SRMJEEE Chemistry Sample Paper – 2

Duration: 41 Minutes **Maximum Marks: 35**

Instructions

- This paper contains **35** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry section of **SRMJEEE** (SRM Joint Engineering Entrance Examination).
- Each correct answer carries **+1 mark**. There is **no negative marking**; an unattempted or wrong answer scores 0.
- Only **one** option is correct. Choose carefully.
- The actual SRMJEEE is a **computer-based test** conducted in remote-proctored online mode, with all sections sharing a common time window and no per-section limit.
- Personal calculators, mobile phones, log tables and other electronic gadgets are strictly prohibited.

Q1. A solution is prepared by dissolving 2 mol of a solute in 8 mol of solvent. The mole fraction of the solute in the solution is:

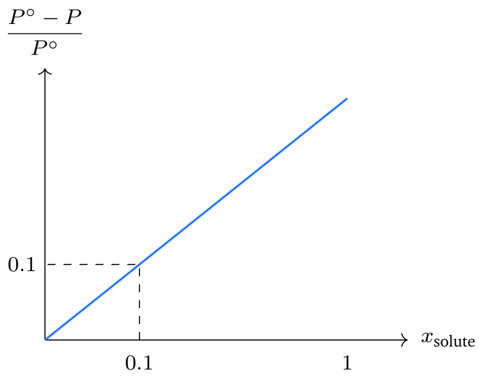
(A) 0.80

(B) 0.25

(C) 0.20

(D) 0.50

Q2. For a dilute solution of a non-volatile solute, the relative lowering of vapour pressure equals the mole fraction of the solute, as the linear plot shows. If 0.5 mol of solute is dissolved in 4.5 mol of solvent, the relative lowering of vapour pressure $\dfrac{P^\circ - P}{P^\circ}$ is:



(A) 0.10

(B) 0.50

(C) 0.90

(D) 0.05

Q3. The osmotic pressure of a 0.1 mol L^{-1} solution of glucose at 300 K is (take $R = 0.0821$ L atm $\text{K}^{-1}\text{mol}^{-1}$, $i = 1$):

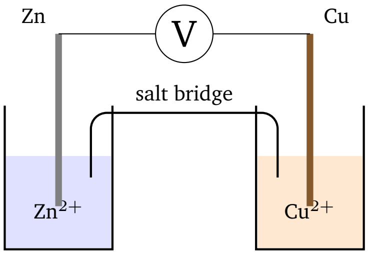
(A) 1.23 atm

(B) 2.46 atm

(C) 4.92 atm

(D) 24.6 atm

Q4. For the cell shown, $E^\circ_{\text{cell}} = 1.10$ V. Using the Nernst equation at 298 K, if the concentration of Cu^{2+} in the cathode compartment is *increased*, the cell potential E_{cell} will:



(A) become exactly 0 V

(B) fall below 1.10 V

(C) remain exactly 1.10 V

(D) rise above 1.10 V

Q5. Given $\lambda^\circ_{\text{H}^+} = 350$ S cm^{2}mol^{-1} and $\lambda^\circ_{\text{CH}_3\text{COO}^-} = 41$ S cm^{2}mol^{-1}, the limiting molar conductivity Λ°_m of acetic acid (a weak electrolyte), from Kohlrausch's law of independent migration, is:

(A) 309 S cm^{2}mol^{-1}

(B) 700 S cm^{2}mol^{-1}

(C) 391 S cm^{2}mol^{-1}

(D) 41 S cm^{2}mol^{-1}

Q6. When 0.2 faraday of charge is passed through molten/aqueous Cu^{2+}, the mass of copper deposited is (atomic mass of Cu $= 63.5$, $1\ F = 96500$ C):

(A) 6.35 g

(B) 12.70 g

(C) 63.5 g

(D) 3.18 g

Q7. For a reaction that is *first order* overall, the units of the rate constant k are:

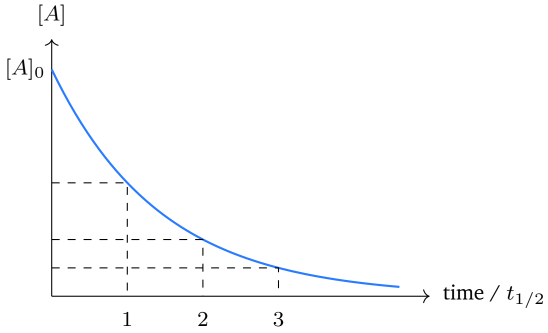
(A) mol L^{-1}s^{-1}

(B) s^{-1}

(C) L mol^{-1}s^{-1}

(D) L^{2}mol^{-2}s^{-1}

Q8. A first-order reaction is followed as shown. After *three* half-lives have elapsed, the fraction of the reactant still remaining is:



(A) $\frac{1}{2}$

(B) $\frac{1}{4}$

(C) $\frac{1}{3}$

(D) $\frac{1}{8}$

Q9. In the Arrhenius equation, a plot of $\ln k$ against $\frac{1}{T}$ is a straight line. The activation energy E_a of the reaction is obtained from the line's:

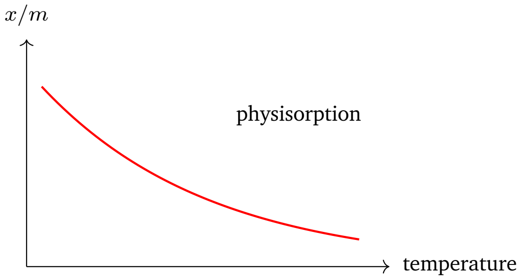
(A) intercept, which equals E_a

(B) slope $= +E_a/R$

(C) slope $= -E_a/R$

(D) intercept, which equals E_a/R

Q10. The adsorption of a gas on a solid is studied as the temperature is raised, giving the curve shown for one type of adsorption. Compared with chemisorption, *physisorption* is characterised by:



(A) a low enthalpy of adsorption and no specificity (weak van der Waals forces)

(B) a high enthalpy of adsorption and high specificity

(C) the formation of strong chemical bonds with the surface

(D) an enthalpy of adsorption near 200 kJ mol^{-1}

Q11. The continuous random zig-zag movement of colloidal particles in a sol (Brownian motion) is caused by:

(A) the electric charge on the dispersion medium

(B) unequal bombardment of the particles by the molecules of the dispersion medium

(C) gravitational settling of the particles

(D) the scattering of light by the particles

Q12. In the contact process, SO_2 is oxidised to SO_3 over solid V_2O_5. This is an example of:

(A) homogeneous catalysis

(B) enzyme catalysis

(C) acid–base catalysis in solution

(D) heterogeneous catalysis

Q13. Among the halogens, the *strongest oxidising agent* (and the most electronegative element) is:

(A) I_2

(B) Br_2

(C) F_2

(D) Cl_2

Q14. The oxidation state of chlorine in perchloric acid, $HClO_4$, is:

(A) $+7$

(B) $+5$

(C) $+3$

(D) $+1$

Q15. The correct order of *thermal stability* of the group-15 hydrides is:

(A) $SbH_3 > AsH_3 > PH_3 > NH_3$

(B) $NH_3 > PH_3 > AsH_3 > SbH_3$

(C) $PH_3 > NH_3 > AsH_3 > SbH_3$

(D) $AsH_3 > NH_3 > PH_3 > SbH_3$

Q16. The spin-only magnetic moment $\mu = \sqrt{n(n+2)}$ BM of the Fe^{3+} ion (which has five unpaired d-electrons) is approximately:

(A) 1.73 BM

(B) 2.83 BM

(C) 4.90 BM

(D) 5.92 BM

Q17. In potassium dichromate, $K_2Cr_2O_7$, the oxidation state of chromium is:

(A) $+3$

(B) $+7$

(C) $+6$

(D) $+2$

Q18. Across the $3d$ transition series (Sc to Zn), the atomic radii:

(A) first decrease, stay nearly constant in the middle, then increase slightly towards the end

(B) increase steadily and continuously

(C) decrease sharply and uniformly throughout

(D) remain exactly the same for every element

Q19. The IUPAC name of the coordination compound $[Co(NH_3)_6]Cl_3$ is:

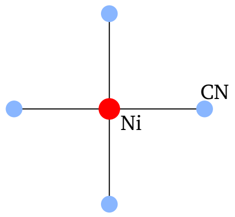
(A) hexaamminecobalt(II) chloride

(B) hexaamminecobalt(III) chloride

(C) hexaamminecobaltate(III) chloride

(D) cobalt hexaammine trichloride

Q20. The complex ion $[Ni(CN)_4]^{2-}$ has the geometry sketched below, with the four ligands at the corners of a square around the central nickel. Its coordination number and geometry are:



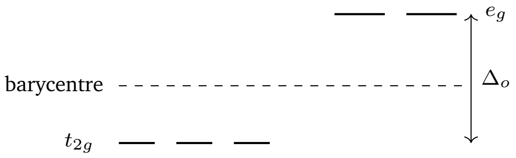
(A) 4, tetrahedral

(B) 6, octahedral

(C) 4, square planar

(D) 2, linear

Q21. The octahedral splitting diagram below shows the gap Δ_o between the t_{2g} and e_g sets. A *strong-field* ligand (large Δ_o) tends to give a complex that is:



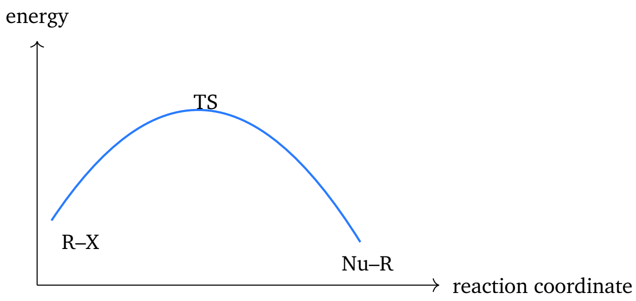
(A) high-spin, with the maximum number of unpaired electrons

(B) paramagnetic regardless of Δ_o

(C) identical to a weak-field complex

(D) low-spin, because electrons pair up in t_{2g} before filling e_g

Q22. A primary alkyl halide reacts with a nucleophile through the *single*-hump energy profile shown, passing through one transition state in which the nucleophile attacks from the side opposite the leaving group. This mechanism is:



(A) S_N1 (via a carbocation, two steps)

(B) S_N2 (single step, concerted, with inversion of configuration)

(C) E1 elimination

(D) free-radical substitution

Q23. When an alkyl halide is heated with *aqueous* KOH, the major product is:

(A) an alcohol

(B) an alkene

(C) an ether

(D) an alkane

Q24. Nucleophilic substitution in haloarenes is greatly accelerated when electron-withdrawing groups are present at the ortho/para positions. The group that most strongly *activates* chlorobenzene towards nucleophilic substitution is:

(A) $-CH_3$ at the para position

(B) $-OCH_3$ at the para position

(C) $-NO_2$ at the ortho and para positions

(D) $-NH_2$ at the para position

Q25. On controlled oxidation, a primary, a secondary and a tertiary alcohol respectively give:

(A) ketone, aldehyde, and no easy oxidation

(B) carboxylic acid, ketone, and an aldehyde

(C) aldehyde, carboxylic acid, and a ketone

(D) aldehyde (then acid), a ketone, and resistance to oxidation (no C–H on the carbinol carbon)

Q26. Which of the following substituted phenols is the *most acidic*?

(A) p-cresol (p-CH_3–C_6H_4–OH)

(B) p-nitrophenol (p-NO_2–C_6H_4–OH)

(C) p-methoxyphenol (p-CH_3O–C_6H_4–OH)

(D) phenol itself

Q27. When methoxyethane (CH_3–O–C_2H_5) is heated with an *excess* of hot concentrated HI, the organic products formed are:

(A) CH_3I and C_2H_5I

(B) CH_3OH and C_2H_5OH

(C) CH_3I and C_2H_5OH only

(D) CH_4 and C_2H_6

Q28. The nucleophilic addition of HCN across the carbonyl group of acetaldehyde (CH_3CHO) gives a product known as a:

(A) hemiacetal

(B) Schiff base (imine)

(C) oxime

(D) cyanohydrin

Q29. Which of the following carbonyl compounds *undergoes* the aldol condensation (because it possesses at least one α-hydrogen)?

(A) benzaldehyde, C_6H_5CHO

(B) formaldehyde, HCHO

(C) acetaldehyde, CH_3CHO

(D) benzophenone, $(C_6H_5)_2CO$

Q30. The correct order of *decreasing acidic strength* among the four species is:

(A) phenol $>$ carboxylic acid $>$ water $>$ alcohol

(B) carboxylic acid $>$ phenol $>$ water $>$ alcohol

(C) water $>$ alcohol $>$ phenol $>$ carboxylic acid

(D) alcohol $>$ water $>$ phenol $>$ carboxylic acid

Q31. Aniline ($C_6H_5NH_2$) is a *weaker* base than methylamine (CH_3NH_2). The main reason is that in aniline:

(A) the lone pair on nitrogen is delocalised into the benzene ring, reducing its availability

(B) nitrogen has no lone pair at all

(C) the $-NH_2$ group is positively charged

(D) there is strong intramolecular hydrogen bonding to the ring

Q32. Aniline is converted to benzene diazonium chloride by treatment with:

(A) $NaNO_2$ and dilute HCl at 60–70 °C

(B) concentrated H_2SO_4 alone, at room temperature

(C) Br_2 water at 0 °C

(D) $NaNO_2$ and dilute HCl at 0–5 °C

Q33. The reagent used in Hinsberg's test to distinguish between primary, secondary and tertiary amines is:

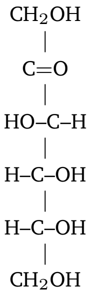
(A) nitrous acid ($NaNO_2$ + HCl)

(B) chloroform and alcoholic KOH

(C) benzenesulphonyl chloride ($C_6H_5SO_2Cl$)

(D) Tollens' reagent

Q34. The open-chain Fischer projection of fructose is shown. On the basis of the carbonyl group (at C-2) and the number of carbon atoms, fructose is classified as:



$$\begin{array}{c} CH_2OH \\ | \\ C{=}O \\ | \\ HO{-}C{-}H \\ | \\ H{-}C{-}OH \\ | \\ H{-}C{-}OH \\ | \\ CH_2OH \end{array}$$

(A) an aldohexose

(B) a ketohexose

(C) a ketopentose

(D) an aldopentose

Q35. At its isoelectric point, an α-amino acid such as glycine exists predominantly as a dipolar ion (zwitterion). Its structure at this pH is:

(A) $\overset{+}{N}H_3{-}CH_2{-}COO^-$ (net charge zero)

(B) $H_2N{-}CH_2{-}COOH$ (fully neutral, uncharged)

(C) $\overset{+}{N}H_3{-}CH_2{-}COOH$ (net charge $+1$)

(D) $H_2N{-}CH_2{-}COO^-$ (net charge -1)

Detailed Solutions

Q1.

Solution

Concept — Mole fraction: the mole fraction of a component is its moles divided by the total moles of all components: $x_{\text{solute}} = \dfrac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}}$.

Step 1 — Total moles: $n_{\text{total}} = 2 + 8 = 10$ mol.

Step 2 — Mole fraction of solute: $x_{\text{solute}} = \dfrac{2}{10} = 0.20$.

Why other options are wrong:

- (A) 0.80 is the mole fraction of the *solvent*.
- (B) 0.25 wrongly divides moles of solute by moles of solvent $(2/8)$.
- (D) 0.50 would require equal moles of solute and solvent.

Final Answer: $x_{\text{solute}} = 0.20 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Relative lowering of vapour pressure: for a dilute solution of a non-volatile solute, Raoult's law gives $\dfrac{P^\circ - P}{P^\circ} = x_{\text{solute}}$, the mole fraction of the solute. The plot is therefore a straight line of slope 1 through the origin.

Step 1 — Mole fraction of solute: $x_{\text{solute}} = \dfrac{0.5}{0.5 + 4.5} = \dfrac{0.5}{5.0} = 0.10$.

Step 2 — Read off the relation: since the relative lowering equals the solute mole fraction, $\dfrac{P^\circ - P}{P^\circ} = 0.10$.

Why other options are wrong:

- (B) 0.50 wrongly uses moles of solute over moles of solvent.
- (C) 0.90 is the solvent mole fraction, not the lowering.
- (D) 0.05 halves the correct value.

Final Answer: $\dfrac{P^\circ - P}{P^\circ} = 0.10 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Osmotic pressure: $\pi = iCRT$, where C is molar concentration, i the van't Hoff factor, R the gas constant and T the temperature in kelvin. Glucose is a non-electrolyte, so $i = 1$.

Step 1 — Substitute:

$$\pi = (1)(0.1)(0.0821)(300).$$

Step 2 — Compute: $0.1 \times 0.0821 \times 300 = 2.463 \approx 2.46$ atm.

Why other options are wrong:

- (A) 1.23 uses $T = 150$ K or halves the concentration.
- (C) 4.92 doubles the value (as if $i = 2$).
- (D) 24.6 misplaces a decimal (uses $C = 1$ mol L^{-1}).

Final Answer: $\pi = 2.46$ atm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Nernst equation: for the Daniell cell, $E_{\text{cell}} = E^\circ_{\text{cell}} - \dfrac{0.059}{2} \log \dfrac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$. Increasing $[\text{Cu}^{2+}]$ makes the log term *smaller* (more negative argument is avoided; the ratio decreases), so the subtracted quantity decreases and E_{cell} rises.

Step 1 — Effect of raising $[\text{Cu}^{2+}]$: a larger $[\text{Cu}^{2+}]$ lowers the ratio $\dfrac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$, making $\log(\cdots)$ negative.

Step 2 — Result: subtracting a negative number adds to E°_{cell}, so $E_{\text{cell}} > 1.10$ V.

Why other options are wrong:

- (B) the potential would *fall* only if $[\text{Cu}^{2+}]$ were decreased.
- (A),(C) the potential neither vanishes nor stays fixed when a concentration is changed.

Final Answer: E_{cell} rises above 1.10 V $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Kohlrausch's law of independent migration: at infinite dilution each ion contributes independently, so $\Lambda^\circ_m = \nu_+\lambda^\circ_+ + \nu_-\lambda^\circ_-$. This lets us find Λ°_m of a weak electrolyte (which cannot be measured directly) from ionic values.

Step 1 — For acetic acid (CH_3COOH): it furnishes one H^+ and one CH_3COO^-, so

$$\Lambda^\circ_m = \lambda^\circ_{\mathrm{H}^+} + \lambda^\circ_{\mathrm{CH_3COO^-}}.$$

Step 2 — Add: $350 + 41 = 391$ S cm^{2}mol^{-1}.

Why other options are wrong:

- (A) 309 subtracts instead of adding the ionic conductivities.
- (B) 700 wrongly doubles $\lambda^\circ_{\mathrm{H}^+}$.
- (D) 41 uses only the acetate ion.

Final Answer: $\Lambda^\circ_m = 391\ \mathrm{S\ cm^2mol^{-1}} \Rightarrow \boxed{\mathrm{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept — Faraday's first law: the mass deposited is $w = \dfrac{M}{nF} \times Q$, where n is the number of electrons per ion and Q is the charge in coulombs (or, in faradays, $w = \dfrac{M}{n} \times$ (faradays passed)).

Step 1 — For Cu^{2+}: $n = 2$, so depositing one mole of Cu needs 2 faradays; the equivalent mass is $\dfrac{63.5}{2} = 31.75$ g per faraday.

Step 2 — Charge passed $= 0.2\ F$: $w = 0.2 \times 31.75 = 6.35$ g.

Why other options are wrong:

- (B) 12.70 treats Cu as if $n = 1$.
- (C) 63.5 is the mass for a full 2 faradays (one mole).
- (D) 3.18 halves the correct value.

Final Answer: $w = 6.35\ \mathrm{g} \Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Units of the rate constant: for an n-th order reaction the units of k are $(\text{mol L}^{-1})^{1-n}\,\text{s}^{-1}$, obtained by dimensional balance of rate $= k[\text{A}]^n$.

Step 1 — Put $n = 1$: units $= (\text{mol L}^{-1})^{1-1}\text{s}^{-1} = (\text{mol L}^{-1})^0\text{s}^{-1} = \text{s}^{-1}$.

Step 2 — Cross-check: rate $(\text{mol L}^{-1}\ \text{s}^{-1}) = k\times$ [A] (mol L^{-1}) forces k to be s^{-1}.

Why other options are wrong:

- (A) $\text{mol L}^{-1}\text{s}^{-1}$ are the units for a *zero*-order constant.
- (C) $\text{L mol}^{-1}\text{s}^{-1}$ is second order; (D) is third order.

Final Answer: k has units $\text{s}^{-1} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Half-lives of a first-order reaction: each half-life halves the amount remaining, independent of concentration. After n half-lives the fraction left is $\left(\frac{1}{2}\right)^n$.

Step 1 — Put $n = 3$: fraction remaining $= \left(\frac{1}{2}\right)^3 = \frac{1}{8}$.

Step 2 — Graph check: the dashed lines show $[A]$ halving at each $t_{1/2}$: $1 \to \frac{1}{2} \to \frac{1}{4} \to \frac{1}{8}$ at the third half-life.

Why other options are wrong:

- (A) $\frac{1}{2}$ is after one half-life; (B) $\frac{1}{4}$ is after two.
- (C) $\frac{1}{3}$ has no basis in repeated halving.

Final Answer: fraction $= \frac{1}{8} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Arrhenius equation (logarithmic form): taking logs of $k = A\,e^{-E_a/RT}$ gives $\ln k = \ln A - \dfrac{E_a}{R}\cdot\dfrac{1}{T}$. This is a straight line of $\ln k$ versus $1/T$.

Step 1 — Identify the slope: comparing with $y = c + mx$, the slope $m = -\dfrac{E_a}{R}$.

Step 2 — Extract E_a: hence $E_a = -R \times (\text{slope})$; the two-point form $\ln\dfrac{k_2}{k_1} = -\dfrac{E_a}{R}\left(\dfrac{1}{T_2} - \dfrac{1}{T_1}\right)$ uses the same slope.

Why other options are wrong:

- (B) the slope is negative, $-E_a/R$, not $+E_a/R$.
- (A),(D) the intercept is $\ln A$, related to the pre-exponential factor, not E_a.

Final Answer: slope $= -E_a/R \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Physisorption vs chemisorption: physisorption arises from weak van der Waals forces (low enthalpy, 20–40 kJ mol^{-1}, not specific, reversible, decreases with rising temperature), whereas chemisorption involves chemical bond formation (high enthalpy, 80–240 kJ mol^{-1}, highly specific).

Step 1 — Match the description: “low enthalpy and no specificity” is the hallmark of physisorption; the curve falling as temperature rises is also typical of physical adsorption.

Why other options are wrong:

- (B),(C) high enthalpy, high specificity and strong chemical bonds describe *chemisorption*.
- (D) ~ 200 kJ mol^{-1} is a chemisorption-scale enthalpy.

Final Answer: low enthalpy, no specificity (van der Waals) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Brownian motion: colloidal particles are bombarded unequally from all sides by the rapidly moving molecules of the dispersion medium. The net unbalanced force at any instant pushes each particle in a random direction.

Step 1 — Cause: the unequal molecular bombardment produces the continuous, random zig-zag motion of the sol particles, which also helps keep the colloid stable against settling.

Why other options are wrong:

- (A) the motion is due to molecular collisions, not a charge on the medium.
- (C) Brownian motion opposes gravitational settling; (D) light scattering is the Tyndall effect, a separate phenomenon.

Final Answer: unequal bombardment by medium molecules $\Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q11**

Q12.

Solution

Concept — Homogeneous vs heterogeneous catalysis: in homogeneous catalysis the catalyst and reactants are in the same phase; in heterogeneous catalysis they are in *different* phases (commonly a solid catalyst with gaseous or liquid reactants).

Step 1 — Identify the phases: SO_2 and O_2 are gases, while V_2O_5 is a solid catalyst $\Rightarrow$ the reactants and catalyst are in different phases.

Step 2 — Classify: different phases $\Rightarrow$ heterogeneous (contact/surface) catalysis.

Why other options are wrong:

- (A) homogeneous would require the catalyst in the same (gas) phase.
- (B),(C) no enzyme and no solution-phase acid–base catalyst is involved here.

Final Answer: heterogeneous catalysis $\Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q12**

Q13.

Solution

Concept — Oxidising power of halogens: oxidising strength falls down the group $F_2 > Cl_2 > Br_2 > I_2$, because the small fluorine atom has the highest electronegativity and a very favourable (highly negative) electron-gain/hydration energetics, making F_2 the strongest oxidiser.

Step 1 — Pick the maximum: F_2 is both the most electronegative element and the strongest oxidising halogen.

Why other options are wrong:

- (D) Cl_2 is a strong oxidiser but weaker than F_2.
- (A),(B) Br_2 and I_2 are weaker still, with I_2 the weakest.

Final Answer: $F_2 \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q13**

Q14.

Solution

Concept — Oxidation-state balance: the algebraic sum of oxidation states equals the net charge (zero for a neutral molecule). Take H $= +1$, O $= -2$.

Step 1 — Set up for $HClO_4$: $(+1) + x + 4(-2) = 0 \Rightarrow 1 + x - 8 = 0.$

Step 2 — Solve: $x = +7$, the highest oxidation state of chlorine.

Why other options are wrong:

- (B) $+5$ is the state in $HClO_3$ (chloric acid).
- (C) $+3$ is in $HClO_2$; (D) $+1$ is in HClO (hypochlorous acid).

Final Answer: oxidation state of Cl $= +7 \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q14**

Q15.

Solution

Concept — Thermal stability of group-15 hydrides: stability depends on the strength of the E–H bond, which weakens as the central atom grows larger down the group (poorer overlap with the small H $1s$ orbital). Hence stability falls from NH_3 to BiH_3.

Step 1 — Order: $NH_3 > PH_3 > AsH_3 > SbH_3$ ($> BiH_3$). Nitrogen forms the strongest, most stable E–H bond.

Why other options are wrong:

- (A) reverses the trend completely.
- (C),(D) misplace NH_3, which must be the most stable.

Final Answer: $NH_3 > PH_3 > AsH_3 > SbH_3 \Rightarrow \boxed{B}$

Answer: (B) **Go Back to Q15**

Q16.

Solution

Concept — Spin-only magnetic moment: $\mu = \sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons. Fe^{3+} is $3d^5$ with all five d-electrons unpaired, so $n = 5$.

Step 1 — Substitute $n = 5$:

$$\mu = \sqrt{5(5+2)} = \sqrt{35}.$$

Step 2 — Evaluate: $\sqrt{35} \approx 5.92$ BM.

Why other options are wrong:

- (A) 1.73 is for $n = 1$; (B) 2.83 is for $n = 2$.
- (C) 4.90 is for $n = 4$, not 5.

Final Answer: $\mu \approx 5.92$ BM $\Rightarrow \boxed{D}$

Answer: (D) **Go Back to Q16**

Q17.

Solution

Concept — Oxidation state in a dichromate salt: for $K_2Cr_2O_7$, K $= +1$, O $= -2$, and the sum of all oxidation states is zero.

Step 1 — Set up: $2(+1) + 2x + 7(-2) = 0 \Rightarrow 2 + 2x - 14 = 0.$

Step 2 — Solve: $2x = 12 \Rightarrow x = +6$ for each chromium.

Why other options are wrong:

- (A) $+3$ is the state of Cr in Cr^{3+} salts; (D) $+2$ in chromous compounds.
- (B) $+7$ exceeds chromium's group oxidation state of $+6$.

Final Answer: oxidation state of Cr $= +6 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q17

Q18.

Solution

Concept — Atomic radii across the $3d$ series: as nuclear charge increases, radius would tend to fall, but the added $3d$ electrons screen the nucleus, partly cancelling the pull. The two effects nearly balance in the middle of the series.

Step 1 — Describe the trend: radii decrease at the start (Sc, Ti, V), stay almost constant through the middle (Cr–Cu), and rise slightly at the end (towards Zn) as electron–electron repulsion in the filled d-shell grows.

Why other options are wrong:

- (B) radii do not increase steadily; (C) they do not fall sharply throughout because of d-electron screening.
- (D) the radii clearly vary, they are not identical.

Final Answer: decrease, then nearly constant, then slight rise $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q18

Q19.

Solution

Concept — Naming coordination compounds: name the cation first; within the complex ion name the ligands alphabetically (NH_3 = ammine) before the metal, then give the metal's oxidation state in Roman numerals; finally name the anion.

Step 1 — Oxidation state of Co: the three Cl^- outside carry -3, NH_3 is neutral, so Co $= +3$.

Step 2 — Assemble the name: six $NH_3 \rightarrow$ "hexaammine"; metal "cobalt(III)"; anion "chloride" $\Rightarrow$ hexaamminecobalt(III) chloride.

Why other options are wrong:

- (A) the oxidation state is III, not II.
- (C) "-ate" is used only when the complex ion is an *anion*; here it is a cation.
- (D) is not systematic IUPAC nomenclature.

Final Answer: hexaamminecobalt(III) chloride $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Coordination number and geometry: the coordination number is the number of donor atoms bonded to the metal. With four strong-field CN^- ligands, Ni^{2+} (d^8) uses dsp^2 hybridisation, giving a *square-planar* arrangement (the four ligands at the corners of a square, as drawn).

Step 1 — Count the ligands: $[Ni(CN)_4]^{2-}$ has four $CN^- \Rightarrow$ coordination number 4.

Step 2 — Geometry: CN^- is a strong field ligand, pairing the d^8 electrons and forcing $dsp^2 \Rightarrow$ square planar (diamagnetic).

Why other options are wrong:

- (A) tetrahedral would arise with weak-field ligands (sp^3), e.g. $[NiCl_4]^{2-}$.
- (B) octahedral needs six ligands; (D) linear needs only two.

Final Answer: 4, square planar $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Strong-field vs weak-field ligands: the size of the splitting Δ_o relative to the pairing energy P decides the spin state. A strong-field ligand gives a large $\Delta_o > P$, so electrons pair up in the lower t_{2g} set before any enter the higher e_g set, producing a *low-spin* complex.

Step 1 — Compare Δ_o and P: large Δ_o ($> P$) makes pairing energetically cheaper than promotion to e_g.

Step 2 — Result: electrons pair in t_{2g}, minimising the number of unpaired electrons $\Rightarrow$ low-spin.

Why other options are wrong:

- (A) maximum unpaired electrons (high-spin) results from a *weak* field ($\Delta_o < P$).
- (B) the magnetism depends on Δ_o; (C) a strong field is not equivalent to a weak field.

Final Answer: low-spin (pairing in t_{2g}) $\Rightarrow \boxed{\text{D}}$

$\boxed{\text{Answer: (D)}}$ **Go Back to Q21**

Q22.

Solution

Concept — S$_N$2 mechanism: a bimolecular nucleophilic substitution is a single-step, concerted process. The nucleophile attacks the carbon from the side opposite the leaving group, passing through one transition state, so the energy profile shows a *single* hump.

Step 1 — Why primary: a 1° carbon is least hindered, allowing easy backside attack, so primary halides favour S$_N$2.

Step 2 — Stereochemistry: backside attack flips the configuration at the carbon — the Walden inversion (like an umbrella turning inside out).

Why other options are wrong:

- (A) S$_N$1 is two-step with a carbocation (two humps), favoured by 3° halides.
- (C),(D) E1 and free-radical paths give different products and profiles.

Final Answer: S$_N$2 (single step, with inversion) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Aqueous vs alcoholic KOH: with *aqueous* KOH the hydroxide ion acts as a nucleophile and substitutes the halogen, giving an alcohol; with alcoholic KOH it acts as a base and causes elimination to an alkene.

Step 1 — Reaction: $R\text{–}X + KOH(aq) \rightarrow R\text{–}OH + KX$ (nucleophilic substitution).

Why other options are wrong:

- (B) an alkene forms with *alcoholic* KOH (elimination).
- (C),(D) ethers/alkanes require different reagents (alkoxide; reduction).

Final Answer: an alcohol (substitution) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q23

Q24.

Solution

Concept — Nucleophilic aromatic substitution (SNAr): haloarenes are normally unreactive, but strongly electron-withdrawing groups (especially $\text{–}NO_2$) at the ortho and para positions stabilise the negative charge of the intermediate (Meisenheimer complex), greatly accelerating substitution.

Step 1 — Identify the activating group: $\text{–}NO_2$ at o-/p- positions withdraws electron density and stabilises the carbanion intermediate $\Rightarrow$ strongest activation.

Why other options are wrong:

- (A) $\text{–}CH_3$ is electron-*donating*, so it deactivates towards nucleophiles.
- (B),(D) $\text{–}OCH_3$ and $\text{–}NH_2$ are also electron-donating (by resonance), hindering SNAr.

Final Answer: $\text{–}NO_2$ at ortho and para positions $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Oxidation of alcohols by class: primary alcohols oxidise to aldehydes and then to carboxylic acids; secondary alcohols give ketones; tertiary alcohols, having no H on the carbinol (C–OH) carbon, resist mild oxidation.

Step 1 — Primary: $R–CH_2OH \to R–CHO \to R–COOH$.

Step 2 — Secondary and tertiary: $R_2CH–OH \to R_2C{=}O$ (ketone); $R_3C–OH$ has no α-C–H bond on the carbinol carbon, so it does not oxidise easily.

Why other options are wrong:

- (A),(B),(C) swap the products of the three classes (e.g. assigning a ketone to a primary alcohol or an aldehyde to a secondary alcohol).

Final Answer: aldehyde/acid, ketone, and no easy oxidation $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q25

Q26.

Solution

Concept — Substituent effects on phenol acidity: electron-*withdrawing* groups (e.g. $–NO_2$) stabilise the phenoxide ion and increase acidity, while electron-*donating* groups ($–CH_3$, $–OCH_3$) destabilise the phenoxide and decrease acidity.

Step 1 — Compare: p-nitrophenol has a strong $–NO_2$ group that delocalises the negative charge of the phenoxide, so it is the most acidic of the four.

Why other options are wrong:

- (A),(C) p-cresol and p-methoxyphenol bear electron-donating groups, so they are *less* acidic than phenol.
- (D) plain phenol is less acidic than p-nitrophenol.

Final Answer: p-nitrophenol $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Ether cleavage by HI: hot concentrated HI cleaves the C–O bond of ethers. With an excess of HI, the alcohol formed in the first step is itself converted to an alkyl iodide, so both alkyl groups end up as iodides.

Step 1 — First cleavage: $CH_3\text{–}O\text{–}C_2H_5 + HI \rightarrow CH_3I + C_2H_5OH$ (the smaller group leaves as the iodide; here both are simple alkyl).

Step 2 — Excess HI: $C_2H_5OH + HI \rightarrow C_2H_5I + H_2O$. Net products: CH_3I and C_2H_5I.

Why other options are wrong:

- (B) alcohols are intermediates only; excess HI converts them to iodides.
- (C) holds only for limited HI; (D) C–C bonds are not cleaved to alkanes here.

Final Answer: CH_3I and $C_2H_5I \Rightarrow \boxed{A}$

Answer: (A) **Go Back to Q27**

Q28.

Solution

Concept — Nucleophilic addition of HCN: the cyanide ion adds to the electrophilic carbonyl carbon and a proton adds to the oxygen, giving an α-hydroxynitrile, the *cyanohydrin*.

Step 1 — Product structure: $CH_3CHO + HCN \rightarrow CH_3\text{–}CH(OH)\text{–}CN$ (acetaldehyde cyanohydrin), bearing both –OH and –CN on the same carbon.

Why other options are wrong:

- (A) a hemiacetal forms with an alcohol, not HCN.
- (B) a Schiff base/imine forms with a primary amine; (C) an oxime forms with hydroxylamine.

Final Answer: a cyanohydrin $\Rightarrow \boxed{D}$

Answer: (D) **Go Back to Q28**

Q29.

Solution

Concept — Aldol condensation: a carbonyl compound undergoes the aldol reaction only if it has at least one α-hydrogen, which a base can remove to form the nucleophilic enolate that attacks another carbonyl.

Step 1 — Check for α-H: acetaldehyde (CH_3CHO) has three α-hydrogens on its CH_3 group, so it readily undergoes the aldol condensation.

Why other options are wrong:

- (A) benzaldehyde and (B) formaldehyde have *no* α-hydrogen (they give the Cannizzaro reaction instead).
- (D) benzophenone has no α-hydrogen either.

Final Answer: acetaldehyde, $CH_3CHO \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q29

Q30.

Solution

Concept — Relative acidity: acidity is judged by the stability of the conjugate base. Carboxylate is resonance-stabilised over two equivalent oxygens (most stable), phenoxide is resonance-stabilised over the ring (next), hydroxide from water is less stabilised, and alkoxide from an alcohol is the least stable.

Step 1 — Rank the conjugate-base stability: $RCOO^- > C_6H_5O^- > OH^- > RO^-$.

Step 2 — Translate to acidity: carboxylic acid $>$ phenol $>$ water $>$ alcohol.

Why other options are wrong:

- (A) wrongly places phenol above the carboxylic acid.
- (C),(D) completely reverse the true order.

Final Answer: carboxylic acid $>$ phenol $>$ water $>$ alcohol $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — Basicity of aromatic vs aliphatic amines: the basicity of an amine depends on how available the nitrogen lone pair is. In aniline the lone pair is delocalised into the benzene ring by resonance, so it is less available to accept a proton.

Step 1 — Effect of delocalisation: resonance ties up the nitrogen lone pair with the ring, reducing electron density on N; in methylamine the lone pair is fully available and even enhanced by the $+I$ effect of CH_3.

Step 2 — Conclusion: less available lone pair $\Rightarrow$ aniline is a weaker base than methylamine.

Why other options are wrong:

- (B) nitrogen does have a lone pair; it is merely delocalised.
- (C),(D) the $-NH_2$ group is not positively charged, and no such internal H-bonding causes the weakening.

Final Answer: lone pair delocalised into the ring $\Rightarrow \boxed{\text{A}}$

Answer: (A)

Go Back to Q31

Q32.

Solution

Concept — Diazotisation: a primary aromatic amine is converted to a diazonium salt by nitrous acid (generated in situ from $NaNO_2$ and a mineral acid). The reaction must be done at low temperature (0–5 °C) because diazonium salts decompose on warming.

Step 1 — Reagents and conditions: $C_6H_5NH_2 + NaNO_2 + 2HCl$, kept at 0–$5\ ^\circ C$ $\rightarrow C_6H_5N_2^+Cl^- + NaCl + 2H_2O$.

Step 2 — Why cold: above $5\ ^\circ C$ the diazonium salt readily hydrolyses to phenol with loss of N_2.

Why other options are wrong:

- (A) 60–$70\ ^\circ C$ is too warm; the salt would decompose.
- (B),(C) H_2SO_4 alone or Br_2 water does not give the diazonium salt.

Final Answer: $NaNO_2$ + dilute HCl at 0–$5\ ^\circ C \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Hinsberg's test: the amine is shaken with benzenesulphonyl chloride (Hinsberg's reagent) in the presence of alkali. Primary amines give a sulphonamide soluble in KOH; secondary amines give a sulphonamide insoluble in KOH; tertiary amines do not react.

Step 1 — Identify the reagent: the distinguishing reagent is benzenesulphonyl chloride, $C_6H_5SO_2Cl$.

Step 2 — Outcomes: $1^\circ \to$ alkali-soluble product; $2^\circ \to$ alkali-insoluble product; $3^\circ \to$ no reaction, distinguishing all three classes.

Why other options are wrong:

- (A) nitrous acid is used in a different (HNO_2) test.
- (B) $CHCl_3$/alcoholic KOH is the carbylamine test for 1° amines only; (D) Tollens' reagent tests aldehydes.

Final Answer: benzenesulphonyl chloride $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q33

Q34.

Solution

Concept — Classifying monosaccharides: a sugar is named by its carbonyl group (aldo- for –CHO, keto- for C=O within the chain) and its number of carbons (pentose $= 5$, hexose $= 6$).

Step 1 — Read the structure: fructose has six carbon atoms and a keto group (C=O) at C-2, as the Fischer projection shows.

Step 2 — Classify: six carbons $+$ ketone group $\Rightarrow$ a ketohexose.

Why other options are wrong:

- (A) "aldo" is wrong — fructose has a ketone, not an aldehyde (that is glucose).
- (C),(D) fructose has six carbons, not five.

Final Answer: a ketohexose $\Rightarrow \boxed{B}$

$\boxed{\text{Answer: (B)}}$ Go Back to Q34

Q35.

Solution

Concept — Zwitterion at the isoelectric point: an amino acid has both an acidic –COOH and a basic –NH_2 group. Internal proton transfer gives a dipolar ion (zwitterion): the carboxyl loses a proton to become –COO^- and the amino group gains it to become –$\overset{+}{N}H_3$. At the isoelectric point the net charge is zero.

Step 1 — Structure of glycine zwitterion: $\overset{+}{N}H_3–CH_2–COO^-$, with the positive and negative charges cancelling.

Step 2 — Why isoelectric point: it is the pH at which the molecule carries no net charge and does not migrate in an electric field.

Why other options are wrong:

- (B) the fully neutral, uncharged form is not the dominant species in this pH range.
- (C) net $+1$ exists in strongly acidic solution; (D) net -1 in strongly basic solution.

Final Answer: $\overset{+}{N}H_3–CH_2–COO^-$ (zwitterion, net charge zero) $\Rightarrow \boxed{A}$

$\boxed{\text{Answer: (A)}}$ Go Back to Q35

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	A	3	B	4	D	5	C
6	A	7	B	8	D	9	C	10	A
11	B	12	D	13	C	14	A	15	B
16	D	17	C	18	A	19	B	20	C
21	D	22	B	23	A	24	C	25	D
26	B	27	A	28	D	29	C	30	B
31	A	32	D	33	C	34	B	35	A