11-12-23

Day 65

P1. An electron is accelerated by the potential of 150 V. What is the wavelength of that electron wave?

(Potential difference)

Soln: De-broglie wavelength.

$\lambda = h/mv \Rightarrow \lambda = h/\sqrt{2meV}$

$\lambda = 6.625 \times 10^{-34} / \sqrt{2 \times 9.11 \times 10^{-31} \times 9 \times 10^{-19} \times 150}$

$\lambda = 12.25 \times 10^{-10} / \sqrt{5} = 12.25 \times 10^{-10} / \sqrt{150}$

$\lambda = 1 \times 10^{-10}$ m (or) 1 Å.

P2. Calculate the de-Broglie wavelength of an electron of energy 100eV.

Soln: Given data:

$E = 100$ eV ; $\lambda = ?$ (Energy)

we know,

$\lambda = h/\sqrt{2mE} = 6.625 \times 10^{-34} / \sqrt{2 \times 9.11 \times 10^{-31} \times E}$

$= 6.625 \times 10^{-34} / \sqrt{2 \times 9.11 \times 10^{-31} \times 100 \times 1.6 \times 10^{-19}}$

$\lambda = 1.235 \times 10^{-10}$

$m = 1.235$ Å

3. An electron at rest is accelerated through a potential of 5000V. Calculate the de-Broglie wavelength of matter wave associated with it.

Given data:

$V = 5000\ V$

$\lambda = h/\sqrt{2meV} = 12.25 \times 10^{-10}/\sqrt{V}$

$= 12.25 \times 10^{-10}/\sqrt{5000} = 0.1736 \times 10^{-10}$ (or)

$m = 0.1736\ \text{Å}$

4. A neutron of mass 1.675×10^{-27} kg is moving with a K.E of 10 KeV. Calculate the De-broglie wavelength associated with it.

Given data:

K.E = 10 KeV $= 10 \times 10^3$

$E = 10 \times 10^3 \times 1.6 \times 10^{-19}$ J.

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

$= \dfrac{6.625 \times 10^{-34}}{\sqrt{2 \times 1.675 \times 10^{-27} \times 10 \times 10^3 \times 1.6 \times 10^{-9}}}$

$\lambda = 2.8596 \times 10^{-3}\ m$

5. Calculate the de-broglie wavelength of an electron having a velocity of $10^6\ ms^{-1}$.

Sol^n:

Given:

$V = 10^6\ ms^{-1}$

$\lambda = h/mV = 6.625 \times 10^{-34}/9.11 \times 10^{-31} \times 10^6$

$\lambda = 7.25 \times 10^{-10}$

$m = 7.25\ \text{Å}$

6. Find the charge of wavelength of an x-ray photon when it is scattered through an angle of 90° by a free electron.

Given data :

$\theta = 90^\circ$

$\Delta\lambda = h / m_0 c \ (1 - \cos\theta)$

$\Delta\lambda = 6.626 \times 10^{-34} / 9.11 \times 10^{-31} \times 3 \times 10^8 \ (1 - \cos\theta)$

$= 2.24 \times 10^{-12} m$

$\therefore \Delta\lambda = 0.02242 \times 10^{-10} m$

7. Calculate the minimum energy of an electron can posses in an infinitely deep potential well of width 4nm.

Given data ;

$a = 4 nm = 4 \times 10^{-9} m$

$E = n^2 h^2 / 8 m a^2$

$E = 1^2 \times (6.625 \times 10^{-34})^2 / 8 \times 9.11 \times 10^{-31} \times (4 \times 10^{-9})$

$E = 3.7639 \times 10^{-21} J$

$E = 3.7639 \times 10^{-21} / 1.6 \times 10^{-9} = 0.02352 eV$