Estimation of minimum energy of a confined particles using Uncertainty principle :-

Uncertainty principle

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

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

$$\Delta p = P_{min} \Rightarrow P_{min} = \frac{\hbar}{2l} \quad \text{--- (1)}$$

and $\Delta x = l$ (size of the atom or nucleus)

$$\text{Kinetic energy} = \frac{p^2}{2m}.$$

where, m is the mass of the particle

$$K.E = \frac{P_{min}^2}{2m}.$$

Now from equation (1)

$$K.E = \frac{(\hbar/2l)^2}{2m}$$

$$K.E = \frac{\hbar^2}{4l^2 \times 2m}$$

$$\boxed{K.E = \frac{\hbar^2}{8ml^2}}$$

If particle confined in an atom

assume atomic size $l = 0.4\,nm$

$$l = 0.4 \times 10^{-9}\ m$$

$$K.E = \frac{\hbar^2}{8ml^2} \qquad \hbar = \frac{h}{2\pi} = \frac{6.63 \times 10^{-34}}{2\pi}.$$

For electron $m = 9.11 \times 10^{-31}\ Kg$.

$$K.E = \frac{\hbar^2}{8ml^2}.$$

$$K.E = \frac{6.63 \times 10^{-34} \times 6.63 \times 10^{-34}}{2 \times 3.14 \times 8 \times 9.11 \times 10^{-31} \times (0.4 \times 10^{-9})^2}$$

$$K.E = 0.6 \times 10^{-19}\ J$$

$$K.E = \frac{0.6 \times \cancel{10^{-19}}}{1.6 \times \cancel{10^{-19}}}\ eV$$

$$\boxed{K.E = 0.375\ eV.}$$