SRMJEEE Chemistry Sample Paper – 6

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. 4 g of sodium hydroxide, NaOH (molar mass $= 40$ g mol^{-1}), is dissolved in 200 g of water. The molality of the resulting solution is:

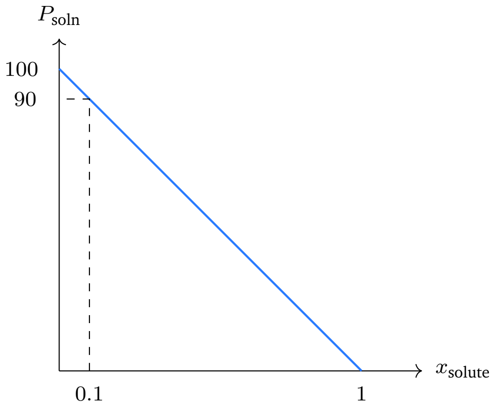
(A) 0.5 m

(B) 0.1 m

(C) 1.0 m

(D) 0.25 m

Q2. The vapour pressure of pure water is 100 units. When a non-volatile solute is added, the vapour pressure of the solvent falls in proportion to its mole fraction, as shown. If the solution contains 1 mol of solute in 9 mol of water, the vapour pressure of the solution is:



(A) 100 units

(B) 90 units

(C) 10 units

(D) 50 units

Q3. A solute dimerises completely (two molecules associate into one) when dissolved in benzene. The experimentally observed (abnormal) molar mass will be:

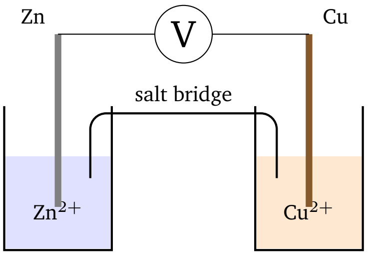
(A) equal to the normal molar mass

(B) one-half of the normal molar mass

(C) twice the normal molar mass

(D) one-quarter of the normal molar mass

Q4. For the galvanic cell shown, the standard EMF is $E^\circ_{\text{cell}} = +1.10$ V and two electrons are transferred ($n = 2$). Using $\Delta G^\circ = -nFE^\circ_{\text{cell}}$ with $F = 96500$ C mol^{-1}, the standard free-energy change is:



(A) $+212.3$ kJ mol^{-1}

(B) -106.2 kJ mol^{-1}

(C) $+106.2$ kJ mol^{-1}

(D) -212.3 kJ mol^{-1}

Q5. A conductivity cell filled with a solution of conductivity $\kappa = 1.3$ S m^{-1} shows a resistance of $50\ \Omega$. The cell constant G^* $(= \kappa \times R)$ of the cell is:

(A) 65 m^{-1}

(B) 0.026 m^{-1}

(C) 38.5 m^{-1}

(D) 1.3 m^{-1}

Q6. The same quantity of electricity is passed through molten $AlCl_3$ and molten NaCl in series. If 9 g of aluminium (equivalent mass $= 9$) is deposited, the mass of sodium (equivalent mass $= 23$) deposited is:

(A) 9 g

(B) 23 g

(C) 69 g

(D) 3 g

Q7. For the reaction $2A + B \rightarrow$ products, the following initial-rate data are obtained. The overall order of the reaction is:

Expt	$[A]$	$[B]$	Rate
1	0.1	0.1	r
2	0.2	0.1	$2r$
3	0.2	0.2	$8r$

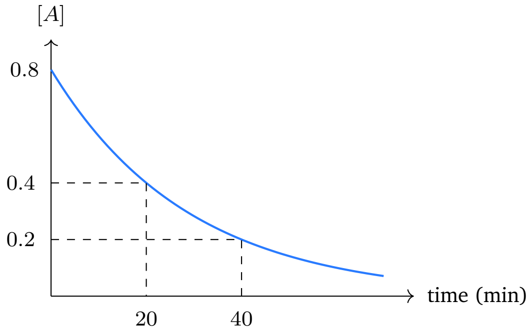
(A) 1

(B) 2

(C) 3

(D) 0

Q8. A first-order reaction has a half-life of 20 min. Starting from an initial concentration $[A]_0 = 0.8$ M, the concentration of the reactant remaining after 40 min is (read the decay curve):



(A) 0.8 M

(B) 0.4 M

(C) 0.1 M

(D) 0.2 M

Q9. The activation energy of a chemical reaction is best described as:

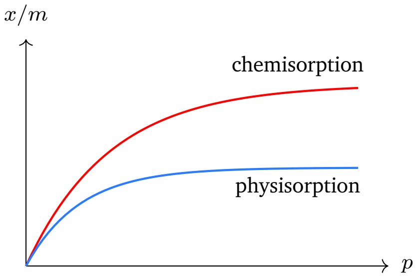
(A) the minimum extra energy that reactant molecules must possess to form products

(B) the total energy of the product molecules

(C) the heat released when the reaction is complete

(D) the average kinetic energy of all the molecules

Q10. Adsorption isotherms for a gas on a solid are shown for physisorption and chemisorption. The enthalpy of adsorption for *physisorption* is typically:



(A) very high (about 200 kJ mol^{-1})

(B) low (about 20–40 kJ mol^{-1})

(C) exactly zero

(D) always negative and below -300 kJ mol^{-1}

Q11. The gold number is a measure of the protective power of a lyophilic colloid. The *smaller* the gold number of a protective colloid, the:

(A) smaller is its protecting power

(B) greater is the size of its particles

(C) greater is its protecting power

(D) lower is its surface area

Q12. According to the adsorption theory of heterogeneous catalysis, the catalytic action of a solid catalyst is mainly due to:

(A) formation of a stable compound with the products

(B) complete dissolution of the reactants in the catalyst

(C) an increase in the activation energy of the reaction

(D) adsorption of reactant molecules on the catalyst surface, increasing their local concentration and weakening their bonds

Q13. The correct order of *oxidising power* of the halogens is:

(A) $I_2 > Br_2 > Cl_2 > F_2$

(B) $F_2 > Cl_2 > Br_2 > I_2$

(C) $Cl_2 > F_2 > Br_2 > I_2$

(D) $Br_2 > Cl_2 > F_2 > I_2$

Q14. The average oxidation state of sulphur in the thiosulphate ion, $S_2O_3^{2-}$, is:

(A) $+2$

(B) $+6$

(C) $+4$

(D) -2

Q15. Which of the following statements about the anomalous behaviour of fluorine among the halogens is *correct*?

(A) fluorine shows a maximum oxidation state of $+7$

(B) fluorine forms several oxoacids like HFO_3

(C) fluorine shows only the -1 oxidation state and has no d-orbitals available for bonding

(D) the F–F bond is the strongest among all halogen–halogen bonds

Q16. Which of the following ions is *colourless* because of its d^{10} electronic configuration?

(A) Cr^{3+}

(B) Co^{2+}

(C) Mn^{2+}

(D) Cu^{+}

Q17. The most common and characteristic oxidation state shown by almost all the lanthanides is:

(A) $+3$

(B) $+2$

(C) $+4$

(D) $+6$

Q18. Transition metals and their compounds are widely used as catalysts mainly because they:

(A) have completely filled d-orbitals

(B) show variable oxidation states and can provide a large surface for adsorption

(C) are all diamagnetic

(D) have very low melting points

Q19. In the complex ion $[\mathrm{Fe(CN)_6}]^x$, iron is present in the $+3$ oxidation state. The overall charge x on the complex ion is:

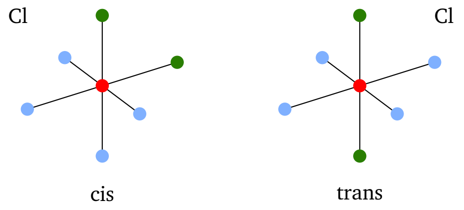
(A) -4

(B) $+3$

(C) -3

(D) -6

Q20. The octahedral complex ion $[\mathrm{Co(NH_3)_4Cl_2}]^+$ shows geometrical (cis–trans) isomerism, as illustrated. The number of geometrical isomers it has is:



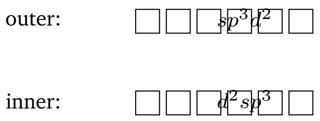
(A) 4

(B) 3

(C) 1

(D) 2

Q21. An octahedral complex in which the metal uses inner d-orbitals for hybridisation (as in the lower diagram) is called an inner-orbital complex. The hybridisation of such an inner-orbital octahedral complex is:



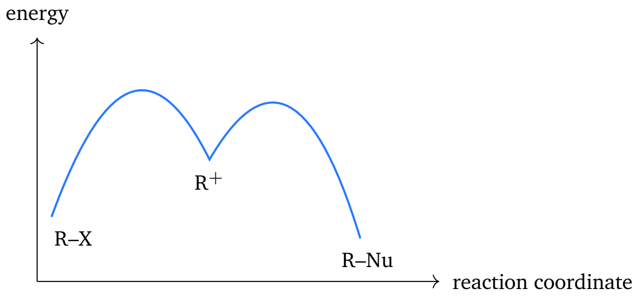
(A) d^2sp^3

(B) sp^3d^2

(C) sp^3

(D) dsp^2

Q22. The two-step energy profile of a substitution reaction is shown, passing through a carbocation. The use of a *polar protic* solvent (e.g. water, alcohol) favours this pathway because it:



(A) destabilises the carbocation intermediate

(B) makes the reaction a single concerted step

(C) solvates and stabilises the carbocation and the leaving ion, favouring the S_N1 path

(D) has no effect on the rate of substitution

Q23. In the Finkelstein reaction, an alkyl chloride or bromide is treated with NaI in dry acetone to give an alkyl iodide. The reaction is driven to completion because:

(A) NaI is insoluble in acetone

(B) NaCl (or NaBr) is sparingly soluble in acetone and precipitates out, shifting the equilibrium

(C) the alkyl iodide is more reactive than the alkyl chloride

(D) iodide is a poorer nucleophile than chloride

Q24. When chlorobenzene is heated with aqueous NaOH at about 623 K and 300 atm pressure (the Dow process), and the product is then acidified, the compound obtained is:

(A) benzene

(B) benzoic acid

(C) aniline

(D) phenol

Q25. When ethanol is heated with acetic acid in the presence of a few drops of concentrated H_2SO_4, the main organic product is:

(A) ethyl acetate (an ester)

(B) acetaldehyde

(C) diethyl ether

(D) ethylene

Q26. When a few drops of neutral ferric chloride solution are added to an aqueous solution of phenol, the colour observed is:

(A) a yellow precipitate

(B) a violet (purple) colouration

(C) a brick-red precipitate

(D) no visible change

Q27. The most suitable pair for preparing *tert*-butyl methyl ether, $(CH_3)_3C–O–CH_3$, by Williamson synthesis is:

(A) sodium *tert*-butoxide + methanol

(B) methanol + *tert*-butyl chloride

(C) sodium *tert*-butoxide + methyl iodide

(D) sodium methoxide + *tert*-butyl chloride

Q28. When propanal, CH_3CH_2CHO, is treated with sodium borohydride ($NaBH_4$), the product formed is:

(A) propan-1-ol, $CH_3CH_2CH_2OH$

(B) propanoic acid, CH_3CH_2COOH

(C) propan-2-ol, $CH_3CH(OH)CH_3$

(D) propane, $CH_3CH_2CH_3$

Q29. A cross-aldol condensation gives a *single* major product when one of the carbonyl partners has no α-hydrogen. Which pair will give essentially one aldol product?

(A) acetaldehyde + propanal

(B) acetaldehyde + acetone

(C) propanal + butanal

(D) benzaldehyde + acetaldehyde

Q30. When ethanoic acid (acetic acid), CH_3COOH, is reduced with lithium aluminium hydride ($LiAlH_4$), the product obtained is:

(A) acetaldehyde, CH_3CHO

(B) ethanol, CH_3CH_2OH

(C) ethane, CH_3CH_3

(D) ethyl acetate

Q31. In the Hofmann bromamide degradation reaction, an amide R–$CONH_2$ is treated with Br_2 and aqueous KOH. The amine produced has:

(A) the same number of carbon atoms as the amide

(B) one carbon atom more than the amide

(C) one carbon atom fewer than the amide

(D) two carbon atoms fewer than the amide

Q32. In the Gattermann reaction, benzene diazonium chloride is treated with copper powder and the corresponding halogen acid (Cu/HX). The product is:

(A) an aryl halide (e.g. chlorobenzene or bromobenzene)

(B) phenol

(C) aniline

(D) nitrobenzene

Q33. In Hofmann's exhaustive methylation followed by elimination, a quaternary ammonium hydroxide on heating gives, as the major alkene, the:

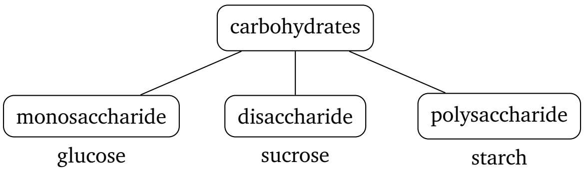
(A) most highly substituted alkene (Saytzeff product)

(B) an alcohol instead of an alkene

(C) a mixture with the more stable alkene predominating

(D) least substituted (least hindered) alkene (Hofmann product)

Q34. Carbohydrates are classified by hydrolysis into mono-, di- and polysaccharides, as outlined below. To which class does *sucrose* belong?



(A) monosaccharide

(B) disaccharide

(C) polysaccharide

(D) it is not a carbohydrate

Q35. In the double helix of DNA, the complementary bases pair through hydrogen bonds. The correct pairing and number of hydrogen bonds is:

(A) A–G (2 bonds) and C–T (3 bonds)

(B) A–C (2 bonds) and G–T (3 bonds)

(C) A–T (2 bonds) and G–C (3 bonds)

(D) A–T (3 bonds) and G–C (2 bonds)

Detailed Solutions

Q1.

Solution

Concept — Molality: Molality $m = \dfrac{\text{moles of solute}}{\text{mass of solvent in kg}}$. It depends only on masses, not on temperature.

Step 1 — Moles of NaOH: $n = \dfrac{4}{40} = 0.1$ mol.

Step 2 — Mass of solvent: 200 g $= 0.2$ kg, so $m = \dfrac{0.1}{0.2} = 0.5$ m.

Why other options are wrong:

- (B) 0.1 is the number of moles, not the molality.
- (C),(D) use 0.1 kg or 0.4 kg of solvent incorrectly.

Final Answer: $m = 0.5$ m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Lowering of vapour pressure (Raoult's law): for a non-volatile solute, $P_{\text{soln}} = x_{\text{solvent}}\,P^{\circ}$, so the solution vapour pressure falls below the pure-solvent value P°.

Step 1 — Mole fraction of solvent: $x_{\text{water}} = \dfrac{9}{9+1} = 0.9$.

Step 2 — Apply Raoult's law:

$$P_{\text{soln}} = 0.9 \times 100 = 90 \text{ units.}$$

Step 3 — Read the graph: at $x_{\text{solute}} = 0.1$ the dashed line meets the curve at 90 units, confirming the value.

Why other options are wrong:

- (A) 100 is the pure-solvent value (no solute).
- (C) 10 is the lowering (ΔP), not the vapour pressure; (D) 50 has no basis.

Final Answer: $P_{\text{soln}} = 90$ units $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Abnormal molar mass and association: colligative properties depend on the number of particles. The van't Hoff factor is $i = \frac{M_{\text{normal}}}{M_{\text{observed}}}$. When the solute associates, the number of particles falls, so $i < 1$ and the observed molar mass is *higher* than the normal value.

Step 1 — Complete dimerisation: two molecules combine into one, so $i = \frac{1}{2}$.

Step 2 — Observed molar mass: $M_{\text{observed}} = \frac{M_{\text{normal}}}{i} = \frac{M_{\text{normal}}}{1/2} = 2\,M_{\text{normal}}$, i.e. twice the normal value.

Why other options are wrong:

- (B),(D) halving or quartering corresponds to *dissociation* ($i > 1$), not association.
- (A) equality would mean no association at all.

Final Answer: twice the normal molar mass $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q3**

Q4.

Solution

Concept — Free energy and cell potential: the maximum useful work of a galvanic cell equals the decrease in free energy: $\Delta G^\circ = -nFE^\circ_{\text{cell}}$. A positive E°_{cell} gives a negative ΔG° (spontaneous).

Step 1 — Substitute the values:

$$\Delta G^\circ = -(2)(96500)(1.10) = -212\,300\ \text{J mol}^{-1}.$$

Step 2 — Convert to kJ: $\Delta G^\circ = -212.3\ \text{kJ mol}^{-1}$.

Why other options are wrong:

- (A),(C) a positive sign would imply a non-spontaneous reaction, contradicting $E^\circ > 0$.
- (B) -106.2 uses $n = 1$ instead of $n = 2$.

Final Answer: $\Delta G^\circ = -212.3\ \text{kJ mol}^{-1} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Cell constant: the cell constant relates measured resistance to conductivity through $\kappa = \dfrac{G^*}{R}$, so $G^* = \kappa \times R$. Its unit is m^{-1} (length/area).

Step 1 — Substitute:

$$G^* = \kappa \times R = 1.3\ \mathrm{S\ m}^{-1} \times 50\ \Omega = 65\ \mathrm{m}^{-1}.$$

(Recall $\mathrm{S} \times \Omega = 1$, so the units reduce to m^{-1}.)

Why other options are wrong:

- (B) 0.026 divides instead of multiplying.
- (C) $38.5 = 50/1.3$, the wrong operation; (D) 1.3 ignores the resistance.

Final Answer: $G^* = 65\ \mathrm{m}^{-1} \Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Faraday's second law: when the same charge is passed through different electrolytes, the masses deposited are proportional to their equivalent masses: $\dfrac{m_1}{m_2} = \dfrac{E_1}{E_2}$.

Step 1 — Set up the ratio:

$$\frac{m_{\mathrm{Na}}}{m_{\mathrm{Al}}} = \frac{E_{\mathrm{Na}}}{E_{\mathrm{Al}}} = \frac{23}{9}.$$

Step 2 — Solve for sodium: $m_{\mathrm{Na}} = 9 \times \dfrac{23}{9} = 23$ g.

Why other options are wrong:

- (A) 9 g ignores the difference in equivalent masses.
- (C) 69 uses atomic mass of Al (27) wrongly; (D) 3 inverts the ratio.

Final Answer: 23 g of sodium $\Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Order from initial-rate data: for rate $= k[A]^x[B]^y$, compare experiments where only one concentration changes.

Step 1 — Order in A (Expt 1 vs 2): $[A]$ doubles, $[B]$ fixed, rate doubles ($r \to 2r$). So $2^x = 2 \Rightarrow x = 1$.

Step 2 — Order in B (Expt 2 vs 3): $[B]$ doubles, $[A]$ fixed, rate goes $2r \to 8r$ (a four-fold rise). So $2^y = 4 \Rightarrow y = 2$.

Step 3 — Overall order: $x + y = 1 + 2 = 3$.

Why other options are wrong:

- (A),(B) account for only one of the two orders.
- (D) zero order would leave the rate unchanged.

Final Answer: overall order $= 3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — First-order half-life: for a first-order reaction the concentration halves every half-life $t_{1/2}$, independent of starting concentration.

Step 1 — Count the half-lives: 40 min $= 2 \times 20$ min $= 2$ half-lives.

Step 2 — Halve twice:

$$[A] = 0.8 \times \left(\tfrac{1}{2}\right)^2 = 0.8 \times \tfrac{1}{4} = 0.2\ \text{M}.$$

Step 3 — Graph check: the dashed lines show $0.8 \to 0.4$ at 20 min and $0.4 \to 0.2$ at 40 min.

Why other options are wrong:

- (A) 0.8 is the initial value; (B) 0.4 is the value after only one half-life.
- (C) 0.1 corresponds to three half-lives (60 min).

Final Answer: $[A] = 0.2\text{ M} \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q8**

Q9.

Solution

Concept — Activation energy: reactant molecules must first reach a high-energy transition state before they can form products. The energy barrier between the reactants and this transition state is the activation energy E_a.

Step 1 — Correct description: E_a is the *minimum extra energy*, over and above the average energy of the reactants, that colliding molecules must possess for an effective (product-forming) collision.

Why other options are wrong:

- (B) the energy of the products is unrelated to the barrier height.
- (C) the heat released is ΔH, the enthalpy change, not E_a.
- (D) E_a is a threshold, not the average kinetic energy.

Final Answer: the minimum threshold energy for reaction $\Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q9**

Q10.

Solution

Concept — Physisorption vs chemisorption: physisorption involves weak van der Waals forces, whereas chemisorption involves the formation of chemical (covalent) bonds with the surface.

Step 1 — Enthalpy of physisorption: because only weak forces are involved, the enthalpy of physical adsorption is *low*, typically of the order of $20\text{–}40\text{ kJ mol}^{-1}$.

Step 2 — Contrast: chemisorption, involving bond formation, releases much more energy ($80\text{–}240\text{ kJ mol}^{-1}$), as reflected by its higher isotherm in the figure.

Why other options are wrong:

- (A) $\sim 200\text{ kJ mol}^{-1}$ is characteristic of chemisorption.
- (C) adsorption is exothermic, so the enthalpy is not zero; (D) the magnitude is far smaller than 300 kJ mol^{-1}.

Final Answer: low, about $20\text{–}40\text{ kJ mol}^{-1} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Gold number: the gold number is the minimum mass (in mg) of a protective colloid that just prevents the coagulation of 10 mL of a standard gold sol when 1 mL of 10% NaCl is added. A *small* amount needed means strong protection.

Step 1 — Inverse relationship: a smaller gold number means less protective colloid is required, hence *greater* protecting power. (Gelatin, with a very small gold number, is an excellent protective colloid.)

Why other options are wrong:

- (A) is the opposite of the correct relationship.
- (B),(D) particle size and surface area are not what the gold number directly measures.

Final Answer: greater protecting power $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Adsorption theory of heterogeneous catalysis: the reactant gases are adsorbed on the catalyst surface at active centres.

Step 1 — Mechanism: adsorption raises the local concentration of reactants on the surface and weakens the bonds within the adsorbed molecules, lowering the activation energy. The products then desorb, freeing the surface.

Step 2 — Conclusion: catalytic action arises from adsorption of reactants on the surface, not from any permanent chemical combination.

Why other options are wrong:

- (A) a stable compound with the product would poison, not catalyse.
- (B) the reactants are adsorbed, not dissolved; (C) a catalyst *lowers*, not raises, the activation energy.

Final Answer: adsorption of reactants on the surface $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Oxidising power of halogens: oxidising power depends on the ease of reduction $X_2 + 2e^- \to 2X^-$, governed by the standard reduction potential. It decreases down the group: F_2 is the strongest oxidising agent and I_2 the weakest.

Step 1 — Correct order: $F_2 > Cl_2 > Br_2 > I_2$. Fluorine has the most positive reduction potential ($+2.87$ V) owing to its low bond enthalpy and high hydration energy of F^-.

Why other options are wrong:

- (A) reverses the order entirely.
- (C),(D) wrongly place F_2 below Cl_2 or Br_2.

Final Answer: $F_2 > Cl_2 > Br_2 > I_2 \Rightarrow \boxed{B}$

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

Q14.

Solution

Concept — Average oxidation state: treat oxygen as -2 and let the average oxidation state of S be x; the sum equals the ionic charge.

Step 1 — Set up for $S_2O_3^{2-}$: $2x + 3(-2) = -2$.

Step 2 — Solve: $2x - 6 = -2 \Rightarrow 2x = +4 \Rightarrow x = +2$. (Structurally the two sulphur atoms have different states, but the *average* is $+2$.)

Why other options are wrong:

- (B) $+6$ is the state in sulphate, SO_4^{2-}.
- (C) $+4$ is the state in sulphite, SO_3^{2-}; (D) -2 is sulphide.

Final Answer: average oxidation state $= +2 \Rightarrow \boxed{A}$

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

Q15.

Solution

Concept — Anomalous behaviour of fluorine: fluorine differs from the heavier halogens because of its small size, highest electronegativity, low F–F bond enthalpy and, crucially, the *absence of d-orbitals* in its valence shell.

Step 1 — Consequence: lacking accessible d-orbitals, fluorine cannot expand its octet, so it shows only the -1 oxidation state (and 0 in F_2), unlike Cl, Br, I which show $+1, +3, +5, +7$.

Why other options are wrong:

- (A) fluorine never reaches $+7$; (B) fluorine forms no conventional oxoacids like HFO_3.
- (D) the F–F bond is actually *weak* due to lone-pair repulsion between the small atoms.

Final Answer: only -1 state; no d-orbitals $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Colour and d-configuration: colour in transition-metal ions arises from d–d transitions, which need *partially filled* d-orbitals. Ions with d^0 or d^{10} configurations are colourless.

Step 1 — Configurations: Cr^{3+} (d^3), Co^{2+} (d^7), Mn^{2+} (d^5) are all partially filled (coloured); Cu^+ is d^{10} (completely filled).

Step 2 — Conclusion: Cu^+ has no possible d–d transition, so it is colourless.

Why other options are wrong:

- (A),(B),(C) all have partly filled d-orbitals and are coloured.

Final Answer: Cu^+ (d^{10}) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Oxidation states of lanthanides: although a few lanthanides also show $+2$ or $+4$ states, the $+3$ state is common to and the most stable for almost all of them, because removal of the two $6s$ and one $5d/4f$ electron gives a stable Ln^{3+} core.

Step 1 — Characteristic state: $+3$ is the dominant oxidation state across the entire lanthanide series.

Why other options are wrong:

- (B) $+2$ (e.g. Eu^{2+}) and (C) $+4$ (e.g. Ce^{4+}) occur only for a few elements.
- (D) $+6$ is not shown by the lanthanides.

Final Answer: $+3 \Rightarrow \boxed{\text{A}}$

$\boxed{\textbf{Answer: (A)}}$ **Go Back to Q17**

Q18.

Solution

Concept — Transition metals as catalysts: their catalytic activity is linked to two features — variable oxidation states and the ability to provide a surface for adsorption.

Step 1 — Variable oxidation states: a transition metal can readily change oxidation state, allowing it to form unstable intermediates with reactants and provide an alternative, lower-energy pathway.

Step 2 — Surface adsorption: finely divided transition metals adsorb reactant molecules on their surface, increasing local concentration and weakening bonds.

Why other options are wrong:

- (A) completely filled d-orbitals (as in Zn) generally make poor catalysts.
- (C) many are paramagnetic; (D) transition metals have high, not low, melting points.

Final Answer: variable oxidation states + surface for adsorption $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q18**

Q19.

Solution

Concept — Charge on a complex ion: the overall charge equals the oxidation state of the metal plus the sum of the ligand charges.

Step 1 — Ligand charges: cyanide CN^- carries a charge of -1 each, and there are six of them: $6 \times (-1) = -6$.

Step 2 — Add the metal: Fe is $+3$, so the overall charge $x = (+3) + (-6) = -3$. The ion is $[Fe(CN)_6]^{3-}$ (the hexacyanoferrate(III) ion).

Why other options are wrong:

- (A) -4 would require Fe^{2+} (ferrocyanide).
- (B) $+3$ ignores the ligand charges; (D) -6 ignores the metal charge.

Final Answer: $x = -3 \Rightarrow \boxed{\text{C}}$

Answer: (C)

Go Back to Q19

Q20.

Solution

Concept — Geometrical isomerism in octahedral MA_4B_2: an octahedral complex of type $[MA_4B_2]$ can have the two B ligands either adjacent (cis, 90° apart) or opposite (trans, 180° apart).

Step 1 — Count the arrangements: only two distinct geometries exist — *cis* and *trans* — as shown in the figure.

Step 2 — Conclusion: $[Co(NH_3)_4Cl_2]^+$ has *two* geometrical isomers (it does not show optical isomerism here).

Why other options are wrong:

- (A),(B) 4 or 3 overcount; no other distinct placements are possible.
- (C) 1 ignores the existence of the cis form.

Final Answer: 2 (cis and trans) $\Rightarrow \boxed{\text{D}}$

Answer: (D)

Go Back to Q20

Q21.

Solution

Concept — Inner- vs outer-orbital octahedral complexes: in valence-bond theory an octahedral complex uses six hybrid orbitals. If the inner $(n-1)d$ orbitals are used, the hybridisation is d^2sp^3 (inner-orbital, low-spin); if the outer nd orbitals are used, it is sp^3d^2 (outer-orbital, high-spin).

Step 1 — Inner-orbital case: strong-field ligands cause pairing, freeing inner $(n-1)d$ orbitals, giving d^2sp^3 hybridisation.

Why other options are wrong:

- (B) sp^3d^2 is the outer-orbital (high-spin) octahedral case.
- (C) sp^3 is tetrahedral; (D) dsp^2 is square planar.

Final Answer: d^2sp^3 (inner-orbital) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Effect of solvent on S$_N$1: the rate-determining step of S$_N$1 is the ionisation of R–X into a carbocation R$^+$ and a leaving anion X$^-$. A polar protic solvent stabilises both of these charged species through solvation and hydrogen bonding.

Step 1 — Lowering the barrier: by solvating the developing positive and negative charges in the transition state, a polar protic solvent lowers the activation energy for ionisation, speeding up the S$_N$1 path.

Step 2 — Match the profile: the two-step curve through R$^+$ is the S$_N$1 profile, favoured by polar protic media.

Why other options are wrong:

- (A) it *stabilises*, not destabilises, the carbocation.
- (B) S$_N$1 remains two-step; (D) the solvent strongly affects the rate.

Final Answer: solvates/stabilises the carbocation, favouring S$_N$1 $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept — Finkelstein reaction: R–Cl (or R–Br) + NaI $\xrightarrow{\text{dry acetone}}$ R–I + NaCl (or NaBr). The conversion exploits a solubility difference.

Step 1 — Driving force: NaI is soluble in dry acetone, but NaCl and NaBr are only sparingly soluble. As they precipitate out, they are removed from the equilibrium, which (by Le Chatelier's principle) drives the reaction towards the alkyl iodide.

Why other options are wrong:

- (A) NaI is in fact soluble in acetone.
- (C) reactivity of the product does not drive the equilibrium; (D) iodide is a good nucleophile, but that is not the equilibrium driver.

Final Answer: NaCl/NaBr precipitates, shifting the equilibrium $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept — Dow process: aryl halides are normally unreactive towards nucleophiles, but under forcing conditions (high temperature and pressure) chlorobenzene can be hydrolysed.

Step 1 — Reaction: chlorobenzene + NaOH $\xrightarrow{623\ \text{K},\, 300\ \text{atm}}$ sodium phenoxide; acidification then gives phenol.

$$C_6H_5Cl \xrightarrow{\text{NaOH}} C_6H_5ONa \xrightarrow{\text{H}^+} C_6H_5OH.$$

Why other options are wrong:

- (A),(B) benzene/benzoic acid are not formed by alkaline hydrolysis of the C–Cl bond.
- (C) aniline would need an amine source, not NaOH.

Final Answer: phenol $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Esterification (Fischer): a carboxylic acid reacts with an alcohol in the presence of an acid catalyst (conc. H_2SO_4) to give an ester and water.

Step 1 — Reaction:

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O.$$

The product is ethyl acetate (ethyl ethanoate). The H_2SO_4 acts as catalyst and dehydrating agent.

Why other options are wrong:

- (B) acetaldehyde would need oxidation of ethanol.
- (C) diethyl ether forms from two ethanol molecules, not with the acid; (D) ethylene needs dehydration of ethanol alone.

Final Answer: ethyl acetate (an ester) $\Rightarrow \boxed{\text{A}}$

$\boxed{\textbf{Answer: (A)}}$ **Go Back to Q25**

Q26.

Solution

Concept — Neutral $FeCl_3$ test: phenols form coloured iron(III) complexes with neutral ferric chloride solution, a classic test for the phenolic –OH group.

Step 1 — Observation: phenol gives a characteristic violet (purple) colouration due to the formation of a coloured coordination complex of the type $[Fe(OC_6H_5)_6]^{3-}$.

Why other options are wrong:

- (A),(C) yellow/brick-red precipitates are not given in this test.
- (D) a positive test does produce a visible colour change.

Final Answer: a violet (purple) colouration $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q26**

Q27.

Solution

Concept — Williamson synthesis of an unsymmetrical ether: the reaction is an S_N2 between an alkoxide and an alkyl halide. To avoid elimination, the *alkyl halide must be the less hindered (primary) partner*, while the bulky group is supplied as the alkoxide.

Step 1 — Choose correctly: for $(CH_3)_3C\text{–}O\text{–}CH_3$, use the bulky *tert*-butoxide ion with the small methyl iodide: $(CH_3)_3CO^-Na^+ + CH_3I \to (CH_3)_3C\text{–}O\text{–}CH_3$.

Why other options are wrong:

- (A),(B) one partner is an alcohol/halide that does not give the alkoxide + R–X combination.
- (D) methoxide + *tert*-butyl chloride would mainly give elimination (isobutylene) because the 3° halide undergoes E2.

Final Answer: sodium *tert*-butoxide + methyl iodide $\Rightarrow \boxed{C}$

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

Q28.

Solution

Concept — Reduction by $NaBH_4$: sodium borohydride is a mild hydride reagent that reduces the carbonyl group of aldehydes to primary alcohols and ketones to secondary alcohols (it does not touch C=C or COOH).

Step 1 — Reaction: propanal (an aldehyde) is reduced to a *primary* alcohol:

$$CH_3CH_2CHO \xrightarrow{NaBH_4} CH_3CH_2CH_2OH.$$

Why other options are wrong:

- (B) $NaBH_4$ reduces (it does not oxidise to the acid).
- (C) propan-2-ol comes from reducing acetone, not propanal; (D) the C=O is reduced to C–OH, not removed.

Final Answer: propan-1-ol, $CH_3CH_2CH_2OH \Rightarrow \boxed{A}$

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

Q29.

Solution

Concept — Cross-aldol condensation: a cross-aldol between two different carbonyl compounds, each with α-hydrogens, gives a mixture of four products. A clean single product results when *one* partner has *no* α-hydrogen (so it can only act as the electrophile).

Step 1 — Identify the pair: benzaldehyde, C_6H_5CHO, has no α-hydrogen, so it cannot enolise; only the acetaldehyde enolate forms and attacks benzaldehyde, giving essentially one product (cinnamaldehyde after dehydration).

Why other options are wrong:

- (A),(B),(C) both partners possess α-hydrogens, so each can be donor or acceptor, giving a mixture of products.

Final Answer: benzaldehyde $+$ acetaldehyde $\Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ Go Back to Q29

Q30.

Solution

Concept — Reduction of carboxylic acids: $LiAlH_4$ is a strong reducing agent that reduces a carboxylic acid all the way to the corresponding *primary* alcohol.

Step 1 — Reaction:

$$CH_3COOH \xrightarrow{LiAlH_4} CH_3CH_2OH.$$

The –COOH group (3 bonds to O) is reduced to $–CH_2OH$.

Why other options are wrong:

- (A) the reduction does not stop at the aldehyde stage with $LiAlH_4$.
- (C) the C–C skeleton is retained, so ethane is not formed; (D) no ester is produced.

Final Answer: ethanol, $CH_3CH_2OH \Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ Go Back to Q30

Q31.

Solution

Concept — Hofmann bromamide degradation: an amide is converted to a primary amine with *one fewer carbon atom* by treatment with bromine and a strong base.

$$R\text{–}CONH_2 + Br_2 + 4KOH \rightarrow R\text{–}NH_2 + K_2CO_3 + 2KBr + 2H_2O.$$

Step 1 — Carbon count: the carbonyl carbon is lost (as carbonate), so the amine $R\text{–}NH_2$ has one carbon fewer than the starting amide $R\text{–}CONH_2$.

Why other options are wrong:

- (A) the carbon count changes, it is not preserved.
- (B) the carbon number decreases, not increases; (D) only one carbon is lost, not two.

Final Answer: one carbon fewer than the amide $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Gattermann reaction: an aryl diazonium salt is converted to an aryl halide using copper powder and the halogen acid (HCl or HBr). It is a cheaper alternative to the Sandmeyer reaction (which uses Cu(I) halides).

Step 1 — Reaction:

$$C_6H_5N_2^+Cl^- \xrightarrow{Cu/HCl} C_6H_5Cl + N_2.$$

The diazonium group is replaced by the halogen, giving the aryl halide.

Why other options are wrong:

- (B) phenol forms on warming the diazonium salt with water, not with Cu/HX.
- (C),(D) aniline/nitrobenzene are not products of this substitution.

Final Answer: an aryl halide $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q32

Q33.

Solution

Concept — Hofmann elimination: when a quaternary ammonium hydroxide is heated, β-elimination occurs. Because the bulky $–N^+(CH_3)_3$ leaving group and base prefer to remove the *least hindered* β-hydrogen, the *least substituted* alkene predominates (Hofmann's rule, anti-Saytzeff).

Step 1 — Product: the major alkene is the terminal, least-substituted one (e.g. but-1-ene rather than but-2-ene).

Why other options are wrong:

- (A),(C) the more substituted (Saytzeff) alkene is the *minor* product here.
- (B) an alkene, not an alcohol, is the elimination product.

Final Answer: least substituted (Hofmann) alkene $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q33

Q34.

Solution

Concept — Classification of carbohydrates: on hydrolysis, monosaccharides give no simpler sugars (e.g. glucose, fructose); disaccharides give two monosaccharide units; polysaccharides give many.

Step 1 — Hydrolysis of sucrose: sucrose on hydrolysis gives *one* glucose and *one* fructose unit, i.e. two monosaccharides. Hence sucrose is a disaccharide ($C_{12}H_{22}O_{11}$).

Why other options are wrong:

- (A) a monosaccharide cannot be hydrolysed further (glucose is one).
- (C) polysaccharides (starch, cellulose) give many units; (D) sucrose is certainly a carbohydrate.

Final Answer: disaccharide $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Complementary base pairing in DNA: in the DNA double helix, the bases pair specifically through hydrogen bonds — adenine (A) with thymine (T), and guanine (G) with cytosine (C).

Step 1 — Number of H-bonds: A pairs with T through *two* hydrogen bonds; G pairs with C through *three* hydrogen bonds (the G≡C pair is therefore stronger).

Step 2 — Conclusion: the correct scheme is A–T (2 bonds) and G–C (3 bonds).

Why other options are wrong:

- (A),(B) pair the wrong bases (a purine must pair with a pyrimidine: A with T, G with C).
- (D) reverses the number of hydrogen bonds in each pair.

Final Answer: A–T (2 H-bonds), G–C (3 H-bonds) $\Rightarrow \boxed{\text{C}}$

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

Answer Key

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