Mix Test-1

Some Basic concepts of chemistry + Atomic Structure

— *JEE Solutions*

Q1. Magnitude of energy in the first excited state of Be^{3+}?

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

Steps: $|E_2| = 13.6 \times \frac{4^2}{2^2} = 13.6 \times 4 = 54.4$ eV ≈ 54 eV. **Final Answer:** $\boxed{54 \text{ eV}}$ (Option 2)

Q2. Radius of the first excited state of He^+?

> **Conceptual Approach:** Bohr radius: $r_n = \frac{n^2 a_0}{Z}$. For He^+, $Z = 2$, first excited $n = 2$.

Steps: $r = \frac{4a_0}{2} = 2a_0$. **Final Answer:** $\boxed{2a_0}$ (Option 2)

Q3. (I) A spectral line will be observed for $2p_x \to 2p_y$. (II) $2p_x$ and $2p_y$ are degenerate.

> **Conceptual Approach:** Transitions emit photons only for $\Delta E \neq 0$. Orbitals with same n, ℓ are degenerate (same energy) in absence of fields.

Final Answer: $\boxed{\text{I false, II true}}$ (Option 1)

Q4. Suitable H spectral line for $\lambda \approx 900\,\text{nm}$?

Conceptual Approach: 900 nm lies in near IR. Hydrogen IR series with $n_1 = 3$ is **Paschen**. The series spans $\sim$ 821–1875 nm.

Steps: For n_1=3, $\lambda_{\text{limit}} = \dfrac{1}{R_H/9} \approx 821$ nm; a line with $n_2 \approx 10$ gives $\sim$ 900 nm. **Final Answer:** $\boxed{\text{Paschen series}}$ (closest option: $3 \to \infty$, Option 4)

Q5. Degeneracy in a multi-electron atom (no fields): which have same energy?

Conceptual Approach: In multi-electron atoms, E depends on n *and* ℓ (not m_ℓ). Same $(n, \ell) \Rightarrow$ degenerate.

Final Answer: $\boxed{(3, 2, 1) \text{ and } (3, 2, 0)}$ (D and E only, Option 4)

Q6. Sequences of orbital energies in H atom — which are *not* correct?

Conceptual Approach: For H, E depends only on n: $1s < 2s{=}2p < 3s{=}3p{=}3d < 4s{=}4p{=}4d{=}4f$.

Steps: (3) shows $2s < 2p$ (wrong); (4) shows $4s < 3d$ (wrong).
(1) and (2) are consistent with n-ordering (equalities implied within a shell). **Final Answer:** $\boxed{\text{(3) and (4) are not correct.}}$ *(If single-correct is enfo*

Q7. Heisenberg statements:
(I) Impossible to specify x and p simultaneously with arbitrary precision.
(II) If $\Delta x = \Delta p$ for electron, then $\Delta v \geq \dfrac{h}{2\pi m}$.

Conceptual Approach: $\Delta x\,\Delta p \geq \dfrac{\hbar}{2}$. Statement (I) is the principle; (II) is dimensionally and conceptually wrong ($\Delta v = \Delta p/m$).

Final Answer: $\boxed{\text{I true, II false}}$ (Option 4)

Q8. Truth about the $2p_x$ orbital.

Conceptual Approach: ℓ tells shape; $+/-$ on ψ denotes phase (not charge); nodal plane for $2p_x$ is yz (i.e. x=0), not the xy plane.

Final Answer: $\boxed{(A)\ \&\ (B)\text{ only}}$ (Option 1)

Q9. Empirical formula mass from % composition: C 14.5%, H 1.8%, Cl 64.46%, (O by diff.) 19.24%.

Conceptual Approach: Take 100 g: convert to moles → simplest ratio → empirical formula → mass.

Steps: $n_{\mathrm{C}} = 14.5/12 = 1.208$, $n_{\mathrm{H}} = 1.8$, $n_{\mathrm{Cl}} = 64.46/35.5 = 1.816$, $n_{\mathrm{O}} = 19.24/16 = 1.202$.
Divide by 1.202: C 1.00, H 1.50, Cl 1.51, O 1.00 $\Rightarrow\ \times 2 \Rightarrow\ C_2H_3Cl_3O_2$.
$M = 2(12) + 3(1) + 3(35.5) + 2(16) = 165.5\ \mathrm{g\,mol^{-1}} = 1655 \times 10^{-1}$.
Final Answer: $\boxed{1655 \times 10^{-1}}$ (Option 2)

Q10. Largest number of atoms among: 4.0 g H_2, 71.0 g Cl_2, 127.0 g I_2, 48.0 g Mg.

Conceptual Approach: Atoms = (moles of species)× (atoms per molecule/atom).

Steps: $4\,\mathrm{g}\ H_2 \Rightarrow 2$ mol molecules $\Rightarrow 4$ mol atoms; $71\,\mathrm{g}\ Cl_2 \Rightarrow 1$ mol

$\Rightarrow$ 2 mol atoms;
127 g $I_2 \Rightarrow$ 0.5 mol $\Rightarrow$ 1 mol atoms; 48 g Mg $\Rightarrow$ 2 mol atoms. **Final Answer:** $\boxed{\text{4.0 g hydrogen}}$ (Option 1)

Q11. 20 mL of 2 M NaOH mixed with 400 mL of 0.5 M NaOH. Final concentration $= \cdots \times 10^{-2}$ M (nearest integer).

Conceptual Approach: Moles add; volumes add. $M_{\text{final}} = \dfrac{n_1 + n_2}{V_1 + V_2}$.

Steps: $n_1 = 0.020 \times 2 = 0.040$; $n_2 = 0.400 \times 0.5 = 0.200$; total $= 0.240$ mol. $V = 0.420$ L.
$M = 0.240/0.420 = 0.5714$ M $= 57.14 \times 10^{-2}$ M. **Final Answer:** $\boxed{57}$

Q12. In sulphur estimation, 160 mg compound $\rightarrow$ 466 mg $BaSO_4$. %S =?

Conceptual Approach: Mass of S in $BaSO_4$ is $\dfrac{32}{233}$ of its mass. $\%\text{S} = \dfrac{m_S}{m_{\text{sample}}} \times 100$.

Steps: $m_S = 466 \times \dfrac{32}{233} \approx 64.0$ mg; $\%\text{S} = 64/160 \times 100 = 40\%$. **Final Answer:** $\boxed{40}$

Q13. CaO from 150 kg limestone (75% pure).

Conceptual Approach: $CaCO_3$ (100) $\xrightarrow{\Delta}$ CaO (56) + CO_2. Yield is proportional to purity.

Steps: Pure $CaCO_3 = 0.75 \times 150 = 112.5$ kg. CaO mass $= 112.5 \times$

$$\frac{56}{100} = 63.0 \text{ kg}.$$ **Final Answer:** $\boxed{63 \text{ kg}}$