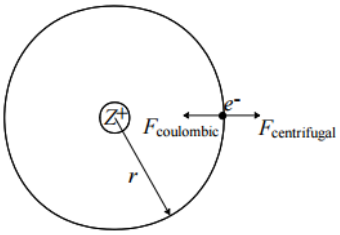
Answer on Question #66797 – Chemistry | Inorganic Chemistry

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

Solution:

1. Derivation of expression for calculating the radius of orbits in He^+.
   Bohr atomic model:



$$F_{centrifugal} = -mv^2/r$$
$$F_{coulombic} = -Ze^2/r^2$$
$$\frac{mv^2}{r} = \frac{Ze^2}{r^2} \Longrightarrow r = \frac{mv^2r^2}{Ze^2}$$
$$r = \frac{mv^2r^2}{Ze^2} \times \frac{m}{m} = \frac{m^2v^2r^2}{mZe^2} = \frac{(mvr)^2}{mZe^2}$$

Quantum hypothesis:

$$mvr = nh/2\pi$$

So:

$$r = \frac{n^2h^2}{4\pi^2mZe^2}$$

For the Hydrogen atom (Z=1), the smallest radius (n = 1) will be:

$$a_0 = \frac{1 * h^2}{4\pi^2m * 1 * e^2} = 0.529 \text{ Å}$$

$a_0 - Bohr\ radius$, constant

So:

$$r = \frac{n^2a_0}{Z}$$

For He^+ ion (Z=2), the calculation of radius is:

$$r = \frac{n^2a_0}{2}$$

2. Calculation of the radius of fourth orbit of He^+ ion.
   n = 4

$$r = \frac{4^2 \times 0.529 \text{ Å}}{2} = 4.232 \text{ Å}$$

Answer: The radius of fourth orbit of He^+ ion is 4.232 Å.