Niels Bohr used the Rutherford model by proposing the following postulates:

- Only orbits of certain total energies are allowed. While the electron is in such an orbital, the electron does not radiate. Such orbitals are also called stationary orbitals.

- An electron can jump from one level to another by either emitting or absorbing a photon of energy exactly equal to the energy difference of the two levels.

- There is a lowest energy state, which is called ground state.

Bohr furthermore calculated the energy levels for the hydrogen atom by proposing that the angular momentum of the electron is quantized. As it turned out, the quantization of the angular momentum is in general a correct concept, however the way how Bohr proceeded with the quantization is indeed incorrect.

Let's anyway proceed following Bohr and see why his model was successful (to certain extent):

$$L = m v r = n \frac{h}{2\pi} = n \hbar \quad ; \text{ quantization by Bohr}$$

$$\text{with } \hbar = \frac{h}{2\pi}$$

$$\text{and } n = 1, 2, 3, 4, \ldots$$

$$\Rightarrow \quad v = v_n = \frac{n\hbar}{m r_n}$$; discrete values of radius and velocity.

Use now $F_{centripetal} = F_{Coulomb}$

$$\Rightarrow \quad m\frac{v^2}{r} = \frac{ke^2}{r^2}$$

$$\underset{\text{use } v_n}{\Rightarrow} \quad m\frac{n^2\hbar^2}{m^2 r_n^3} = \frac{ke^2}{r_n^2}$$

$$\Rightarrow \quad r_n = n^2 \underbrace{\frac{\hbar^2}{kme^2}}_{= a_B}$$; discrete values for radius of orbitals given by fundamental constants

$$a_B = \frac{\hbar^2}{kme^2}$$; (Bohr) radius of ground state

The quantization of radius leads to quantization of energy values in hydrogen atom as follows:

$$TE = -\frac{1}{2}\frac{ke^2}{r^2} \underset{r = r_n}{\Rightarrow} E_n = -\frac{1}{2} ke^2 \frac{mke^2}{n^2\hbar^2}$$

$$\Rightarrow \quad E_n = -\frac{1}{2}\frac{mk^2e^4}{\hbar^2}\frac{1}{n^2}$$

$$= \frac{E_1}{n^2}$$ with $n = 1, 2, 3, 4, \ldots$

with $E_1 = -\frac{1}{2}\frac{mk^2e^4}{\hbar^2}$

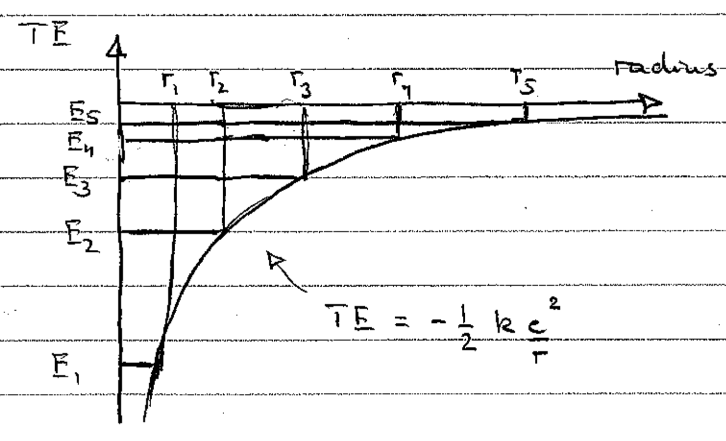
Notes :

- Energy level $(n=1)$ with $E_1 = -\frac{1}{2} \frac{mk^2e^4}{\hbar^2}$ is the level with the lowest energy and therefore the ground state of the hydrogen atom

- There are infinitely many discrete energy levels with negative total energies, which are called bound states, since the electron is bound in a stationary orbital.

- The energy difference between adjacent energy levels E_{n+1} and E_n gets smaller and smaller as n increases and the total energy approaches zero.

- The radii of the orbitals gets larger and larger as well as the difference between the radii as n increases.



– Sketch –