SAAT Chemistry

Sample Paper – 5

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 number of moles of an ideal gas occupying 5.6 litres at STP (molar volume 22.4 L/mol) is

(A) 0.25 mol

(B) 0.5 mol

(C) 1 mol

(D) 0.1 mol

Q2. The mass of 3.011×10^{23} molecules of methane (CH_4, molar mass 16 g/mol; $N_A = 6.022 \times 10^{23}$) is

(A) 16 g

(B) 8 g

(C) 4 g

(D) 32 g

Q3. In a reaction the theoretical yield of a product is 50 g, but only 40 g is actually obtained. The percentage yield of the reaction is

(A) 90%

(B) 50%

(C) 125%

(D) 80%

Q4. The maximum number of electrons in an atom that can have the quantum numbers $n = 3$ and $l = 2$ is

(A) 6

(B) 2

(C) 10

(D) 14

Q5. The spin-only magnetic moment of the Ni^{2+} ion ($Z = 28$), whose two unpaired $3d$ electrons are shown, is approximately

$$3d: \boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow}\ \boxed{\uparrow}$$

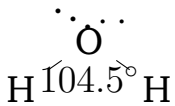
(A) 2.83 BM

(B) 1.73 BM

(C) 3.87 BM

(D) 5.92 BM

Q6. The molecular geometry of the water molecule (H_2O), which has two bond pairs and two lone pairs on oxygen as shown, is



(A) linear

(B) bent (angular)

(C) trigonal planar

(D) tetrahedral

Q7. According to molecular orbital theory, the bond order of the carbon monoxide molecule (CO, 14 electrons) is

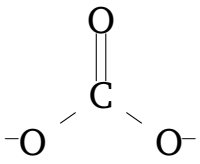
(A) 1

(B) 2

(C) 3

(D) 2.5

Q8. The carbonate ion (CO_3^{2-}), one resonance form of which is drawn, is best described by a set of equivalent resonance structures. The number of such equivalent resonance structures is



(A) 1

(B) 2

(C) 4

(D) 3

Q9. The heat absorbed by a system at constant volume is equal to

(A) the change in enthalpy, ΔH

(B) the change in internal energy, ΔU

(C) the work done, w

(D) the change in Gibbs energy, ΔG

Q10. For a reaction that is endothermic ($\Delta H > 0$) and has a positive entropy change ($\Delta S > 0$), the reaction becomes spontaneous

(A) only at high temperature

(B) only at low temperature

(C) at all temperatures

(D) at no temperature

Q11. For a gaseous equilibrium at constant volume, the addition of an inert (non-reacting) gas

(A) shifts the equilibrium forward

(B) shifts the equilibrium backward

(C) increases the value of K_c

(D) has no effect on the equilibrium position

Q12. The solubility product of silver chloride (AgCl) is 1.0×10^{-10} at 298 K. Its molar solubility in pure water is

(A) 1.0×10^{-10} M

(B) 1.0×10^{-4} M

(C) 1.0×10^{-5} M

(D) 2.0×10^{-5} M

Q13. The osmotic pressure of a solution containing 0.1 mol of a non-electrolyte in 1 litre at 300 K ($R = 0.0821\ \mathrm{L\,atm\,K^{-1}\,mol^{-1}}$) is approximately

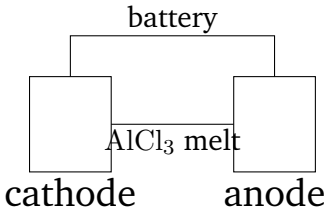
(A) 2.46 atm

(B) 24.6 atm

(C) 0.246 atm

(D) 1.23 atm

Q14. The galvanic/electrolytic relationship below uses Faraday's law. When 2 faradays of charge are passed through molten $\mathrm{AlCl_3}$, the mass of aluminium (atomic mass 27, $n = 3$) deposited is



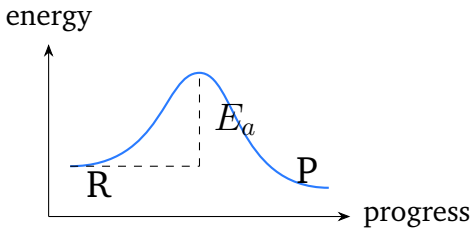
(A) 27 g

(B) 18 g

(C) 9 g

(D) 54 g

Q15. In the reaction energy profile shown, the activation energy (E_a) of the forward reaction corresponds to



the gap between the reactant energy and the

(A) product energy level

(B) energy of the products plus heat

(C) energy of the transition state (peak)

(D) zero of energy

Q16. In the half-reaction $\mathrm{MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O}$, the number of electrons gained per permanganate ion (its n-factor in acidic medium) is

(A) 2

(B) 3

(C) 1

(D) 5

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

(A) decreases

(B) increases

(C) remains unchanged

(D) first decreases then increases

Q18. An element has the atomic number 17. To which period and group of the modern periodic table does it belong?

(A) Period 2, Group 17

(B) Period 3, Group 17

(C) Period 3, Group 16

(D) Period 2, Group 16

Q19. Among the oxides Na_2O, MgO, Al_2O_3 and SO_2, the most basic oxide is

(A) Al_2O_3

(B) SO_2

(C) Na_2O

(D) MgO

Q20. Carbon dioxide (CO_2), the linear molecule shown, dissolves in water to give carbonic acid. Its oxide nature is therefore

$$O{=}C{=}O$$
$$180^\circ$$

(A) neutral, like CO

(B) basic

(C) amphoteric

(D) acidic

Q21. The H–N–H bond angle in ammonia (NH_3) compared with the H–P–H bond angle in phosphine (PH_3) is

(A) larger (107° vs $\sim 94^\circ$)

(B) smaller (94° vs 107°)

(C) exactly equal

(D) both exactly 109.5°

Q22. In the xenon fluoride XeF_4, the hybridization of the central xenon atom and the shape of the molecule are

(A) sp^3, tetrahedral

(B) sp^3d^2, square planar

(C) sp^3d, see-saw

(D) sp^2, trigonal planar

Q23. Which of the following ions is colourless in aqueous solution because it has no partially filled d orbital?

(A) Cu^{2+}

(B) Fe^{3+}

(C) Zn^{2+}

(D) Co^{2+}

Q24. Which of the following statements about the actinide series ($5f$ elements) is correct?

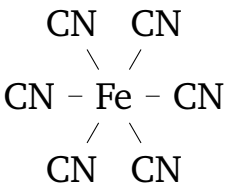
(A) All actinides are diamagnetic

(B) None of the actinides is radioactive

(C) All actinides show only the $+2$ oxidation state

(D) All actinides are radioactive

Q25. For the complex $[Fe(CN)_6]^{4-}$ (Fe is $+2$, $Z = 26$), shown below, the effective atomic number (EAN) of the central iron atom is



(A) 30

(B) 36

(C) 24

(D) 54

Q26. In the spectrochemical series, which of the following ligands produces the largest crystal-field splitting (is the strongest-field ligand)?

(A) Cl^-

(B) H_2O

(C) CN^-

(D) F^-

Q27. The IUPAC name of the compound CH_3CH_2COOH is

(A) propanoic acid

(B) ethanoic acid

(C) propanal

(D) propan-1-ol

Q28. Metamerism arises due to a different distribution of carbon atoms (alkyl groups) on either side of a functional group. Which pair of ethers are metamers?

(A) ethanol and dimethyl ether

(B) propan-1-ol and propan-2-ol

(C) but-1-ene and but-2-ene

(D) methoxypropane ($CH_3OC_3H_7$) and ethoxyethane ($C_2H_5OC_2H_5$)

Q29. The correct order of stability of free radicals is

(A) methyl $>$ primary $>$ secondary $>$ tertiary

(B) tertiary $>$ secondary $>$ primary $>$ methyl

(C) primary $>$ secondary $>$ tertiary $>$ methyl

(D) all are equally stable

Q30. When sodium acetate (CH_3COONa) is heated with soda lime ($NaOH + CaO$), the hydrocarbon formed by decarboxylation is

(A) methane (CH_4)

(B) ethane (C_2H_6)

(C) ethene (C_2H_4)

(D) propane (C_3H_8)

Q31. An alkene such as ethene decolourises cold dilute alkaline $KMnO_4$ (Baeyer's reagent). The organic product of this test is a

$$CH_2{=}CH_2$$

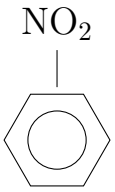
(A) carboxylic acid

(B) ketone

(C) vicinal diol (glycol)

(D) aldehyde only

Q32. In the electrophilic substitution of the substituted benzene shown, the nitro group ($-NO_2$) directs the incoming electrophile mainly to the



(A) ortho position only

(B) para position only

(C) ortho and para positions

(D) meta position

Q33. Chlorobenzene is much less reactive than chloroethane towards nucleophilic substitution mainly because

(A) chlorobenzene is more volatile

(B) the C–Cl bond in chlorobenzene has partial double-bond character due to resonance

(C) chlorine in chlorobenzene carries a positive charge

(D) chloroethane has no leaving group

Q34. The correct order of acidic strength among phenol, water and ethanol is

(A) phenol $>$ water $>$ ethanol

(B) ethanol $>$ water $>$ phenol

(C) water $>$ phenol $>$ ethanol

(D) phenol $>$ ethanol $>$ water

Q35. Crown ethers are cyclic polyethers that are especially useful because they

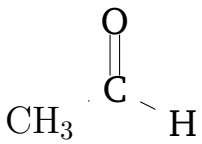
(A) act as strong oxidising agents

(B) are highly acidic

(C) selectively bind (complex) specific metal cations in their cavity

(D) polymerise readily to form plastics

Q36. When acetaldehyde (the carbonyl compound shown) reacts with hydrogen cyanide (HCN), nucleophilic addition gives a



(A) carboxylic acid

(B) ester

(C) ether

(D) cyanohydrin

Q37. In the Hell–Volhard–Zelinsky (HVZ) reaction, a carboxylic acid having an α-hydrogen is treated with Cl_2/Br_2 in the presence of red phosphorus to give

(A) an α-halo carboxylic acid

(B) an aldehyde

(C) an ester

(D) an amide

Q38. The Gabriel phthalimide synthesis is used for the preparation of

(A) aromatic primary amines (anilines)

(B) aliphatic primary amines

(C) secondary amines

(D) tertiary amines

Q39. Among the carbohydrates below, which is a non-reducing sugar (does not reduce Tollens' or Fehling's reagent) because both its anomeric carbons are involved in the glycosidic linkage?

(A) glucose

(B) fructose

(C) sucrose

(D) maltose

Q40. Which of the following is a condensation polymer (formed with loss of a small molecule such as water)?

(A) polythene

(B) polystyrene

(C) PVC (poly(vinyl chloride))

(D) nylon-6,6

Detailed Solutions

Q1.

Solution

Concept — Molar volume at STP: One mole of any ideal gas occupies 22.4 L at STP, so $n = \dfrac{V}{22.4}$.

Step 1 — Substitute: $n = \dfrac{5.6}{22.4}$.

Step 2 — Compute: $n = 0.25$ mol.

Why other options are wrong: 0.5 uses 11.2 L; 1 uses 22.4 L; 0.1 uses 2.24 L.

Final Answer: $n = 0.25$ mol $\Rightarrow$ A

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Moles from molecules: $n = \dfrac{\text{number of molecules}}{N_A}$, then mass $= n \times$ molar mass.

Step 1 — Moles: $n = \dfrac{3.011 \times 10^{23}}{6.022 \times 10^{23}} = 0.5$ mol.

Step 2 — Mass: $0.5 \times 16 = 8$ g.

Why other options are wrong: 16 g is 1 mol; 4 g is 0.25 mol; 32 g is 2 mol.

Final Answer: mass $= 8$ g $\Rightarrow$ B

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Percentage yield: $\%$ yield $= \dfrac{\text{actual yield}}{\text{theoretical yield}} \times 100$.

Step 1 — Substitute: $= \dfrac{40}{50} \times 100$.

Step 2 — Compute: $= 80\%$.

Why other options are wrong: 90% and 50% use wrong ratios; 125% inverts actual and theoretical, which is impossible.

Final Answer: 80% yield $\Rightarrow$ D

Answer: (D) Go Back to Q3

Q4.

Solution

Concept — Electrons in a subshell: For a given l, there are $(2l+1)$ orbitals, each holding 2 electrons, so $2(2l+1)$ electrons.

Step 1 — Identify subshell: $n = 3,\ l = 2$ is the $3d$ subshell.

Step 2 — Count: $2(2 \times 2 + 1) = 2 \times 5 = 10$ electrons.

Why other options are wrong: 6 is for p ($l = 1$); 2 is for s ($l = 0$); 14 is for f ($l = 3$).

Final Answer: 10 electrons $\Rightarrow$ C

Answer: (C) Go Back to Q4

Q5.

Solution

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

Step 1 — Configuration of Ni^{2+}: Ni is $[Ar]3d^8 4s^2$; removing $4s^2$ gives $Ni^{2+} = 3d^8$, which has 2 unpaired electrons.

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

Why other options are wrong: 1.73 is for 1 unpaired e^-; 3.87 for 3; 5.92 for 5.

Final Answer: $\mu \approx 2.83$ BM $\Rightarrow$ A

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — VSEPR shape: Oxygen in H_2O has 2 bond pairs and 2 lone pairs (sp^3, four electron domains). Lone-pair repulsion bends the molecule.

Step 1 — Apply VSEPR: Four domains with two lone pairs give a bent (angular) shape with a bond angle of about $104.5°$.

Why other options are wrong: Linear would need 180° and no lone pairs; trigonal planar and tetrahedral describe different domain counts/arrangements.

Final Answer: H_2O is bent (angular) $\Rightarrow$ B

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Bond order (MOT): Bond order $= \frac{1}{2}(N_b - N_a)$. CO is isoelectronic with N_2 (14 electrons).

Step 1 — Fill MOs: $N_b = 10$, $N_a = 4$.

Step 2 — Compute: Bond order $= \frac{1}{2}(10 - 4) = 3$ (a triple bond).

Why other options are wrong: 1 and 2 are too low; 2.5 would mean an odd electron count, but CO has none.

Final Answer: Bond order of CO $= 3 \Rightarrow$ C

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Resonance in CO_3^{2-}: The double bond can be placed on any of the three equivalent C–O positions.

Step 1 — Count: Three positions $\Rightarrow$ three equivalent resonance structures, so the C–O bonds are identical (bond order 1.33).

Why other options are wrong: A single structure (1) cannot explain equal bond lengths; 2 and 4 do not match the three oxygens.

Final Answer: 3 equivalent resonance structures $\Rightarrow$ D

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — First law at constant volume: At constant volume the work $w = -P\Delta V = 0$, so $q_V = \Delta U$.

Step 1 — Apply: Heat absorbed at constant volume equals the change in internal energy ΔU.

Why other options are wrong: $\Delta H = q_P$ (heat at constant pressure); $w = 0$ here; ΔG relates to spontaneity, not heat at constant V.

Final Answer: $q_V = \Delta U \Rightarrow$ B

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Gibbs energy and temperature: $\Delta G = \Delta H - T\Delta S$; spontaneity requires $\Delta G < 0$.

Step 1 — Both positive: With $\Delta H > 0$ and $\Delta S > 0$, the term $-T\Delta S$ becomes more negative as T rises.

Step 2 — Threshold: $\Delta G < 0$ only when $T > \Delta H/\Delta S$, i.e. at high temperature.

Why other options are wrong: At low T the positive ΔH dominates ($\Delta G > 0$); it is not spontaneous at all T, nor at no T.

Final Answer: Spontaneous only at high temperature $\Rightarrow$ A

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Inert gas at constant volume: Adding an inert gas at constant volume does not change the partial pressures or concentrations of the reacting species.

Step 1 — Apply: Since the concentrations of reactants and products are unchanged, Q stays equal to K_c and the equilibrium does not shift.

Why other options are wrong: No forward or backward shift occurs; K_c depends only on temperature, not on inert gas.

Final Answer: No effect on the equilibrium position $\Rightarrow$ D

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — K_{sp} for a 1:1 salt: For $AgCl \rightleftharpoons Ag^+ + Cl^-$, $K_{sp} = s^2$ where s is the molar solubility.

Step 1 — Solve: $s = \sqrt{K_{sp}} = \sqrt{1.0 \times 10^{-10}}$.

Step 2 — Compute: $s = 1.0 \times 10^{-5}$ M.

Why other options are wrong: 1.0×10^{-10} is K_{sp} itself; 1.0×10^{-4} takes the wrong root; 2.0×10^{-5} misapplies the stoichiometry.

Final Answer: $s = 1.0 \times 10^{-5}$ M $\Rightarrow$ C

Answer: (C) Go Back to Q12

Q13.

Solution

Concept — Osmotic pressure: $\pi = \frac{n}{V}RT = CRT$ for a dilute solution of a non-electrolyte.

Step 1 — Substitute: $\pi = \frac{0.1}{1} \times 0.0821 \times 300$.

Step 2 — Compute: $\pi = 0.1 \times 24.63 = 2.46$ atm.

Why other options are wrong: 24.6 drops the 0.1 factor; 0.246 and 1.23 use the wrong concentration or temperature.

Final Answer: $\pi \approx 2.46$ atm $\Rightarrow$ A

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Faraday's law: The mass deposited $= \frac{(\text{charge in faradays}) \times \text{atomic mass}}{n}$, where n is electrons per ion.

Step 1 — Identify n: For $Al^{3+} + 3e^- \rightarrow Al$, $n = 3$. Depositing 1 mol Al needs 3 F.

Step 2 — Compute: With 2 F, moles of Al $= 2/3$; mass $= \dfrac{2}{3} \times 27 = 18$ g.

Why other options are wrong: 27 g needs 3 F; 9 g uses 1 F; 54 g uses 6 F.

Final Answer: 18 g of Al deposited $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Activation energy: E_a is the minimum energy the reactants must gain to reach the transition state (the peak of the energy profile).

Step 1 — Read the graph: The forward E_a is the height from the reactant level up to the transition-state (peak) energy.

Why other options are wrong: The product level gives ΔH, not E_a; the zero of energy is arbitrary; "products plus heat" is not the barrier.

Final Answer: E_a is the gap to the transition-state peak $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — n-factor in redox: The number of electrons transferred per ion equals its change in oxidation number.

Step 1 — Mn change: In $\mathrm{MnO_4^-}$, Mn is $+7$; in $\mathrm{Mn^{2+}}$ it is $+2$.

Step 2 — Compute: $\Delta = 7 - 2 = 5$ electrons gained, consistent with the $5e^-$ in the half-reaction.

Why other options are wrong: 2, 3 and 1 do not match the $+7 \rightarrow +2$ change.

Final Answer: 5 electrons (n-factor $= 5$) $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Metallic character trend: Metallic character depends on the ease of losing electrons, which falls as ionization energy rises.

Step 1 — Across a period: Effective nuclear charge increases, ionization energy increases, so electrons are held more tightly and metallic character decreases.

Why other options are wrong: Metallic character increases *down* a group, not across; it does not stay constant.

Final Answer: Metallic character decreases across a period $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Period and group from configuration: The highest principal quantum number gives the period; the valence-electron arrangement gives the group.

Step 1 — Configuration of $Z = 17$: $1s^2 2s^2 2p^6 3s^2 3p^5$ (chlorine).

Step 2 — Assign: Highest $n = 3 \Rightarrow$ Period 3; $3s^2 3p^5$ (7 valence electrons) $\Rightarrow$ Group 17.

Why other options are wrong: Period 2 needs highest $n = 2$; Group 16 needs $3s^2 3p^4$.

Final Answer: Period 3, Group 17 $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Acidic/basic nature of oxides: Metal oxides on the left of a period are basic; non-metal oxides on the right are acidic; basicity decreases across a period.

Step 1 — Compare: Na_2O (most metallic, Group 1) is strongly basic; MgO is basic but less so; Al_2O_3 is amphoteric; SO_2 is acidic.

Why other options are wrong: SO_2 is acidic; Al_2O_3 is amphoteric; MgO is less basic than Na_2O.

Final Answer: Na_2O is the most basic oxide $\Rightarrow$ C

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Nature of carbon oxides: CO is a neutral oxide, whereas CO_2 dissolves in water to form carbonic acid, H_2CO_3.

Step 1 — Reaction: $CO_2 + H_2O \rightarrow H_2CO_3$, which behaves as a weak acid.

Why other options are wrong: CO (not CO_2) is neutral; CO_2 is not basic or amphoteric.

Final Answer: CO_2 is an acidic oxide $\Rightarrow$ D

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Bond angle in group-15 hydrides: As the central atom becomes larger and less electronegative down the group, the bond angle decreases.

Step 1 — Compare: NH_3 has a bond angle of about $107°$; PH_3 has about $94°$ because the bonding pairs in P–H lie farther from the larger P atom.

Why other options are wrong: The NH_3 angle is larger, not smaller; they are not equal, and neither is the ideal $109.5°$.

Final Answer: NH_3 angle is larger ($107°$ vs $\sim 94°$) $\Rightarrow$ A

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Hybridization of XeF_4: Xe has 4 bond pairs and 2 lone pairs, giving 6 electron domains.

Step 1 — Hybridization: Six domains $\Rightarrow sp^3d^2$ (octahedral electron geometry).

Step 2 — Shape: The two lone pairs occupy axial positions, leaving a square planar arrangement of the four F atoms.

Why other options are wrong: sp^3 is for 4 domains; sp^3d see-saw is SF_4; sp^2

trigonal planar has 3 domains.

Final Answer: sp^3d^2, square planar $\Rightarrow$ B

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Colour and d electrons: Colour in transition-metal ions arises from d–d transitions, which require a partially filled d subshell. A d^0 or d^{10} ion is colourless.

Step 1 — Configurations: Zn^{2+} is $3d^{10}$ (full), so no d–d transition is possible $\Rightarrow$ colourless.

Why other options are wrong: Cu^{2+} (d^9), Fe^{3+} (d^5) and Co^{2+} (d^7) all have partly filled d orbitals and are coloured.

Final Answer: Zn^{2+} is colourless $\Rightarrow$ C

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Actinide properties: The actinides are the $5f$ series; every one of them is radioactive.

Step 1 — Recall: All actinides (from Th to Lr) have radioactive isotopes, and the later members are man-made.

Why other options are wrong: They are not all diamagnetic; they are not non-radioactive; they show several oxidation states (commonly $+3$ to $+6$), not only $+2$.

Final Answer: All actinides are radioactive $\Rightarrow$ D

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Effective atomic number (EAN): EAN = (atomic number $-$ oxidation state) $+2\times$(coordination number).

Step 1 — Electrons on Fe: Fe^{2+} has $26 - 2 = 24$ electrons.

Step 2 — Add ligand donation: Six CN^- donate $6 \times 2 = 12$ electrons; EAN $= 24 + 12 = 36$ (the krypton configuration).

Why other options are wrong: 24 ignores ligand donation; 30 and 54 use wrong counts.

Final Answer: EAN $= 36 \Rightarrow$ B

Answer: (B) Go Back to Q25

Q26.

Solution

Concept — Spectrochemical series: Ligands are ordered by the size of the crystal-field splitting they produce: weak field ($I^- < Br^- < Cl^- < F^- < H_2O < NH_3 < en < CN^- < CO$) strong field.

Step 1 — Compare: Of the choices, CN^- lies farthest to the strong-field end and gives the largest splitting.

Why other options are wrong: Cl^- and F^- are weak-field; H_2O is intermediate, weaker than CN^-.

Final Answer: CN^- is the strongest-field ligand $\Rightarrow$ C

Answer: (C) Go Back to Q26

Q27.

Solution

Concept — IUPAC naming of acids: A $-COOH$ group is named with the suffix "-oic acid"; count the carbon chain including the carboxyl carbon.

Step 1 — Count carbons: CH_3CH_2COOH has three carbons.

Step 2 — Name: Three carbons + "-oic acid" = propanoic acid.

Why other options are wrong: ethanoic acid has two carbons; propanal is an aldehyde; propan-1-ol is an alcohol.

Final Answer: The compound is propanoic acid $\Rightarrow$ A

Answer: (A) Go Back to Q27

Q28.

Solution

Concept — Metamerism: Metamers have the same molecular formula and same functional group but differ in the alkyl groups attached on either side of the functional group (common in ethers, amines, ketones).

Step 1 — Check: Methoxypropane $CH_3{-}O{-}C_3H_7$ and ethoxyethane $C_2H_5{-}O{-}C_2H_5$ are both $C_4H_{10}O$ ethers with different alkyl distribution $\Rightarrow$ metamers.

Why other options are wrong: ethanol/dimethyl ether are functional isomers; the two propanols are position isomers; the butenes are position isomers.

Final Answer: Methoxypropane and ethoxyethane are metamers $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Free-radical stability: Like carbocations, free radicals are stabilised by alkyl groups through hyperconjugation and the inductive effect.

Step 1 — Order: tertiary $>$ secondary $>$ primary $>$ methyl.

Why other options are wrong: The reverse order and "all equal" contradict the stabilising effect of alkyl substituents.

Final Answer: tertiary $>$ secondary $>$ primary $>$ methyl $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Decarboxylation: Heating the sodium salt of a carboxylic acid with soda lime removes CO_2 and gives an alkane with one fewer carbon.

Step 1 — Reaction: $CH_3COONa + NaOH \xrightarrow{CaO,\ \Delta} CH_4 + Na_2CO_3$.

Step 2 — Product: The hydrocarbon is methane.

Why other options are wrong: Ethane comes from sodium propanoate; ethene and propane are not the decarboxylation products of acetate.

Final Answer: Methane is formed $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q30

Q31.

Solution

Concept — Baeyer's test: Cold dilute alkaline $KMnO_4$ adds two $-OH$ groups across the C=C double bond (syn-hydroxylation).

Step 1 — Reaction with ethene: $CH_2{=}CH_2 \rightarrow HOCH_2{-}CH_2OH$ (ethane-1,2-diol), and the purple $KMnO_4$ is decolourised.

Why other options are wrong: Cold dilute $KMnO_4$ gives a vicinal diol (glycol), not a carboxylic acid, ketone or aldehyde (those need stronger/hot conditions or ozonolysis).

Final Answer: A vicinal diol (glycol) is formed $\Rightarrow$ C

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Directing effect: The $-NO_2$ group is a strong electron-withdrawing (deactivating) group; it is meta-directing.

Step 1 — Reasoning: It withdraws electron density most from the ortho and para positions, leaving the meta position relatively electron-rich for the electrophile.

Why other options are wrong: Ortho/para direction is characteristic of activating (electron-donating) groups, not $-NO_2$.

Final Answer: $-NO_2$ is meta-directing $\Rightarrow$ D

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Low reactivity of haloarenes: In chlorobenzene the lone pair on Cl is delocalised into the ring, giving the C–Cl bond partial double-bond character.

Step 1 — Consequence: This shortens and strengthens the C–Cl bond, so it is hard to break, making nucleophilic substitution very slow.

Why other options are wrong: Volatility and a non-existent positive Cl are irrelevant; chloroethane does have a leaving group (Cl^-).

Final Answer: Resonance gives C–Cl partial double-bond character $\Rightarrow$ B

Answer: (B) Go Back to Q33

Q34.

Solution

Concept — Acidity comparison: Acidity depends on the stability of the conjugate base. Phenoxide is resonance-stabilised; hydroxide (from water) is less stabilised; ethoxide (from ethanol) is destabilised by the electron-donating ethyl group.

Step 1 — Order: phenol ($pK_a \approx 10$) $>$ water (≈ 15.7) $>$ ethanol (≈ 16).

Why other options are wrong: Ethanol is the weakest acid, not the strongest; water is not stronger than phenol.

Final Answer: phenol $>$ water $>$ ethanol $\Rightarrow$ A

Answer: (A) Go Back to Q34

Q35.

Solution

Concept — Crown ethers: These macrocyclic polyethers have a central cavity lined with oxygen atoms.

Step 1 — Function: The cavity binds specific metal cations (e.g. 18-crown-6 binds K^+) by ion–dipole interactions, so crown ethers act as host molecules and phase-transfer agents.

Why other options are wrong: They are not strong oxidants or acids and do not polymerise into plastics.

Final Answer: They selectively bind specific metal cations $\Rightarrow$ C

Answer: (C) Go Back to Q35

Q36.

Solution

Concept — Nucleophilic addition of HCN: The cyanide ion adds to the electrophilic carbonyl carbon; protonation of the alkoxide gives an α-hydroxynitrile (cyanohydrin).

Step 1 — Reaction: $CH_3CHO + HCN \rightarrow CH_3CH(OH)CN$ (acetaldehyde cyanohydrin).

Why other options are wrong: A carboxylic acid, ester or ether is not the direct product of HCN addition to a carbonyl.

Final Answer: A cyanohydrin is formed $\Rightarrow$ D

Answer: (D) Go Back to Q36

Q37.

Solution

Concept — HVZ reaction: A carboxylic acid with α-hydrogen, treated with Cl_2 or Br_2 and red phosphorus, undergoes halogenation at the α-carbon.

Step 1 — Product: $CH_3COOH \xrightarrow{Cl_2/\text{red P}} ClCH_2COOH$, an α-halo carboxylic acid.

Why other options are wrong: Aldehydes, esters and amides are not formed in the HVZ reaction.

Final Answer: An α-halo carboxylic acid is formed $\Rightarrow$ A

Answer: (A) Go Back to Q37

Q38.

Solution

Concept — Gabriel phthalimide synthesis: Phthalimide is converted to its potassium salt, alkylated with an alkyl halide, and then hydrolysed to give a pure primary amine.

Step 1 — Scope: It works only for aliphatic primary amines, because aryl halides do not undergo the required S_N2 alkylation.

Why other options are wrong: It cannot prepare aromatic amines (anilines) or secondary/tertiary amines.

Final Answer: Aliphatic primary amines $\Rightarrow$ B

Answer: (B) Go Back to Q38

Q39.

Solution

Concept — Reducing vs non-reducing sugars: A sugar reduces Tollens'/Fehling's reagent only if it has a free anomeric (hemiacetal) carbon.

Step 1 — Sucrose: In sucrose the anomeric carbons of glucose and fructose are

both locked in the glycosidic bond, leaving no free reducing group.

Why other options are wrong: Glucose, fructose and maltose all have a free reducing group and are reducing sugars.

Final Answer: Sucrose is the non-reducing sugar $\Rightarrow$ C

Answer: (C) Go Back to Q39

Q40.

Solution

Concept — Addition vs condensation polymers: Condensation polymers form by the combination of monomers with the loss of a small molecule (often water); addition polymers form without loss of any molecule.

Step 1 — Identify: Nylon-6,6 is made from a diamine and a diacid, releasing water at each linkage, so it is a condensation polymer.

Why other options are wrong: Polythene, polystyrene and PVC are addition polymers of ethene, styrene and vinyl chloride respectively.

Final Answer: Nylon-6,6 is a condensation polymer $\Rightarrow$ D

Answer: (D) Go Back to Q40

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	D	4	C	5	A
6	B	7	C	8	D	9	B	10	A
11	D	12	C	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	B
26	C	27	A	28	D	29	B	30	A
31	C	32	D	33	B	34	A	35	C
36	D	37	A	38	B	39	C	40	D