Atomic Structure Overview

Problems Based on Bohr's Radius

1. **Problem 1: Calculating the First Orbit Radius**
   - Calculate the radius of the first orbit ($n = 1$) for a hydrogen atom using Bohr's model. Use the known value for the Bohr radius $a_0 = 0.529\,\text{Å}$.
2. **Problem 2: Radius of the Second Orbit**
   - Determine the radius of the second orbit ($n = 2$) for a hydrogen atom.
3. **Problem 3: Radius for Hydrogen-like Ion**
   - Find the radius of the first orbit ($n = 1$) for a hydrogen-like ion with atomic number $Z = 3$ (e.g., $Li^{2}+$).
4. **Problem 4: Comparison of Radii**
   - Compare the radius of the third orbit ($n = 3$) with that of the first orbit ($n = 1$) for a hydrogen atom. What is the ratio of the two radii?
5. **Problem 5: Radius of the n-th Orbit for a Helium Ion**
   - Calculate the radius of the fourth orbit ($n = 4$) for a singly ionized helium ion (He^{+}) with $Z = 2$.
6. **Problem 6: General Expression for Orbit Radius**
   - Derive the general expression for the radius of the n-th orbit for a hydrogen-like ion with atomic number Z. Calculate the radius of the $n = 3$ orbit for a helium ion (He^{+}).

Answer Key (Next Page)

1. **Problem 1:**
   - Radius of the first orbit for hydrogen: $r_1 = a_0 = 0.529\,\text{Å}$.
2. **Problem 2:**
   - Radius of the second orbit for hydrogen: $r_2 = 2^2 \times r_1 = 4 \times 0.529\,\text{Å} = 2.116\,\text{Å}$.
3. **Problem 3:**
   - Radius of the first orbit for $Z = 3$: $r_1 = \frac{a_0}{Z} = \frac{0.529\,\text{Å}}{3} \approx 0.176\,\text{Å}$.

4. **Problem 4:**

   - Radius of the third orbit for hydrogen: $r_3 = 3^2 \times r_1 = 9 \times 0.529\,\text{Å} = 4.761\,\text{Å}$.
   - Ratio $r_3 : r_1 = 9 : 1$.

5. **Problem 5:**

   - Radius of the fourth orbit for He^+: $r_4 = \frac{n^2 \times a_0}{Z} = \frac{4^2 \times 0.529\,\text{Å}}{2} = 4.232\,\text{Å}$.

6. **Problem 6:**

   - General expression: $r_n = \frac{n^2 \times a_0}{Z}$.
   - Radius of the $n = 3$ orbit for He^+: $r_3 = \frac{3^2 \times 0.529\,\text{Å}}{2} = 2.381\,\text{Å}$.