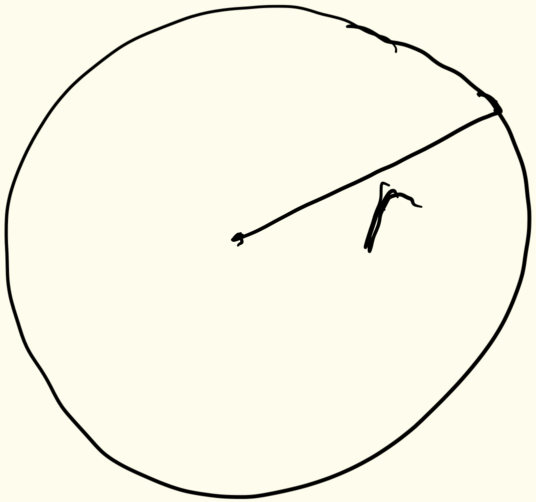
Bohr Model



Angular Momentum, $L = mvr$

Bohr equated the Coloumb Force to the Centripetal Force.

$$\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$$

$$\Rightarrow v^2 = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\frac{1}{m}$$

Now we are going to quantise the system

$$L = \hbar n = \frac{h}{2\pi} n \quad \text{where } n = 1, 2, 3, 4, \ldots$$

$$L = mvr = \hbar n$$

$$v^2 = \left(\frac{\hbar n}{mr}\right)^2$$

Equating two expressions for v^2:

$$\frac{\hbar^2 n^2}{m^2 r^2} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r} \frac{1}{m}$$

$$\Rightarrow \quad r = \frac{4\pi\varepsilon_0 \hbar^2 n^2}{me^2} = a_0 n^2$$

Bohr radius

$$a_0 = \frac{4\pi\varepsilon_0 \hbar^2}{me^2}$$

$$a_0 \simeq 5.3 \times 10^{-11}\,\text{m}$$

What about energy?

Energy = Kinetic Energy + Potential Energy

$$E = T + V$$ ← Potential

$$= \frac{1}{2} m v^2 - \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$$

But we know

velocity → $$v^2 = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\frac{1}{m}$$

$$E = \frac{1}{2} m \left(\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}\frac{1}{m}\right) - \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$$

$$E = -\frac{1}{2}\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$$

But $r = a_0 n^2$

$$E_n = -\frac{1}{2}\frac{1}{4\pi\varepsilon_0}\frac{e^2}{a_0} \cdot \frac{1}{n^2}$$

$$E_n = \frac{-2.2 \times 10^{-18}\,\text{J}}{n^2}$$

$$E_n = \frac{-13.6\,\text{eV}}{n^2}$$