SAAT Chemistry

Sample Paper – 3

Duration: 40 Minutes **Maximum Marks: 40**

Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry section of the **SAAT** (Siksha 'O' Anusandhan Admission Test).
- Each correct answer carries **+1 mark**. There is **no negative marking** for incorrect or unattempted answers.
- Only **one** option is correct. Attempt every question, since wrong answers are not penalised.
- Use of mobile phones, calculators, or other electronic gadgets is strictly prohibited.

Q1. The mass of 0.2 mol of calcium carbonate ($\mathrm{CaCO_3}$, molar mass 100 g/mol) is

(A) 10 g

(B) 20 g

(C) 50 g

(D) 0.2 g

Q2. The total number of atoms present in 1 mol of ammonia ($\mathrm{NH_3}$) is ($N_A = 6.022 \times 10^{23}$)

(A) 2.41×10^{24}

(B) 6.022×10^{23}

(C) 1.81×10^{24}

(D) 3.011×10^{23}

Q3. When 1 mol of calcium carbonate is completely decomposed as $CaCO_3 \rightarrow CaO + C$
the volume of CO_2 liberated at STP (22.4 L/mol) is

(A) 11.2 L

(B) 44.8 L

(C) 22.4 L

(D) 2.24 L

Q4. In the Bohr model of the hydrogen atom, the energy of the electron in the nth orbit is $E_n = -\dfrac{13.6}{n^2}$ eV. The energy of the electron in the second orbit ($n = 2$) is

(A) -13.6 eV

(B) -1.51 eV

(C) -6.8 eV

(D) -3.4 eV

Q5. The ground-state electronic configuration of the chloride ion Cl^- ($Z = 17$) is

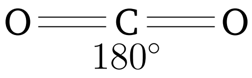
(A) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$

(B) $1s^2\,2s^2\,2p^6\,3s^2\,3p^5$

(C) $1s^2\,2s^2\,2p^6\,3s^2\,3p^4$

(D) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1$

Q6. The hybridization of the central carbon atom in carbon dioxide (CO_2), whose linear shape is shown, is



(A) sp^3

(B) sp

(C) sp^2

(D) dsp^2

Q7. According to molecular orbital theory, the bond order of the superoxide ion O_2^- is

(A) 2

(B) 1

(C) 1.5

(D) 2.5

Q8. The abnormally high boiling point of water compared with H_2S is mainly due to

(A) its higher molar mass

(B) weaker van der Waals forces

(C) its larger size

(D) intermolecular hydrogen bonding

Q9. For the reaction $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$, the bond enthalpies are $H-H = 436$, $Cl-Cl = 242$ and $H-Cl = 431$ kJ/mol. The enthalpy of the reaction is

(A) -184 kJ

(B) $+184$ kJ

(C) -247 kJ

(D) -100 kJ

Q10. For a reaction with $\Delta H = -40$ kJ and $\Delta S = -100$ J/K at 300 K, the Gibbs free-energy change ΔG is

(A) -70 kJ

(B) -10 kJ

(C) $+10$ kJ

(D) -40 kJ

Q11. For the gaseous equilibrium $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, the correct expression for the equilibrium constant K_c is

(A) $\dfrac{[N_2][H_2]^3}{[NH_3]^2}$

(B) $\dfrac{[NH_3]}{[N_2][H_2]}$

(C) $\dfrac{[NH_3]^2}{[N_2][H_2]}$

(D) $\dfrac{[NH_3]^2}{[N_2][H_2]^3}$

Q12. At $25\,°C$ an aqueous solution has $\mathrm{pOH} = 4$. The pH of the solution is

(A) 4

(B) 7

(C) 10

(D) 14

Q13. A solution is prepared by dissolving 2 mol of ethanol in 8 mol of water. The mole fraction of ethanol in the solution is

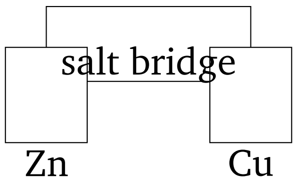
(A) 0.2

(B) 0.8

(C) 0.25

(D) 0.5

Q14. For the cell reaction shown, $E^\circ_{cell} = 1.10$ V and $n = 2$ ($F = 96500$ C/mol). The standard Gibbs free-energy change $\Delta G^\circ = -nFE^\circ$ is approximately



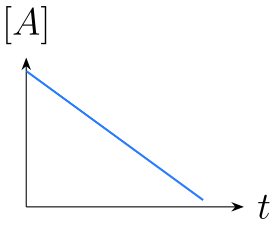
(A) -106 kJ/mol

(B) -212 kJ/mol

(C) $+212$ kJ/mol

(D) -1.10 kJ/mol

Q15. For a zero-order reaction the plot of concentration $[A]$ against time is a straight line, as shown. If $[A]_0 = 0.40$ M and $k = 0.05\ \text{mol}\,\text{L}^{-1}\,\text{min}^{-1}$, the half-life $t_{1/2} = \dfrac{[A]_0}{2k}$ is



(A) 8 min

(B) 2 min

(C) 4 min

(D) 0.5 min

Q16. The oxidation number of sulphur in sulphuric acid (H_2SO_4) is

(A) $+2$

(B) $+4$

(C) -2

(D) $+6$

Q17. On moving from left to right across a period in the periodic table, the electronegativity of the elements generally

(A) decreases

(B) increases

(C) remains constant

(D) first decreases then increases

Q18. Lithium shows a close similarity in many properties to which of the following elements, due to the diagonal relationship?

(A) Magnesium

(B) Sodium

(C) Calcium

(D) Potassium

Q19. Beryllium resembles which of the following elements due to a diagonal relationship in the periodic table?

(A) Magnesium

(B) Calcium

(C) Boron

(D) Aluminium

Q20. Which is the most abundant element (by mass) in the Earth's crust?

(A) Silicon

(B) Aluminium

(C) Oxygen

(D) Carbon

Q21. The oxidation state of nitrogen in nitric acid (HNO_3) is

(A) $+5$

(B) $+3$

(C) $+4$

(D) -3

Q22. The correct order of acidic strength of the hydrogen halides in aqueous solution is

(A) $HF > HCl > HBr > HI$

(B) $HI > HBr > HCl > HF$

(C) $HCl > HF > HBr > HI$

(D) $HBr > HI > HCl > HF$

Q23. The spin-only magnetic moment of the Ni^{2+} ion ($3d^8$, two unpaired electrons), given by $\mu = \sqrt{n(n+2)}$ BM, is approximately

(A) 1.73 BM

(B) 3.87 BM

(C) 2.83 BM

(D) 5.92 BM

Q24. Which of the following lanthanide ions is colourless in aqueous solution?

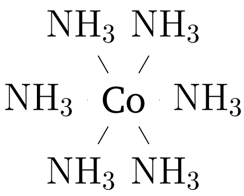
(A) Nd^{3+}

(B) Pr^{3+}

(C) Sm^{3+}

(D) La^{3+}

Q25. The correct IUPAC name of the octahedral complex $[Co(NH_3)_6]Cl_3$, shown below, is



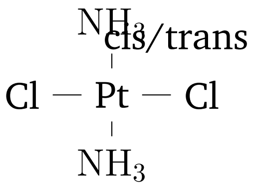
(A) hexaamminecobalt(III) chloride

(B) hexaamminecobalt(II) chloride

(C) hexaaminecobalt(III) trichloride

(D) cobalt hexaammine chloride

Q26. The square-planar complex $[\mathrm{Pt(NH_3)_2Cl_2}]$, drawn below, exhibits which type of isomerism?



$\mathrm{Cl} - \overset{\overset{\textstyle \mathrm{NH_3}}{|}}{\underset{\underset{\textstyle \mathrm{NH_3}}{|}}{\mathrm{Pt}}} - \mathrm{Cl}$

(A) optical isomerism

(B) geometrical (cis–trans) isomerism

(C) linkage isomerism

(D) ionisation isomerism

Q27. The IUPAC name of the compound $\mathrm{CH_3CH_2CH_2OH}$ is

(A) propan-2-ol

(B) propanal

(C) propan-1-ol

(D) propanoic acid

Q28. Ethanol ($\mathrm{C_2H_5OH}$) and dimethyl ether ($\mathrm{CH_3OCH_3}$) have the same molecular formula $\mathrm{C_2H_6O}$ but different functional groups. They are

(A) chain isomers

(B) position isomers

(C) geometrical isomers

(D) functional isomers

Q29. In the nitro group ($-\mathrm{NO_2}$) attached to a benzene ring, the group withdraws electron density from the ring by

(A) a $-R$ (electron-withdrawing resonance) effect

(B) a $+R$ (electron-donating resonance) effect

(C) hyperconjugation only

(D) no electronic effect

Q30. The complete combustion of an alkane such as methane (CH_4) in excess oxygen gives

(A) carbon monoxide and water

(B) carbon dioxide and water

(C) only carbon dioxide

(D) carbon and water

Q31. The reductive ozonolysis of but-2-ene ($CH_3-CH=CH-CH_3$), shown below, gives

$$CH_3 - CH = CH - CH_3$$

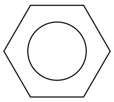
(A) one molecule of propanal

(B) formaldehyde and acetaldehyde

(C) two molecules of acetaldehyde (ethanal)

(D) one molecule of butanal

Q32. The reagent used for the sulphonation of benzene, shown below, is



(A) dilute HCl

(B) aqueous NaOH

(C) Br_2 in CCl_4

(D) fuming sulphuric acid (oleum, SO_3 in conc. H_2SO_4)

Q33. An S_N2 reaction at a chiral carbon proceeds with

(A) retention of configuration

(B) inversion of configuration (Walden inversion)

(C) complete racemisation

(D) no change in the spatial arrangement

Q34. When ethanol is heated with concentrated sulphuric acid at about 443 K, the major organic product is

(A) ethanal

(B) ethanoic acid

(C) ethene

(D) diethyl ether

Q35. The common name of the ether $CH_3{-}O{-}C_2H_5$ is

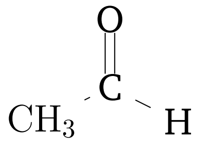
(A) ethyl methyl ether

(B) dimethyl ether

(C) methoxymethane

(D) diethyl ether

Q36. Which of the following carbonyl compounds, having α-hydrogen atoms, can undergo the aldol condensation?



(A) benzaldehyde (C_6H_5CHO)

(B) formaldehyde ($HCHO$)

(C) methanal ($HCHO$)

(D) acetaldehyde (CH_3CHO)

Q37. When acetic acid reacts with ethanol in the presence of a little concentrated H_2SO_4, the organic product formed is

(A) acetaldehyde

(B) ethyl ethanoate (ethyl acetate)

(C) sodium acetate

(D) diethyl ether

Q38. Hinsberg's reagent (benzenesulphonyl chloride) is used to

(A) distinguish primary, secondary and tertiary amines

(B) test for a carbonyl group

(C) prepare diazonium salts

(D) detect unsaturation

Q39. Which of the following nitrogenous bases is present in RNA but *not* in DNA?

(A) Adenine

(B) Guanine

(C) Uracil

(D) Cytosine

Q40. Which of the following is a naturally occurring polymer?

(A) Polythene

(B) Nylon-6,6

(C) PVC

(D) Cellulose

Detailed Solutions

Q1.

Solution

Concept — Mass from moles: mass $= n\times$ molar mass.

Step 1 — Substitute: mass $= 0.2 \times 100$.

Step 2 — Compute: mass $= 20$ g.

Why other options are wrong: 10 g uses 0.1 mol; 50 g uses 0.5 mol; 0.2 g ignores the molar mass.

Final Answer: mass $= 20$ g $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Atoms via Avogadro number: number of atoms $=$ (moles) $\times$ (atoms per formula unit) $\times N_A$.

Step 1 — Atoms per NH_3: 1 N $+ 3$ H $= 4$ atoms.

Step 2 — Compute: $1 \times 4 \times 6.022 \times 10^{23} = 2.41 \times 10^{24}$ atoms.

Why other options are wrong: 6.022×10^{23} counts only molecules; 1.81×10^{24} uses 3 atoms; 3.011×10^{23} is half a mole of molecules.

Final Answer: 2.41×10^{24} atoms $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Molar volume at STP: 1 mol of any gas occupies 22.4 L at STP.

Step 1 — Stoichiometry: 1 mol $CaCO_3$ gives 1 mol CO_2.

Step 2 — Volume: $1 \times 22.4 = 22.4$ L.

Why other options are wrong: 11.2 L is 0.5 mol; 44.8 L is 2 mol; 2.24 L is 0.1 mol.

Final Answer: 22.4 L of $CO_2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Bohr energy levels: $E_n = -\dfrac{13.6}{n^2}$ eV for hydrogen.

Step 1 — Put $n = 2$**:** $E_2 = -\dfrac{13.6}{4}$.

Step 2 — Compute: $E_2 = -3.4$ eV.

Why other options are wrong: -13.6 eV is $n = 1$; -1.51 eV is $n = 3$; -6.8 eV divides by 2 instead of n^2.

Final Answer: $E_2 = -3.4$ eV $\Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ Go Back to Q4

Q5.

Solution

Concept — Configuration of an anion: Add electrons to the neutral atom to form the anion.

Step 1 — Cl ($Z = 17$**):** $1s^2\,2s^2\,2p^6\,3s^2\,3p^5$.

Step 2 — Add one electron for Cl^-**:** $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$ (argon configuration, 18 electrons).

Why other options are wrong: $3p^5$ is neutral Cl; $3p^4$ is Cl^+; the $4s^1$ option has the wrong count and order.

Final Answer: $1s^2\,2s^2\,2p^6\,3s^2\,3p^6 \Rightarrow \boxed{\text{A}}$

$\boxed{\textbf{Answer: (A)}}$ Go Back to Q5

Q6.

Solution

Concept — Hybridization and shape: A central atom with two sigma bonds and no lone pair is sp hybridized (linear).

Step 1 — Count domains on C: In $\mathrm{O{=}C{=}O}$ carbon forms two sigma bonds, no lone pairs.

Step 2 — Assign hybridization: Two domains $\Rightarrow sp$, bond angle 180°.

Why other options are wrong: sp^2 is trigonal planar; sp^3 is tetrahedral; dsp^2 is square planar.

Final Answer: Carbon is sp hybridized $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Bond order (MOT): Bond order $= \frac{1}{2}(N_b - N_a)$.

Step 1 — O_2^- has 17 electrons: one electron is added to the neutral O_2 ($N_b = 10, N_a = 6$), entering the antibonding π^*, giving $N_b = 10, N_a = 7$.

Step 2 — Compute: Bond order $= \frac{1}{2}(10 - 7) = 1.5$.

Why other options are wrong: 2 is neutral O_2; 2.5 is O_2^+; 1 is the peroxide ion O_2^{2-}.

Final Answer: Bond order $= 1.5 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Hydrogen bonding: Strong intermolecular H-bonds raise the boiling point above what molar mass alone predicts.

Step 1 — Compare with H_2S: Oxygen is small and very electronegative, so H_2O forms extensive hydrogen bonds; sulphur does not.

Step 2 — Result: Water boils much higher (100 °C) than H_2S despite lower molar mass.

Why other options are wrong: Water has a *lower* molar mass than H_2S; van der Waals forces are weaker, not the cause; size is not the reason.

Final Answer: Intermolecular hydrogen bonding $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Bond enthalpy: $\Delta H = \sum(\text{bonds broken}) - \sum(\text{bonds formed})$.

Step 1 — Bonds broken: $\mathrm{H{-}H} + \mathrm{Cl{-}Cl} = 436 + 242 = 678$ kJ.

Step 2 — Bonds formed: two $\mathrm{H{-}Cl} = 2 \times 431 = 862$ kJ.

Step 3 — Compute: $\Delta H = 678 - 862 = -184$ kJ.

Why other options are wrong: $+184$ reverses the sign; -247 and -100 miscount the bonds.

Final Answer: $\Delta H = -184 \text{ kJ} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Gibbs equation: $\Delta G = \Delta H - T\Delta S$ (use consistent units).

Step 1 — Convert ΔS: -100 J/K $= -0.1$ kJ/K.

Step 2 — Compute $T\Delta S$: $300 \times (-0.1) = -30$ kJ.

Step 3 — Combine: $\Delta G = -40 - (-30) = -10$ kJ.

Why other options are wrong: -70 adds $T\Delta S$ with the wrong sign; $+10$ flips the result; -40 ignores the entropy term.

Final Answer: $\Delta G = -10 \text{ kJ} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Equilibrium constant expression: $K_c = \dfrac{[\text{products}]^{\text{coeff}}}{[\text{reactants}]^{\text{coeff}}}$.

Step 1 — Write products over reactants: products NH_3 (coefficient 2); reactants N_2 (1) and H_2 (3).

Step 2 — Assemble: $K_c = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$.

Why other options are wrong: Option A inverts products and reactants; B and C use wrong exponents.

Final Answer: $K_c = \dfrac{[NH_3]^2}{[N_2][H_2]^3} \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — pH–pOH relation: At 25 °C, $\text{pH} + \text{pOH} = 14$.

Step 1 — Substitute: $\text{pH} = 14 - \text{pOH} = 14 - 4$.

Step 2 — Compute: $\text{pH} = 10$ (a basic solution).

Why other options are wrong: 4 is the pOH; 7 is neutral; 14 ignores the given pOH.

Final Answer: $\text{pH} = 10 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q12

Q13.

Solution

Concept — Mole fraction: $x_{\text{ethanol}} = \dfrac{n_{\text{ethanol}}}{n_{\text{ethanol}} + n_{\text{water}}}$.

Step 1 — Total moles: $2 + 8 = 10$ mol.

Step 2 — Compute: $x = \dfrac{2}{10} = 0.2$.

Why other options are wrong: 0.8 is the mole fraction of water; 0.25 uses a wrong total; 0.5 assumes equal moles.

Final Answer: $x_{\text{ethanol}} = 0.2 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Free energy and cell EMF: $\Delta G^\circ = -nFE^\circ_{cell}$.

Step 1 — Substitute: $\Delta G^\circ = -(2)(96500)(1.10)$.

Step 2 — Compute: $\Delta G^\circ = -212300 \text{ J} \approx -212 \text{ kJ/mol}$.

Why other options are wrong: -106 uses $n = 1$; $+212$ has the wrong sign; -1.10 omits nF.

Final Answer: $\Delta G^\circ \approx -212$ kJ/mol $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q14**

Q15.

Solution

Concept — Zero-order half-life: $t_{1/2} = \dfrac{[A]_0}{2k}$.

Step 1 — Substitute: $t_{1/2} = \dfrac{0.40}{2 \times 0.05}$.

Step 2 — Compute: $t_{1/2} = \dfrac{0.40}{0.10} = 4$ min.

Why other options are wrong: 8 min omits the factor of 2; 2 min doubles k wrongly; 0.5 min inverts the ratio.

Final Answer: $t_{1/2} = 4$ min $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q15**

Q16.

Solution

Concept — Oxidation number: The oxidation numbers in a neutral molecule sum to zero.

Step 1 — Known values: H $= +1$ $(\times 2 = +2)$, O $= -2$ $(\times 4 = -8)$.

Step 2 — Solve for S: $+2 + x - 8 = 0 \Rightarrow x = +6$.

Why other options are wrong: $+4$ is S in SO_2/H_2SO_3; $+2$ and -2 occur in other species, not H_2SO_4.

Final Answer: S is $+6 \Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q16**

Q17.

Solution

Concept — Electronegativity trend: Across a period the nuclear charge rises and atomic size falls, so the atom attracts bonding electrons more strongly.

Step 1 — Apply: Increasing effective nuclear charge ⇒ electronegativity increases left to right.

Why other options are wrong: Electronegativity decreases down a group, not across; it does not stay constant.

Final Answer: Electronegativity increases ⇒ $\boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Diagonal relationship: An element of period 2 resembles the element diagonally placed in period 3 (next group).

Step 1 — Locate Li: Lithium (group 1, period 2) lies diagonal to magnesium (group 2, period 3).

Step 2 — Result: Li and Mg share similarities (e.g. both form normal oxides, similar carbonate behaviour).

Why other options are wrong: Na, K and Ca do not show the Li diagonal relationship.

Final Answer: Lithium resembles magnesium ⇒ $\boxed{\text{A}}$

Answer: (A) Go Back to Q18

Q19.

Solution

Concept — Diagonal relationship: Beryllium (group 2, period 2) resembles aluminium (group 13, period 3) diagonally.

Step 1 — Shared properties: Both Be and Al form amphoteric oxides, covalent halides, and are passivated by nitric acid.

Why other options are wrong: Mg and Ca are simply the heavier group-2 congeners; boron is not the diagonal partner of Be.

Final Answer: Beryllium resembles aluminium ⇒ $\boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Crustal abundance: The Earth's crust is dominated by oxygen, then silicon.

Step 1 — Recall figures: Oxygen $\approx 46\%$ by mass, silicon $\approx 28\%$, aluminium $\approx 8\%$.

Step 2 — Conclude: Oxygen is the most abundant.

Why other options are wrong: Silicon is second; aluminium is the most abundant *metal*; carbon is a minor crustal constituent.

Final Answer: Oxygen ⇒ $\boxed{\text{C}}$

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Oxidation state in an oxoacid: The sum of oxidation numbers in a neutral acid is zero.

Step 1 — Known values for HNO_3: H $= +1$, O $= -2$ $(\times 3 = -6)$.

Step 2 — Solve for N: $+1 + x - 6 = 0 \Rightarrow x = +5$.

Why other options are wrong: $+3$ is N in HNO_2; $+4$ is in NO_2; -3 is in NH_3.

Final Answer: N is $+5$ in HNO_3 ⇒ $\boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Acid strength of hydrogen halides: Acidity in water increases as the H–X bond becomes weaker down the group.

Step 1 — Order of bond strength: $\mathrm{H{-}F} > \mathrm{H{-}Cl} > \mathrm{H{-}Br} > \mathrm{H{-}I}$ (weakest is H–I).

Step 2 — Acidity is the reverse: $\mathrm{HI} > \mathrm{HBr} > \mathrm{HCl} > \mathrm{HF}$.

Why other options are wrong: HF is the *weakest* acid (strong H–F bond and H-bonding), so any order placing HF first is wrong.

Final Answer: $\mathrm{HI} > \mathrm{HBr} > \mathrm{HCl} > \mathrm{HF} \Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Spin-only magnetic moment: $\mu = \sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons.

Step 1 — Ni^{2+} **is** $3d^8$**:** it has 2 unpaired electrons.

Step 2 — Compute: $\mu = \sqrt{2(2+2)} = \sqrt{8} \approx 2.83$ BM.

Why other options are wrong: 1.73 is $n = 1$; 3.87 is $n = 3$; 5.92 is $n = 5$.

Final Answer: $\mu \approx 2.83$ BM $\Rightarrow \boxed{\mathrm{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Colour of lanthanide ions: Ln^{3+} ions with empty ($4f^0$) or full ($4f^{14}$) sub-shells are colourless; partly filled $4f$ ions are coloured.

Step 1 — La^{3+}**:** configuration $4f^0$, no f–f transitions, so colourless.

Why other options are wrong: $\mathrm{Nd}^{3+}, \mathrm{Pr}^{3+}, \mathrm{Sm}^{3+}$ have partly filled $4f$ orbitals and are coloured.

Final Answer: La^{3+} is colourless $\Rightarrow \boxed{\mathrm{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — IUPAC naming of complexes: Name ligands alphabetically with Greek prefixes, then the metal with its oxidation state in Roman numerals, then the counter-ion.

Step 1 — Oxidation state of Co: six neutral $\mathrm{NH_3}$ and three $\mathrm{Cl^-}$ outside $\Rightarrow$ Co is $+3$.

Step 2 — Name: six ammine ligands $\Rightarrow$ "hexaammine"; metal cobalt(III); chloride counter-ion: *hexaamminecobalt(III) chloride*.

Why other options are wrong: (II) is the wrong oxidation state; "hexaamine" misspells ammine and "trichloride" is not used; the last name ignores IUPAC rules.

Final Answer: hexaamminecobalt(III) chloride $\Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Geometrical isomerism in square-planar complexes: $\mathrm{MA_2B_2}$ square-planar complexes exist as cis and trans forms.

Step 1 — Analyse $[\mathrm{Pt(NH_3)_2Cl_2}]$: the two $\mathrm{NH_3}$ (and two Cl) can be adjacent (cis) or opposite (trans).

Step 2 — Conclude: it shows geometrical (cis–trans) isomerism.

Why other options are wrong: this complex is achiral (no optical isomerism); there is no ambidentate ligand (no linkage isomerism) and no exchange of ionisable groups (no ionisation isomerism).

Final Answer: Geometrical (cis–trans) isomerism $\Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — IUPAC naming of alcohols: The $-\mathrm{OH}$ group is named with the suffix "-ol" and the lowest possible locant.

Step 1 — Count carbons: $\mathrm{CH_3CH_2CH_2OH}$ has three carbons; the OH is on a terminal carbon (C-1).

Step 2 — Name: propan-1-ol.

Why other options are wrong: propan-2-ol has OH on the middle carbon; propanal is an aldehyde; propanoic acid is the $-\mathrm{COOH}$ compound.

Final Answer: propan-1-ol $\Rightarrow \boxed{\mathrm{C}}$

Answer: (C) Go Back to Q27

Q28.

Solution

Concept — Functional isomerism: Compounds with the same molecular formula but different functional groups are functional isomers.

Step 1 — Compare: ethanol (C_2H_6O, alcohol $-OH$) and dimethyl ether (C_2H_6O, ether $-O-$).

Step 2 — Conclude: same formula, different functional group ⇒ functional isomers.

Why other options are wrong: chain and position isomers keep the same functional group; geometrical isomerism needs a C=C double bond.

Final Answer: Functional isomers $\Rightarrow \boxed{\mathrm{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Resonance (mesomeric) effect: A group that withdraws π-electron density through resonance shows a $-R$ (or $-M$) effect.

Step 1 — Analyse $-NO_2$**:** its π system delocalises ring electrons onto the oxygen atoms, pulling charge out of the ring.

Step 2 — Conclude: the nitro group is a strong $-R$ (electron-withdrawing) group and is meta-directing/deactivating.

Why other options are wrong: $+R$ describes electron-donating groups like $-OH/-NH_2$; hyperconjugation involves σ C–H bonds; the group certainly has an electronic effect.

Final Answer: $-R$ (electron-withdrawing resonance) effect $\Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Complete combustion of alkanes: In excess oxygen, alkanes burn fully to carbon dioxide and water.

Step 1 — Write the reaction: $CH_4 + 2O_2 \to CO_2 + 2H_2O$.

Step 2 — Identify products: carbon dioxide and water.

Why other options are wrong: CO and soot (carbon) form only in *incomplete* combustion; “only CO_2” ignores the water produced.

Final Answer: Carbon dioxide and water $\Rightarrow \boxed{\text{B}}$

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

Q31.

Solution

Concept — Reductive ozonolysis: A C=C bond is cleaved (with O_3 then Zn/H_2O) into two carbonyl fragments.

Step 1 — Cleave but-2-ene: $CH_3{-}CH{=}CH{-}CH_3$ splits at the double bond, putting $=O$ on each carbon.

Step 2 — Products: two molecules of CH_3CHO (acetaldehyde / ethanal).

Why other options are wrong: propanal/butanal would need a different carbon skeleton; formaldehyde forms only from a terminal $=CH_2$, absent here.

Final Answer: Two molecules of acetaldehyde $\Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q31**

Q32.

Solution

Concept — Sulphonation of benzene: Benzene reacts with the electrophile SO_3 from oleum to give benzenesulphonic acid.

Step 1 — Identify the reagent: fuming sulphuric acid (oleum), i.e. SO_3 dissolved in concentrated H_2SO_4.

Step 2 — Reaction: $C_6H_6 + SO_3 \to C_6H_5SO_3H$.

Why other options are wrong: dilute HCl and NaOH do not sulphonate; Br_2/CCl_4 tests for unsaturation.

Final Answer: Fuming sulphuric acid (oleum) ⇒ $\boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ Go Back to Q32

Q33.

Solution

Concept — S_N2 stereochemistry: The nucleophile attacks from the side opposite the leaving group, flipping the configuration.

Step 1 — Mechanism: Backside attack passes through a planar transition state.

Step 2 — Result: The product has inverted configuration (Walden inversion).

Why other options are wrong: retention occurs in some neighbouring-group cases; racemisation is characteristic of S_N1; "no change" contradicts the backside attack.

Final Answer: Inversion of configuration ⇒ $\boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ Go Back to Q33

Q34.

Solution

Concept — Acid-catalysed dehydration: At high temperature, concentrated H_2SO_4 removes water from an alcohol to give an alkene.

Step 1 — React ethanol at 443 K: $CH_3CH_2OH \xrightarrow{\text{conc. } H_2SO_4,\, 443\,\text{K}} CH_2{=}CH_2 + H_2O$.

Step 2 — Major product: ethene.

Why other options are wrong: diethyl ether forms at the lower temperature (413 K); ethanal/ethanoic acid require oxidation, not dehydration.

Final Answer: Ethene ⇒ $\boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ Go Back to Q34

Q35.

Solution

Concept — Common naming of ethers: An unsymmetrical ether $R{-}O{-}R'$ is named by listing both alkyl groups alphabetically followed by "ether".

Step 1 — Identify groups: $CH_3{-}O{-}C_2H_5$ has a methyl and an ethyl group.

Step 2 — Name: ethyl methyl ether (IUPAC: methoxyethane).

Why other options are wrong: diethyl ether is $C_2H_5OC_2H_5$; dimethyl ether is CH_3OCH_3; methoxymethane is dimethyl ether.

Final Answer: Ethyl methyl ether $\Rightarrow \boxed{\text{A}}$

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

Q36.

Solution

Concept — Aldol condensation: Only carbonyl compounds bearing α-hydrogen atoms can form the enolate needed for the aldol reaction.

Step 1 — Check for α-H: acetaldehyde CH_3CHO has three α-hydrogens on the methyl group.

Step 2 — Conclude: it undergoes aldol condensation.

Why other options are wrong: benzaldehyde and formaldehyde (methanal) have *no* α-hydrogen, so they give the Cannizzaro reaction instead.

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

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q36**

Q37.

Solution

Concept — Esterification (Fischer): A carboxylic acid and an alcohol, with an acid catalyst, give an ester and water.

Step 1 — Write the reaction: $CH_3COOH + C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$.

Step 2 — Product: ethyl ethanoate (ethyl acetate).

Why other options are wrong: acetaldehyde would need reduction; sodium acetate needs a base; diethyl ether comes from ethanol alone.

Final Answer: Ethyl ethanoate $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q37**

Q38.

Solution

Concept — Hinsberg's test: Benzenesulphonyl chloride reacts differently with 1°, 2° and 3° amines, allowing them to be told apart.

Step 1 — Behaviour: 1° amines give a sulphonamide soluble in alkali; 2° amines give an alkali-insoluble sulphonamide; 3° amines do not react.

Step 2 — Conclude: the reagent distinguishes the three classes of amine.

Why other options are wrong: diazonium salts come from $\mathrm{HNO_2}$; carbonyl tests use $2,4$-DNP; unsaturation is tested with bromine water.

Final Answer: Distinguishes 1°, 2°, 3° amines $\Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q38**

Q39.

Solution

Concept — Bases in nucleic acids: DNA contains A, G, C and thymine (T); RNA contains A, G, C and uracil (U) in place of thymine.

Step 1 — Compare: adenine, guanine and cytosine occur in both DNA and RNA.

Step 2 — Identify: uracil is unique to RNA.

Why other options are wrong: A, G and C are common to both nucleic acids, so they cannot be the distinguishing base.

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

Answer: (C) **Go Back to Q39**

Q40.

Solution

Concept — Natural vs synthetic polymers: Natural polymers occur in living systems, while synthetic polymers are man-made.

Step 1 — Classify: cellulose is a natural polysaccharide of β-glucose units.

Step 2 — Conclude: cellulose is the naturally occurring polymer.

Why other options are wrong: polythene, nylon-6,6 and PVC are all synthetic (man-made) polymers.

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

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q40**

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	C	4	D	5	A
6	B	7	C	8	D	9	A	10	B
11	D	12	C	13	A	14	B	15	C
16	D	17	B	18	A	19	D	20	C
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	B	34	C	35	A
36	D	37	B	38	A	39	C	40	D