SAAT Chemistry

Sample Paper – 9

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 molarity of a solution prepared by dissolving 9.8 g of sulphuric acid (H_2SO_4, molar mass 98 g/mol) in water to make 500 mL of solution is

(A) 0.2 M

(B) 0.1 M

(C) 0.5 M

(D) 2 M

Q2. The number of gram-equivalents present in 9.8 g of phosphoric acid (H_3PO_4, molar mass 98 g/mol, basicity 3) is

(A) 0.1

(B) 0.3

(C) 0.5

(D) 1.0

Q3. What volume of water must be added to 100 mL of 2 M HCl to dilute it to 0.5 M (assume volumes are additive)?

(A) 100 mL

(B) 200 mL

(C) 300 mL

(D) 400 mL

Q4. The total number of nodes (radial + angular) present in a $3p$ orbital is

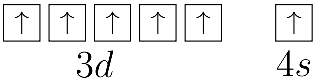
(A) 0

(B) 3

(C) 1

(D) 2

Q5. The correct ground-state electronic configuration of chromium ($Z = 24$), whose stable half-filled $3d$ set is suggested below, is



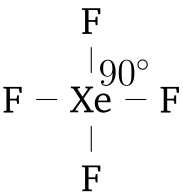
(A) $[\mathrm{Ar}]3d^5 4s^1$

(B) $[\mathrm{Ar}]3d^4 4s^2$

(C) $[\mathrm{Ar}]3d^6 4s^0$

(D) $[\mathrm{Ar}]3d^3 4s^2 4p^1$

Q6. The shape of the xenon tetrafluoride molecule ($\mathrm{XeF_4}$), which has two lone pairs on xenon as shown, is



$$\begin{array}{c} \mathrm{F} \\ |\,{}^{90^\circ} \\ \mathrm{F - Xe - F} \\ | \\ \mathrm{F} \end{array}$$

(A) tetrahedral

(B) square planar

(C) see-saw

(D) trigonal bipyramidal

Q7. According to molecular orbital theory, the bond order of the fluorine molecule (F_2, 18 electrons) is

(A) 2

(B) 1.5

(C) 1

(D) 0

Q8. According to Fajans' rules, which of the following compounds has the greatest covalent character?

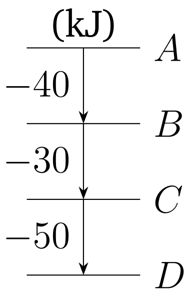
(A) NaCl

(B) KCl

(C) NaF

(D) $AlCl_3$

Q9. Using Hess's law for the three steps shown, the enthalpy change for the overall reaction $A \rightarrow D$ is



(A) -70 kJ

(B) -120 kJ

(C) $+120$ kJ

(D) -90 kJ

Q10. For which of the following processes is the entropy change (ΔS) positive?

(A) Condensation of steam to water

(B) Freezing of water to ice

(C) Sublimation of solid iodine to vapour

(D) Dimerisation $2NO_2 \rightarrow N_2O_4$

Q11. For the equilibrium $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$ at constant temperature, continuous removal of methanol from the vessel causes the equilibrium to

(A) shift forward (more methanol formed)

(B) shift backward (towards CO and H_2)

(C) remain completely unchanged

(D) stop reacting altogether

Q12. The approximate pH of a very dilute 10^{-8} M aqueous solution of a strong acid (HCl) is closest to

(A) 8

(B) 7.0

(C) 6.0

(D) just below 7 (about 6.96)

Q13. The normality of a solution containing 4.9 g of sulphuric acid (H_2SO_4, equivalent mass 49 g/equiv) dissolved to make 250 mL of solution is

(A) 0.2 N

(B) 0.4 N

(C) 0.1 N

(D) 1.0 N

Q14. A redox reaction in a galvanic cell is thermodynamically feasible (spontaneous) when the standard cell potential E°_{cell} is

(A) positive

(B) negative

(C) zero

(D) independent of ΔG°

Q15. For a first-order reaction, the half-life $t_{1/2}$ depends on

(A) the initial concentration only

(B) the square of the concentration

(C) the rate constant only (independent of initial concentration)

(D) both the rate constant and the concentration

Q16. At constant temperature, a fixed mass of an ideal gas occupies 4 L at 1 atm. If the pressure is increased to 2 atm, the new volume (Boyle's law) is

(A) 8 L

(B) 4 L

(C) 1 L

(D) 2 L

Q17. The electron gain enthalpy (electron affinity) of fluorine is less negative than that of chlorine. This anomaly is mainly because

(A) fluorine has a larger atomic size than chlorine

(B) the small, compact $2p$ subshell of fluorine causes strong inter-electronic repulsion

(C) chlorine has a higher nuclear charge than fluorine

(D) fluorine is a metal whereas chlorine is a non-metal

Q18. Among the alkali metals lithium, sodium, potassium and caesium, which is the most reactive (most easily loses its valence electron)?

(A) Caesium

(B) Lithium

(C) Sodium

(D) Potassium

Q19. The oxidation state of oxygen in hydrogen peroxide (H_2O_2) is

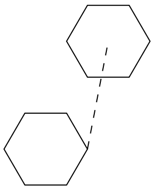
(A) -2

(B) 0

(C) -1

(D) $+1$

Q20. Graphite, whose layered hexagonal sheets are shown, is a good conductor of electricity, unlike diamond, because in graphite



(A) each carbon is sp^3 hybridised with four sigma bonds

(B) the structure contains only ionic bonds

(C) carbon atoms are held by weak hydrogen bonds

(D) each carbon is sp^2 hybridised, leaving one delocalised p electron free to move

Q21. In the brown-ring test for nitrate ions, the brown ring is due to the complex

(A) $[Fe(H_2O)_5NO]^{2+}$

(B) $[Fe(CN)_6]^{3-}$

(C) Fe_2O_3

(D) $FeSO_4$

Q22. The number of S–OH (hydroxyl) groups present in one molecule of sulphuric acid (H_2SO_4) is

(A) 1

(B) 2

(C) 3

(D) 4

Q23. The high melting points of transition metals compared with s-block metals are mainly attributed to

(A) their large atomic radii

(B) the presence of only s-electrons in bonding

(C) strong metallic bonding involving unpaired d-electrons

(D) their low effective nuclear charge

Q24. The electronic configuration of the cerium(III) ion, Ce^{3+} (Z of Ce $= 58$), is

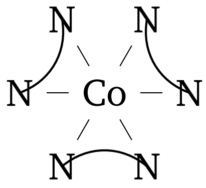
(A) $[Xe]4f^2$

(B) $[Xe]4f^05d^1$

(C) $[Xe]5d^1$

(D) $[Xe]4f^1$

Q25. Ethylenediamine (en) acting as a ligand in the octahedral complex $[Co(en)_3]^{3+}$, shown below, is best described as



(A) a bidentate (chelating) ligand

(B) a monodentate ligand

(C) an ambidentate ligand

(D) a hexadentate ligand

Q26. The pair of complexes $[Co(NH_3)_5(NO_2)]^{2+}$ and $[Co(NH_3)_5(ONO)]^{2+}$ are examples of

(A) geometrical isomerism

(B) linkage isomerism

(C) optical isomerism

(D) coordination isomerism

Q27. The IUPAC name of the compound $CH_3CH_2CH_2NH_2$ is

(A) ethanamine

(B) N-methylethanamine

(C) propan-2-amine

(D) propan-1-amine

Q28. Tartaric acid has a stereoisomer that is optically inactive due to an internal plane of symmetry. This isomer is called the

(A) dextrorotatory enantiomer

(B) levorotatory enantiomer

(C) meso form

(D) racemic mixture

Q29. Among the following aliphatic amines in the gas phase, which is the strongest base (most influenced by the electron-donating inductive effect of alkyl groups)?

(A) $(CH_3)_2NH$ (dimethylamine, $2°$)

(B) NH_3 (ammonia)

(C) CH_3NH_2 (methylamine, $1°$)

(D) $C_6H_5NH_2$ (aniline)

Q30. Which of the following statements about alkanes is correct?

(A) Alkanes readily add bromine across a double bond

(B) Alkanes do not react with steam under ordinary conditions (they are chemically inert)

(C) Alkanes decolourise Baeyer's reagent

(D) Alkanes undergo electrophilic addition with HBr

Q31. When ethene is subjected to high pressure in the presence of a suitable catalyst, the product formed is

ethene

$$H_2C{=}CH_2$$

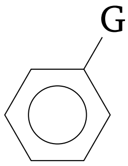
(A) ethanol

(B) ethyne

(C) polythene (polyethene)

(D) ethane

Q32. For electrophilic substitution on the benzene ring shown, which of the following substituents (already attached to the ring) is an activating, ortho/para-directing group?



(A) $-NO_2$

(B) $-COOH$

(C) $-C\equiv N$

(D) $-OH$

Q33. A Grignard reagent ($R-MgX$) is prepared by the reaction of an alkyl halide with

(A) sodium metal in dry ether

(B) magnesium metal in dry ether

(C) zinc dust in water

(D) aqueous sodium hydroxide

Q34. When ethanol is heated with acetic acid in the presence of a little concentrated H_2SO_4, the main organic product is

(A) ethyl acetate (an ester)

(B) ethene

(C) diethyl ether

(D) acetaldehyde

Q35. Anisole ($C_6H_5-O-CH_3$) on treatment with hot concentrated HI is cleaved to give

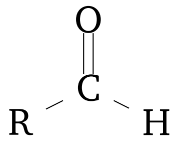
(A) iodobenzene and methanol

(B) benzene and methyl iodide

(C) phenol and methane

(D) phenol and methyl iodide

Q36. Towards nucleophilic addition reactions, which carbonyl compound is the most reactive?



(A) acetone, $(CH_3)_2CO$

(B) benzaldehyde, C_6H_5CHO

(C) formaldehyde, HCHO

(D) acetophenone, $C_6H_5COCH_3$

Q37. Among the following carboxylic acids, which is the strongest (lowest $\mathrm{p}K_a$)?

(A) trichloroacetic acid, CCl_3COOH

(B) acetic acid, CH_3COOH

(C) chloroacetic acid, $ClCH_2COOH$

(D) dichloroacetic acid, $Cl_2CHCOOH$

Q38. A primary aliphatic amine on warming with chloroform and alcoholic KOH gives a foul-smelling isocyanide. This reaction (the carbylamine test) is used to

(A) detect a tertiary amine only

(B) distinguish a primary amine from secondary and tertiary amines

(C) detect a quaternary ammonium salt

(D) convert an amine to an amide

Q39. Which of the following vitamins is water-soluble?

(A) Vitamin A

(B) Vitamin D

(C) Vitamin C

(D) Vitamin K

Q40. Which of the following is used as an antiseptic to kill or prevent the growth of micro-organisms on living tissue (e.g. on wounds)?

(A) Aspirin (an analgesic)

(B) Chloramphenicol (an antibiotic taken internally)

(C) Sodium chloride (common salt)

(D) Dettol / dilute tincture of iodine

Detailed Solutions

Q1.

Solution

Concept — Molarity from mass and volume: $M = \dfrac{\text{mass/molar mass}}{\text{volume in litres}}$.

Step 1 — Moles of H_2SO_4: $n = \dfrac{9.8}{98} = 0.1$ mol.

Step 2 — Volume: 500 mL $= 0.5$ L, so $M = \dfrac{0.1}{0.5} = 0.2$ M.

Why other options are wrong: 0.1 forgets to divide by litres; 0.5 uses the mole value as molarity; 2 inverts the volume.

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

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

Q2.

Solution

Concept — Gram-equivalents: gram-equivalents $= \dfrac{\text{mass}}{\text{equivalent mass}}$, and equivalent mass $= \dfrac{\text{molar mass}}{\text{basicity}}$.

Step 1 — Equivalent mass of H_3PO_4: $\dfrac{98}{3} \approx 32.67$ g/equiv.

Step 2 — Compute: gram-equivalents $= \dfrac{9.8}{98} \times 3 = 0.1 \times 3 = 0.3$.

Why other options are wrong: 0.1 ignores the basicity; 0.5 and 1.0 use wrong factors.

Final Answer: 0.3 gram-equivalents $\Rightarrow \boxed{\text{B}}$

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

Q3.

Solution

Concept — Dilution: $M_1V_1 = M_2V_2$ (moles of solute are conserved on adding water).

Step 1 — Final volume: $2 \times 100 = 0.5 \times V_2 \Rightarrow V_2 = 400$ mL.

Step 2 — Water added: $V_2 - V_1 = 400 - 100 = 300$ mL.

Why other options are wrong: 400 mL is the final total volume, not the water added; 100 and 200 use wrong ratios.

Final Answer: 300 mL of water $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Nodes in an orbital: total nodes $= n - 1$; angular nodes $= l$; radial nodes $= n - l - 1$.

Step 1 — For $3p$: $n = 3$, $l = 1$.

Step 2 — Compute: total nodes $= n - 1 = 2$ (radial $= 3 - 1 - 1 = 1$, angular $= 1$).

Why other options are wrong: 0 ignores nodes; 3 uses n; 1 counts only one type of node.

Final Answer: 2 nodes $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Anomalous configuration: A half-filled $3d^5$ set is extra stable, so chromium promotes one $4s$ electron to $3d$.

Step 1 — Expected vs actual: Expected $[\text{Ar}]3d^4 4s^2$; actual (stable) $[\text{Ar}]3d^5 4s^1$.

Step 2 — Reason: The symmetrical, exchange-stabilised half-filled d subshell lowers the energy.

Why other options are wrong: $3d^4 4s^2$ is the naive (incorrect) filling; $3d^6 4s^0$ and the $4p$ option are not chromium's ground state.

Final Answer: $[\text{Ar}]3d^5 4s^1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — VSEPR with lone pairs: $\mathrm{XeF_4}$ has 4 bond pairs and 2 lone pairs (sp^3d^2). The lone pairs occupy axial positions, leaving the four F atoms in a plane.

Step 1 — Electron geometry: Six electron domains $\Rightarrow$ octahedral arrangement.

Step 2 — Molecular shape: With two trans lone pairs removed, the shape is square planar.

Why other options are wrong: Tetrahedral and see-saw correspond to different domain counts; trigonal bipyramidal is for 5 bond pairs with no lone pair.

Final Answer: $\mathrm{XeF_4}$ is square planar $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

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

Step 1 — $\mathrm{F_2}$ has 18 electrons: $N_b = 10$, $N_a = 8$.

Step 2 — Compute: Bond order $= \frac{1}{2}(10 - 8) = 1$.

Why other options are wrong: 2 is $\mathrm{O_2}$; 1.5 is $\mathrm{F_2^-}/\mathrm{O_2^-}$-type; 0 would mean no bond.

Final Answer: Bond order of $\mathrm{F_2} = 1 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Fajans' rules: Covalent character increases with greater cation charge, smaller cation size, and larger anion size (greater polarising power).

Step 1 — Compare cations: $\mathrm{Al^{3+}}$ is small and highly charged, giving it the highest polarising power among the listed cations.

Step 2 — Conclusion: $\mathrm{AlCl_3}$ is the most covalent (it even sublimes and exists as $\mathrm{Al_2Cl_6}$).

Why other options are wrong: $\mathrm{Na^+}$ and $\mathrm{K^+}$ are large, singly-charged ions giving predominantly ionic NaCl, KCl, NaF.

Final Answer: $AlCl_3$ has the greatest covalent character $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Hess's law (multistep): The overall enthalpy change equals the sum of the step enthalpies along any path.

Step 1 — Add the three steps: $\Delta H_{A\to D} = (-40) + (-30) + (-50)$.

Step 2 — Compute: $\Delta H = -120$ kJ.

Why other options are wrong: -70 and -90 omit a step; $+120$ has the wrong sign.

Final Answer: $\Delta H_{A\to D} = -120$ kJ $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Sign of ΔS: Entropy increases when disorder increases, e.g. when a solid or liquid becomes a gas.

Step 1 — Examine each: Sublimation (solid $\to$ vapour) greatly increases molecular freedom, so $\Delta S > 0$.

Why other options are wrong: Condensation, freezing and dimerisation all reduce the number of gaseous particles/disorder, giving $\Delta S < 0$.

Final Answer: Sublimation of iodine has $\Delta S > 0 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Le Chatelier (removing product): Removing a product reduces its concentration, so the system shifts to replace it.

Step 1 — Apply: Continuous removal of CH_3OH drives the reaction forward to produce more methanol.

Why other options are wrong: A backward shift would consume product, not replace it; the equilibrium does respond, and reactions do not simply stop.

Final Answer: The equilibrium shifts forward $\Rightarrow \boxed{\text{A}}$

$\boxed{\textbf{Answer: (A)}}$ **Go Back to Q11**

Q12.

Solution

Concept — pH of very dilute acid: When acid concentration is comparable to 10^{-7} M, the H^+ from water cannot be neglected.

Step 1 — Total $[H^+]$**:** $\approx 10^{-7} + 10^{-8} \approx 1.1 \times 10^{-7}$ M (rigorously slightly above 10^{-7}).

Step 2 — pH: $\text{pH} = -\log(1.1 \times 10^{-7}) \approx 6.96$, i.e. just below 7 (acidic).

Why other options are wrong: pH 8 would be basic, which a strong acid can never give; 7.0 ignores the acid; 6.0 overestimates the acidity.

Final Answer: pH is just below 7 (≈ 6.96) $\Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q12**

Q13.

Solution

Concept — Normality: $N = \dfrac{\text{mass/equivalent mass}}{\text{volume in litres}}$.

Step 1 — Gram-equivalents: $\dfrac{4.9}{49} = 0.1$ equiv.

Step 2 — Compute: $N = \dfrac{0.1}{0.25} = 0.4$ N.

Why other options are wrong: 0.2 uses 0.5 L; 0.1 skips the volume; 1.0 uses a wrong volume.

Final Answer: $N = 0.4$ N $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q13**

Q14.

Solution

Concept — Feasibility and EMF: $\Delta G^\circ = -nFE^\circ_{cell}$; a reaction is spontaneous when $\Delta G^\circ < 0$.

Step 1 — Relate signs: $\Delta G^\circ < 0$ requires $E^\circ_{cell} > 0$.

Why other options are wrong: A negative E°_{cell} gives $\Delta G^\circ > 0$ (non-spontaneous); zero means equilibrium; E°_{cell} is directly linked to ΔG°, not independent.

Final Answer: The reaction is feasible when E°_{cell} is positive $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — First-order half-life: $t_{1/2} = \dfrac{0.693}{k}$, which contains no concentration term.

Step 1 — Examine the formula: Only k appears, so $t_{1/2}$ is independent of the initial concentration.

Why other options are wrong: For first order, $t_{1/2}$ has no dependence on concentration; it is governed solely by k.

Final Answer: $t_{1/2}$ depends only on $k \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Boyle's law: At constant T, $P_1V_1 = P_2V_2$.

Step 1 — Substitute: $1 \times 4 = 2 \times V_2$.

Step 2 — Solve: $V_2 = \dfrac{4}{2} = 2$ L.

Why other options are wrong: 8 L doubles instead of halving; 4 L assumes no change; 1 L over-compresses.

Final Answer: New volume $= 2$ L $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Anomalous electron gain enthalpy of F: Although F is smaller, its compact $2p$ subshell crowds the incoming electron.

Step 1 — Reason: The added electron experiences strong electron–electron repulsion in the small $2p$ orbitals, releasing less energy than for chlorine.

Why other options are wrong: F is smaller, not larger; chlorine actually has a lower nuclear charge; F is a non-metal, not a metal.

Final Answer: Strong inter-electronic repulsion in the small $2p$ subshell $\Rightarrow \boxed{\text{B}}$

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

Q18.

Solution

Concept — Reactivity of alkali metals: Reactivity increases down the group as ionization enthalpy falls and the valence electron is more easily lost.

Step 1 — Order: $\mathrm{Li} < \mathrm{Na} < \mathrm{K} < \mathrm{Cs}$.

Step 2 — Pick: Caesium, being lowest in the group listed, is the most reactive.

Why other options are wrong: Lithium is the least reactive; Na and K are intermediate.

Final Answer: Caesium is the most reactive $\Rightarrow \boxed{\text{A}}$

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

Q19.

Solution

Concept — Oxidation state in peroxides: In a peroxide linkage (O–O), each oxygen is -1.

Step 1 — Balance H_2O_2**:** $2(+1) + 2x = 0 \Rightarrow x = -1$.

Why other options are wrong: -2 is the normal oxide value; 0 is elemental O_2; $+1$ occurs only with fluorine (O_2F_2).

Final Answer: Oxygen is -1 in $H_2O_2 \Rightarrow \boxed{\text{C}}$

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

Q20.

Solution

Concept — Structure and conductivity of graphite: Graphite has layers of sp^2 carbons; each carbon uses three electrons in sigma bonds and the fourth in a delocalised π system.

Step 1 — Free electrons: The delocalised p electrons move along the layers, conducting electricity.

Why other options are wrong: sp^3 describes diamond (an insulator); graphite has no ionic or hydrogen bonding holding the carbons.

Final Answer: sp^2 carbons with delocalised electrons make graphite conduct $\Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q20**

Q21.

Solution

Concept — Brown-ring test: Nitrate is reduced by Fe^{2+} in the presence of conc. H_2SO_4 to NO, which coordinates to iron.

Step 1 — Brown ring species: The brown ring is the nitrosyl complex $[Fe(H_2O)_5NO]^{2+}$ (iron in the $+1$ state).

Why other options are wrong: $[Fe(CN)_6]^{3-}$, Fe_2O_3 and $FeSO_4$ are not the brown-ring complex.

Final Answer: $[Fe(H_2O)_5NO]^{2+} \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q21**

Q22.

Solution

Concept — Structure of H_2SO_4: Sulphuric acid is tetrahedral about S with two S=O bonds and two S–OH groups.

Step 1 — Count OH groups: Both ionisable hydrogens are on hydroxyl groups, so there are 2 S–OH groups (which makes it dibasic).

Why other options are wrong: 1 is for a monobasic oxoacid; 3 is for H_3PO_4; 4 exceeds the available positions.

Final Answer: H_2SO_4 has 2 S–OH groups $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Melting points of transition metals: Strong metallic bonding from a large number of unpaired d-electrons (plus s-electrons) gives high cohesive energy.

Step 1 — Reason: The more unpaired d-electrons available for bonding, the stronger the metallic lattice and the higher the melting point.

Why other options are wrong: Transition metals are not large-radius; they do not bond with s-electrons alone; their effective nuclear charge is high, not low.

Final Answer: Strong d-electron metallic bonding $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Configuration of a lanthanide ion: Cerium is $[\mathrm{Xe}]4f^1 5d^1 6s^2$; the common $+3$ ion loses the $6s$ and $5d$ (and is left with $4f^1$).

Step 1 — Form Ce^{3+}**:** Remove three electrons $\Rightarrow [\mathrm{Xe}]4f^1$.

Why other options are wrong: $4f^2$ has one electron too many; $4f^0 5d^1$ and $5d^1$ wrongly retain a $5d$ electron instead of the more stable $4f^1$.

Final Answer: $\mathrm{Ce}^{3+} = [\mathrm{Xe}]4f^1 \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Denticity: A ligand's denticity is the number of donor atoms it uses to bind the metal.

Step 1 — Examine en: Ethylenediamine ($H_2N{-}CH_2{-}CH_2{-}NH_2$) binds through two nitrogen atoms, forming a five-membered chelate ring.

Step 2 — Classify: It is therefore a bidentate (chelating) ligand.

Why other options are wrong: Monodentate uses one donor; ambidentate has two possible donors but binds through one; hexadentate (like EDTA) uses six.

Final Answer: en is a bidentate chelating ligand ⇒ $\boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Linkage isomerism: It arises when an ambidentate ligand binds through different donor atoms.

Step 1 — Identify the ligand: The nitrite ion can coordinate through N ($-NO_2$, nitro) or through O ($-ONO$, nitrito).

Step 2 — Classify: The two complexes differ only in this donor atom, so they are linkage isomers.

Why other options are wrong: The geometry, optical activity and coordination spheres are otherwise identical, ruling out the other isomerism types.

Final Answer: They are linkage isomers ⇒ $\boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Naming amines: An $-NH_2$ on a carbon chain is named “alkan-position-amine”.

Step 1 — Count carbons: $CH_3CH_2CH_2NH_2$ is a three-carbon chain with $-NH_2$ on C1.

Step 2 — Name: propan-1-amine.

Why other options are wrong: ethanamine has two carbons; N-methylethanamine is a secondary amine; propan-2-amine puts $-NH_2$ on C2.

Final Answer: propan-1-amine ⇒ $\boxed{\text{D}}$

Answer: (D) Go Back to Q27

Q28.

Solution

Concept — Meso compound: A molecule with two stereocentres but an internal mirror plane is achiral overall (optically inactive) despite having chiral centres.

Step 1 — Apply to tartaric acid: The meso form has (R, S) centres whose rotations cancel internally.

Why other options are wrong: The dextro and levo forms are optically active enantiomers; a racemic mixture is inactive only by external compensation (equal amounts of two enantiomers), not by an internal plane.

Final Answer: It is the meso form $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q28**

Q29.

Solution

Concept — Basicity via inductive effect: Electron-donating alkyl groups increase the electron density on nitrogen, strengthening basicity; in the gas phase basicity rises with the number of alkyl groups.

Step 1 — Compare: Among NH_3, CH_3NH_2 and $(CH_3)_2NH$, the secondary amine has the most +I donation, and aniline is much weaker due to resonance.

Step 2 — Pick the strongest: $(CH_3)_2NH$ (dimethylamine).

Why other options are wrong: NH_3 has no alkyl donation; methylamine has only one; aniline's lone pair is delocalised into the ring.

Final Answer: Dimethylamine is the strongest base $\Rightarrow \boxed{\text{A}}$

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

Q30.

Solution

Concept — Inertness of alkanes: Alkanes are saturated, with strong nonpolar C–C and C–H bonds, so they are generally unreactive.

Step 1 — Test the statement: Alkanes do not react with steam under ordinary conditions (no functional group to attack).

Why other options are wrong: Alkanes do not add bromine, do not decolourise Baeyer's reagent, and do not undergo electrophilic addition (those are alkene properties).

Final Answer: Alkanes are inert to steam under ordinary conditions ⇒ $\boxed{\text{B}}$

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

Q31.

Solution

Concept — Addition polymerisation: Many ethene molecules join through their double bonds to form a long-chain polymer.

Step 1 — Reaction: $n\,\mathrm{CH_2{=}CH_2} \xrightarrow{\text{high } P,\ \text{catalyst}} -(\mathrm{CH_2{-}CH_2})-_n$.

Step 2 — Product: polythene (polyethene).

Why other options are wrong: Ethanol comes from hydration; ethyne from dehydrogenation; ethane from hydrogenation – none is the high-pressure polymerisation product.

Final Answer: The product is polythene ⇒ $\boxed{\text{C}}$

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

Q32.

Solution

Concept — Directing/activating groups: Groups with a lone pair that can donate electrons into the ring (like $-\mathrm{OH}$, $-\mathrm{NH_2}$) activate it and direct ortho/para.

Step 1 — Examine $-\mathrm{OH}$: The oxygen lone pair raises ring electron density, speeding electrophilic substitution at ortho/para positions.

Why other options are wrong: $-\mathrm{NO_2}$, $-\mathrm{COOH}$ and $-\mathrm{C{\equiv}N}$ are electron-withdrawing, deactivating and meta-directing.

Final Answer: $-\mathrm{OH}$ is activating and o/p-directing ⇒ $\boxed{\text{D}}$

Answer: (D) **Go Back to Q32**

Q33.

Solution

Concept — Grignard reagent: An alkyl/aryl halide reacts with magnesium turnings in dry ether to form $\mathrm{R{-}MgX}$.

Step 1 — Reaction: $\mathrm{R{-}X + Mg \xrightarrow{dry\ ether} R{-}MgX}$.

Why other options are wrong: Sodium gives the Wurtz coupling product; zinc/water and aqueous NaOH would destroy or fail to form the organometallic.

Final Answer: Magnesium in dry ether $\Rightarrow \boxed{\mathrm{B}}$

Answer: (B) **Go Back to Q33**

Q34.

Solution

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

Step 1 — Reaction: $\mathrm{CH_3COOH + C_2H_5OH \xrightarrow{conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O}$.

Step 2 — Product: ethyl acetate.

Why other options are wrong: Ethene and diethyl ether form on strong heating of ethanol alone (dehydration); acetaldehyde needs oxidation, not this reaction.

Final Answer: Ethyl acetate is formed $\Rightarrow \boxed{\mathrm{A}}$

Answer: (A) **Go Back to Q34**

Q35.

Solution

Concept — Cleavage of aryl alkyl ethers by HI: The alkyl–oxygen bond breaks; the aryl–oxygen bond is strong (partial double-bond character) and is retained, giving the phenol.

Step 1 — Reaction: $\mathrm{C_6H_5{-}O{-}CH_3 + HI \rightarrow C_6H_5OH + CH_3I}$.

Step 2 — Products: phenol and methyl iodide.

Why other options are wrong: Iodine attaches to the alkyl carbon, not the ring, so iodobenzene/benzene/methane products are incorrect.

Final Answer: Phenol and methyl iodide $\Rightarrow \boxed{\mathrm{D}}$

Answer: (D) Go Back to Q35

Q36.

Solution

Concept — Reactivity toward nucleophilic addition: Reactivity falls with greater steric crowding and greater electron donation to the carbonyl carbon. Formaldehyde (two H atoms) is the least hindered and least electron-rich.

Step 1 — Compare: HCHO $>$ aldehydes $>$ ketones; aromatic carbonyls are further deactivated by resonance.

Step 2 — Pick: Formaldehyde (HCHO) is the most reactive.

Why other options are wrong: Acetone and acetophenone are ketones (two alkyl/aryl groups); benzaldehyde is stabilised by ring conjugation – all less reactive than HCHO.

Final Answer: Formaldehyde is most reactive $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept — Acid strength and the inductive effect: Electron-withdrawing chlorine atoms stabilise the carboxylate anion; more Cl atoms means a stronger acid.

Step 1 — Order: $\mathrm{CH_3COOH} < \mathrm{ClCH_2COOH} < \mathrm{Cl_2CHCOOH} < \mathrm{CCl_3COOH}$.

Step 2 — Pick: Trichloroacetic acid has three Cl atoms, so it is the strongest (lowest $\mathrm{p}K_a$).

Why other options are wrong: Acetic acid has no Cl; mono- and dichloroacetic acids have fewer Cl atoms than trichloroacetic acid.

Final Answer: Trichloroacetic acid is the strongest $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

Concept — Carbylamine (isocyanide) test: Only primary amines react with $\mathrm{CHCl_3}$ and alcoholic KOH to give foul-smelling isocyanides.

Step 1 — Reaction: $\mathrm{R{-}NH_2 + CHCl_3 + 3KOH \rightarrow R{-}NC + 3KCl + 3H_2O}$.

Step 2 — Use: Since only 1° amines respond, the test distinguishes primary amines from secondary and tertiary amines.

Why other options are wrong: Secondary, tertiary and quaternary species do not give the isocyanide; the reaction does not form an amide.

Final Answer: It distinguishes a primary amine $\Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q38

Q39.

Solution

Concept — Solubility of vitamins: Vitamins B and C are water-soluble; A, D, E and K are fat-soluble.

Step 1 — Classify: Vitamin C (ascorbic acid) dissolves in water.

Why other options are wrong: Vitamins A, D and K are fat-soluble and are stored in fatty tissue.

Final Answer: Vitamin C is water-soluble $\Rightarrow \boxed{\mathrm{C}}$

Answer: (C) Go Back to Q39

Q40.

Solution

Concept — Antiseptics: Antiseptics are applied to living tissue to kill or stop the growth of micro-organisms.

Step 1 — Identify: Dettol (chloroxylenol) and dilute tincture of iodine are common antiseptics for wounds and skin.

Why other options are wrong: Aspirin is an analgesic; chloramphenicol is an antibiotic taken internally; common salt is not used as a tissue antiseptic in this sense.

Final Answer: Dettol / dilute tincture of iodine $\Rightarrow \boxed{\mathrm{D}}$

Answer: (D)

Go Back to Q40

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	B	10	C
11	A	12	D	13	B	14	A	15	C
16	D	17	B	18	A	19	C	20	D
21	A	22	B	23	C	24	D	25	A
26	B	27	D	28	C	29	A	30	B
31	C	32	D	33	B	34	A	35	D
36	C	37	A	38	B	39	C	40	D