Atomic Structure — Exam- 1 (JEE) (Concise Solutions)

Q1. The ionization energy of ground-state H is 2.18×10^{-18} J. Energy of $n = 2$ electron?

Conceptual Approach: In H, $E_n = -\dfrac{E_1}{n^2}$ where E_1 equals the ionization energy from $n = 1$.

Steps: $E_2 = -\dfrac{2.18 \times 10^{-18}}{2^2} = -5.45 \times 10^{-19}\,\text{J}$.

Final Answer: $\boxed{-5.45 \times 10^{-19}\ \text{J}}$ (Option D)

Q2. For a d-electron, orbital angular momentum?

Conceptual Approach: $L = \sqrt{\ell(\ell+1)}\,\hbar$, with $\ell = 2$ for d; $\hbar = \dfrac{h}{2\pi}$.

Final Answer: $\boxed{\sqrt{6}\,h/(2\pi)}$ (Option A)

Q3. Order of increasing energy for (i) $4p$, (ii) $4s$, (iii) $3d$, (iv) $3p$.

Conceptual Approach: Use $n + \ell$ rule; for a tie, lower n is lower in energy.

Steps: $4p : 5,\ 4s : 4,\ 3d : 5,\ 3p : 4 \Rightarrow 3p < 4s < 3d < 4p$.

Final Answer: $\boxed{\text{iv} < \text{ii} < \text{iii} < \text{i}}$ (Option A)

Q4. Ground state configuration of N.

Conceptual Approach: $Z = 7$; fill by Aufbau and Hund's rule.

Final Answer: $\boxed{1s^2\,2s^2\,2p^3}$ (Option A)

Q5. Why $(1s)^7$ not observed though closer to nucleus?

Conceptual Approach: Max 2 electrons per orbital with opposite spins.

Final Answer: Pauli exclusion principle is violated. (Option C)

Q6. Which statement on ψ is NOT correct?

Conceptual Approach: Physical probability $\propto |\psi|^2$, not ψ itself.

Final Answer: $\boxed{\text{“}\psi \text{ is proportional to probability” is incorrect}}$ (Option D)

Q7. Which set of quantum numbers is *not* allowed?

Conceptual Approach: For shell n: $0 \le \ell \le n-1$; $m_\ell \in \{-\ell, \ldots, +\ell\}$.

Steps: (A) n=2, ℓ=1, m= + 2 invalid; (B) n=2, ℓ=1 invalid; (C) $2, 0, 0$ valid; (D) $2, 1, -1$ valid.

Final Answer: $\boxed{\text{(A) and (B) are not allowed.}}$ *(If single-correct was intended, item is ambiguous.)*

Q8. Photoelectric effect: I vs. frequency statements.

Conceptual Approach: Number of emitted electrons $\propto$ intensity; frequency controls photon energy/KE (above threshold).

Final Answer: $\boxed{\text{Statement I incorrect; Statement II correct}}$ (Option D)

Q9. Match H spectral series: Lyman/Balmer/Paschen/Pfund with n_1.

Conceptual Approach: Lyman n_1=1; Balmer n_1=2; Paschen n_1=3; Pfund n_1=5.

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

Q10. Match orbitals with characteristic properties.

Conceptual Approach: 2s orbital has one radial node and zero nodal plane and s has 2 radial node and zero nodal plane. From these two only answer is coming

Q11 (Integer). Count correct Bohr-theory statements.

Conceptual Approach: For H-like circular orbits: $U = -2K$ and $E = K + U = -K$.

Steps: (A) $K = \frac{1}{2}|U|$ true; (B) $K = |U|$ false; (C) $E = -K$ true; (D) $U = -mv^2$ true (since $U = -2K$ and $K = \frac{1}{2}mv^2$).

Final Answer: $\boxed{3}$

Q12 (Integer). For Li^{2+}, $r_2 : r_5 = x : 25$. Find x.

Conceptual Approach: Hydrogenic radius: $r_n = \dfrac{n^2 a_0}{Z}$.

Steps: For $Z = 3$: $r_2 : r_5 = (4/3) : (25/3) = 4 : 25$.

Final Answer: $\boxed{4}$

Q13 (Integer). A dipositive ion has electron distribution $2, 8, 14$; atomic weight 56. Neutrons?

Conceptual Approach: Given configuration is for M^{2+} with 24 e^-; neutral atom has $Z = 26$.

Steps: Neutrons $= A - Z = 56 - 26 = 30$.

Final Answer: $\boxed{30}$