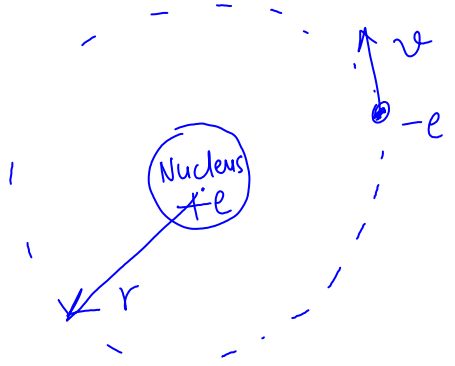
Friday, November 20, 2009
3:22 PM

Solution to Quiz 9c



$$E = \frac{1}{2}mv^2 - \frac{e^2}{4\pi\epsilon_0 r} \quad \text{—(1)}$$

From force balance

$$\frac{mv^2}{r} = \frac{e^2}{4\pi\epsilon_0 r^2}$$

$$\Rightarrow mv^2 = \frac{e^2}{4\pi\epsilon_0 r} \quad \text{—(2)}$$

Use (2) in (1) to get

$$E = \frac{e^2}{8\pi\epsilon_0 r} - \frac{e^2}{4\pi\epsilon_0 r} = \frac{-e^2}{8\pi\epsilon_0 r}$$

$\Rightarrow$ Energy required to ionize

$$= \frac{e^2}{8\pi\epsilon_0 r} = 5 \text{ eV}$$

$$\Rightarrow r = \frac{e^2}{8\pi\epsilon_0 \times E_{ionization}} = \frac{(1.6\times10^{-19})^2}{8\times\pi\times8.85\times10^{-12}\times5\times1.6\times10^{-19}}$$

$$= 1.43\times10^{-10} \text{ m} = 1.43 \text{ Å}$$

Now, using (2);

$$mv^2 = \frac{e^2}{4\pi\epsilon_0 r} = 2\times\frac{e^2}{8\pi\epsilon_0 r} = 2\times5 = 10 \text{ eV}$$

$$\Rightarrow v = \sqrt{\frac{10\times1.6\times10^{-19}}{9.1\times10^{-31}}} = 1.325\times10^6 \text{ m/s}$$