SRMJEEE Chemistry Sample Paper – 4

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. 20 g of common salt (NaCl) is dissolved in 180 g of water. The mass percentage ($\%$ w/w) of NaCl in the resulting solution is:

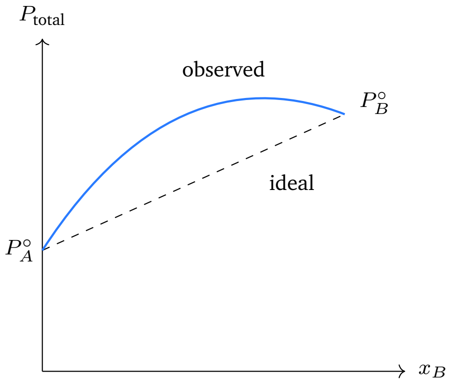
(A) 10%

(B) 20%

(C) 11.1%

(D) 18%

Q2. The vapour-pressure curve of a binary liquid mixture is shown. The total vapour pressure rises *above* the dashed ideal (Raoult) line at every composition. This solution shows:



(A) negative deviation from Raoult's law

(B) positive deviation from Raoult's law

(C) ideal behaviour at all compositions

(D) no deviation, obeying Raoult's law exactly

Q3. When 3 g of a non-volatile, non-electrolyte solute is dissolved in 100 g of water, the boiling point rises by 0.26 K. Taking $K_b = 0.52$ K kg mol^{-1}, the molar mass of the solute is:

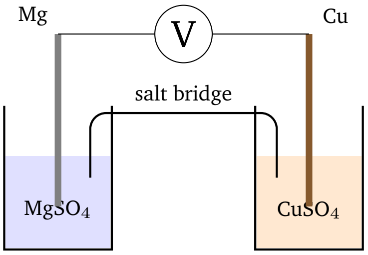
(A) 30 g mol^{-1}

(B) 120 g mol^{-1}

(C) 60 g mol^{-1}

(D) 90 g mol^{-1}

Q4. In the galvanic cell shown, magnesium ($E^\circ_{\text{Mg}^{2+}/\text{Mg}} = -2.37$ V) is paired with copper ($E^\circ_{\text{Cu}^{2+}/\text{Cu}} = +0.34$ V). The electrode that acts as the *anode* (negative electrode, where oxidation occurs) is:



(A) the copper electrode (oxidation)

(B) the salt bridge

(C) the copper electrode (reduction)

(D) the magnesium electrode (oxidation)

Q5. On progressive dilution of an electrolyte solution, the *specific* (electrolytic) conductivity κ:

(A) decreases, because the number of ions per unit volume falls

(B) increases sharply

(C) stays exactly constant

(D) first increases and then becomes infinite

Q6. In the electrolysis of acidified water, 4 F (4×96500 C) of charge is passed. The number of moles of O_2 gas liberated at the anode is:

(A) 2 mol

(B) 1 mol

(C) 4 mol

(D) 0.5 mol

Q7. For a *zero-order* reaction, which one of the following statements is correct?

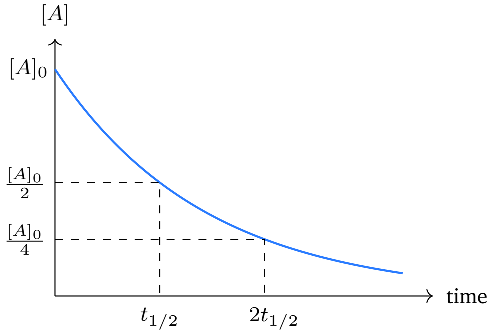
(A) the rate doubles when the concentration is doubled

(B) the half-life is independent of the initial concentration

(C) the rate is independent of the concentration of the reactant

(D) a plot of $\ln[A]$ against time is a straight line

Q8. A first-order reaction has a half-life $t_{1/2} = 20$ min. From the decay curve shown, the time required for the reaction to reach 75% completion (when $[A]$ falls to one-quarter of $[A]_0$) is:



(A) 20 min

(B) 80 min

(C) 60 min

(D) 40 min

Q9. For a reaction obeying the Arrhenius equation, a graph of $\ln k$ against $1/T$ is a straight line. The slope of this line is equal to:

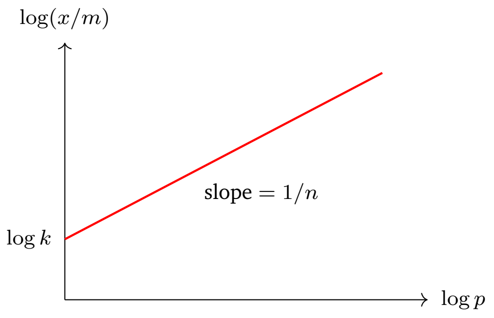
(A) $-\frac{E_a}{R}$

(B) $+\frac{E_a}{R}$

(C) $-\frac{R}{E_a}$

(D) $\ln A$

Q10. Taking logarithms of the Freundlich isotherm $\frac{x}{m} = k\,p^{1/n}$ gives a straight line on a plot of $\log\left(\frac{x}{m}\right)$ against $\log p$, as shown. The slope and intercept of this line are, respectively:



(A) slope $= k$, intercept $= 1/n$

(B) slope $= 1/n$, intercept $= \log k$

(C) slope $= \log k$, intercept $= 1/n$

(D) slope $= n$, intercept $= k$

Q11. According to the Hardy–Schulze rule, the coagulating power of an ion towards a colloidal sol depends on its charge. Which of the following will most effectively coagulate a *negatively* charged As_2S_3 sol?

(A) Na^+

(B) Cl^-

(C) Al^{3+}

(D) SO_4^{2-}

Q12. An emulsifying agent (such as soap) is added to an oil–water mixture mainly to:

(A) increase the surface tension between oil and water

(B) make the two liquids completely miscible

(C) speed up the separation of oil and water

(D) stabilise the emulsion by forming a protective film around the droplets

Q13. Among the noble gases, xenon forms several stable fluorides (XeF_2, XeF_4, XeF_6). This compound-forming ability is greatest for xenon (rather than helium or neon) chiefly because xenon has:

(A) a relatively low ionisation enthalpy and large, easily polarised atoms

(B) a completely empty valence shell

(C) the highest electronegativity of the noble gases

(D) no electrons available for bonding

Q14. The oxidation state of phosphorus in orthophosphoric acid, H_3PO_4, is:

(A) $+3$

(B) $+5$

(C) $+4$

(D) $+6$

Q15. The correct order of the H–X–H (or H–E–H) bond angles in the group-15 hydrides is:

(A) $AsH_3 > PH_3 > NH_3$

(B) $PH_3 > NH_3 > AsH_3$

(C) $NH_3 > PH_3 > AsH_3$

(D) $NH_3 > AsH_3 > PH_3$

Q16. Which of the following ions has the *maximum* number of unpaired electrons (and hence the greatest paramagnetism)?

(A) Ti^{3+}

(B) V^{3+}

(C) Cr^{3+}

(D) Mn^{2+}

Q17. The dichromate ion ($Cr_2O_7^{2-}$) and the chromate ion (CrO_4^{2-}) are interconverted by a change in pH. Regarding the oxidation state of chromium in these ions, the correct statement is:

(A) Cr is $+6$ in both ions; dichromate predominates in acidic and chromate in alkaline solution

(B) Cr is $+6$ in dichromate but $+3$ in chromate

(C) Cr is $+7$ in both ions

(D) Cr is $+3$ in both ions, independent of pH

Q18. Zinc, cadmium and mercury (group 12) are usually *not* regarded as typical transition metals because:

(A) they are radioactive

(B) their d-orbitals are completely filled (d^{10}) in the atom and in their common $+2$ ions

(C) they belong to the f-block

(D) they cannot form any compounds

Q19. The IUPAC name of the complex $K_4[Fe(CN)_6]$ is:

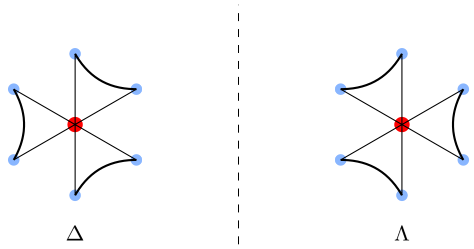
(A) potassium hexacyanoiron(II)

(B) potassium hexacyanidoferrum(II)

(C) potassium hexacyanidoferrate(II)

(D) tetrapotassium hexacyanoiron(III)

Q20. The octahedral complex $[Co(en)_3]^{3+}$ (en $=$ ethylenediamine, a bidentate ligand) exists as two non-superimposable mirror images, as shown. This type of stereoisomerism is called:



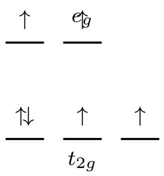
(A) geometrical (cis–trans) isomerism

(B) linkage isomerism

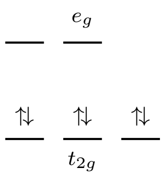
(C) ionisation isomerism

(D) optical isomerism (the complex is chiral)

Q21. For an octahedral d^6 metal ion, the crystal-field diagram on the left (weak field, $\Delta_o < P$) and on the right (strong field, $\Delta_o > P$) are shown. The number of unpaired electrons in the *high-spin* (weak-field) case is:



high spin



low spin

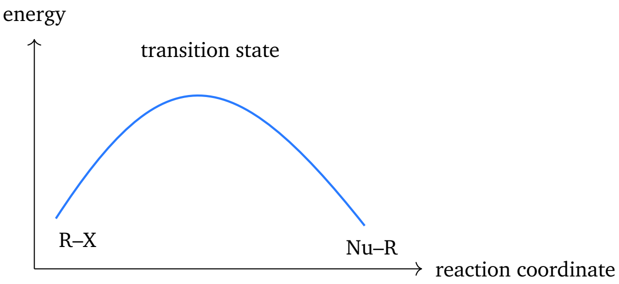
(A) 4

(B) 0

(C) 2

(D) 6

Q22. The single-step energy profile shown is that of an S_N2 reaction, in which the nucleophile attacks the carbon from the side opposite the leaving group. Because of *steric* hindrance, the correct order of S_N2 reactivity of alkyl halides is:



(A) $3^\circ > 2^\circ > 1^\circ > CH_3X$

(B) $CH_3X > 1^\circ > 2^\circ > 3^\circ$

(C) $2^\circ > 1^\circ > 3^\circ > CH_3X$

(D) all alkyl halides react at the same rate

Q23. When an alkyl halide R–X is heated with alcoholic *potassium cyanide* (KCN), the major product is:

(A) an isocyanide, R–NC

(B) an alcohol, R–OH

(C) a nitrile (alkyl cyanide), R–CN

(D) an amine, R–NH_2

Q24. The presence of nitro ($-NO_2$) groups at the *ortho* and *para* positions of an aryl halide makes nucleophilic aromatic substitution much easier. This is because the $-NO_2$ groups:

(A) increase the electron density on the ring

(B) donate electrons by resonance

(C) have no effect on the reaction rate

(D) withdraw electrons and stabilise the negatively charged intermediate (Meisenheimer complex)

Q25. Acid-catalysed hydration of propene (CH_3–$CH{=}CH_2$) follows Markovnikov's rule. The major product is:

(A) propan-2-ol, CH_3–$CH(OH)$–CH_3

(B) propan-1-ol, CH_3–CH_2–CH_2OH

(C) propane

(D) propanoic acid

Q26. When phenol is treated with chloroform and aqueous NaOH, followed by acid hydrolysis (the Reimer–Tiemann reaction), the main product is:

(A) benzaldehyde

(B) salicylaldehyde (2-hydroxybenzaldehyde)

(C) benzoic acid

(D) anisole

Q27. When anisole (methyl phenyl ether, C_6H_5–O–CH_3) is heated with excess HI, the products formed are:

(A) iodobenzene and methanol

(B) phenol and iodobenzene

(C) phenol and methyl iodide (CH_3I)

(D) anisole iodide and water

Q28. A Grignard reagent (R–MgX) reacts with a *ketone* and, after acid work-up, gives:

(A) a primary alcohol

(B) an aldehyde

(C) a carboxylic acid

(D) a tertiary alcohol

Q29. Which of the following compounds gives a yellow precipitate of iodoform (CHI_3) when treated with I_2 and NaOH?

(A) acetone (CH_3COCH_3)

(B) benzophenone ($C_6H_5COC_6H_5$)

(C) benzaldehyde (C_6H_5CHO)

(D) methanol (CH_3OH)

Q30. Carboxylic acids can be distinguished from phenols because, on adding aqueous sodium bicarbonate ($NaHCO_3$), a carboxylic acid:

(A) gives a violet colour

(B) liberates carbon dioxide gas with brisk effervescence

(C) gives no visible reaction

(D) forms a yellow precipitate

Q31. Nitrobenzene ($C_6H_5NO_2$) is reduced with Sn and concentrated HCl. The organic product is:

(A) nitrosobenzene

(B) phenol

(C) aniline ($C_6H_5NH_2$)

(D) benzoic acid

Q32. When benzene diazonium chloride is warmed with dilute aqueous acid (hydrolysed in warm water), the $-N_2^+$ group is replaced and the product is:

(A) chlorobenzene

(B) benzene

(C) nitrobenzene

(D) phenol (C_6H_5OH)

Q33. On strong heating, a quaternary ammonium hydroxide undergoes Hofmann elimination. According to the Hofmann rule, the major alkene formed is:

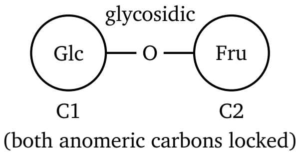
(A) the least-substituted (Hofmann) alkene

(B) the most-substituted (Zaitsev) alkene

(C) an alcohol, not an alkene

(D) a mixture in which no alkene predominates

Q34. The structure of sucrose is shown: the anomeric carbons of glucose and fructose are joined through the glycosidic oxygen, leaving *no* free anomeric –OH. Therefore sucrose is:



(A) a reducing sugar

(B) a non-reducing sugar

(C) a monosaccharide

(D) an amino sugar

Q35. The difference between an essential and a non-essential amino acid is that an *essential* amino acid:

(A) is required only by plants

(B) contains no nitrogen

(C) cannot be synthesised by the human body and must be supplied in the diet

(D) is one that the body can make for itself

Detailed Solutions

Q1.

Solution

Concept — Mass percentage (% w/w): $\%\,\text{w/w} = \dfrac{\text{mass of solute}}{\text{mass of solution}} \times 100$, where mass of solution = mass of solute + mass of solvent.

Step 1 — Mass of solution: $20 + 180 = 200$ g.

Step 2 — Apply the formula: $\%\,\text{w/w} = \dfrac{20}{200} \times 100 = 10\%$.

Why other options are wrong:

- (B) 20% uses only the solvent mass ($100 \times 20/100$) as the denominator.
- (C) 11.1% wrongly divides by the solvent (20/180); (D) 18% has no valid basis.

Final Answer: $\%\,\text{w/w} = 10\% \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q1**

Q2.

Solution

Concept — Deviations from Raoult's law: an ideal solution gives a straight (P_{total} vs composition) line. If the observed total vapour pressure lies *above* this line, the solution shows a *positive* deviation; if it lies below, a negative deviation.

Step 1 — Read the curve: the solid (observed) curve bulges above the dashed ideal line at every composition, so the actual vapour pressure is higher than predicted.

Step 2 — Interpret: positive deviation arises when A–B interactions are *weaker* than A–A and B–B interactions, so molecules escape more easily (e.g. ethanol + acetone).

Why other options are wrong:

- (A) negative deviation would dip below the ideal line.
- (C),(D) an ideal solution would lie exactly on the dashed line, not above it.

Final Answer: positive deviation from Raoult's law $\Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q2**

Q3.

Solution

Concept — Molar mass from boiling-point elevation: $\Delta T_b = K_b\, m = K_b \dfrac{w_2/M_2}{w_1(\text{kg})}$, so $M_2 = \dfrac{K_b\, w_2 \times 1000}{\Delta T_b\, w_1}$ (masses in grams).

Step 1 — Substitute the data: $w_2 = 3$ g, $w_1 = 100$ g, $K_b = 0.52$, $\Delta T_b = 0.26$.

$$M_2 = \frac{0.52 \times 3 \times 1000}{0.26 \times 100} = \frac{1560}{26} = 60 \text{ g mol}^{-1}.$$

Step 2 — Check: molality $m = \Delta T_b / K_b = 0.26/0.52 = 0.5$ m; moles $= 0.5 \times 0.1 = 0.05$; $M = 3/0.05 = 60$. Consistent.

Why other options are wrong:

- (A) 30 doubles ΔT_b; (B) 120 halves it.
- (D) 90 uses the wrong solvent mass.

Final Answer: $M_2 = 60 \text{ g mol}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Anode of a galvanic cell: the electrode with the *more negative* (lower) standard reduction potential is oxidised; it is the anode (negative electrode).

Step 1 — Compare potentials: $E^\circ_{\text{Mg}^{2+}/\text{Mg}} = -2.37$ V is far more negative than $E^\circ_{\text{Cu}^{2+}/\text{Cu}} = +0.34$ V.

Step 2 — Assign electrodes: Mg is oxidised ($\text{Mg} \to \text{Mg}^{2+} + 2e^-$) $\Rightarrow$ Mg is the anode; Cu^{2+} is reduced at the copper cathode.

Why other options are wrong:

- (A) copper is reduced (cathode), not oxidised.
- (B) the salt bridge only completes the circuit; (C) describes the cathode, not the anode.

Final Answer: the magnesium electrode (oxidation) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Specific conductivity and dilution: specific conductivity κ is the conductance of unit volume of solution, so it depends on the number of current-carrying ions *per unit volume*.

Step 1 — Effect of dilution: on dilution the same ions are spread through a larger volume, so the number of ions per cm^3 falls, and κ *decreases*.

Step 2 — Contrast with molar conductivity: molar conductivity $\Lambda_m = \kappa \times 1000/c$ *increases* on dilution, because it accounts for all ions from one mole; do not confuse the two.

Why other options are wrong:

- (B) κ falls, it does not rise, on dilution.
- (C) it is not constant; (D) it never becomes infinite.

Final Answer: κ decreases on dilution $\Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q5**

Q6.

Solution

Concept — Gas liberated in electrolysis of water: at the anode, $2\text{H}_2\text{O} \rightarrow \text{O}_2 + 4\text{H}^+ + 4e^-$, so 4 mol of electrons (i.e. 4 F) release 1 mol of O_2.

Step 1 — Use the electron count: O_2 requires 4 electrons per molecule, hence 1 mol O_2 per 4 F.

Step 2 — Apply to 4 F: moles of $\text{O}_2 = \dfrac{4\text{ F}}{4\text{ F mol}^{-1}} = 1$ mol. (The cathode would give 2 mol H_2.)

Why other options are wrong:

- (A) 2 mol is the amount of H_2, not O_2.
- (C) 4 ignores the 4-electron requirement; (D) 0.5 uses 8 electrons per O_2.

Final Answer: 1 mol of $\text{O}_2 \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q6**

Q7.

Solution

Concept — Zero-order reaction: for a zero-order reaction, rate $= k[A]^0 = k$, a constant. The rate does not change as the reactant is consumed.

Step 1 — Key feature: since rate $= k$ is independent of $[A]$, doubling the concentration leaves the rate unchanged.

Step 2 — Other features: a plot of $[A]$ (not $\ln[A]$) against time is linear, and $t_{1/2} = [A]_0/2k$ *depends* on the initial concentration.

Why other options are wrong:

- (A) describes a first-order reaction.
- (B),(D) the concentration-independent half-life and linear $\ln[A]$ plot are properties of first-order, not zero-order, reactions.

Final Answer: the rate is independent of concentration $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — First-order completion in half-lives: each half-life halves the remaining reactant. 75% completion means $[A]$ has fallen to $25\% = \frac{1}{4}[A]_0$, i.e. two successive halvings.

Step 1 — Count half-lives: $[A]_0 \rightarrow \frac{1}{2}[A]_0$ (1st $t_{1/2}$) $\rightarrow \frac{1}{4}[A]_0$ (2nd $t_{1/2}$). So 75% completion needs $2\,t_{1/2}$.

Step 2 — Substitute: $t = 2 \times 20 = 40$ min (the graph shows $\frac{1}{4}[A]_0$ reached at $2t_{1/2}$).

Why other options are wrong:

- (A) 20 min is one half-life (50% completion).
- (B) 80 min is $4\,t_{1/2}$; (C) 60 min is $3\,t_{1/2}$ (87.5%).

Final Answer: $t = 2t_{1/2} = 40$ min $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Arrhenius plot: taking logarithms of $k = A\,e^{-E_a/RT}$ gives

$$\ln k = \ln A - \frac{E_a}{R}\cdot\frac{1}{T}.$$

This is of the form $y = c + mx$ with $x = 1/T$.

Step 1 — Identify the slope: comparing, the slope $m = -\dfrac{E_a}{R}$ (a negative number, since $E_a > 0$), and the intercept is $\ln A$.

Step 2 — Use it: E_a is obtained as $E_a = -R \times (\text{slope})$.

Why other options are wrong:

- (B) the slope is negative, not $+E_a/R$.
- (C) $-R/E_a$ inverts the ratio; (D) $\ln A$ is the *intercept*, not the slope.

Final Answer: slope $= -\dfrac{E_a}{R} \Rightarrow \boxed{\text{A}}$

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

Q10.

Solution

Concept — Linearised Freundlich isotherm: taking $\log_{10}$ of $\dfrac{x}{m} = k\,p^{1/n}$ gives

$$\log\left(\frac{x}{m}\right) = \log k + \frac{1}{n}\log p.$$

Step 1 — Compare with $y = c + mx$: with $y = \log(x/m)$ and $x = \log p$, the *slope* is $1/n$ and the *intercept* (at $\log p = 0$) is $\log k$.

Step 2 — Read the graph: the straight line cuts the vertical axis at $\log k$ and rises with gradient $1/n$, exactly as labelled.

Why other options are wrong:

- (A),(C) swap or mislabel the slope and intercept.
- (D) the slope is $1/n$, not n, and the intercept is $\log k$, not k.

Final Answer: slope $= 1/n$, intercept $= \log k \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q10**

Q11.

Solution

Concept — Hardy–Schulze rule: the ion responsible for coagulating a sol is the one carrying a charge *opposite* to that of the colloidal particles, and its coagulating power increases sharply with the magnitude of that charge.

Step 1 — Identify the active ion: the As_2S_3 sol is negatively charged, so a *cation* causes coagulation. Among the options, the cations are Na^+ and Al^{3+}.

Step 2 — Pick the highest charge: Al^{3+} $(+3)$ coagulates far more effectively than Na^+ $(+1)$.

Why other options are wrong:

- (A) Na^+ is a cation but only $+1$, much weaker than Al^{3+}.
- (B),(D) Cl^- and SO_4^{2-} are anions; they cannot coagulate a negative sol.

Final Answer: $Al^{3+} \Rightarrow \boxed{\text{C}}$

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

Q12.

Solution

Concept — Emulsifying agent: an emulsifier (e.g. soap, protein) collects at the oil–water interface, lowering the interfacial tension and forming a protective layer that keeps the dispersed droplets from coalescing.

Step 1 — Its action: the emulsifier molecule has a hydrophilic head and a hydrophobic tail, so it surrounds each oil droplet and stabilises the emulsion.

Step 2 — Result: a stable emulsion is formed; without the emulsifier the two liquids would quickly separate.

Why other options are wrong:

- (A) it *lowers* interfacial tension, not raises it.
- (B) the liquids remain immiscible (dispersed, not dissolved); (C) it slows, not speeds, separation.

Final Answer: stabilises the emulsion by forming a protective film $\Rightarrow \boxed{\text{D}}$

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

Q13.

Solution

Concept — Reactivity of noble gases: a noble gas can form compounds only if its outer electrons can be involved in bonding. This is easiest for heavier atoms with low ionisation enthalpy and large, polarisable electron clouds.

Step 1 — Why xenon: xenon, being large, has a comparatively low ionisation enthalpy, so its valence electrons can be drawn towards highly electronegative atoms such as F.

Step 2 — Products: xenon thus forms XeF_2, XeF_4 and XeF_6, whereas the small He and Ne (very high ionisation enthalpy) form essentially no stable compounds.

Why other options are wrong:

- (B),(D) noble-gas atoms have *full* valence shells, but xenon's electrons are still loosely held enough to bond.
- (C) xenon does not have the highest electronegativity; its large size is the key factor.

Final Answer: low ionisation enthalpy and large polarisable atoms $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

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

Step 1 — Set up for H_3PO_4: $3(+1) + x + 4(-2) = 0 \Rightarrow 3 + x - 8 = 0.$

Step 2 — Solve: $x = +5$, the maximum (group) oxidation state of phosphorus.

Why other options are wrong:

- (A) $+3$ is the state of P in H_3PO_3 (phosphorous acid).
- (C) $+4$ has no valid count here; (D) $+6$ exceeds the group oxidation state of $+5$.

Final Answer: oxidation state of P $= +5 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Bond angles of group-15 hydrides: as the central atom gets larger and less electronegative down the group, the bonding electron pairs lie farther from it and repel one another less, so the bond angle decreases.

Step 1 — Order: NH_3 $(107^\circ) > PH_3$ $(\approx 94^\circ) > AsH_3$ $(\approx 92^\circ) > SbH_3$ $(\approx 91^\circ)$.

Step 2 — Reason: nitrogen, being most electronegative and smallest, keeps the bond pairs closest, giving the widest angle.

Why other options are wrong:

- (A) reverses the order completely.
- (B),(D) misplace PH_3 or AsH_3 within the trend.

Final Answer: $NH_3 > PH_3 > AsH_3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Counting unpaired electrons: write the d^n configuration of each ion and apply Hund's rule. More unpaired electrons mean greater paramagnetism.

Step 1 — Configurations: Ti^{3+} is $3d^1$ (1 unpaired), V^{3+} is $3d^2$ (2), Cr^{3+} is $3d^3$ (3), Mn^{2+} is $3d^5$ (5 unpaired).

Step 2 — Pick the maximum: Mn^{2+} ($3d^5$, half-filled) has 5 unpaired electrons, the most of the four.

Why other options are wrong:

- (A),(B),(C) have only 1, 2 and 3 unpaired electrons respectively.

Final Answer: Mn^{2+} ($3d^5$, 5 unpaired) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Chromium in chromate/dichromate: both $Cr_2O_7^{2-}$ and CrO_4^{2-} contain chromium in the $+6$ oxidation state; only the degree of condensation of the oxoanion changes with pH.

Step 1 — Check the oxidation state: in CrO_4^{2-}, $x + 4(-2) = -2 \Rightarrow x = +6$; in $Cr_2O_7^{2-}$, $2x + 7(-2) = -2 \Rightarrow x = +6$. Same in both.

Step 2 — pH dependence: $2CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$. Acid favours orange dichromate; alkali favours yellow chromate.

Why other options are wrong:

- (B),(D) the oxidation state stays $+6$ in both ions; it is not $+3$.
- (C) $+7$ would exceed chromium's group oxidation state of $+6$.

Final Answer: Cr is $+6$ in both; dichromate in acid, chromate in alkali $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Definition of a transition metal: a transition element has a partially filled d-subshell in its atom or in one of its common ions. Metals lacking this are not "typical" transition metals.

Step 1 — Configuration of group 12: Zn, Cd, Hg have $(n-1)d^{10}ns^2$; their common $+2$ ions are $(n-1)d^{10}$ — a completely filled d-subshell.

Step 2 — Consequence: with no partly filled d-orbitals, they lack typical transition-metal behaviour (variable oxidation states, coloured ions, strong catalytic/magnetic properties).

Why other options are wrong:

- (A) they are not radioactive; (C) they are d-block, not f-block.
- (D) they do form compounds (e.g. ZnO, $HgCl_2$); the issue is the filled d^{10} shell.

Final Answer: d-orbitals completely filled $(d^{10}) \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Naming an anionic complex: when the complex ion carries a negative charge, the metal name ends in "-ate" (often using the Latin stem). Ligands are named first, with the metal oxidation state in Roman numerals.

Step 1 — Oxidation state of Fe: four K^+ ($+4$ total) balance the complex ion, so $[Fe(CN)_6]^{4-}$; with six CN^- (-6), $x - 6 = -4 \Rightarrow x = +2$.

Step 2 — Assemble the name: six CN^- → "hexacyanido"; anionic iron → "ferrate"; oxidation state (II) ⇒ potassium hexacyanidoferrate(II).

Why other options are wrong:

- (A) "iron" lacks the required "-ate" ending for an anion.
- (B) "ferrum" is not the correct stem; (D) the oxidation state is (II), not (III).

Final Answer: potassium hexacyanidoferrate(II) ⇒ $\boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q19

Q20.

Solution

Concept — Optical isomerism: a complex that is non-superimposable on its mirror image (chiral) shows optical isomerism; the two forms are called enantiomers (Δ and Λ).

Step 1 — Recognise chirality: $[Co(en)_3]^{3+}$ has three bidentate en ligands arranged as a three-bladed propeller; its mirror image cannot be rotated to coincide with the original (as the figure shows).

Step 2 — Classify: the two non-superimposable mirror images ⇒ optical isomers (the complex is chiral).

Why other options are wrong:

- (A) geometrical isomerism needs cis/trans ligand positions, not present here.
- (B),(C) linkage and ionisation isomerism arise from different donor atoms or counter-ions, not from mirror images.

Final Answer: optical isomerism (chiral complex) ⇒ $\boxed{\text{D}}$

$\boxed{\text{Answer: (D)}}$ Go Back to Q20

Q21.

Solution

Concept — High-spin vs low-spin d^6: in a weak octahedral field ($\Delta_o < P$, the pairing energy) electrons fill all five d-orbitals singly before pairing (Hund), giving the high-spin arrangement.

Step 1 — Fill the orbitals (high spin): $d^6 = t_{2g}^4\, e_g^2$. Distributing 6 electrons over 5 orbitals with maximum spin gives one paired orbital and four singly occupied $\Rightarrow$ 4 unpaired electrons.

Step 2 — Contrast (low spin): in a strong field ($\Delta_o > P$) all six electrons pair in $t_{2g}^6\, e_g^0 \Rightarrow 0$ unpaired (diamagnetic).

Why other options are wrong:

- (B) 0 is the low-spin (strong-field) case, not high spin.
- (C),(D) 2 and 6 do not match the $t_{2g}^4 e_g^2$ high-spin filling.

Final Answer: high-spin d^6 has 4 unpaired electrons $\Rightarrow \boxed{\text{A}}$

Answer: (A)

Go Back to Q21

Q22.

Solution

Concept — S$_N$2 and steric hindrance: the S$_N$2 mechanism is a one-step backside attack through a crowded five-coordinate transition state. Bulky alkyl groups around the reacting carbon hinder this approach.

Step 1 — Effect of substitution: the more alkyl groups on the carbon, the greater the steric crowding, so the slower the S$_N$2 reaction.

Step 2 — Order of reactivity: least hindered reacts fastest: $CH_3X > 1° > 2° > 3°$. (Tertiary halides essentially do not undergo S$_N$2.)

Why other options are wrong:

- (A) is the reverse (that order suits S$_N$1, governed by carbocation stability).
- (C) misorders the series; (D) the rates clearly differ with structure.

Final Answer: $CH_3X > 1° > 2° > 3° \Rightarrow \boxed{\text{B}}$

Answer: (B)

Go Back to Q22

Q23.

Solution

Concept — Ambident cyanide nucleophile: in KCN the cyanide ion is ambident, but in alcoholic medium it bonds to carbon through its *carbon* atom, giving a nitrile (alkyl cyanide).

Step 1 — Reaction: $R\text{–}X + KCN \xrightarrow{\text{alcohol}} R\text{–}C\equiv N + KX$ (an S_N2 substitution).

Step 2 — Use: the nitrile can be hydrolysed to a carboxylic acid or reduced to a primary amine, adding one carbon to the chain.

Why other options are wrong:

- (A) the isocyanide (R–NC) forms with *silver* cyanide (AgCN), not KCN.
- (B),(D) alcohol and amine require different reagents (KOH_{aq} / reduction).

Final Answer: a nitrile, R–CN $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Activation of haloarenes by $-NO_2$: nucleophilic aromatic substitution proceeds through a carbanion-like (Meisenheimer) intermediate in which negative charge builds up on the ring.

Step 1 — Role of $-NO_2$: a nitro group at the ortho/para position is strongly electron-withdrawing (by $-$M and $-$I), so it delocalises and stabilises that negative charge.

Step 2 — Consequence: the more stable intermediate lowers the activation energy, so o-/p-nitro substitution greatly speeds up the reaction (e.g. 2,4,6-trinitrochlorobenzene reacts very readily).

Why other options are wrong:

- (A),(B) $-NO_2$ *withdraws* electron density, it does not donate it.
- (C) the groups have a large accelerating effect, not none.

Final Answer: they withdraw electrons and stabilise the intermediate $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Markovnikov hydration of an alkene: in acid-catalysed addition of water, H^+ adds to the double-bond carbon bearing *more* hydrogens, generating the more stable carbocation; $-$OH then adds to the other (more substituted) carbon.

Step 1 — Form the carbocation: for $CH_3CH{=}CH_2$, protonation gives the secondary cation $CH_3\text{–}\overset{+}{C}H\text{–}CH_3$ (more stable than the primary).

Step 2 — Add water: $-$OH attaches to that carbon, giving propan-2-ol, $CH_3CH(OH)CH_3$, as the major product.

Why other options are wrong:

- (B) propan-1-ol is the anti-Markovnikov (minor) product.
- (C),(D) propane and propanoic acid are not formed by simple hydration.

Final Answer: propan-2-ol $\Rightarrow \boxed{A}$

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

Q26.

Solution

Concept — Reimer–Tiemann reaction: phenol with $CHCl_3$ and aqueous NaOH generates dichlorocarbene ($:CCl_2$), which attacks the activated ring (mainly at the ortho position) to introduce a $-$CHO group after hydrolysis.

Step 1 — Mechanism outline: phenoxide $+$ $:CCl_2$ $\rightarrow$ ortho-substituted intermediate $\rightarrow$ (hydrolysis) *o*-hydroxybenzaldehyde.

Step 2 — Product: the main product is salicylaldehyde (2-hydroxybenzaldehyde).

Why other options are wrong:

- (A) plain benzaldehyde lacks the ortho $-$OH that phenol directs in.
- (C) benzoic acid would need CCl_4 (Reimer–Tiemann carboxylation gives salicylic acid, not benzoic); (D) anisole is an ether, not formed here.

Final Answer: salicylaldehyde $\Rightarrow \boxed{B}$

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

Q27.

Solution

Concept — Ether cleavage by HI: hot HI cleaves the weaker C–O bond of an ether. For an alkyl aryl ether the attack occurs at the *alkyl* carbon (the aryl C–O bond resists nucleophilic attack), so the alkyl group leaves as an alkyl iodide.

Step 1 — Cleave anisole: $C_6H_5\text{–O–}CH_3 + HI \rightarrow C_6H_5\text{–OH} + CH_3I$.

Step 2 — Note: phenol is *not* further converted to iodobenzene, because the aryl C–O bond is strong (partial double-bond character).

Why other options are wrong:

- (A),(B) iodobenzene does not form; the aryl C–O bond stays intact.
- (D) there is no “anisole iodide”; HI cleaves the ether.

Final Answer: phenol + methyl iodide (CH_3I) $\Rightarrow \boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q27

Q28.

Solution

Concept — Grignard addition to carbonyls: R–MgX adds across the C=O double bond; the class of alcohol formed depends on the carbonyl substrate — formaldehyde → 1°, other aldehydes → 2°, ketones → 3°.

Step 1 — React with a ketone: $R'\ R''C{=}O + R\text{–}MgX$ gives, after hydrolysis, $R'R''R\text{–}C\text{–}OH$, a carbon bearing *three* carbon groups.

Step 2 — Classify: three alkyl/aryl groups on the carbinol carbon ⇒ a tertiary alcohol.

Why other options are wrong:

- (A) primary alcohols come from formaldehyde; (B),(C) aldehydes/CO_2 give secondary alcohols / acids, not from a ketone.

Final Answer: a tertiary alcohol $\Rightarrow \boxed{\text{D}}$

$\boxed{\text{Answer: (D)}}$ Go Back to Q28

Q29.

Solution

Concept — Iodoform test: a positive iodoform test (yellow CHI_3) is given by compounds containing a CH_3CO– group (methyl ketone) or a $CH_3CH(OH)$– group (which I_2/NaOH first oxidises to a methyl ketone), including ethanol and acetaldehyde.

Step 1 — Check each compound: acetone (CH_3COCH_3) has a CH_3CO– group ⇒ positive.

Step 2 — Reaction: $CH_3COCH_3 + 3I_2 + 4NaOH \rightarrow CHI_3 \downarrow + CH_3COONa + 3NaI + 3H_2O$.

Why other options are wrong:

- (B),(C) benzophenone and benzaldehyde have no CH_3CO– (or $CH_3CH(OH)$–) group.
- (D) methanol (CH_3OH) lacks the required $CH_3CH(OH)$– pattern, so it gives no iodoform.

Final Answer: acetone ⇒ $\boxed{A}$

Answer: (A) **Go Back to Q29**

Q30.

Solution

Concept — Reaction with $NaHCO_3$: carboxylic acids are strong enough to react with the weak base sodium bicarbonate, liberating CO_2; phenols (much weaker acids) do not.

Step 1 — Reaction: $R–COOH + NaHCO_3 \rightarrow R–COONa + H_2O + CO_2 \uparrow$, seen as brisk effervescence.

Step 2 — Distinguishing test: because phenol gives no bubbles with $NaHCO_3$, this neatly separates carboxylic acids from phenols.

Why other options are wrong:

- (A) the violet colour is the neutral $FeCl_3$ test for phenols, not this reaction.
- (C) "no reaction" is what phenol does, not the acid; (D) no precipitate forms.

Final Answer: liberates CO_2 with brisk effervescence ⇒ $\boxed{B}$

Answer: (B) **Go Back to Q30**

Q31.

Solution

Concept — Amines by reduction of nitro compounds: a nitro group ($-NO_2$) on an aromatic ring is reduced to a primary amino group ($-NH_2$) by metal/acid systems such as Sn/HCl or Fe/HCl.

Step 1 — Reaction: $C_6H_5NO_2 \xrightarrow{Sn/HCl} C_6H_5NH_2$ (aniline), the amine salt being liberated on adding base.

Step 2 — Note: this is the standard laboratory preparation of aniline from nitrobenzene.

Why other options are wrong:

- (A) nitrosobenzene is only a partial-reduction intermediate, not the final product.
- (B),(D) phenol and benzoic acid are not produced by reduction of $-NO_2$.

Final Answer: aniline, $C_6H_5NH_2 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Replacement of the diazonium group by $-OH$: when an arene diazonium salt is warmed with water (dilute acid), the $-N_2^+$ group is replaced by $-OH$, with loss of N_2 gas.

Step 1 — Reaction: $C_6H_5N_2^+Cl^- + H_2O \xrightarrow{warm} C_6H_5OH + N_2\uparrow + HCl$.

Step 2 — Product: the aromatic product is phenol.

Why other options are wrong:

- (A) chlorobenzene needs the Sandmeyer reaction (CuCl/HCl), not warm water.
- (B) benzene results from H_3PO_2 reduction; (C) nitrobenzene is not formed here.

Final Answer: phenol, $C_6H_5OH \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Hofmann elimination: on heating a quaternary ammonium hydroxide, β-elimination occurs. Unlike acid-catalysed dehydration (Zaitsev), the bulky $-NR_3$ leaving group and the base abstract the *least hindered* β-hydrogen.

Step 1 — Hofmann rule: the proton is removed from the carbon bearing the most hydrogens, giving the less-substituted (terminal) alkene as the major product.

Step 2 — Example: sec-butyltrimethylammonium hydroxide gives mainly but-1-ene (Hofmann), not but-2-ene (Zaitsev).

Why other options are wrong:

- (B) the most-substituted (Zaitsev) alkene is the minor product in Hofmann elimination.
- (C),(D) an alkene is indeed formed, and one isomer (the Hofmann product) predominates.

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

Answer: (A)

Go Back to Q33

Q34.

Solution

Concept — Reducing vs non-reducing sugars: a sugar is reducing if it has a free anomeric carbon (a hemiacetal $-$OH) that can open to an aldehyde/keto form and reduce Tollens'/Fehling's reagent.

Step 1 — Examine sucrose: in sucrose the glycosidic bond links the anomeric C-1 of glucose to the anomeric C-2 of fructose, so *both* anomeric carbons are tied up; no free hemiacetal $-$OH remains.

Step 2 — Conclusion: with no free anomeric $-$OH to open, sucrose cannot reduce Tollens'/Fehling's reagent $\Rightarrow$ it is a non-reducing sugar.

Why other options are wrong:

- (A) sucrose is non-reducing; glucose, fructose, maltose and lactose are reducing.
- (C) sucrose is a disaccharide, not a monosaccharide; (D) it contains no amino group.

Final Answer: a non-reducing sugar $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Essential vs non-essential amino acids: the body can synthesise some amino acids itself (non-essential), but others it cannot make in adequate amounts and must obtain from food (essential).

Step 1 — Definition: an *essential* amino acid is one that cannot be synthesised by the human body, so it must be supplied through the diet (e.g. valine, lysine, leucine).

Step 2 — Contrast: non-essential amino acids (e.g. glycine, alanine) are made within the body and need not be ingested.

Why other options are wrong:

- (A),(B) "essential" refers to human dietary need, not to plants or to nitrogen content (all amino acids contain N).
- (D) describes a *non*-essential amino acid, the opposite of essential.

Final Answer: cannot be synthesised by the body and must come from the diet $\Rightarrow \boxed{\text{C}}$

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	A	14	B	15	C
16	D	17	A	18	B	19	C	20	D
21	A	22	B	23	C	24	D	25	A
26	B	27	C	28	D	29	A	30	B
31	C	32	D	33	A	34	B	35	C