ATOMIC STRUCTURE

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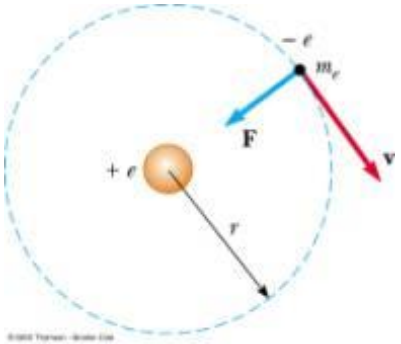
ELECTRON ORBITS

In Rutherford model, the atom consists of a tiny massive positive charged nucleus surrounded at a great distance by enough electrons to render the atom electrically neutral as a whole.



The electrons can't be stationary. **Why?**

Let us look at the classical dynamics of the H atom:

$$F_c = \frac{m\upsilon^2}{r} \qquad F_e = \frac{1}{4\pi\varepsilon_o}\frac{e^2}{r^2}$$

The condition for dynamically stable orbit

$$F_c = F_e$$

$$\frac{m\upsilon^2}{r} = \frac{1}{4\pi\varepsilon_o}\frac{e^2}{r^2}$$

$$\upsilon = \frac{e}{\sqrt{4\pi\varepsilon_o mr}}$$

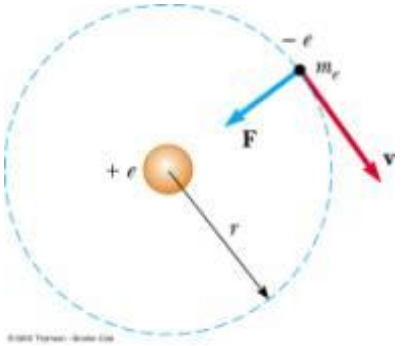
ELECTRON ORBITS

The total energy E of the electron in a H atom is the sum of its KE and PE which are:

$$KE = \frac{m\upsilon^2}{2} \qquad PE = -\frac{1}{4\pi\varepsilon_o}\frac{e^2}{r}$$

$$E = KE + PE = \frac{m\upsilon^2}{2} + \frac{1}{4\pi\varepsilon_o}\frac{e^2}{r}$$

$$\upsilon = \frac{e}{\sqrt{4\pi\varepsilon_o mr}} \qquad E = -\frac{e^2}{8\pi\varepsilon_o r}$$



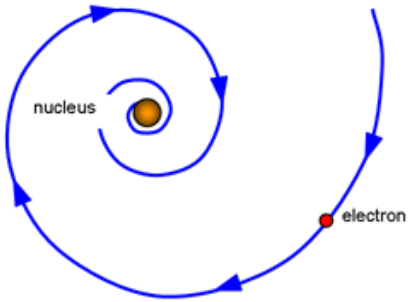
The total energy of the electron is negative ← electron is bound to the nucleus.

ELECTRON ORBITS

The failure of classical physics

This analysis is in accord with Newton's law of motion and Coulomb's law of electric force and in accord with the experimental observation that atoms are stable.

But it is NOT in accord with EM theory "accelerated electric charges radiate energy in the form of EM waves"



→An electron in a curved path is accelerated and should continuously lose energy, spiraling into the nucleus in a fraction of second.

The laws of physics that are valid in the macroworld do not always hold in the microworld of the atom!

ELECTRON ORBITS

Remember…

The planetary model of the atom and its failure.