Concepts Involved in the Given Questions

The questions in the image cover **quantum mechanics, atomic structure, de Broglie wavelength, kinetic energy, and energy levels**. Below is a breakdown of the key concepts:

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1. Balmer Series and Series Limit (Q21)

- The **Balmer series** consists of spectral lines resulting from electron transitions to $n = 2$ in hydrogen.
- The **series limit** refers to the **shortest wavelength** (highest energy) transition when $n_2 \to \infty$.
- The frequency of emitted radiation is given by:

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

  - Here, $Z = 1$ for hydrogen.
  - The last line of the series occurs when $n_2 \to \infty$.

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2. Bond Dissociation Energy Calculation (Q22)

- **Energy required to break a bond** (Cl–Cl in Cl_2) is given in kJ/mol.
- The energy per molecule is calculated using Avogadro's number (N_A).

$$E = \frac{\text{Bond energy}}{N_A}$$

- Using **Planck's equation**:

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

  - Rearranging gives the bond energy per molecule in terms of wavelength.

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3. de Broglie Wavelength (Q23, Q26)

- **de Broglie wavelength equation**:

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

- Example for a **car moving at 36 km/hr**:
  - Convert speed to **m/s**.
  - Substitute values into **de Broglie equation**.

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4. Bohr's Atomic Model and Electron Orbit Radius (Q24)

- **Bohr's model states** that the **radius of an electron orbit** is given by:

$$r_n = a_0 n^2 Z^{-1}$$

  where a_0 is the Bohr radius.
- For $n = 3$, the orbit radius is:

$$r = 9a_0$$

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5. Orbital Representation (Q25)

- The graph represents a **d-orbital electron density distribution**.
- **For $l = 2$, the orbital is a d-orbital**.
- $r^2\psi^2$ represents the **probability density of the electron**.

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6. Relationship Between Kinetic Energy and Wavelength (Q26)

- Using **kinetic energy relation**:

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

  - Rearranging in terms of de Broglie wavelength:

$$\lambda \propto \frac{1}{\sqrt{KE}}$$

  - If **KE is quadrupled**, the **wavelength becomes half**.

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7. Electronic Configuration and Quantum Numbers (Q27)

- **Rubidium (Rb, Z = 37)** has the configuration:

$$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$$

  - The **last electron enters the 5s orbital**.
  - Quantum numbers:
    - $n = 5$
    - $l = 0$ (s-orbital)
    - $m = 0$, $s = \pm\frac{1}{2}$.

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8. Photoelectric Effect and Kinetic Energy (Q28)

- **Photoelectric equation**:

$$h\nu = h\nu_0 + \frac{1}{2}mv^2$$

  - Rearranging for velocity:

$$v = \sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$$

- This equation determines the velocity of **ejected photoelectrons**.

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9. Total Energy of a Revolving Electron (Q29)

- The **total energy** of an electron in orbit is the sum of its **kinetic** and **potential energy**.

$$KE = \frac{e^2}{2r}, \quad PE = -\frac{e^2}{r}$$

  - Thus, **total energy**:

$$E = KE + PE = -\frac{e^2}{2r}$$

  - This relation applies to Bohr's model.

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10. Energy of 1 Mole of Photons (Q30)

- **Photon energy**:

$$E = N_0 h\nu = \frac{N_0 hc}{\lambda}$$

- Substituting values:
  - **Avogadro's number** $N_0 = 6.023 \times 10^{23}$.
  - **Planck's constant** $h = 6.63 \times 10^{-34}$.
  - **Speed of light** $c = 3.0 \times 10^8$.
- Energy conversion to **kinetic energy**:
  - **Percentage energy used** is calculated as:

$$\frac{\text{Energy converted into KE}}{\text{Total energy}} \times 100$$

Summary of Key Concepts

1. **Balmer series** and spectral limits.
2. **Bond dissociation energy** and wavelength calculations.
3. **de Broglie wavelength** and particle motion.
4. **Bohr's atomic model** for orbit radius.
5. **Quantum numbers** for electron configuration.
6. **Kinetic energy and photoelectric effect**.
7. **Total energy of an orbiting electron** in Bohr's model.
8. **Energy of a mole of photons** and conversion to kinetic energy.

These concepts are crucial for **modern physics and atomic structure**, especially for **NEET, JEE, and other competitive exams**.