

Atomic Structure



Problems Based on Bohr's Energy of Electron in the n -th Orbit

1. Problem 1: Energy in the First Orbit

- Calculate the total energy of an electron in the first orbit ($n = 1$) of a hydrogen atom, given that the radius of the first orbit is $r_1 = 0.529 \text{ \AA}$.

2. Problem 2: Energy in the Second Orbit

- Determine the total energy of an electron in the second orbit ($n = 2$) of a hydrogen atom, given the radius of the second orbit is $r_2 = 2.116 \text{ \AA}$.

3. Problem 3: Energy of Electron in a Hydrogen-like Ion

- Find the total energy of an electron in the third orbit ($n = 3$) of a hydrogen-like ion with atomic number $Z = 3$ (e.g., Li^{2+}). Assume the radius of the third orbit is $r_3 = 0.588 \text{ \AA}$.

4. Problem 4: Energy Comparison Between Orbits

- Compare the total energy of an electron in the fourth orbit ($n = 4$) with that in the first orbit ($n = 1$) of a hydrogen atom. What is the ratio of their energies if the radius of the fourth orbit is $r_4 = 8.464 \text{ \AA}$ and the radius of the first orbit is $r_1 = 0.529 \text{ \AA}$?

5. Problem 5: Energy in the Fifth Orbit of a Helium Ion

- Calculate the total energy of an electron in the fifth orbit ($n = 5$) of a hydrogen-like helium ion (He^+) with $Z = 2$. Assume the radius of the fifth orbit is $r_5 = 1.323 \text{ \AA}$.

6. Problem 6: General Expression for Energy in the n -th Orbit

- Derive the general expression for the total energy of an electron in the n -th orbit of a hydrogen-like ion with atomic number Z . Calculate the energy of an electron in the $n = 2$ orbit for a singly ionized helium ion (He^+), given $r_2 = 0.529 \text{ \AA}$.

Answer Key (Next Page)

1. Problem 1:

- Energy of the first orbit for hydrogen: $E_1 = -\frac{e^2}{2r_1}$

2. Problem 2:

- Energy of the second orbit for hydrogen: $E_2 = -\frac{e^2}{2r_2}$

3. Problem 3:

- Energy of the third orbit for $Z = 3$: $E_3 = -\frac{Z^2 e^2}{2r_3}$

4. Problem 4:

- Energy of the fourth orbit for hydrogen: $E_4 = -\frac{e^2}{2r_4}$
- Ratio $E_1 : E_4$

5. Problem 5:

- Energy of the fifth orbit for $Z = 2$: $E_5 = -\frac{Z^2 e^2}{2r_5}$

6. Problem 6:

- General expression: $E_n = -\frac{Z^2 e^2}{2r_n}$
- Energy of the $n = 2$ orbit for $Z = 2$: $E_2 = -\frac{Z^2 e^2}{2r_2}$