PYQ Solution [IIT-JAM]

(Chapter 1 Basic Nuclear Properties)

Ans. 1: (a), (b)

Ans. 2: 0.31

Solution: $\Delta p \Delta x \simeq \frac{h}{4\pi}$

$$\Delta v \simeq \frac{h}{4\pi m \Delta x} \simeq \frac{6.6\times10^{-34}}{4\times3.14\times1.672\times10^{-27}\times\left(10^{-15}\right)} \simeq 0.31\times10^{8}\, m/s$$

Ans. 3: (d)

Solution: $p = \frac{h}{\lambda} = \frac{6.6\times10^{-34}}{10^{-15}} = 6.6\times10^{-19}\, kgm/\text{sec}$

$$\because E = \frac{p^2}{2m_e} = \frac{44\times10^{-38}}{2\times9.1\times10^{-31}} = 2.4\times10^{-7}\ Joule$$

$$\Rightarrow E = \frac{2.4\times10^{-7}}{1.6\times10^{-19}} eV = 1.5\times10^{12}\ eV = 1.5\times10^{6}\ MeV$$

Ans. 4: (c)

Solution: The radius of a nucleus can be combined as $\frac{\lambda}{2\pi}$ (greater than the wavelength of electron)

The moment $p = \frac{h}{\lambda}$

$\lambda - R = R_0 A^{1/3}$ which implies $p \propto \frac{h}{R_0} \cdot A^{-1/3}$.

As, $p \propto A^{-1/3}$

PYQ Solution [GATE]

Ans. 1: 0.29

Solution: Here, Fermi-momentum or fermi radius, $k_F = 1.40\, fm^{-1}$ and $\hbar c = 197$ Mev- fm

Now, Fermi velocity –

$$V_F = \frac{P}{m} = \frac{\hbar k_F}{m} = \frac{(\hbar c)k_F \cdot c}{mc^2} = \frac{(197)\times 1\cdot 40 \times c}{939} = \frac{275\cdot 8c}{939} = 0.29c$$

Ans. 2: -0.67

Solution: $\langle T \rangle = \frac{P_{av}^2}{2m} = \left(\frac{3}{4}P_F\right)^2 \frac{1}{2m} = \frac{9}{32m}P_F^2 = \frac{9}{32m}\left[\frac{\hbar}{r_0}\left(\frac{9\pi}{4}\frac{z}{A}\right)^{1/3}\right]^2$

$$\left[\langle T \rangle \propto A^{-2/3}\right] \Rightarrow n = -\frac{2}{3} = -0.667 = -0.67$$

Ans. 3: (c)

Solution: Fermi energy $E_F = \frac{\hbar^2}{2m}\left(3\pi^2 \frac{N}{V}\right)^{2/3}$

$$V = \frac{4\pi}{3}R^3 = \frac{4\pi}{3}\left(R_0 A^{1/3}\right)^3 = \frac{4\pi}{3}R_0^3 A$$

$$\therefore E_F = \frac{\hbar^2}{2m}\left(\frac{3\pi^2 N}{\frac{4\pi}{3}R_0^3 A}\right)^{2/3} = \frac{\hbar^2}{2m}\left(\frac{9\pi N}{4A}\cdot\frac{1}{R_0^3}\right)^{2/3} \qquad \Rightarrow E_F \propto \frac{1}{R_0^2}$$

Thus correct option is (c)

PYQ Solution [NET-JRF]

Ans. 1: (c)

Solution: Since $R = R_0 (A)^{1/3} \Rightarrow \frac{R_{Mg}}{R_{Cu}} = \left(\frac{A_{Mg}}{A_{Cu}}\right)^{1/3} = \left(\frac{27}{64}\right)^{1/3}$

$$\Rightarrow \frac{R_{Mg}}{R_{Cu}} = \frac{3}{4} \Rightarrow R_{Mg} = \frac{3}{4} \times 4.8 \times 10^{-13} = 3.6 \times 10^{-13} cm.$$

Ans. 2: (c)

Ans. 3: (b)

Solution: The internal structure of proton can only be determined if the wavelength of the incoming electron is nearly equal to the size of the proton

i.e. $\lambda = R = 1.2 A^{1/3} (fm) = 1.2\, fm = 1.2 \times 10^{-15}\, m$

According to de-Broglie relation, $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

This can be also written as $E^2 = h^2 \lambda^2 / c^2 + m_0^2 c^4$