11

Modern Physics

Tut: 2

— Ramendra Pandey

1. $\lambda = \frac{h}{mv} = \frac{h}{p}$

$\lambda_e = \frac{h}{m_e v_e}$; $\lambda_p = \frac{h}{m_p v_p}$

$(KE)_e = (KE)_p$

$\frac{1}{2} m_e v_e^2 = \frac{1}{2} m_p v_p^2$

$\frac{v_p}{v_e} = \sqrt{\frac{m_e}{m_p}}$

$\frac{\lambda_e}{\lambda_p} = \frac{m_p v_p}{m_e v_e} = \frac{m_p}{m_e}\left(\sqrt{\frac{m_e}{m_p}}\right) = \sqrt{\frac{m_p}{m_e}}$

2. $\Delta x \cdot \Delta p \geq \frac{\hbar}{2}$

$\hbar = \frac{h}{2\pi} \approx 1.055 \times 10^{-34}\ J.s$

$\Delta x \cdot m_p \Delta v \geq \frac{\hbar}{2}$

$\Delta v \geq \frac{\hbar}{2 m_p \Delta x}$

$$\boxed{\Delta v \geq \frac{h}{4\pi m_p \Delta x}}$$

3. $\lambda_e = \lambda_p$

$$\frac{h}{m_e v_e} = \frac{h}{m_p v_p} \Rightarrow m_p v_p = m_e v_e$$

$$\Rightarrow \frac{v_p}{v_e} = \frac{m_e}{m_p}$$

~~$(KE)_e = (KE)_p$~~

~~$\frac{1}{2} m_e v_e^2 = \frac{1}{2} m_p v_p^2$~~

$$\frac{(KE)_e}{(KE)_p} = \frac{m_e v_e^2}{m_p v_p^2} = \frac{m_e}{m_p}\left(\frac{m_p}{m_e}\right)^2$$

$$\boxed{\frac{(KE)_e}{(KE)_p} = \frac{m_p}{m_e}}$$

4. $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$

$$\Delta x \cdot \Delta p \geq \frac{h}{2} \Rightarrow \Delta x \cdot m \Delta v \geq \frac{h}{2}$$

$$\Delta x \cdot \Delta v \geq \frac{h}{4\pi m}$$

$$\Delta v = \frac{0.004}{100} \times 500 = 0.02$$

$$\boxed{\Delta x \geq \frac{h}{4\pi m (0.02)}}$$ Solve.

5. $\Delta E \times \Delta t \geq \frac{h}{2}$

$$\Delta E \geq \frac{h}{2\Delta t} \quad ; \quad E = \frac{hc}{\lambda} \longrightarrow \boxed{\lambda = 6000 \text{ Å}}$$

Get this value

$$\boxed{\Delta E = \frac{hc}{\lambda^2}\Delta\lambda}$$ Error in E.

$$\boxed{\Delta\lambda = \frac{\Delta E \lambda^2}{hc}}$$ Solve

(6) $\Delta E \cdot \Delta t \geq \frac{\hbar}{2} \Rightarrow$ (i) $\Delta E \geq \frac{\hbar}{2\Delta t}$ — (a)

$E = -13.6 \frac{Z^2}{n^2}$ ($\because Z = 1$ for Hydrogen atom)

$= -13.6 \left(\frac{1}{4} - 1\right)$ eV

$E_{2-1} = 10.2$ eV — (b)

(ii) $\frac{\Delta E}{E}$ ⟶ from eq (a) & (b)

(iii) $E_{2-1} = \frac{hc}{\lambda} \Rightarrow \boxed{\lambda = \frac{hc}{E_{2-1}}}$

$\Delta E = \frac{hc}{\lambda^2} \Delta\lambda \Rightarrow \boxed{\Delta\lambda = \frac{\lambda^2 \Delta E}{hc}}$

(7) $\Delta x \cdot \Delta p \geq \frac{\hbar}{2}$

$\Delta x \cdot m \Delta v \geq \frac{\hbar}{4\pi}$

$\Delta x \cdot \Delta v \geq \frac{\hbar}{4\pi m}$; $\Delta v = \frac{0.02}{100} \times 500$

$= 0.1$

$\Delta x \geq \frac{\hbar}{4\pi m (0.1)}$

(8) $\Delta x \cdot \Delta p \geq \frac{\hbar}{4\pi}$

$\Delta p \geq \frac{\hbar}{4\pi \Delta x}$;

$\Rightarrow \left(\frac{\Delta p}{p} \times 100\right)\%$

$KE = (m - m_0)c^2$

$KE = pc \Rightarrow p = \frac{KE}{c}$

$KE = \frac{1}{2} m v^2$

$5000 \text{ eV} = \frac{1}{2} m v^2$