e, b-d, c-g 2) a-i, b-h, c-f 3) a-e, b-h, c-f 4) a-i, b-d, c-g

Ans: 1

Sol ---

14. Consider the two following statements A and B and identify the correct choice given in the answers:
A) In photovoltaic cells, the photoelectric current produced is not proportional to the intensity of incident light.
B) In gas filled photoemissive cells, the velocity of photoelectrons depends on the wavelength of the incident radiation. **(2003 E)**
1) Both A and B are true 2) Both A and B are false
3) A is true but B is false 4) A is false but B is true

Ans: 4

Sol. A) According to the laws of photoelectric effect photoelectric current is proportional to intensity of incident light.

15. When radiation of wavelength λ is incident on a metallic surface, the stopping potential is 4.8 volts. If the same surface is illuminated with radiation of double the wavelength, then the stopping potential becomes 1.6 volts. Then the threshold wavelength for the surface is **[2003 E]**
1) 2λ 2) 4λ 3) 6λ 4) 8λ

Ans:2

Sol From Einsteins photoelectric equation

$$: eV_0 = h\upsilon - h\upsilon_0$$

$$= \frac{hc}{\lambda} - \frac{hc}{\lambda_0} \Rightarrow e \times 4.8 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0} \text{.........(1)}$$

$$e \times 1.6 = \frac{hc}{2\lambda} - \frac{hc}{\lambda_0} \text{...........................(2)}$$

$$\Rightarrow \frac{hc}{\lambda} = 4.8e + \frac{hc}{\lambda_0}$$

$$1.6e = 2.4e + \frac{hc}{2\lambda_0} - \frac{hc}{\lambda_0}$$

$$\Rightarrow 1.6e = 2.4e - \frac{hc}{2\lambda_0} \Rightarrow \frac{hc}{2\lambda_0} = 0.8e$$

$$\Rightarrow \lambda_0 = \frac{hc}{1.6e} \Rightarrow 1.6e = \frac{hc}{\lambda_0}$$

$$\Rightarrow \frac{hc}{\lambda} = 6.4e \quad \Rightarrow \frac{1.6e}{6.4e} = \frac{hc/\lambda_0}{hc/\lambda_0}$$

$$\Rightarrow \frac{1}{4} = \frac{\lambda}{\lambda_0} \quad \Rightarrow \lambda_0 = 4\lambda$$

16. Two photons of energies twice and thrice the work function of a metal are incident on the metal surface. Then the ratio of maximum velocities of the photoelectrons emitted in the two cases respectively is **(2002 E)**
1) $\frac{1}{2}$ 2) $\frac{1}{4}$ 3) $\frac{1}{3}$ 4) $\frac{1}{\sqrt{2}}$

Ans :4

Sol: From Einsteins photoelectric equation $hv = w + K.E$

$K = h\upsilon - W$

$K_1 = 2W - W = W$

$K_2 = 3W - W = 2W$

But kinetic energy = $\frac{1}{2}mv^2$

$\frac{v_1}{v_2} = \sqrt{\frac{K_1}{K_2}} = \sqrt{\frac{W}{2W}} = \frac{1}{\sqrt{2}}$

17. In Compton scattering process, the incident X=radiation is scattered at an angle 60°. The wavelength of the scattered radiation is 0.22A°. The wavelength of the incident X-radiation in A° units is $\left(\text{take}\frac{\text{h}}{\text{m}_0\text{c}} = 0.024\text{A°}\right)$ **[2002 E]**

1) 0.508 2) 0.408 3) 0.232 4) 0.208

Ans :4

Sol: From Compton effect

$\lambda - \lambda_0 = \frac{h}{m_0 c}(1 - \cos\theta)$

$\Rightarrow \lambda_0 = \lambda - \frac{h}{m_0 c}(1 - \cos\theta)$

$\lambda_0 = 0.22 - 0.24(1 - \cos\theta)$

$\lambda_0 = 0.208 A^0$

18. If λ_0 is the de Broglie wavelength for a proton accelerated through a potential difference of 100 V, the de Broglie wavelength for α-particle accelerated through the same potential difference is **[2002 E]**

1) $2\sqrt{2}\lambda_0$ 2) $\frac{\lambda_0}{2}$ 3) $\frac{\lambda_0}{2\sqrt{2}}$ 4) $\frac{\lambda_0}{\sqrt{2}}$

Ans:3

Sol: De-broglie wavelength $\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2m(K.E)}}$

$\lambda_p = \frac{h}{p} = \frac{h}{\sqrt{2m_p k_p}} = \frac{h}{\sqrt{2m_p eV}}$

$\lambda_\alpha = \frac{h}{\sqrt{2m_\alpha k_\alpha}} = \frac{h}{\sqrt{2 \times 4m_p \times 2eV}}$

$\Rightarrow \frac{\lambda_\alpha}{\lambda_p} = \frac{1}{\sqrt{8}} \Rightarrow \lambda_\alpha = \frac{\lambda_0}{2\sqrt{2}}$

19. Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light rays $(\upsilon_1 > \upsilon_2)$. If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in ratio of 1:k, then the threshold frequency of the metallic surface is **(2001 E)**

1) $\dfrac{k\upsilon_2-\upsilon_1}{k-1}$ 2) $\dfrac{k\upsilon_1-\upsilon_2}{k-1}$ 3) $\dfrac{k\upsilon_1+\upsilon_2}{k-1}$ 4) 0

Ans : 2

Sol: Let the maximum energy of the photoelectrons be x and Kx

$x = h\upsilon_1 - h\upsilon_0 = h(\upsilon_1-\upsilon_0)$ ....(1)

k $x = h\upsilon_2 - h\upsilon_0 = h(\upsilon_2-\upsilon_0)$ ....(2)

$\dfrac{(2)}{(1)} \Rightarrow \upsilon_0 = \dfrac{k\upsilon_1-\upsilon_2}{k-1}$

20. The de Broglie wavelength of an electron having 80 eV of energy is nearly (1eV = 1.6x 10^{-19} J), mass of the electron = 9 x 10^{-31} kg), Planck's constant = 6.6 x 10^{-34} Js) **(2001 E)**

1) 140 A° 2) 0.14 A° 3) 14 A° 4) 1.4 A°

Ans :4

Sol: de-Broglie wavelength $\lambda = \dfrac{h}{\sqrt{2mE}}$

$\lambda = \sqrt{\dfrac{150}{\nu}} = \sqrt{\dfrac{150}{80}} = 1.37A^0$

21. When a metal surface is illuminated by light of wavelengths 400 nm and 250 nm, the maximum velocities of the photoelectrons ejected are v and 2v respectively. The work function of the metal is (h = Plank's constant, c = velocity of light in air) **(2000 E)**

1) $2hc\times10^6$ J 2) $1.5hc\times10^6$ J 3) $hc\times10^6$ J 4) $0.5hc\times10^6$ J

Ans :1

Sol : $\dfrac{hc}{4000} = W_0 + \dfrac{1}{2}mv^2$ ....(1)

$\dfrac{hc}{2500} = W_0 + 4\left(\dfrac{1}{2}mv^2\right)$ ....(2)

From (1), $\dfrac{1}{2}mv^2 = \dfrac{hc}{4000} - W_0$

Substituting in equation (2)

$\dfrac{hc}{2500} = W_0 + 4\times\left[\dfrac{hc}{400} - W_0\right] = \dfrac{hc}{1000} - 3W_0$

$W_0 = \dfrac{hc}{5000\times10^{-10}} = (2hc\times10^6)J$

MEDICAL

22. A photon of energy 'E' ejects a photo electron from a metal surface whose work function is W_0. If this electron enters into a uniform magnetic field of induction 'B' in a direction perpendicular to the field and describes a circular path of radius r, then the radius r is given by (in the usual notation) :

(2009 E)

1) $\sqrt{\dfrac{2m(E+W_0)}{eB}}$ 2) $\sqrt{2m(E-W_0)eB}$ 3) $\sqrt{\dfrac{2m(E-W_0)}{mB}}$ 4) $\dfrac{\sqrt{2m(E-W_0)}}{Be}$

Ans :4

Sol: $E = w_0 + \frac{1}{2}mv^2$

$\Rightarrow v = \sqrt{\frac{2(E - w_0)}{m}}$ ……………………….(1)

In the magnetic field,

$Be\ v = \frac{mv^2}{r}$

$\Rightarrow r = \frac{mv}{Be}$ ……………..…………………(2)

Substituting (1) in (2)

$r = \frac{\sqrt{2m(E - w_0)}}{Be}$

23. Electrons accelerated by a potential of 'V' volts strike a target material to produce 'continuous X-rays'. Ratio between the de-Broglie wavelength of the electrons striking the target and the shortest wavelength of the continuous X-rays emitted is **(2009 M)**

1) $\frac{h}{\sqrt{2Vem}}$ 2) $\frac{1}{c}\sqrt{\frac{2m}{Ve}}$ 3) $\frac{1}{c}\sqrt{\frac{Ve}{2m}}$ 4) $\frac{hc}{\sqrt{\frac{Ve}{2m}}}$

Ans : 3

Sol: de-Broglie wave length

$\lambda_1 = \frac{h}{mv} = \frac{h}{\sqrt{2meV}}$

Shortest wavelength = $\lambda_2 = \frac{hc}{eV}$

$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{h}{\sqrt{2meV}} \times \frac{eV}{hc} = \frac{1}{c}\sqrt{\frac{eV}{2m}}$

24. In Millikan's oil drop experiment, a charged oil drop of mass $3.2\times10^{-14}kg$ is held stationary between two parallel plates 6 mm apart, by applying a potential difference of 1200V between them. How many electrons does the oil drop carry ? (g=10ms^{-2}) **(2009 M)**

1) 7 2) 8 3) 9 4) 10

Ans: 4

Sol: Under equilibrium

mg = Eq

$\Rightarrow mg = \left[\frac{V}{d}\right](ne)$

$\Rightarrow n = \frac{mgd}{Ve} = \frac{(3.2\times10^{-4})(10)(6\times10^{-3})}{(1200)(1.6\times10^{-19})}$

$\Rightarrow n = 10$

25. An oil drop having a charge was kept between two plates having a potential difference of 400V is in equilibrium. Now another drop of same oil with same charge but double the radius is introduced between the plates. Then the potential difference necessary to keep the drop in equilibrium is **(2008 M)**

1) 200 V 2) 800 V 3) 1600 V 4) 3200 V

Ans :4

Sol: $F = Eq = mg \quad but \quad E = \frac{v}{d}$

$\frac{Vq}{d} = mg$

$\frac{Vq}{d} = \frac{4}{3}\pi R^3 \rho g$

$V \propto R^3$

$\frac{V_1}{V_2} = \frac{R_1^3}{R_2^3}$

$\frac{400}{V_2} = \frac{R^3}{8R^3}$; $V_2 = 3200$

26. The threshold frequency for a certain metal is v_0. When a certain radiation of frequency $2v_0$ is incident on this metal surface the maximum velocity of the photoelectrons emitted is 2×10^6 ms^{-1}. If a radiation of frequency $3v_0$ is incident on the same metal surface the maximum velocity of the photoelectrons emitted (in ms^{-1}) is **(2008 M)**

1) 2×10^6 2) $2\sqrt{2}\times10^6$ 3) $4\sqrt{2}\times10^6$ 4) $4\sqrt{3}\times10^6$

Ans :2

Sol: $K.E_1 = h(2v_0) - hv_0 = hv_0$ ……………..(1)

$K.E_2 = h(3v_0) - hv_0 = 2hv_0$ ……………..(2)

Dividing (1) and (2)

$\frac{\frac{1}{2}mv_1^2}{\frac{1}{2}mv_2^2} = \frac{1}{2}$

$\therefore V_2 = \sqrt{2}V_1$

$V_2 = 2\sqrt{2}\times10^6$

27. The velocity of the most energetic electron emitted from a metallic surface is doubled when the frequency 'v' of the incident radiation is doubled. The work function of this metal is **(2007 M)**

1) $\frac{h\nu}{4}$ 2) $\frac{h\nu}{3}$ 3) $\frac{h\nu}{2}$ 4) $\frac{2h\nu}{3}$

Ans: 4

Sol: $hv = \omega_0 + \frac{1}{2}mV^2$ …………………………(1)

$h2v = \omega_0 + \left(\frac{1}{2}mV^2\right)4$ …………………..(2)

$(1)\times 4 \Rightarrow 4hv = 4\omega_0 + 4\frac{1}{2}mv^2$

(2) $\Rightarrow 2hv = \omega_0 + 4\frac{1}{2}mv^2$

Substracting $2hv = 3\omega_0 \Rightarrow \omega_0 = \frac{2hv}{3}$

28. A proton and an alpha particle are accelerated through the same potential difference. The ratio of the wavelength associated with proton and alpha particle respectively is **(2007M)**

1) $1:2\sqrt{2}$ 2) 2 : 1 3) $2\sqrt{2}:1$ 4) 4 : 1

Ans :3

Sol: From de-Broglie wavelength $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}}$

$$\frac{\lambda_p}{\lambda_\alpha} = \frac{\frac{h}{\sqrt{2m_p q_p V}}}{\frac{h}{\sqrt{2m_\alpha q_\alpha V}}} = 2\sqrt{2}:1$$

29. In X-ray spectrum, transition of an electron from an outer shell to an inner shell gives a characteristic X-ray spectral line. If we consider the spectral lines K_β, L_β and M_α, then **(2006 M)**

1) K_β and L_β have a common inner shell 2) K_β and L_β have a common outer shell

3) L_β and M_α have a common outer shell 4) L_β and M_α have a common inner shell

Ans :3

Sol. L_β is transition from N to L

M_α is transition from N to M

In both of them , the outer shell is same.

30. The de-Broglie wavelength of an electron and the wavelength of a photon are the same. The ratio between the energy of that photon and the momentum of that electron is **(2006 M)**

1) h 2) C 3) 1/h 4) 1/C

Ans : 2

Sol: $\lambda_e = \frac{h}{p_e}$

$\lambda_{P_h} = \frac{hC}{E_{Ph}}$

$\Rightarrow \frac{h}{P_e} = \frac{hC}{E_{Ph}}$

$\Rightarrow \frac{E_{Ph}}{P_e} = C$

31. A proton is projected with a velocity 10^7 ms^{-1} at right angles to a uniform magnetic field of induction 100mT. The time (in seconds) taken by the proton to traverse 90° arc is
(Mass of proton= 1.65 x 10^{-27} kg and charge of proton = 1.6 x 10^{-19}C) **(2005 M)**
1) 0.81 x 10^{-7} 2) 1.62 x 10^{-7} 3) 2.43 x 10^{-7} 4) 3.24 x 10^{-7}

Ans :2

Sol: If proton is projected right angle to the magnetic field it rotating in circular path the required centripetal force is supplied by force due to magnetic field.

$$mr\omega^2 = Bqv \Rightarrow \omega = \sqrt{\frac{Bqv}{mr}}$$

$$T = 2\pi\sqrt{\frac{mr}{Bqv}} = \frac{2\pi m}{Bq}$$

Time taken to transverse 90^0 arc is $\frac{T}{4}$.

$$\therefore \frac{T}{4} = \frac{\pi m}{2Bq} = 1.6\times10^{-7}$$

32. The incident photon involved in the photoelectric effect experiment **[2005M]**
1) completely disappears
2) comes out with increased frequency
3) comes out with a decreased frequency
4) comes out with out change in frequency

Ans :1

Sol. As the total incident energy is completely absored by the electrons the incident photon completely disappears.

33. k_1 and k_2 are the maximum kinetic energies of the photoelectrons emitted when light of wave length λ_1 and λ_2 respectively are incident on a metallic surface. If $\lambda_1 = 3\lambda_2$ then **[2004 M]**

1) $k_1 > \frac{k_2}{3}$ 2) $k_1 < \frac{k_2}{3}$ 3) $k_1 = 3k_2$ 4) $k_2 = 3k_1$

Ans : 2

Sol: From Einsteins photo electric equation $\frac{hc}{\lambda} = w + K.E$

$$K_1 = \frac{hc}{\lambda_1} - W = \frac{hc}{3\lambda_2} - W = \frac{X}{3} - W$$

$$K_2 = \frac{hc}{\lambda_2} - W = X - W$$

Where $X = \frac{hc}{\lambda_2}$

$$\frac{K_1}{K_2} = \frac{\frac{X}{3} - W}{X - W} = \frac{X/3 - W}{X - W}$$

Now x>W. Hence $\frac{K_1}{K_2} < \frac{1}{3} \Rightarrow K_1 < \frac{K_2}{3}$

34. The de-Brogile wavelength of a particle moving with a velocity 2.25 x 10^8 $ms^{-1}$is equal to the wavelength of photon. The ratio of kinetic energy of the particle to the energy of the photon is [velocity of light = 3 x 10^8 ms^{-1}] **[2003 M]**
1) 1/8 2) 3/8 3) 5/8 4) 7/8

Ans :2

Sol: From Compton effect

$\lambda = \frac{h}{p} = \frac{c}{\upsilon}$ [From de-Broglie wavelength]

c p = h υ

$$\frac{k}{h\upsilon} = \frac{p^2}{2mh\upsilon} = \frac{p^2}{2mcp}$$

$$= \frac{p}{2mc} = \frac{v}{2c} = \frac{2.25\times10^8}{2\times3\times10^8} = \frac{3}{8}$$

35. Monochromatic X-rays of wavelength 0.12 A° undergo Compton scattering through an angle 60° from a carbon block. The wavelength of the scattered X-rays, in A° is $\left(\text{take}\frac{h}{m_0c} = 0.024\,A°\right)$ **(2002 M)**
1) 0.112 2) 0.136 3) 0.156 4) 0.182

Ans :2

$$\lambda - \lambda_0 = \frac{h}{m_0c}\left(1-\cos\theta\right) = 0.024\left(1-\cos60^0\right)$$

$$\Rightarrow \lambda = \lambda_0 + 0.012 = 0.124 + 0.012 = 0.136A^0$$

36. The value of de Broglie wavelength of an electron moving with a speed of 6.6 x 10^5 ms^{-1} is approximately **(2002 M)**
1) 11 A° 2) 111A° 3) 211 A° 4) 311 A°

Ans :1

Sol: $\Rightarrow \lambda = \frac{h}{p} = \frac{h}{mv} = \frac{6.63\times10^{-34}}{9.1\times10^{-31}\times6.6\times10^5}$

= $11\times10^{-10}m = 11A^0$

37. The maximum wavelength of light that can be used to produce photoelectric effect on a metal is 250nm. The maximum K.E of the electrons in joule, emitted from the surface of the metal when a beam of light of wavelength 200 nm is used: **(2002 M)**
1) 89 .61 x 10^{-22} 2) 69.81 x 10^{-22} 3) 18.96 x 10^{-20} 4) 19.86 x 10^{-20}

Ans:4

Sol: When λ is expressed in A° then , $W = \frac{12400}{\lambda}$

$$W = \frac{1240}{250} = 4.96eV$$

$$h\upsilon = \frac{1240}{200} = 6.20eV$$

K =6.20 – 4.96 = 1.24eV

=$1.24\times1.6\times10^{-19}$

= $19.84\times10^{-20}J$

38. The work function of Potassium is 2.0 eV. When it is illuminated by light of wavelength 3300 A°, photoelectrons are emitted. The stopping potential of photoelectrons is **(2001 M)**

1) 0.75 V 2) 1.75 V 3) 2.5 V 4) 3.75 V

Ans :2

Sol: $\lambda = 3300A^0 = 330nm$

$h\upsilon = \frac{1240}{330} = 3.757$

$eV_0 = h\upsilon - W = 3.757 - 2 = 1.757eV$

$\Rightarrow V_0 = 1.757\ V$

39. A positron and a proton are accelerated by the same accelerating potential. Then the ratio of the associated wavelength of positron and proton will be (M-mass of proton, m=mass of positron)

(2001 M)

1) $\frac{M}{m}$ 2) $\sqrt{\frac{M}{m}}$ 3) $\frac{m}{M}$ 4) $\sqrt{\frac{m}{M}}$

Ans: 4

Sol Since both proton and positron have the same charge

$\lambda_{proton} = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2MeV}}$

$\lambda_{positron} = \frac{h}{\sqrt{2meV}} \Rightarrow \frac{\lambda_{proton}}{\lambda_{positron}} = \sqrt{\frac{m}{M}}$

40. In Compton scattering, X-rays of 1A° are scatter from carbon block (Z=6) and a zinc block (Z=30) at 90° with incident beam. The ratio of scattered wavelength is **(2001 M)**

1) 1 : 5 2) 5 : 1 3) 1 : 1 4) 1 : 25

Ans :3

Sol The Compton scattering takes place when the X-ray is incident on a single electron. It is immaterial whether the electron belongs to the carbon atom or zinc atom the wavelength of the scattered photon will be identical

∴ Ratio of scattered wavelength = 1 : 1

41. The work function of metals A and B are in the ratio 1:2. If light of frequencies f and 2f are incident on metal surfaces A and B respectively, the ratio of the maximum kinetic energies of the photo electrons emitted is **(2000 M)**

1) 1:1 2) 1:2 3) 1:3 4) 1:4

Ans: 2

Sol $: W_1 : W_2 = 1:2$

$v_1 : v_2$ = 1:2

According to photo – electric equation,

$\frac{1}{2}mv_1^2 = h\upsilon_1 - W_0 = hf - 1$ ……………………..(1)

$\frac{1}{2}mv_2^2 = h\upsilon_2 - W_0 = 2hf - 2 = 2(hf - 1)$

Ratio of kinetic energies = 1:2

42. An x-ray tube is operated at a constant p.d and it is required to get x-rays of wavelength not less than 0.2 nano-metres. Then the p.d in kilo-volts is **[2003 M]**

1) 24.8 2) 12.4 3) 6.2 4) 3.1

Ans : 3

Sol: $\lambda_c = \frac{hc}{eV}, \Rightarrow V = \frac{hc}{e\lambda_c}$

$$= \frac{6.63\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times0.2\times10^{-9}}$$

$$= 6.2\times10^{3} v = 6.2KV$$

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