Answer on Question #67097 – Physics – Mechanics – Relativity

Using Bohr atomic model, drive expression for calculating the radius of orbits in He+. Using this expression, calculate the radius of forth orbit of He+ ion.

Solution.

According to Bohr model, electron orbit is stationary only if angular momentum is an integer multiple of $\hbar$:

$$mvr = n\hbar$$

On the other hand attractive force (electrostatic interaction) should be equal to centrifugal force:

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

where

ε_0 - electric constant;

m – mass of electron;

v –velocity of electron;

r – radius of orbit;

e – elementary charge;

$\hbar$ - Planck's constant;

$Z = 2$ - serial number of He;

n – positive integer.

So we have a system:

$$\begin{cases} \boldsymbol{mvr = n\hbar} \\ \dfrac{\boldsymbol{e^2}}{\boldsymbol{2\pi\varepsilon_0 r^2}} = \dfrac{\boldsymbol{mv^2}}{\boldsymbol{r}} \end{cases} => \begin{cases} v = \dfrac{\boldsymbol{n\hbar}}{mr} \\ r = \dfrac{\boldsymbol{e^2}}{\boldsymbol{2\pi\varepsilon_0 mv^2}} \end{cases} => r = \frac{\boldsymbol{e^2} mr^2}{\boldsymbol{2\pi\varepsilon_0} n^2\hbar^2} => r = \frac{\boldsymbol{2\pi\varepsilon_0} n^2\hbar^2}{m\boldsymbol{e^2}}$$

The forth orbit:

$$r_4 = \frac{\boldsymbol{2\pi\varepsilon_0} 4^2\hbar^2}{m\boldsymbol{e^2}} = \frac{2 * 3.14 * 8.85 * 10^{-12} * 4^2 * (1.054 * 10^{-34})^2}{9.1 * 10^{-31} * (1.6 * 10^{-19})^2} = 4.24 * 10^{-10} m = 4.24 Å$$

Answer $\boldsymbol{4.24 * 10^{-10} m = 4.24 Å}$

Answer provided by https://www.AssignmentExpert.com