

Problem#3 (5 points)

To what voltage must we accelerate electrons if we wish to resolve an atom of diameter 0.12 nm.

De Broglie wavelength $\lambda = \frac{h}{p} \Rightarrow p = \frac{h}{\lambda} = \frac{6.63 \times 10^{-34}}{0.12 \times 10^{-9}}$

$$p = 5.53 \times 10^{-24} \text{ Kg} \cdot \frac{\text{m}}{\text{s}}$$

$$pc = 1.66 \times 10^{-15} \text{ J} = 10359 \text{ eV} = 10.4 \text{ keV}$$

Since $pc \ll mc^2$ we use non-relativistic kinetic energy

$$\text{K.E} = \frac{p^2}{2m} = \frac{(5.53 \times 10^{-24})^2}{2 \times 9.1 \times 10^{-31}} = 1.68 \times 10^{-17} \text{ J}$$

$$\text{K.E} = eV \Rightarrow V = \frac{\text{K.E}}{e} = \frac{1.68 \times 10^{-17}}{1.6 \times 10^{-19}}$$

$$\boxed{V = 105 \text{ volts}}$$