

Concepts Involved in the Given Questions

The image contains questions related to **quantum mechanics, atomic structure, and the Bohr model.**

Below is a breakdown of the main concepts:

1. Heisenberg's Uncertainty Principle (Q12)

- The **uncertainty principle** states that the product of uncertainties in position (Δx) and momentum (Δp) is constrained:

$$\Delta p \cdot \Delta x \geq \frac{h}{4\pi}$$

- Given that $\Delta p = m\Delta v$, we can derive:

$$\Delta v = \frac{h}{4\pi m \Delta x}$$

- This principle means that **it is impossible to precisely measure both position and momentum of a particle simultaneously.**
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2. (n + l) Rule for Energy Levels (Q13)

- The **(n + l) rule** is used to determine the energy of orbitals:
 - Higher $n + l$ value \rightarrow Higher energy.
 - If two orbitals have the same $n + l$, the one with the **lower** n has lower energy.
 - Example ordering:
 - $(n + l) = 5 \rightarrow$ Highest energy
 - $(n + l) = 4 \rightarrow$ Lower energy
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3. Energy Levels and Ionization Energy Calculation (Q14)

- Bohr's equation for **energy levels in hydrogen-like atoms:**

$$E_n = \frac{-Z^2 \times 13.6}{n^2} \text{ eV}$$

where Z is atomic number and n is the quantum number.

- For different ionization energies, we use:

$$I_2 = \frac{Z^2}{n_1^2} \times 13.6 \text{ eV}$$

Substituting values, we find the **second ionization energy.**

4. Bohr's Postulates and Radius of Orbit (Q15)

- **Bohr's model** states:

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

- Using the relation for **radius**:

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

For the second orbit ($n = 2$), $r = 4a_0$.

- **Kinetic energy (KE)** derivation:

$$KE = \frac{h^2}{32\pi^2 m e a_0^2}$$

This formula helps in calculating the kinetic energy of an electron in different orbits.

5. Energy Difference and Wavelength of Photon (Q16)

- The **energy difference** between levels is:

$$\Delta E = 2.178 \times 10^{-18} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

- Using Planck's equation:

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

- Substituting values, we can calculate the **wavelength of emitted radiation**.
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6. Pauli's Exclusion Principle (Q17)

- **Pauli's principle** states:
 - No two electrons can have the same set of **four quantum numbers** in an atom.
 - **Maximum occupancy** per orbital = **2 electrons** with opposite spins.
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7. Energy of Excited States in Hydrogen (Q18)

- The **third energy level** ($n = 3$) corresponds to:

$$E_n = \frac{-13.6}{n^2} \text{ eV}$$

- For $n = 3$:

$$E = \frac{-13.6}{9} = -1.51 \text{ eV}$$

This helps in understanding electron transitions.

8. Isoelectronic Species (Q19)

- **Isoelectronic species** have the **same number of electrons**.
 - Example calculations:
 - $BO_3^{3-} \rightarrow 5 + (8 \times 3) + 3 = 32$ electrons.
 - $NO_3^- \rightarrow 7 + (8 \times 3) + 1 = 32$.
 - Species with **different electron counts are not isoelectronic**.
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9. Energy Required for Excitation (Q20)

- **Energy difference between states** is given by:

$$\Delta E = E_2 - E_1$$

- Energy at $n = 1$:

$$E_1 = -1.312 \times 10^6 \text{ J/mol}$$

- Energy at $n = 2$:

$$E_2 = \frac{-1.312 \times 10^6}{4} = -3.28 \times 10^5 \text{ J/mol}$$

- The energy required to excite the electron is:

$$\Delta E = 9.84 \times 10^5 \text{ J/mol}$$

Summary of Key Concepts

1. **Uncertainty principle:** Limitations in measuring position and momentum simultaneously.
2. **(n + l) rule:** Determines the energy of orbitals.
3. **Bohr's energy levels and ionization energy** calculations.
4. **Wavelength and energy transitions** in hydrogen spectra.
5. **Pauli's exclusion principle:** Limits on electron occupation in orbitals.
6. **Isoelectronic species:** Counting total electrons in ions and molecules.
7. **Excitation energy:** Energy required to move an electron to a higher level.

These concepts are **fundamental to quantum mechanics and atomic physics**, crucial for **NEET, JEE, and other competitive exams**.