Concepts Involved in the Given Questions

The image contains multiple-choice questions related to **atomic structure, quantum mechanics, photoelectric effect, and wave-particle duality**. Below is an explanation of the key concepts:

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1. Isoelectronic Species (Q1)

- **Isoelectronic species** have the **same number of electrons**.
- Example:
  - CO, NO^+, CN^-, C_2^{2-} → All have **14 electrons**.
- By calculating total electrons for different species, we can determine which are **isoelectronic**.

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2. Counting Electrons in Ions (Q2)

- The number of **electrons in cations and anions** can be determined by:

$$\text{No. of electrons} = \text{Atomic Number} - \text{Charge (for cations)} + \text{Charge (for anions)}$$

- Example:
  - Na^+ (from NaCl) → $11 - 1 = 10$ electrons.
  - Cl^- (from NaCl) → $17 + 1 = 18$ electrons.

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3. Bohr's Model and Electron Wavelengths (Q3, Q4)

- **Bohr's quantization of angular momentum**:

$$mvr = \frac{nh}{2\pi}$$

  - Using $\lambda = \frac{h}{mv}$, we derive **wavelength of electrons** in different orbits.
- **For spectral lines**:

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

  where R_H is the **Rydberg constant**.

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4. Balmer Series and Energy Transitions (Q5, Q6)

- **Balmer series**: Electron transitions to **n = 2**.
  - Shortest wavelength (highest energy) occurs at **series limit** ($n_2 \to \infty$).
  - The energy is calculated using:

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

- **Series limit calculation**:
  - $n_1 = 2$, $n_2 = \infty$ gives:

$$\nu = R_H \frac{1}{n_1^2}$$

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5. de Broglie Wavelength and Momentum (Q7)

- **Wave-particle duality**: de Broglie's equation relates wavelength and momentum:

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

- **Comparing kinetic energies**:
  - The ratio of de Broglie wavelengths:

$$\frac{\lambda_1}{\lambda_2} = \frac{m_2 v_2}{m_1 v_1}$$

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6. Magnetic Moment of Transition Metals (Q8)

- **Magnetic moment** is calculated as:

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

  where n is the number of **unpaired electrons**.
- Example:
  - **Fe(III)** = d^5 → 5 unpaired electrons → $\mu = \sqrt{5(5+2)}$
  - **Co(II)** = d^7 → 3 unpaired electrons → $\mu = \sqrt{3(3+2)}$

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7. Photon Energy and Wavelength Calculations (Q9, Q10)

- **Planck's Equation**:

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

- Used to calculate **wavelength from energy**:

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

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8. Wavelength Ratio for Different Particles (Q10)

- **Comparing de Broglie wavelengths**:

$$\lambda = \frac{h}{\sqrt{2eVm}}$$

- **Ratio for protons and lithium ions**:

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

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9. X-ray Transitions and Wavelength Relations (Q11)

- **Energy difference between energy levels**:

$$(E_C - E_B) + (E_B - E_A) = (E_C - E_A)$$

- **Wavelength relation**:

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

  - Used to determine **X-ray emission wavelengths**.

Summary of Key Concepts

1. **Isoelectronic species**: Counting total electrons in ions and molecules.
2. **Bohr's Model**: Energy levels, spectral series, and transitions.
3. **Balmer series**: Series limit and energy calculation.
4. **de Broglie wavelength**: Wave-particle duality and kinetic energy relations.
5. **Magnetic moments**: Unpaired electrons in transition metals.
6. **Planck's equation**: Energy and wavelength relations.
7. **Comparing wavelengths for different masses** using the **de Broglie equation**.
8. **X-ray emission**: Wavelength and energy transitions.

These are fundamental concepts in **modern physics and quantum mechanics**, essential for **NEET, JEE, and other competitive exams**.