JCECE Chemistry Sample Paper – 2

Duration: 60 Minutes **Maximum Marks: 50**

Instructions

- This paper contains **50** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry portion of **JCECE** entrance.
- Each correct answer carries **+1 mark**. There is -0.25 **mark** for each incorrect answer; unattempted questions get 0.
- Only **one** option is correct. Choose carefully.
- Syllabus level: **Class 11 and Class 12 NCERT Chemistry (Jharkhand JAC / CBSE aligned) – Physical, Organic and Inorganic.**
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Q1. 4.0 g of NaOH (molar mass $= 40$ g/mol) is dissolved in water to make 250 mL of solution. The molarity of the solution is:

(A) 0.10 M

(B) 0.20 M

(C) 0.40 M

(D) 1.00 M

Q2. Using the Rydberg formula $\frac{1}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ with $R_H = 1.1 \times 10^7$ m^{-1}, the wavelength of the spectral line for the transition $n_2 = 2 \to n_1 = 1$ (Lyman series) is approximately:

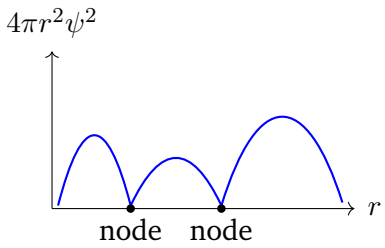
(A) 91 nm

(B) 656 nm

(C) 486 nm

(D) 121 nm

Q3. The number of radial (spherical) nodes in a $3s$ orbital, whose radial probability plot showing the nodes is sketched below, is given by $(n - l - 1)$:



(A) 0

(B) 1

(C) 2

(D) 3

Q4. 2.0 mol of an ideal gas occupies a volume of 44.8 L at a pressure of 1.0 atm. Taking $R = 0.0821$ L atm mol^{-1}K^{-1}, the temperature of the gas is approximately:

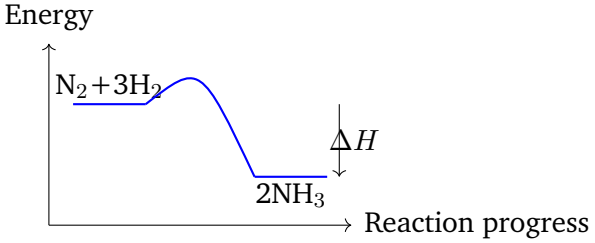
(A) 546 K

(B) 273 K

(C) 137 K

(D) 300 K

Q5. For the reaction $\mathrm{N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)}$ at 300 K (energy levels of reactants and products shown), the difference $\Delta H - \Delta U = \Delta n_g RT$. Taking $R = 8.314$ J K^{-1}mol^{-1}, this difference is:



(A) $+4988$ J

(B) 0 J

(C) -2494 J

(D) -4988 J

Q6. When 1 L of 1 M HCl is mixed with 1 L of 1 M NaOH, the heat released corresponds to the enthalpy of neutralisation of a strong acid by a strong base, which is approximately:

(A) -57.1 kJ/mol

(B) -114.2 kJ/mol

(C) $+57.1$ kJ/mol

(D) -285 kJ/mol

Q7. For the reaction $\mathrm{PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)}$ at 300 K, $K_c = 2.0$. Using $K_p = K_c(RT)^{\Delta n_g}$ with $R = 0.0821$ and $\Delta n_g = +1$, the value of K_p is approximately:

(A) 2.0

(B) 24.6

(C) 49.3

(D) 0.081

Q8. The pH of a 0.1 M solution of a weak monobasic acid HA with $K_a = 1.0 \times 10^{-5}$ at 25°C is (use $[\mathrm{H^+}] = \sqrt{K_a\, C}$):

(A) 2

(B) 3

(C) 5

(D) 1

Q9. The solubility product of AgBr at 25°C is $K_{sp} = 4.0 \times 10^{-13}$. The molar solubility s of AgBr in pure water (with $K_{sp} = s^2$) is:

(A) 6.3×10^{-7} mol/L

(B) 2.0×10^{-13} mol/L

(C) 4.0×10^{-13} mol/L

(D) 1.6×10^{-25} mol/L

Q10. When 0.5 mol of a non-volatile, non-electrolyte solute is dissolved in 500 g of water ($K_f = 1.86$ K kg mol^{-1}), the freezing point of the solution is:

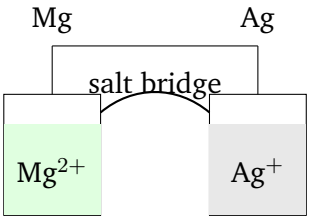
(A) 0.00°C

(B) -0.93°C

(C) -1.86°C

(D) -3.72°C

Q11. For the galvanic cell shown using magnesium and silver electrodes, $E^\circ_{Mg^{2+}/Mg} = -2.37$ V and $E^\circ_{Ag^+/Ag} = +0.80$ V. The standard EMF of the cell is:



(A) -3.17 V

(B) $+1.57$ V

(C) -1.57 V

(D) $+3.17$ V

Q12. The limiting molar conductivities are $\Lambda^\circ_{HCl} = 426$, $\Lambda^\circ_{CH_3COONa} = 91$ and $\Lambda^\circ_{NaCl} = 126$ S cm^{2}mol^{-1}. By Kohlrausch's law, Λ° of acetic acid (CH_3COOH) is:

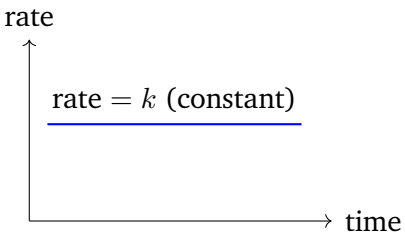
(A) 391 S cm^{2}mol^{-1}

(B) 335 S cm^{2}mol^{-1}

(C) 461 S cm^{2}mol^{-1}

(D) 217 S cm^{2}mol^{-1}

Q13. The rate-versus-time profile of a reaction whose rate stays constant (independent of concentration) is shown. For such a reaction, the unit of the rate constant k is:



(A) $\text{mol}\,\text{L}^{-1}\,\text{s}^{-1}$

(B) s^{-1}

(C) $\text{L}\,\text{mol}^{-1}\,\text{s}^{-1}$

(D) $\text{mol}\,\text{L}^{-1}$

Q14. A first-order reaction has a half-life of 10 minutes. The fraction of the reactant remaining after 40 minutes is:

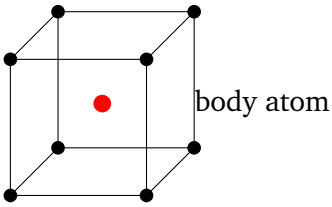
(A) $1/4$

(B) $1/8$

(C) $1/16$

(D) $1/32$

Q15. A metal crystallises in a body-centred cubic (bcc) cell with $Z = 2$ atoms per cell (shown), edge length $a = 3.0 \times 10^{-8}$ cm and atomic mass $M = 52$ g/mol. Using $\rho = \dfrac{ZM}{a^3 N_A}$ with $N_A = 6.0 \times 10^{23}$, the density is approximately:



(A) 3.2 g cm^{-3}

(B) 1.6 g cm^{-3}

(C) 6.4 g cm^{-3}

(D) 12.8 g cm^{-3}

Q16. In the reaction $\mathrm{Zn} + \mathrm{CuSO_4} \rightarrow \mathrm{ZnSO_4} + \mathrm{Cu}$, the species that acts as the oxidising agent is:

(A) Zn

(B) $\mathrm{ZnSO_4}$

(C) $\mathrm{CuSO_4}$ (i.e. $\mathrm{Cu^{2+}}$)

(D) $\mathrm{SO_4^{2-}}$

Q17. A 1.0 M aqueous solution of a solute has a density of 1.04 g/mL. If the molar mass of the solute is 40 g/mol, the molality of the solution is approximately:

(A) 0.80 m

(B) 1.04 m

(C) 1.20 m

(D) 1.00 m

Q18. The IUPAC name of the compound $\mathrm{CH_3–CH{=}CH–CH_3}$ (a four-carbon alkene) is:

(A) but-1-ene

(B) 2-methylprop-1-ene

(C) but-2-ene

(D) butane

Q19. The number of position isomers of the alcohol with molecular formula $\mathrm{C_4H_9OH}$ that have an *unbranched* (straight) four-carbon chain is:

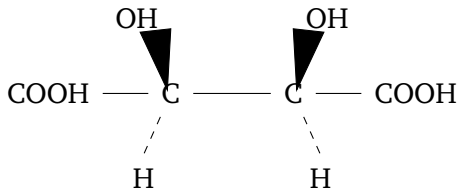
(A) 1

(B) 2

(C) 3

(D) 4

Q20. For 2,3-dihydroxybutanedioic acid (tartaric acid), $\mathrm{HOOC–CH(OH)–CH(OH)–COOH}$ with the two chiral carbons drawn in wedge–dash form, the maximum number of optical isomers predicted by the 2^n rule (with $n = 2$ chiral centres) is:



(A) 1

(B) 2

(C) 4

(D) 8

Q21. Which of the following species is the most stabilised by resonance (delocalisation of charge)?

(A) ethyl carbanion $\mathrm{CH_3CH_2^-}$

(B) carboxylate ion $\mathrm{CH_3COO^-}$

(C) methoxide ion $\mathrm{CH_3O^-}$

(D) ethoxide ion $\mathrm{CH_3CH_2O^-}$

Q22. When but-2-ene (shown) undergoes reductive ozonolysis ($\mathrm{O_3}$ then $\mathrm{Zn/H_2O}$), the organic product(s) formed is/are:

(but-2-ene)

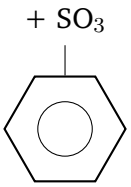
(A) one molecule of propanal

(B) two molecules of acetaldehyde (ethanal)

(C) one molecule of acetone

(D) formaldehyde and acetaldehyde

Q23. When benzene (shown) is treated with fuming sulphuric acid (oleum, SO_3/H_2SO_4), the electrophilic aromatic substitution product is:



(A) benzenesulphonic acid ($C_6H_5SO_3H$)

(B) nitrobenzene

(C) chlorobenzene

(D) phenol

Q24. For a given alkyl group, the reactivity order of the alkyl halides R–I, R–Br and R–Cl towards nucleophilic substitution (fastest first) is:

(A) $\text{R–I} > \text{R–Br} > \text{R–Cl}$

(B) $\text{R–Cl} > \text{R–Br} > \text{R–I}$

(C) $\text{R–Br} > \text{R–I} > \text{R–Cl}$

(D) all react at the same rate

Q25. In the Lucas test (conc. HCl + anhydrous $ZnCl_2$), which alcohol gives immediate turbidity (cloudiness) at room temperature?

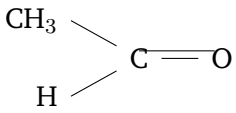
(A) a tertiary alcohol

(B) a primary alcohol

(C) a secondary alcohol

(D) methanol

Q26. Acetaldehyde (whose carbonyl group is shown) undergoes base-catalysed aldol condensation. The initial aldol product, before dehydration, is:



(A) 3-hydroxybutanal ($CH_3CH(OH)CH_2CHO$)

(B) acetic acid

(C) ethanol

(D) but-2-enal (the dehydrated product)

Q27. Which of the following carboxylic acids is the STRONGEST acid?

(A) CH_3COOH

(B) $ClCH_2COOH$

(C) $Cl_2CHCOOH$

(D) Cl_3CCOOH

Q28. In aqueous solution, the correct order of basic strength (most basic first) among ammonia (NH_3), methylamine (CH_3NH_2) and aniline ($C_6H_5NH_2$) is:

(A) $C_6H_5NH_2 > NH_3 > CH_3NH_2$

(B) $NH_3 > CH_3NH_2 > C_6H_5NH_2$

(C) $CH_3NH_2 > NH_3 > C_6H_5NH_2$

(D) $C_6H_5NH_2 > CH_3NH_2 > NH_3$

Q29. In a disaccharide such as sucrose, the two monosaccharide units are joined together by a bond known as the:

(A) peptide linkage

(B) glycosidic linkage

(C) phosphodiester linkage

(D) hydrogen bond

Q30. Which of the following is a condensation polymer (formed with elimination of small molecules such as water)?

(A) polythene

(B) nylon-6,6

(C) PVC (polyvinyl chloride)

(D) polystyrene

Q31. Which of the following species is an electrophile (electron-pair acceptor)?

(A) OH^-

(B) NO_2^+

(C) NH_3

(D) Cl^-

Q32. Two molecules of acetaldehyde, in the presence of dilute alkali, combine to form 3-hydroxybutanal. This reaction is known as the:

(A) Aldol condensation

(B) Cannizzaro reaction

(C) Wurtz reaction

(D) Friedel–Crafts reaction

Q33. In the Lucas test (conc. HCl + anhydrous $ZnCl_2$), which alcohol reacts FASTEST, giving immediate turbidity at room temperature?

(A) ethanol (1°)

(B) propan-1-ol (1°)

(C) butan-2-ol (2°)

(D) 2-methylpropan-2-ol (3°)

Q34. The reagent that converts ethene ($CH_2{=}CH_2$) into ethanol by Markovnikov addition of water is:

(A) Br_2/CCl_4

(B) cold dilute $KMnO_4$

(C) O_3 then Zn

(D) dilute H_2SO_4 (acid-catalysed hydration)

Q35. The correct order of atomic radius among the third-period elements Na, Mg, Al and Si (largest first) is:

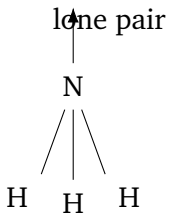
(A) $Si > Al > Mg > Na$

(B) $Mg > Na > Al > Si$

(C) $Al > Si > Na > Mg$

(D) $Na > Mg > Al > Si$

Q36. According to VSEPR theory, the molecular shape of ammonia NH_3 (with one lone pair on N, shown) is:



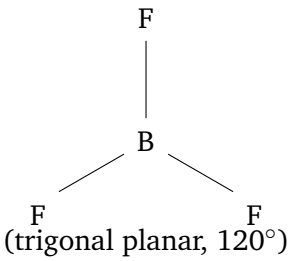
(A) trigonal pyramidal

(B) trigonal planar

(C) tetrahedral

(D) bent

Q37. The hybridization of the central boron atom in boron trifluoride (BF_3, trigonal planar, shown) is:



(A) sp

(B) sp^3

(C) sp^2

(D) sp^3d

Q38. Among the alkaline-earth carbonates $BeCO_3$, $MgCO_3$, $CaCO_3$ and $BaCO_3$, the thermal stability (resistance to decomposition on heating) is:

(A) greatest for $BeCO_3$, decreasing down the group

(B) greatest for $BaCO_3$, increasing down the group

(C) the same for all four

(D) greatest for $CaCO_3$

Q39. Aluminium oxide (Al_2O_3) dissolves both in acids and in alkalis. This behaviour shows that Al_2O_3 is:

(A) a basic oxide only

(B) an acidic oxide only

(C) an amphoteric oxide

(D) a neutral oxide

Q40. Which of the following is a crystalline allotrope of carbon in which each carbon is sp^3 hybridised and bonded tetrahedrally to four other carbons?

(A) diamond

(B) graphite

(C) fullerene (C_{60})

(D) carbon black

Q41. In which of the following compounds does nitrogen exhibit its highest (most positive) oxidation state of $+5$?

(A) NH_3

(B) NO

(C) NO_2

(D) HNO_3

Q42. Sulphur dioxide (SO_2) decolourises acidified potassium permanganate solution. In this reaction SO_2 behaves as:

(A) a reducing agent

(B) an oxidising agent

(C) a bleaching agent only

(D) a Lewis acid only

Q43. The bond dissociation enthalpy of F_2 is unexpectedly LOWER than that of Cl_2. The main reason is:

(A) the larger size of fluorine

(B) strong interelectronic repulsion between the lone pairs on the two small F atoms

(C) the higher electronegativity of fluorine

(D) weaker orbital overlap in Cl_2

Q44. Xenon difluoride XeF_2 has three lone pairs and two bond pairs on the central Xe atom. Its molecular shape is:

(A) bent

(B) trigonal planar

(C) tetrahedral

(D) linear

Q45. Most transition-metal ions are coloured. The colour of a hydrated transition-metal ion such as $[Cu(H_2O)_6]^{2+}$ arises mainly from:

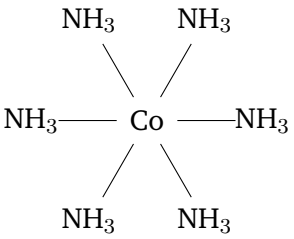
(A) the radioactive decay of the metal

(B) d–d electronic transitions (absorption of visible light)

(C) the presence of unpaired s electrons

(D) ionisation of water molecules

Q46. The IUPAC name of the coordination compound $[Co(NH_3)_6]Cl_3$ (octahedral cation shown) is:



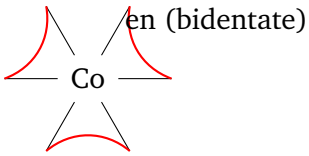
(A) hexaamminecobalt(II) chloride

(B) hexaamminecobalt(III) chloride

(C) hexaamminecobalt(III) trichloride

(D) cobalt(III) hexammine chloride

Q47. The octahedral complex $[Co(en)_3]^{3+}$ (with three bidentate ethylenediamine ligands, drawn schematically) shows which type of stereoisomerism, giving non-superimposable mirror images?



(A) geometrical (cis–trans) isomerism only

(B) linkage isomerism

(C) ionisation isomerism

(D) optical isomerism (it is chiral)

Q48. The process of heating a sulphide ore strongly in the presence of excess air to convert it into the metal oxide is called:

(A) calcination

(B) roasting

(C) smelting

(D) leaching

Q49. Temporary hardness of water can be removed simply by:

(A) adding sodium chloride

(B) filtration through paper

(C) adding hydrochloric acid

(D) boiling the water

Q50. In qualitative analysis, the "brown ring" formed at the junction of two liquids when freshly prepared $FeSO_4$ and then concentrated H_2SO_4 are added confirms the presence of the:

(A) nitrate ion (NO_3^-)

(B) sulphate ion (SO_4^{2-})

(C) chloride ion (Cl^-)

(D) carbonate ion (CO_3^{2-})

Detailed Solutions

Q1.

Solution

Concept — Molarity: Molarity $= \dfrac{\text{moles of solute}}{\text{volume of solution in L}}$.

Step 1 — Find moles of NaOH: $n = \dfrac{4.0}{40} = 0.1$ mol.

Step 2 — Convert the volume: 250 mL $= 0.250$ L.

Step 3 — Apply the formula: $M = \dfrac{0.1}{0.250}$.

Step 4 — Evaluate: $M = 0.40$ M.

Why other options are wrong:

- (A) divides moles by 1 L instead of 0.25 L.
- (B) uses 0.5 L volume.
- (D) uses mass $= 10$ g.

Final Answer: $M = 0.40$ M $\Rightarrow$ C

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Rydberg formula: $\dfrac{1}{\lambda} = R_H\left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right)$ for the hydrogen spectrum.

Step 1 — Insert the levels: $n_1 = 1$, $n_2 = 2$.

Step 2 — Evaluate the bracket: $\dfrac{1}{1^2} - \dfrac{1}{2^2} = 1 - \dfrac{1}{4} = \dfrac{3}{4} = 0.75$.

Step 3 — Find $1/\lambda$: $\dfrac{1}{\lambda} = 1.1 \times 10^7 \times 0.75 = 8.25 \times 10^6$ m^{-1}.

Step 4 — Invert for λ: $\lambda = \dfrac{1}{8.25 \times 10^6} = 1.21 \times 10^{-7}$ m $= 121$ nm.

Why other options are wrong:

- (A) 91 nm is the Lyman series limit ($n_2 = \infty$).
- (B) 656 nm is the Hα line ($3 \to 2$, Balmer).
- (C) 486 nm is the Hβ Balmer line.

Final Answer: $\lambda \approx 121$ nm $\Rightarrow$ D

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Radial nodes: Number of radial (spherical) nodes $= (n - l - 1)$.

Step 1 — Identify n and l for $3s$: $n = 3$, and for an s orbital $l = 0$.

Step 2 — Apply the formula: radial nodes $= n - l - 1 = 3 - 0 - 1$.

Step 3 — Evaluate: $3 - 0 - 1 = 2$.

Step 4 — Match the sketch: the plot shows 2 points where the probability falls to zero, confirming 2 radial nodes.

Why other options are wrong:

- (A) 0 is for $1s$.
- (B) 1 is for $2s$.
- (D) 3 counts an extra node.

Final Answer: radial nodes $= 2 \Rightarrow$ C

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Ideal gas law: $PV = nRT \Rightarrow T = \dfrac{PV}{nR}$.

Step 1 — List data: $P = 1.0$ atm, $V = 44.8$ L, $n = 2.0$ mol, $R = 0.0821$.

Step 2 — Numerator: $PV = 1.0 \times 44.8 = 44.8$.

Step 3 — Denominator: $nR = 2.0 \times 0.0821 = 0.1642$.

Step 4 — Divide: $T = \dfrac{44.8}{0.1642} \approx 273$ K.

Why other options are wrong:

- (A) forgets the factor of 2 in n (would double T).
- (C) halves the correct value.
- (D) is an unrelated round number.

Final Answer: $T \approx 273$ K $\Rightarrow$ B

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — Relation between ΔH and ΔU: $\Delta H - \Delta U = \Delta n_g RT$, where Δn_g is the change in moles of gas.

Step 1 — Count gas moles: reactants $= 1 + 3 = 4$ mol; products $= 2$ mol.

Step 2 — Find Δn_g: $\Delta n_g = 2 - 4 = -2$.

Step 3 — Substitute: $\Delta H - \Delta U = (-2)(8.314)(300)$.

Step 4 — Evaluate: $8.314 \times 300 = 2494.2$; $(-2) \times 2494.2 = -4988$ J.

Why other options are wrong:

- (A) takes the wrong sign of Δn_g.
- (B) wrongly assumes $\Delta n_g = 0$.
- (C) uses $\Delta n_g = -1$.

Final Answer: $\Delta H - \Delta U = -4988$ J $\Rightarrow$ D

Answer: (D) Go Back to Q5

Q6.

Solution

Concept — Enthalpy of neutralisation: For a strong acid neutralised by a strong base, the only reaction is $H^+ + OH^- \rightarrow H_2O$, with a fixed enthalpy of about -57.1 kJ per mole of water formed.

Step 1 — Identify the species: HCl and NaOH are both strong; in solution only H^+ and OH^- react.

Step 2 — Write the net ionic equation: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$.

Step 3 — Recall the standard value: this releases ≈ 57.1 kJ per mole of water.

Step 4 — Conclude: the enthalpy of neutralisation is -57.1 kJ/mol.

Why other options are wrong:

- (B) doubles the value with no reason.

- (C) has the wrong (positive) sign; neutralisation is exothermic.
- (D) is the order of an enthalpy of formation, not neutralisation.

Final Answer: $\Delta H_{neut} = -57.1$ kJ/mol $\Rightarrow$ A

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Relation between K_p and K_c: $K_p = K_c(RT)^{\Delta n_g}$, where Δn_g = (moles of gaseous products) − (moles of gaseous reactants).

Step 1 — Find Δn_g: products $= 2$ mol gas, reactant $= 1$ mol gas, so $\Delta n_g = 2-1 = +1$.

Step 2 — Evaluate RT: $RT = 0.0821 \times 300 = 24.63$.

Step 3 — Apply the formula: $K_p = K_c(RT)^1 = 2.0 \times 24.63$.

Step 4 — Evaluate: $K_p \approx 49.3$.

Why other options are wrong:

- (A) wrongly takes $\Delta n_g = 0$ ($K_p = K_c$).
- (B) forgets to multiply by $K_c = 2$.
- (D) divides instead of multiplying (uses $\Delta n_g = -1$).

Final Answer: $K_p \approx 49.3 \Rightarrow$ C

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — pH of a weak acid: For a weak acid, $[\mathrm{H}^+] = \sqrt{K_a C}$, then $\mathrm{pH} = -\log[\mathrm{H}^+]$.

Step 1 — List data: $K_a = 1.0 \times 10^{-5}$, $C = 0.1$ M.

Step 2 — Multiply $K_a C$: $1.0 \times 10^{-5} \times 0.1 = 1.0 \times 10^{-6}$.

Step 3 — Take the square root: $[\mathrm{H}^+] = \sqrt{1.0 \times 10^{-6}} = 1.0 \times 10^{-3}$ M.

Step 4 — Find pH: $\mathrm{pH} = -\log(1.0 \times 10^{-3}) = 3$.

Why other options are wrong:

- (A) treats the acid as strong ($[H^+] = 0.1 \Rightarrow$ wrong).
- (C) uses $[H^+] = K_a$ directly.
- (D) ignores the dilution factor.

Final Answer: $\text{pH} = 3 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q8

Q9.

Solution

Concept — Solubility from K_{sp}: For a 1:1 salt $AgBr \rightleftharpoons Ag^+ + Br^-$, $K_{sp} = s^2$, so $s = \sqrt{K_{sp}}$.

Step 1 — Write the relation: $s = \sqrt{K_{sp}}$.

Step 2 — Substitute: $s = \sqrt{4.0 \times 10^{-13}}$.

Step 3 — Split the root: $\sqrt{4.0} \times \sqrt{10^{-13}} = 2.0 \times 10^{-6.5}$.

Step 4 — Evaluate: $10^{-6.5} \approx 3.16 \times 10^{-7}$, so $s = 2.0 \times 3.16 \times 10^{-7} \approx 6.3 \times 10^{-7}$ mol/L.

Why other options are wrong:

- (B) halves K_{sp} instead of taking the root.
- (C) just quotes K_{sp}.
- (D) squares K_{sp}.

Final Answer: $s \approx 6.3 \times 10^{-7}$ mol/L $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Depression of freezing point: $\Delta T_f = K_f\, m$, then $T_f = 0^\circ\text{C} - \Delta T_f$.

Step 1 — Find molality: mass of water $= 500$ g $= 0.5$ kg, so $m = \dfrac{0.5 \text{ mol}}{0.5 \text{ kg}} = 1.0$ mol/kg.

Step 2 — Apply the formula: $\Delta T_f = 1.86 \times 1.0$.

Step 3 — Evaluate the depression: $\Delta T_f = 1.86$ K.

Step 4 — Subtract from $0°$C: $T_f = 0 - 1.86 = -1.86°$C.

Why other options are wrong:

- (A) ignores the depression.
- (B) uses $m = 0.5$ instead of 1.0.
- (D) doubles K_f.

Final Answer: $T_f = -1.86°$C $\Rightarrow$ C

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Standard cell EMF: $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$; the electrode with the higher reduction potential is the cathode.

Step 1 — Identify electrodes: $E^\circ_{Ag^+/Ag} = +0.80$ V (cathode); $E^\circ_{Mg^{2+}/Mg} = -2.37$ V (anode).

Step 2 — Write the formula: $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$.

Step 3 — Substitute: $E^\circ_{cell} = 0.80 - (-2.37)$.

Step 4 — Evaluate: $E^\circ_{cell} = 0.80 + 2.37 = 3.17$ V.

Why other options are wrong:

- (A) has the wrong sign.
- (B) and (C) subtract the magnitudes instead of adding.

Final Answer: $E^\circ_{cell} = +3.17$ V $\Rightarrow$ D

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — Kohlrausch's law: The limiting molar conductivity of an electrolyte is the sum of the limiting conductivities of its ions. Hence $\Lambda^\circ_{CH_3COOH} = \Lambda^\circ_{HCl} + \Lambda^\circ_{CH_3COONa} - \Lambda^\circ_{NaCl}$.

Step 1 — Build the combination of ions: HCl gives $H^+ + Cl^-$; CH_3COONa gives $CH_3COO^- + Na^+$; subtracting NaCl removes $Na^+ + Cl^-$, leaving $H^+ + CH_3COO^-$.

Step 2 — Substitute the values: $\Lambda^\circ_{CH_3COOH} = 426 + 91 - 126$.

Step 3 — Add the first two: $426 + 91 = 517$.

Step 4 — Subtract NaCl: $517 - 126 = 391$ S cm^{2}mol^{-1}.

Why other options are wrong:

- (B) subtracts both 91 and 126.
- (C) adds 126 instead of subtracting.
- (D) leaves out the HCl term.

Final Answer: $\Lambda^\circ_{CH_3COOH} = 391$ S cm^{2}mol^{-1} $\Rightarrow$ A

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Units of k: For a reaction of overall order n, the unit of k is $\text{mol}^{1-n}\,\text{L}^{n-1}\,\text{s}^{-1}$. A reaction whose rate is independent of concentration is zero order ($n = 0$).

Step 1 — Identify the order: a constant rate means rate $= k[A]^0 = k$, so $n = 0$.

Step 2 — Equate units: rate has units $\text{mol}\,\text{L}^{-1}\,\text{s}^{-1}$; with $n = 0$, $k =$ rate.

Step 3 — Write the unit of k: k has units $\text{mol}\,\text{L}^{-1}\,\text{s}^{-1}$.

Why other options are wrong:

- (B) s^{-1} is the unit for first order.
- (C) $\text{L}\,\text{mol}^{-1}\,\text{s}^{-1}$ is the unit for second order.
- (D) $\text{mol}\,\text{L}^{-1}$ is a concentration, not a rate constant.

Final Answer: k has units $\text{mol}\,\text{L}^{-1}\,\text{s}^{-1}$ $\Rightarrow$ A

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Half-life decay: After n half-lives the fraction remaining is $\left(\frac{1}{2}\right)^n$.

Step 1 — Find number of half-lives: $n = \dfrac{40}{10} = 4$.

Step 2 — Apply the fraction formula: fraction $= \left(\frac{1}{2}\right)^4$.

Step 3 — Evaluate: $\left(\frac{1}{2}\right)^4 = \dfrac{1}{16}$.

Why other options are wrong:

- (A) corresponds to 2 half-lives.
- (B) corresponds to 3 half-lives.
- (D) corresponds to 5 half-lives.

Final Answer: fraction remaining $= 1/16 \Rightarrow$ C

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Density of a unit cell: $\rho = \dfrac{Z\,M}{a^3\,N_A}$, where Z is atoms per cell, M molar mass, a edge length, N_A Avogadro's number.

Step 1 — Compute a^3: $a^3 = (3.0 \times 10^{-8})^3 = 27 \times 10^{-24} = 2.7 \times 10^{-23}$ cm^3.

Step 2 — Numerator: $Z\,M = 2 \times 52 = 104$.

Step 3 — Denominator: $a^3 N_A = 2.7 \times 10^{-23} \times 6.0 \times 10^{23} = 16.2$.

Step 4 — Divide: $\rho = \dfrac{104}{16.2} \approx 6.4$ g cm^{-3}.

Why other options are wrong:

- (A) uses $Z = 1$.
- (B) halves the correct value.
- (D) uses $Z = 4$ (fcc).

Final Answer: $\rho \approx 6.4$ g cm$^{-3} \Rightarrow$ C

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Oxidising agent: The oxidising agent is the species that is itself reduced (gains electrons; its oxidation number decreases).

Step 1 — Track oxidation states: Zn goes from 0 to $+2$ (oxidised); Cu goes from $+2$ (in $CuSO_4$) to 0 (reduced).

Step 2 — Identify what is reduced: Cu^{2+} (from $CuSO_4$) gains electrons.

Step 3 — Name the oxidising agent: the species reduced is the oxidising agent, i.e. $CuSO_4$ (Cu^{2+}).

Why other options are wrong:

- (A) Zn is oxidised, so it is the reducing agent.
- (B) $ZnSO_4$ is a product.
- (D) the SO_4^{2-} ion is a spectator; its oxidation states do not change.

Final Answer: $CuSO_4$ (Cu^{2+}) $\Rightarrow$ C

Answer: (C) Go Back to Q16

Q17.

Solution

Concept — Molarity to molality: For 1 L of solution, find the mass of solute and the mass of solvent, then $m = \dfrac{\text{moles solute}}{\text{mass solvent in kg}}$.

Step 1 — Mass of 1 L solution: 1000 mL $\times$ 1.04 g/mL $= 1040$ g.

Step 2 — Mass of solute: 1.0 mol $\times 40$ g/mol $= 40$ g.

Step 3 — Mass of solvent (water): $1040 - 40 = 1000$ g $= 1.0$ kg.

Step 4 — Compute molality: $m = \dfrac{1.0 \text{ mol}}{1.0 \text{ kg}} = 1.0$ m.

Why other options are wrong:

- (A) wrongly subtracts solute mass twice.
- (B) confuses density with molality.
- (C) over-corrects the solvent mass.

Final Answer: $m \approx 1.0$ m $\Rightarrow$ D

Answer: (D) Go Back to Q17

Q18.

Solution

Concept — IUPAC naming of alkenes: Choose the longest chain containing the double bond, number to give the double bond the lowest locant, and state its position.

Step 1 — Count the chain: CH_3–CH=CH–CH_3 has 4 carbons, so the parent is butene.

Step 2 — Locate the double bond: it lies between C2 and C3.

Step 3 — Number for the lowest locant: from either end the double bond starts at carbon 2.

Step 4 — Assemble the name: but-2-ene.

Why other options are wrong:

- (A) but-1-ene has the double bond at C1 (a different isomer).
- (B) 2-methylprop-1-ene is a branched C_4H_8 isomer.
- (D) butane is the saturated alkane.

Final Answer: but-2-ene $\Rightarrow$ C

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Position isomerism: Position isomers differ only in the position of the functional group on the same carbon skeleton.

Step 1 — Fix the skeleton: a straight four-carbon chain, C–C–C–C.

Step 2 — Place the $-$OH on C1: gives butan-1-ol.

Step 3 — Place the $-$OH on C2: gives butan-2-ol (positions C3 and C4 simply repeat C2 and C1 by symmetry).

Step 4 — Count distinct positions: 2 position isomers (butan-1-ol and butan-2-ol).

Why other options are wrong:

- (A) misses butan-2-ol.
- (C) and (D) count C3/C4 separately, but symmetry makes them identical to C2/C1.

Final Answer: 2 position isomers $\Rightarrow$ B

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Maximum optical isomers: For a molecule with n chiral carbons, the 2^n rule gives the maximum number of optical (stereo) isomers.

Step 1 — Count chiral centres: tartaric acid has 2 chiral carbons, so $n = 2$.

Step 2 — Apply the rule: maximum $= 2^n = 2^2$.

Step 3 — Evaluate: $2^2 = 4$.

Step 4 — Note: the question asks for the 2^n maximum, which is 4 (in practice one is a meso form, but the predicted maximum is 4).

Why other options are wrong:

- (A) and (B) use too small a power.
- (D) uses $n = 3$.

Final Answer: $2^2 = 4 \Rightarrow$ C

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Resonance stabilisation: An anion is most stabilised when its negative charge is delocalised over two or more equivalent atoms by resonance.

Step 1 — Examine the carboxylate ion: in CH_3COO^- the negative charge is shared equally over two oxygen atoms (two equivalent resonance structures).

Step 2 — Examine the others: ethyl carbanion, methoxide and ethoxide have the charge localised on a single atom with no equivalent delocalisation.

Step 3 — Conclude: the carboxylate ion is the most resonance-stabilised.

Why other options are wrong:

- (A) a carbanion has its charge localised on carbon.
- (C) and (D) alkoxide ions have charge localised on one oxygen, stabilised only by weak induction.

Final Answer: carboxylate ion CH_3COO^- $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q21

Q22.

Solution

Concept — Reductive ozonolysis: Ozone cleaves the C=C double bond; with Zn/H_2O each doubly-bonded carbon becomes a carbonyl (C=O), giving aldehydes/ketones.

Step 1 — Locate the double bond: but-2-ene is CH_3–CH=CH–CH_3.

Step 2 — Cleave it: the bond breaks between the two CH carbons.

Step 3 — Form carbonyls: each CH_3–CH= fragment becomes CH_3–CHO (acetaldehyde).

Step 4 — Count products: two molecules of acetaldehyde (ethanal).

Why other options are wrong:

- (A) propanal would need a longer fragment.
- (C) acetone needs a more substituted alkene.
- (D) would arise from a terminal/unsymmetrical alkene, not but-2-ene.

Final Answer: two molecules of acetaldehyde $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Aromatic sulphonation: Oleum (or fuming H_2SO_4) supplies SO_3, an electrophile that substitutes a ring hydrogen with a sulphonic acid group ($-SO_3H$).

Step 1 — Identify the electrophile: SO_3 (from oleum) attacks the ring.

Step 2 — Substitution: SO_3 replaces an H, and the product picks up a proton to give $-SO_3H$.

Step 3 — Product: $C_6H_5SO_3H$, benzenesulphonic acid.

Why other options are wrong:

- (B) nitrobenzene needs HNO_3/H_2SO_4.
- (C) chlorobenzene needs $Cl_2/FeCl_3$.
- (D) phenol is not formed by direct EAS on benzene.

Final Answer: benzenesulphonic acid $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q23

Q24.

Solution

Concept — Reactivity of alkyl halides: The weaker the C–X bond, the easier the C–X bond breaks; bond strength falls C–I $<$ C–Br $<$ C–Cl, so reactivity is highest for the iodide.

Step 1 — Compare C–X bond strengths: C–I is the weakest, C–Cl the strongest.

Step 2 — Relate to reactivity: weaker bond $\Rightarrow$ leaves more easily $\Rightarrow$ faster substitution.

Step 3 — Write the order: R–I $>$ R–Br $>$ R–Cl.

Why other options are wrong:

- (B) reverses the order.
- (C) misplaces R–Br ahead of R–I.
- (D) ignores the bond-strength difference.

Final Answer: R–I $>$ R–Br $>$ R–Cl $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept — Lucas test: The Lucas reagent reacts via a carbocation; tertiary alcohols form the most stable carbocation and react immediately, giving instant turbidity.

Step 1 — Recall the rates: tertiary alcohol reacts at once; secondary in 5–10 minutes; primary only on heating.

Step 2 — Match "immediate turbidity": only the tertiary alcohol clouds the solution straight away.

Step 3 — Conclude: the tertiary alcohol gives immediate turbidity.

Why other options are wrong:

- (B) primary alcohols give no turbidity at room temperature.
- (C) secondary alcohols react only after a few minutes.
- (D) methanol does not react under Lucas conditions.

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

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Aldol reaction: An aldehyde with α-hydrogens, under dilute base, gives a β-hydroxy aldehyde (the "aldol") before any dehydration.

Step 1 — Generate the enolate: base removes an α-H from one acetaldehyde to give a carbanion.

Step 2 — Nucleophilic addition: this carbanion adds to the carbonyl carbon of a second acetaldehyde.

Step 3 — Protonation: the alkoxide is protonated to give $CH_3CH(OH)CH_2CHO$, 3-hydroxybutanal.

Step 4 — Identify the aldol: the initial product (before heating/dehydration) is 3-hydroxybutanal.

Why other options are wrong:

- (B) and (C) are not aldol products.

- (D) but-2-enal is the product after dehydration, not the initial aldol.

Final Answer: 3-hydroxybutanal $\Rightarrow$ A

Answer: (A) Go Back to Q26

Q27.

Solution

Concept — Inductive effect on acid strength: Electron-withdrawing chlorine atoms pull electron density away through the σ bonds ($-I$ effect), stabilising the carboxylate anion and increasing acid strength. More chlorine atoms give a stronger $-I$ effect and a stronger acid.

Step 1 — Count the chlorine atoms: acetic acid has 0, chloroacetic has 1, dichloroacetic has 2 and trichloroacetic has 3.

Step 2 — Relate to the $-I$ effect: each added Cl increases the electron withdrawal from the $-\mathrm{COOH}$ group.

Step 3 — Compare anion stability: the trichloroacetate anion is the most stabilised, so its acid loses H^+ most readily.

Step 4 — Conclude: $\mathrm{Cl_3CCOOH}$ (trichloroacetic acid) is the strongest acid.

Why other options are wrong:

- (A) $\mathrm{CH_3COOH}$ has no $-I$ group, so it is the weakest.
- (B) one Cl gives only a small $-I$ effect.
- (C) two Cl atoms make it strong, but still weaker than three.

Final Answer: $\mathrm{Cl_3CCOOH}$ $\Rightarrow$ D

Answer: (D) Go Back to Q27

Q28.

Solution

Concept — Basicity in water: An electron-donating alkyl group raises basicity; in aniline the lone pair is delocalised into the ring, sharply lowering basicity.

Step 1 — Methylamine vs ammonia: the $+I$ effect of $\mathrm{CH_3}$ makes $\mathrm{CH_3NH_2}$ more basic than $\mathrm{NH_3}$.

Step 2 — Aniline: the N lone pair conjugates with the benzene ring, so aniline is

the least basic.

Step 3 — Write the order: $CH_3NH_2 > NH_3 > C_6H_5NH_2$.

Why other options are wrong:

- (A) and (D) wrongly place aniline as most basic.
- (B) places NH_3 above CH_3NH_2.

Final Answer: $CH_3NH_2 > NH_3 > C_6H_5NH_2 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q28

Q29.

Solution

Concept — Glycosidic linkage: The oxygen bridge joining two monosaccharide units in a di- or polysaccharide is called a glycosidic linkage.

Step 1 — Recall the sucrose structure: glucose and fructose are joined through an oxygen bridge between their anomeric carbons.

Step 2 — Name the bond: this C–O–C bridge is a glycosidic linkage.

Step 3 — Conclude: the linkage is glycosidic.

Why other options are wrong:

- (A) peptide linkages join amino acids in proteins.
- (C) phosphodiester linkages join nucleotides in DNA/RNA.
- (D) a hydrogen bond is a weak intermolecular force, not the covalent bridge.

Final Answer: glycosidic linkage $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Condensation polymers: These are formed by repeated condensation between two functional groups, eliminating a small molecule such as water.

Step 1 — Examine nylon-6,6: it forms from a diamine and a dicarboxylic acid, releasing water at each amide bond.

Step 2 — Conclude: nylon-6,6 is a condensation polymer.

Why other options are wrong:

- (A) polythene is an addition polymer of ethene.
- (C) PVC is an addition polymer of vinyl chloride.
- (D) polystyrene is an addition polymer of styrene.

Final Answer: nylon-6,6 $\Rightarrow$ B

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — Electrophiles: An electrophile is an electron-deficient species that accepts an electron pair; it is usually positively charged or has an incomplete octet.

Step 1 — Examine NO_2^+: it carries a positive charge and is electron deficient, so it accepts electron pairs.

Step 2 — Examine the others: OH^-, NH_3 and Cl^- all have lone pairs to donate, making them nucleophiles.

Step 3 — Conclude: the electrophile is NO_2^+.

Why other options are wrong:

- (A) OH^- is a nucleophile/base.
- (C) NH_3 donates its lone pair (nucleophile).
- (D) Cl^- is an anionic nucleophile.

Final Answer: $NO_2^+ \Rightarrow$ B

Answer: (B) Go Back to Q31

Q32.

Solution

Concept — Aldol condensation: Two molecules of an aldehyde (or ketone) bearing α-hydrogens combine in dilute alkali to give a β-hydroxy aldehyde (aldol).

Step 1 — Identify the reactants: two molecules of acetaldehyde with dilute base.

Step 2 — Recognise the product: 3-hydroxybutanal, a β-hydroxy aldehyde.

Step 3 — Name the reaction: this is the aldol condensation.

Why other options are wrong:

- (B) Cannizzaro needs aldehydes *without* α-H.
- (C) Wurtz couples alkyl halides.
- (D) Friedel–Crafts is an aromatic substitution.

Final Answer: Aldol condensation $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q32

Q33.

Solution

Concept — Lucas test: The Lucas reagent (conc. HCl + anhydrous $ZnCl_2$) converts an alcohol to its alkyl chloride, which is insoluble and appears as turbidity. The rate follows carbocation stability: tertiary $>$ secondary $>$ primary, so 3° alcohols react immediately at room temperature.

Step 1 — Classify the alcohols: ethanol and propan-1-ol are 1°; butan-2-ol is 2°; 2-methylpropan-2-ol is 3°.

Step 2 — Recall the mechanism: the reaction proceeds through a carbocation (S_N1).

Step 3 — Rank carbocation stability: a 3° carbocation is the most stable, so it forms fastest.

Step 4 — Conclude: 2-methylpropan-2-ol (3°) gives immediate turbidity and reacts fastest.

Why other options are wrong:

- (A) and (B) primary alcohols give no turbidity at room temperature.
- (C) a 2° alcohol turns cloudy only after a few minutes, slower than 3°.

Final Answer: 2-methylpropan-2-ol (3°) $\Rightarrow$ D

Answer: (D) Go Back to Q33

Q34.

Solution

Concept — Acid-catalysed hydration: Warm dilute H_2SO_4 adds water across the C=C double bond following Markovnikov's rule, converting an alkene into an alcohol. For symmetrical ethene this gives ethanol.

Step 1 — Goal: convert $CH_2{=}CH_2$ to CH_3CH_2OH by adding water.

Step 2 — Choose the reagent: dilute H_2SO_4 protonates the alkene, water attacks, then loss of H^+ gives the alcohol.

Step 3 — Product: ethanol, CH_3CH_2OH.

Why other options are wrong:

- (A) Br_2/CCl_4 adds bromine, giving a dibromide, not an alcohol.
- (B) cold dilute $KMnO_4$ gives a 1,2-diol (glycol), not a mono-alcohol.
- (C) O_3 then Zn cleaves the double bond to give carbonyl compounds.

Final Answer: dilute H_2SO_4 (acid-catalysed hydration) $\Rightarrow$ D

Answer: (D) Go Back to Q34

Q35.

Solution

Concept — Atomic radius trend: Across a period, atomic radius decreases from left to right because nuclear charge increases while electrons enter the same shell.

Step 1 — Order by position: Na is leftmost (largest), Si is rightmost of the four (smallest).

Step 2 — Arrange: $Na > Mg > Al > Si$.

Step 3 — Conclude: the largest is Na and the smallest is Si.

Why other options are wrong:

- (A) reverses the trend.
- (B) and (C) jumble the order.

Final Answer: $\text{Na} > \text{Mg} > \text{Al} > \text{Si} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q35

Q36.

Solution

Concept — VSEPR for AB_3E: Three bond pairs and one lone pair on the central atom give a trigonal pyramidal shape (derived from a tetrahedral arrangement of electron pairs).

Step 1 — Count electron domains: N in NH_3 has 3 bond pairs and 1 lone pair, i.e. 4 domains.

Step 2 — Assign electron geometry: 4 domains $\Rightarrow$ tetrahedral electron arrangement.

Step 3 — Account for the lone pair: one position is a lone pair, so the molecular shape is trigonal pyramidal.

Why other options are wrong:

- (B) trigonal planar would require no lone pair (AB_3).
- (C) tetrahedral describes the electron geometry, not the molecular shape.
- (D) bent is for AB_2E_2 (e.g. water).

Final Answer: trigonal pyramidal $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q36

Q37.

Solution

Concept — Hybridization from geometry: A central atom with three sigma bonds and no lone pair has three electron domains, is sp^2 hybridised and trigonal planar with 120° bond angles.

Step 1 — Count sigma bonds on B: in BF_3 there are 3 B–F bonds.

Step 2 — Count lone pairs: 0 lone pairs on B (boron has only 3 valence electrons).

Step 3 — Assign hybridization: 3 electron domains $\Rightarrow$ sp^2, giving a trigonal planar (120°) shape.

Why other options are wrong:

- (A) sp is for 2 domains (linear).
- (B) sp^3 is for 4 domains (tetrahedral).
- (D) sp^3d is for 5 domains.

Final Answer: $sp^2 \Rightarrow$ C

Answer: (C) Go Back to Q37

Q38.

Solution

Concept — Thermal stability of carbonates: Down group 2, the cation gets larger, the carbonate lattice becomes more stable, and the decomposition temperature rises; so stability increases down the group.

Step 1 — Compare cation sizes: $Be^{2+} < Mg^{2+} < Ca^{2+} < Ba^{2+}$.

Step 2 — Relate to stability: larger, less polarising cations give more thermally stable carbonates.

Step 3 — Conclude: $BaCO_3$ is the most stable; stability increases down the group.

Why other options are wrong:

- (A) reverses the trend; $BeCO_3$ is the least stable.
- (C) they are not equally stable.
- (D) $CaCO_3$ is not the most stable.

Final Answer: greatest for $BaCO_3$, increasing down the group $\Rightarrow$ B

Answer: (B) Go Back to Q38

Q39.

Solution

Concept — Amphoteric oxide: An amphoteric oxide reacts with both acids (as a base) and alkalis (as an acid).

Step 1 — React with acid: $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ (acts as a base).

Step 2 — React with alkali: $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ (acts as an acid).

Step 3 — Conclude: since it reacts both ways, Al_2O_3 is amphoteric.

Why other options are wrong:

- (A) a purely basic oxide would not dissolve in alkali.
- (B) a purely acidic oxide would not dissolve in acid.
- (D) a neutral oxide reacts with neither.

Final Answer: amphoteric oxide $\Rightarrow$ C

Answer: (C) Go Back to Q39

Q40.

Solution

Concept — Allotropes of carbon: In diamond each carbon is sp^3 hybridised and bonded tetrahedrally to four other carbons, giving a rigid 3-D network.

Step 1 — Recall diamond's bonding: every carbon forms four single C–C bonds at $109.5°$.

Step 2 — Match the description: "sp^3, tetrahedral, four C neighbours" fits diamond.

Step 3 — Conclude: the allotrope is diamond.

Why other options are wrong:

- (B) graphite carbons are sp^2 (layers of hexagons).
- (C) fullerene carbons are also sp^2.
- (D) carbon black is amorphous, not a tetrahedral crystal.

Final Answer: diamond $\Rightarrow$ A

Answer: (A) Go Back to Q40

Q41.

Solution

Concept — Oxidation state of nitrogen: Set the sum of oxidation numbers equal to the overall charge, using H $= +1$ and O $= -2$.

Step 1 — Test HNO_3: let N $= x$; $(+1) + x + 3(-2) = 0 \Rightarrow x - 5 = 0 \Rightarrow x = +5$.

Step 2 — Compare the others: N is -3 in NH_3, $+2$ in NO, $+4$ in NO_2.

Step 3 — Conclude: the $+5$ state (highest) occurs in HNO_3.

Why other options are wrong:

- (A) NH_3 has N at -3.
- (B) NO has N at $+2$.
- (C) NO_2 has N at $+4$.

Final Answer: HNO_3 (N $= +5$) $\Rightarrow$ D

Answer: (D) Go Back to Q41

Q42.

Solution

Concept — Reducing action of SO_2: When SO_2 reduces another species, sulphur is itself oxidised from $+4$ to $+6$; thus SO_2 is the reducing agent.

Step 1 — Track sulphur: in SO_2 sulphur is $+4$; it is oxidised to $+6$ (sulphate).

Step 2 — Effect on $KMnO_4$: Mn is reduced from $+7$ to $+2$, so the purple colour fades.

Step 3 — Conclude: since SO_2 is oxidised, it acts as a reducing agent.

Why other options are wrong:

- (B) it is not reduced here, so it is not the oxidising agent.
- (C) bleaching by SO_2 is a separate reductive action, not what decolourises $KMnO_4$.
- (D) Lewis acidity is unrelated to this redox decolourisation.

Final Answer: a reducing agent $\Rightarrow$ A

Answer: (A) Go Back to Q42

Q43.

Solution

Concept — Bond enthalpy anomaly of F_2: Fluorine atoms are very small, so in F_2 the three lone pairs on each F are forced close together. The strong repulsion between these non-bonding electrons weakens the F–F bond, making its bond dissociation enthalpy lower than that of Cl_2.

Step 1 — Compare atom sizes: F is smaller than Cl, so the F–F bond is very short.

Step 2 — Identify the repulsion: the lone pairs on the two F atoms are squeezed close and repel strongly.

Step 3 — Effect on the bond: this interelectronic repulsion partly cancels the bonding, lowering the bond enthalpy.

Step 4 — Conclude: the anomaly is due to lone-pair repulsion between the two small F atoms.

Why other options are wrong:

- (A) the small (not large) size of F is the underlying cause; "larger size" is false.
- (C) electronegativity does not directly lower the bond enthalpy.
- (D) Cl_2 actually has the stronger bond, so this is incorrect.

Final Answer: lone-pair repulsion between the small F atoms $\Rightarrow$ B

Answer: (B) Go Back to Q43

Q44.

Solution

Concept — VSEPR for AB_2E_3: Two bond pairs and three lone pairs give a trigonal-bipyramidal electron geometry with the lone pairs in the equatorial plane, leaving a linear molecular shape.

Step 1 — Count electron pairs on Xe: 2 bond pairs $+$ 3 lone pairs $=$ 5 pairs.

Step 2 — Place lone pairs: the three lone pairs occupy the equatorial positions of the trigonal bipyramid.

Step 3 — Determine the shape: the two F atoms sit at the axial positions, giving a linear molecule ($180°$).

Why other options are wrong:

- (A) bent would need a different lone-pair count.
- (B) and (C) do not match AB_2E_3.

Final Answer: linear $\Rightarrow$ D

Answer: (D) Go Back to Q44

Q45.

Solution

Concept — Colour of transition-metal ions: In a ligand field the d orbitals split; an electron absorbs visible light to jump between them (d–d transition), so the complementary colour is seen.

Step 1 — Identify the cause: partially filled d orbitals split in energy in the presence of ligands.

Step 2 — Absorption: a d electron absorbs a photon of visible light and is promoted.

Step 3 — Conclude: the colour arises from d–d electronic transitions.

Why other options are wrong:

- (A) radioactivity is unrelated to colour.
- (C) it is d (not s) electrons that are involved.
- (D) ionisation of water does not produce the colour.

Final Answer: d–d electronic transitions $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q45

Q46.

Solution

Concept — IUPAC naming of complexes: Name the ligands first (in alphabetical order, with the prefix for their number), then the metal with its oxidation state in Roman numerals in parentheses, then the counter-ion. "Ammine" (NH_3) takes the multiplying prefix "hexa".

Step 1 — Find the oxidation state of Co: the three Cl^- give -3 and NH_3 is neutral, so Co is $+3$.

Step 2 — Name the ligands: six neutral NH_3 ligands $\Rightarrow$ "hexaammine".

Step 3 — Name the metal and ion: cobalt(III) for the cation, with chloride as the counter-ion.

Step 4 — Assemble the name: hexaamminecobalt(III) chloride.

Why other options are wrong:

- (A) gives the wrong oxidation state (II instead of III).

- (C) "trichloride" is wrong; counter-ions are not given multiplying prefixes here.
- (D) puts the metal before the ligands, which is incorrect order.

Final Answer: hexaamminecobalt(III) chloride $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q46

Q47.

Solution

Concept — Optical isomerism in complexes: An octahedral tris-bidentate complex $[\text{M(AA)}_3]$ has no plane of symmetry, so it exists as two non-superimposable mirror images (it is chiral).

Step 1 — Identify the type: $[\text{Co(en)}_3]^{3+}$ is a tris-chelate octahedral complex.

Step 2 — Test for symmetry: the propeller-like arrangement of three en ligands has no mirror plane.

Step 3 — Conclude: it forms two enantiomers, i.e. it shows optical isomerism.

Why other options are wrong:

- (A) a $[\text{M(AA)}_3]$ complex has no cis–trans forms.
- (B) linkage isomerism needs an ambidentate ligand.
- (C) ionisation isomerism needs an exchangeable counter-ion.

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

Answer: (D) Go Back to Q47

Q48.

Solution

Concept — Roasting: Roasting heats a (usually sulphide) ore strongly in a free supply of air, converting the sulphide to the oxide and driving off SO_2.

Step 1 — Recall the definition: heating an ore in excess air below its melting point.

Step 2 — Apply to a sulphide: e.g. $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$.

Step 3 — Conclude: this conversion of a sulphide to an oxide in air is roasting.

Why other options are wrong:

- (A) calcination is heating in limited/no air (for carbonates and hydroxides).
- (C) smelting reduces the oxide to the metal with a flux.
- (D) leaching is a chemical (solution) extraction.

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

Answer: (B) Go Back to Q48

Q49.

Solution

Concept — Temporary hardness: Temporary hardness is caused by dissolved bicarbonates of calcium and magnesium, $\text{Ca}(\text{HCO}_3)_2$ and $\text{Mg}(\text{HCO}_3)_2$. On boiling, these decompose to insoluble carbonates which precipitate out, leaving soft water.

Step 1 — Identify the cause: bicarbonate ions of Ca^{2+} and Mg^{2+}.

Step 2 — Heat the water: $\text{Ca}(\text{HCO}_3)_2 \xrightarrow{\Delta} \text{CaCO}_3 \downarrow + \text{H}_2\text{O} + \text{CO}_2$.

Step 3 — Conclude: the insoluble carbonate is removed, so simply boiling softens the water.

Why other options are wrong:

- (A) adding NaCl does not remove the hardness-causing ions.
- (B) the ions are dissolved, so filtration through paper cannot remove them.
- (C) adding HCl would not precipitate the calcium/magnesium ions.

Final Answer: boiling the water $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q49

Q50.

Solution

Concept — Brown ring test: The brown ring is the complex $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{2+}$, formed when nitrate is reduced by Fe^{2+} in the presence of concentrated H_2SO_4. It confirms the nitrate ion.

Step 1 — Recall the test: fresh FeSO_4 is added, then concentrated H_2SO_4 is poured down the side.

Step 2 — Observe the ring: a brown ring of $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{2+}$ forms at the junction of the two layers.

Step 3 — Conclude: the brown ring confirms the presence of the nitrate ion.

Why other options are wrong:

- (B) sulphate is tested with $BaCl_2$ (white precipitate).
- (C) chloride is tested with $AgNO_3$ (white precipitate).
- (D) carbonate is tested by effervescence of CO_2 with acid.

Final Answer: nitrate ion (NO_3^-) $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q50

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	D	3	C	4	B	5	D
6	A	7	C	8	B	9	A	10	C
11	D	12	A	13	A	14	C	15	C
16	C	17	D	18	C	19	B	20	C
21	B	22	B	23	A	24	A	25	A
26	A	27	D	28	C	29	B	30	B
31	B	32	A	33	D	34	D	35	D
36	A	37	C	38	B	39	C	40	A
41	D	42	A	43	B	44	D	45	B
46	B	47	D	48	B	49	D	50	A