# Atomic Structure — NEET Exam-1: Solutions

**Q1.** For $Li^{2+}$ ion, $r_2 : r_5$ is?

**Conceptual Approach:** For a hydrogenic ion, the radius in level $n$ is $r_n = \dfrac{n^2 a_0}{Z}$. Ratios cancel $a_0$ and $Z$.

**Steps:** $r_2 : r_5 = \dfrac{4}{Z} : \dfrac{25}{Z} = 4 : 25$.

**Final Answer:** $\boxed{4 : 25}$ (Option B)

**Q2.** KE of an electron is increased four times. What happens to its de Broglie wavelength?

**Conceptual Approach:** $\lambda = \dfrac{h}{p} = \dfrac{h}{\sqrt{2mK}} \;\Rightarrow\; \lambda \propto \dfrac{1}{\sqrt{K}}$.

**Steps:** $K \mapsto 4K \;\Rightarrow\; \lambda \mapsto \lambda/2$.

**Final Answer:** $\boxed{\text{Half}}$ (Option B)

**Q3.** Maximum number of electrons in a subshell?

**Conceptual Approach:** A subshell with azimuthal quantum number $\ell$ contains $(2\ell+1)$ orbitals; each holds 2 $e^-$.

**Steps:** Max electrons $= 2(2\ell + 1) = 4\ell + 2$.

**Final Answer:** $\boxed{4\ell + 2}$ (Option B)

**Q4.** Orbital angular momentum of an $s$ electron?

**Conceptual Approach:** $L = \sqrt{\ell(\ell+1)}\,\hbar$. For $s$ $(\ell = 0)$, $L = 0$.

**Final Answer:** $\boxed{0}$ (Option C)

**Q5.** Correct quantum numbers for an electron in $4f$?

**Conceptual Approach:** $4f \Rightarrow n = 4,\ \ell = 3,\ m_\ell \in \{-3, \ldots, +3\},\ s = \pm\frac{1}{2}$.

**Final Answer:** $\boxed{n = 4,\ \ell = 3,\ m_\ell = +1,\ s = +\frac{1}{2}}$ (Option D)

**Q6.** Correct set for the 19th electron of Cr?

**Conceptual Approach:** After [Ar] (18 $e^-$), the 19th electron enters $4s$ (aufbau); $\Rightarrow n = 4,\ \ell = 0,\ m_\ell = 0,\ s = +\frac{1}{2}$.

**Final Answer:** $\boxed{n = 4,\ \ell = 0,\ m_\ell = 0,\ s = \frac{1}{2}}$ (Option C)

**Q7.** In which electronic arrangement are *all three* rules (Aufbau, Pauli, Hund) invalid?

> **Conceptual Approach:** In option-3
>
> before completely filling s orbital p orbital id filled so Aufbau's rule is voilted
>
> hunds rule is not followed as first electron should be filled singly
>
> same spin so pauli's rule is voilted .

**Final Answer:** Option-C

**Q8.** Order of orbital energies for H-atom:

> **Conceptual Approach:** For hydrogen, energies depend only on $n$ (degenerate within a shell). Thus $3s = 3p = 3d < 4s = 4p$.

**Final Answer:** $\boxed{3s = 3p = 3d < 4s = 4p}$ (Option C)

**Q9.** Most $\alpha$-particles pass undeflected in Rutherford's experiment because:

> **Conceptual Approach:** The nucleus occupies an extremely small fraction of the atom's volume; the chance of close approach is tiny.

**Final Answer:** Nucleus occupies much smaller volume than atom (Option D)

**Q10.** A dipositive metal has electronic configuration $2, 8, 14$ and atomic weight 56. Neutrons?

> **Conceptual Approach:** $M^{2+}$ has 24 $e^-$ $\Rightarrow$ $Z = 26$ for the neutral atom. Neutrons $= A - Z$.

**Steps:** $A = 56,\ Z = 26 \ \Rightarrow\ N = 56 - 26 = 30.$

**Final Answer:** $\boxed{30}$ (Option A)

**Q11.** Wavelength $= 400\,\text{nm}$. Wavenumber?

> **Conceptual Approach:** Wavenumber $\tilde{\nu} = 1/\lambda$ in $\text{cm}^{-1}$; convert $\lambda$ to cm.

**Steps:** $400\,\text{nm} = 4.00 \times 10^{-7}\,\text{m} = 4.00 \times 10^{-5}\,\text{cm}$;
$\tilde{\nu} = 1/(4.00 \times 10^{-5}) = 2.5 \times 10^{4}\ \text{cm}^{-1}$.

**Final Answer:** $\boxed{2.5 \times 10^{4}\ \text{cm}^{-1}}$ (Option A)

**Q12.** Correct graphical representation (photoelectric effect)?

**Conceptual Approach:**

**I Incorrect.** $K_{\text{max}}$ shown constant with frequency $\nu$. In reality, $K_{\text{max}} = h\nu - \phi = h(\nu - \nu_0)$, so it *increases linearly* with $\nu$ above the threshold $\nu_0$.

**II Correct.** $K_{\text{max}}$ vs $\nu$ is a straight line cutting the $\nu$-axis at $\nu_0$: $K_{\text{max}} = h(\nu - \nu_0)$.

**III Incorrect.** $K_{\text{max}}$ vs *intensity* should be horizontal (independent of intensity) for fixed $\nu > \nu_0$; intensity affects number of electrons, not their maximum KE.

**IV Correct.** Number of photons $\propto$ *intensity* (for fixed $\nu$), hence a straight line through the origin.

**Correct option:** $\boxed{4}$ — (II & IV).

**Final Answer:** $\boxed{\text{Option-4 (II and IV}}$

**Q13.** Which is *not* among shortcomings of Bohr's model?

**Conceptual Approach:** Bohr failed for multi-electron spectra, fine structure and Zeeman effect; but it *does* give discrete energy levels.

**Final Answer:** $\boxed{\text{Statement 4 is NOT a shortcoming (Bohr did give energy levels).}}$

**Q14.** $n_1$ for Paschen series:

**Conceptual Approach:** Paschen series corresponds to transitions ending at $n_1 = 3$.

**Final Answer:** $\boxed{3}$ (Option C)

**Q15.** I: $\ell$ identifies subshell and shape. II: Each subshell type has $(2\ell + 1)$ orbitals.

**Conceptual Approach:** Both statements are standard results from quantum mechanics of atoms.

**Final Answer:** $\boxed{\text{Both I and II are correct}}$ (Option A)

**Q16.** Match the Column–I/II (figure based).

**Conceptual Approach:**

**Diffraction & interference** need the **wave nature** of EM radiation (superposition creates fringes).

The **visible spectrum** from white light is a **continuous spectrum** (no gaps in wavelengths).

**Bohr's frequency rule:** $\nu = \dfrac{E_2 - E_1}{h}$ (photon frequency equals energy gap divided by $h$).

**Emission spectra of gaseous atoms** are **discontinuous line spectra** (only specific quantized wavelengths).

**Final Answer:** $\boxed{\text{— (a–r), (b–s), (c–q), (d–p)}}$ (Option A)

**Q17.** Assertion–Reason: In H atom, $E_{4s} > E_{3d}$; Reason: lower $(n)$ $\Rightarrow$ lower energy.

**Conceptual Approach:** For hydrogen, energy depends only on $n$: $E_{3d} < E_{4s}$, so Assertion is true. The $(n + \ell)$ rule applies to multi-electron atoms, not H; here it would even predict $4s < 3d$.

**Final Answer:** $\boxed{\text{(A) correct, (R) correct (for multi-elctron species)}}$ (Option A)

**Q18.** Match the Column–I/II (figure based).

**Conceptual Approach:**

(a) $\rightarrow$ (p) The orbital wave function $\psi$ has **no direct physical meaning**; only $|\psi|^2$ is measurable (probability density).

(b) $\rightarrow$ (q) **Total nodes** in a hydrogenic orbital = radial + angular = $(n - \ell - 1) + \ell = \mathbf{n - 1}$.

(c) $\rightarrow$ (r) For **1s**, $|\psi|^2$ is **maximum at the nucleus** $(r = 0)$ and decreases rapidly with $r$.

(d) $\rightarrow$ (s) **Nodal surfaces**: loci where $|\psi|^2 = 0$ (probability density vanishes).

**Correct option:** $\boxed{4}$ — (a–p), (b–q), (c–r), (d–s).

**Final Answer:** $\boxed{\text{opyion-D.}}$

**Q19.** Binding energy of H ground state = 13.6 eV. Energy to remove $e^-$ from first excited state of $Li^{2+}$?

**Conceptual Approach:** Hydrogenic levels: $|E_n| = 13.6 \, \frac{Z^2}{n^2}$ eV. For $Li^{2+}$, $Z = 3$, first excited $n = 2$.

**Steps:** $|E_2| = 13.6 \times \frac{9}{4} = 30.6$ eV.

**Final Answer:** $\boxed{30.6 \text{ eV}}$ (Option B)

**Q20.** Third line from the red end in the Bohr (Balmer) series corresponds to?

**Conceptual Approach:** Red end is H-$\alpha$ $(3 \rightarrow 2)$. Counting lines: $3 \rightarrow 2$ (H$\alpha$), $4 \rightarrow 2$ (H$\beta$), $5 \rightarrow 2$ (H$\gamma$).

**Final Answer:** $\boxed{5 \rightarrow 2}$ (Option B)

**Q21.** Golf ball $m = 40\,\text{g} = 0.04\,\text{kg}$, $v = 45\,\text{m s}^{-1}$, 2% speed accuracy. Uncertainty in position?

**Conceptual Approach:** Heisenberg: $\Delta x \, \Delta p \geq \frac{\hbar}{2}$. With $\Delta p = m \, \Delta v$, $\Delta x \geq \frac{\hbar}{2m \, \Delta v}$.

**Steps:** $\Delta v = 0.02 \times 45 = 0.9 \text{ m s}^{-1}$;

$$\Delta x \geq \frac{1.054 \times 10^{-34}}{2 \times 0.04 \times 0.9} \approx 1.46 \times 10^{-33} \text{ m}.$$

**Final Answer:** $\boxed{1.46 \times 10^{-33} \text{ m}}$ (Option A)

**Q22.** Ionization energy of Na(g) = 495.5 kJ mol$^{-1}$. Lowest frequency to ionize a Na atom?

**Conceptual Approach:** $E = h\nu$. Convert molar energy to per-atom: divide by $N_A$, then $\nu = E/h$.

**Steps:** $E_{\text{atom}} = \dfrac{495.5 \times 10^3}{6.022 \times 10^{23}} \approx 8.23 \times 10^{-19}$ J;
$\nu = \dfrac{8.23 \times 10^{-19}}{6.626 \times 10^{-34}} \approx 1.24 \times 10^{15}\ \text{s}^{-1}$.

**Final Answer:** $\boxed{1.24 \times 10^{15}\ \text{s}^{-1}}$ (Option C)