
1. Electronic Configuration and Ionization

- **Isoelectronic species:** Molecules/ions that have the same number of electrons.
 - Example: CO , NO^+ , CN^- , C_2^{2-} each contain **14 electrons**.
- **Number of electrons in ions:**
 - When an atom **gains or loses electrons**, its electron count changes.
 - Example:
 - $NaCl$ dissociates into Na^+ (**loses one electron**) and Cl^- (**gains one electron**).
 - Similarly, for **CsF, NaI, and K_2S** , the number of electrons in each ion is calculated based on their atomic numbers.

2. de Broglie Wavelength and Momentum

- **Wave-particle duality:** Particles like electrons exhibit wave-like behavior.
- **de Broglie wavelength:**

$$\lambda = \frac{h}{mv}$$

where h is Planck's constant, m is the mass, and v is velocity.

- **Relation between kinetic energy and velocity:**

$$KE = \frac{1}{2}mv^2$$

When comparing kinetic energies of different particles:

$$\frac{KE_1}{KE_2} = \frac{m_1}{m_2} \times \frac{v_1^2}{v_2^2}$$

- This helps derive the ratio of wavelengths for different masses.

3. Bohr Model and Energy Levels

- **Bohr's formula for wavelength of spectral lines:**

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

where R_H is the Rydberg constant, and n_1, n_2 are energy levels.

- **Hydrogen and Helium spectra:**
 - For He^+ , the nuclear charge Z must be included:

$$\frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

- **Balmer series:** Involves transitions ending at $n_1 = 2$, with $n_2 = 3, 4, 5, \dots$
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4. Magnetic Moment of Transition Metals

- **Magnetic moment** is given by:

$$\mu = \sqrt{n(n+2)}$$

where n is the number of **unpaired electrons**.

- Example calculations:
 - **Fe(III) = d^5 → 5 unpaired electrons** → $\mu = \sqrt{5(5+2)} = \sqrt{35}$
 - **Co(II) = d^7 → 3 unpaired electrons** → $\mu = \sqrt{3(3+2)} = \sqrt{15}$
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5. X-ray Transitions and Wavelength Relations

- **Energy of a photon:**

$$E = h\nu = \frac{hc}{\lambda}$$

- **Compton Wavelength Shift:**
 - When X-ray photons interact with electrons, they undergo a shift in wavelength due to energy transfer.
- **Wavelength relation for transitions:**

$$\frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$$

This is used in X-ray **Moseley's law** and energy-level calculations.

6. Ratio of Wavelengths for Different Particles

- **de Broglie wavelength for different masses:**

$$\lambda_p = \frac{h}{\sqrt{2eVm_p}}$$

- If comparing a proton and **Li³⁺** ion:

$$\frac{\lambda_{\text{Li}^{3+}}}{\lambda_p} = \frac{\sqrt{2eVm_p}}{\sqrt{2eV9m_p}} = \frac{1}{\sqrt{3}}$$

- Shows that heavier particles have **shorter de Broglie wavelengths**.
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Summary of Key Concepts

1. **Electronic configuration** and counting electrons in ions.
2. **Bohr's model:** energy levels, spectral lines, and wavelength calculations.

3. **de Broglie wavelength**: wave-particle duality and kinetic energy relationships.
4. **Magnetic moments** in transition metals based on unpaired electrons.
5. **Photon energy and wavelength relations** in X-ray transitions.
6. **Ratio of wavelengths** for different particles using mass and charge dependencies.

These concepts are crucial for **modern physics** and quantum mechanics, particularly for competitive exams like **NEET and JEE**.