JCECE Chemistry Sample Paper – 5

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. 18 g of glucose ($C_6H_{12}O_6$, molar mass $= 180$ g/mol) is dissolved in 500 g of water. The molality of the solution is:

(A) 0.10 m

(B) 0.05 m

(C) 0.20 m

(D) 0.40 m

Q2. The ionization energy of the hydrogen atom is 13.6 eV. The ionization energy (energy to remove the electron from $n = 1$) of the hydrogen-like ion Li^{2+} ($Z = 3$) is:

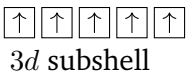
(A) 40.8 eV

(B) 122.4 eV

(C) 13.6 eV

(D) 27.2 eV

Q3. The ground-state electronic configuration of the iron(III) ion Fe^{3+} ($Z = 26$), whose $3d$ subshell is shown, is:


$3d$ subshell

(A) $[\mathrm{Ar}]\, 3d^5$

(B) $[\mathrm{Ar}]\, 3d^6$

(C) $[\mathrm{Ar}]\, 3d^6 4s^2$

(D) $[\mathrm{Ar}]\, 3d^3$

Q4. The root-mean-square (rms) speed of a gas is given by $u_{rms} = \sqrt{\dfrac{3RT}{M}}$. For oxygen gas ($M = 32 \times 10^{-3}$ kg/mol) at 300 K, taking $R = 8.314$ J mol^{-1}K^{-1}, the rms speed is approximately:

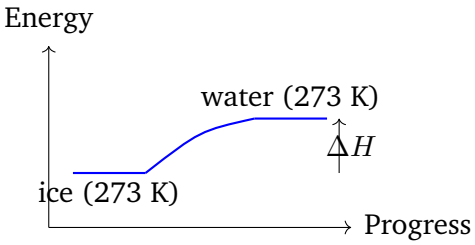
(A) 193 m/s

(B) 341 m/s

(C) 1369 m/s

(D) 484 m/s

Q5. For the melting of 1 mol of ice at its normal melting point 273 K, the enthalpy of fusion is $\Delta H_{fus} = 6.0$ kJ/mol. From the energy diagram, the entropy change ΔS of the system for this reversible phase change is:



(A) 11.0 J K^{-1}mol^{-1}

(B) 22.0 J K^{-1}mol^{-1}

(C) 44.0 J K^{-1}mol^{-1}

(D) 6.0 J K^{-1}mol^{-1}

Q6. The experimental enthalpy of hydrogenation of benzene is -208 kJ/mol, whereas the value calculated for a hypothetical cyclohexatriene (three isolated double bonds, each -120 kJ/mol) is -360 kJ/mol. The resonance (delocalization) energy of benzene is:

(A) -152 kJ/mol

(B) $+568$ kJ/mol

(C) 152 kJ/mol

(D) 208 kJ/mol

Q7. For the reaction $2\mathrm{SO_2(g)} + \mathrm{O_2(g)} \rightleftharpoons 2\mathrm{SO_3(g)}$, the concentrations at a given instant are $[\mathrm{SO_2}] = 2$ M, $[\mathrm{O_2}] = 1$ M and $[\mathrm{SO_3}] = 4$ M. The reaction quotient Q_c at this instant is:

(A) 1

(B) 2

(C) 8

(D) 4

Q8. An aqueous solution of NaOH (a strong monoacidic base) has $[\mathrm{OH^-}] = 1 \times 10^{-3}$ M at 25°C. The pOH of this solution is:

(A) 11

(B) 1

(C) 3

(D) 0.001

Q9. The solubility product of silver bromide AgBr (a $1{:}1$ salt) at 25°C is $K_{sp} = 4.0 \times 10^{-13}$. Its molar solubility in pure water is:

(A) 6.3×10^{-7} mol/L

(B) 4.0×10^{-13} mol/L

(C) 2.0×10^{-7} mol/L

(D) 1.6×10^{-25} mol/L

Q10. When 3.0 g of a non-volatile non-electrolyte is dissolved in 100 g of water, the boiling point is raised by 0.156 K. Taking $K_b = 0.52$ K kg mol^{-1}, the molar mass of the solute is:

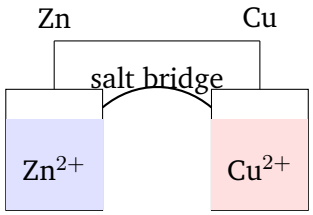
(A) 50 g/mol

(B) 100 g/mol

(C) 200 g/mol

(D) 150 g/mol

Q11. For the Daniell cell shown, $E^\circ_{cell} = 1.10$ V at 298 K. Using the Nernst equation $E_{cell} = E^\circ_{cell} - \dfrac{0.059}{2}\log\dfrac{[\mathrm{Zn}^{2+}]}{[\mathrm{Cu}^{2+}]}$ with $[\mathrm{Zn}^{2+}] = 1$ M and $[\mathrm{Cu}^{2+}] = 0.01$ M, the cell EMF is:



(A) 1.041 V

(B) 1.159 V

(C) 1.100 V

(D) 0.518 V

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

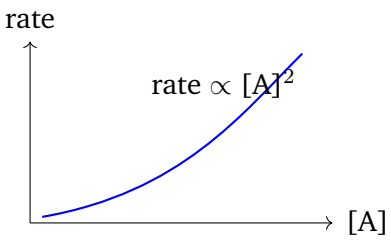
(A) 643 S cm^{2}mol^{-1}

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

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

(D) 209 S cm^{2}mol^{-1}

Q13. For a reaction the rate law is rate $= k[\mathrm{A}]^2$. From the rate-versus-concentration profile shown, if the concentration of A is doubled, the rate of the reaction becomes:



(A) unchanged

(B) doubled

(C) tripled

(D) four times the original

Q14. For many reactions the rate becomes approximately double for every 10°C rise in temperature. If a reaction follows this rule, its rate when the temperature is raised from 20°C to 50°C increases by a factor of about:

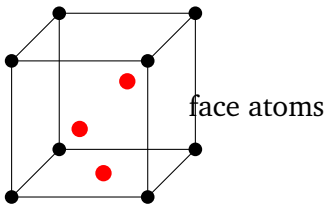
(A) 8

(B) 4

(C) 16

(D) 6

Q15. The fraction of the total volume occupied by spheres (packing efficiency) in a face-centred cubic (fcc) lattice, as illustrated by the cube shown, is:



(A) 52%

(B) 68%

(C) 74%

(D) 32%

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

(A) 5

(B) 3

(C) 2

(D) 1

Q17. An aqueous solution is 1.0 M in a solute and has a density of 1.20 g/mL. If the molar mass of the solute is 40 g/mol, the molality of the solution is approximately:

(A) 1.00 m

(B) 0.85 m

(C) 1.20 m

(D) 0.40 m

Q18. The IUPAC name of the compound $CH_3–CH(CH_3)–CH_2–COOH$ is:

(A) butanoic acid

(B) 2-methylbutanoic acid

(C) 2-methylpropanoic acid

(D) 3-methylbutanoic acid

Q19. The total number of structural (functional + position) isomers having the molecular formula C_3H_8O is:

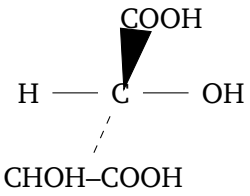
(A) 2

(B) 4

(C) 3

(D) 5

Q20. Tartaric acid, $HOOC–CH(OH)–CH(OH)–COOH$ (one stereocentre shown in wedge–dash form), can exist as an optically inactive form having an internal plane of symmetry. This optically inactive but configurationally distinct form is called the:



(A) meso form

(B) racemic mixture

(C) enantiomer

(D) geometrical isomer

Q21. The relative stability of alkenes increases with the number of α-hydrogens available for hyperconjugation. Among the following, the most stable alkene is:

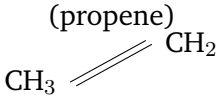
(A) ethene ($CH_2{=}CH_2$)

(B) propene ($CH_3CH{=}CH_2$)

(C) 2,3-dimethyl-2-butene ($(CH_3)_2C{=}C(CH_3)_2$)

(D) 1-butene ($CH_3CH_2CH{=}CH_2$)

Q22. When propene (shown) is treated with hydrogen gas in the presence of finely divided nickel catalyst, the product formed is:



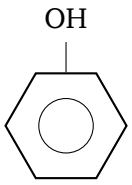
(A) propane ($CH_3CH_2CH_3$)

(B) propyne

(C) 1-propanol

(D) cyclopropane

Q23. When phenol (shown) undergoes electrophilic substitution, the $-OH$ group directs the incoming electrophile mainly to which positions of the ring?



(A) meta only

(B) ortho and para

(C) meta and para

(D) ipso only

Q24. For nucleophilic substitution of the methyl halides, the correct order of reactivity (fastest first) is governed by the ease of breaking the C–X bond. That order is:

(A) $CH_3F > CH_3Cl > CH_3Br > CH_3I$

(B) $CH_3Cl > CH_3Br > CH_3I > CH_3F$

(C) $CH_3F > CH_3I > CH_3Br > CH_3Cl$

(D) $CH_3I > CH_3Br > CH_3Cl > CH_3F$

Q25. The Lucas reagent (concentrated HCl with anhydrous $ZnCl_2$) is used to distinguish primary, secondary and tertiary alcohols. Which alcohol gives immediate turbidity (cloudiness) at room temperature?

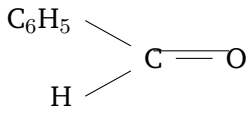
(A) a primary alcohol

(B) a tertiary alcohol

(C) a secondary alcohol

(D) methanol

Q26. Benzaldehyde (whose carbonyl group is shown), which lacks an α-hydrogen, reacts with concentrated NaOH to undergo disproportionation. This reaction is known as the:



(A) aldol condensation

(B) Clemmensen reduction

(C) Cannizzaro reaction

(D) Wurtz reaction

Q27. Which of the following compounds will liberate CO_2 gas (brisk effervescence) on treatment with aqueous sodium bicarbonate ($NaHCO_3$)?

(A) ethanol

(B) phenol

(C) acetone

(D) acetic acid

Q28. In aqueous solution, the correct order of basic strength of the following (most basic first) is:

(A) $(CH_3)_2NH > CH_3NH_2 > NH_3 > C_6H_5NH_2$

(B) $C_6H_5NH_2 > NH_3 > CH_3NH_2 > (CH_3)_2NH$

(C) $NH_3 > CH_3NH_2 > (CH_3)_2NH > C_6H_5NH_2$

(D) $CH_3NH_2 > (CH_3)_2NH > C_6H_5NH_2 > NH_3$

Q29. In a disaccharide such as sucrose or maltose, the two monosaccharide units are joined together through a:

(A) peptide linkage

(B) glycosidic linkage

(C) phosphodiester linkage

(D) hydrogen bond only

Q30. Natural rubber is a polymer (a polyterpene) whose repeating monomer unit is:

(A) vinyl chloride

(B) styrene

(C) ethene

(D) isoprene (2-methyl-1,3-butadiene)

Q31. When an optically active tertiary alkyl halide undergoes hydrolysis by the S_N1 mechanism, the product obtained is:

(A) a single enantiomer with retained configuration

(B) a single enantiomer with inverted configuration

(C) a racemic (optically inactive) mixture

(D) an elimination product only

Q32. Formaldehyde ($HCHO$) on heating with concentrated NaOH gives methanol and sodium formate. This disproportionation of an aldehyde lacking α-hydrogen is called the:

(A) Aldol reaction

(B) Cannizzaro reaction

(C) Friedel–Crafts reaction

(D) Kolbe reaction

Q33. A compound produces brisk effervescence of CO_2 when treated with aqueous sodium bicarbonate ($NaHCO_3$). The functional group present is:

(A) alcohol $-OH$

(B) phenol $-\mathrm{OH}$

(C) aldehyde $-\mathrm{CHO}$

(D) carboxylic acid $-\mathrm{COOH}$

Q34. The reagent used to convert ethanoic acid ($\mathrm{CH_3COOH}$) into ethyl ethanoate (an ester) is:

(A) $\mathrm{LiAlH_4}$

(B) $\mathrm{SOCl_2}$

(C) $\mathrm{C_2H_5OH}$ with conc. $\mathrm{H_2SO_4}$

(D) aqueous NaOH

Q35. The correct order of electronegativity among the second-period elements C, N, O and F (increasing order) is:

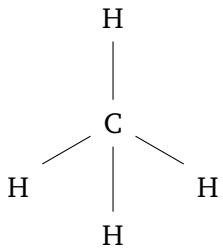
(A) $\mathrm{F} < \mathrm{O} < \mathrm{N} < \mathrm{C}$

(B) $\mathrm{O} < \mathrm{F} < \mathrm{N} < \mathrm{C}$

(C) $\mathrm{C} < \mathrm{O} < \mathrm{N} < \mathrm{F}$

(D) $\mathrm{C} < \mathrm{N} < \mathrm{O} < \mathrm{F}$

Q36. According to VSEPR theory, the molecular shape of methane ($\mathrm{CH_4}$, shown) is:



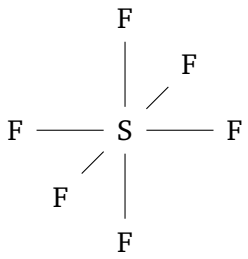
(A) tetrahedral

(B) square planar

(C) trigonal pyramidal

(D) trigonal planar

Q37. The hybridization of the central sulphur atom in sulphur hexafluoride (SF_6, octahedral, shown) is:



(A) sp^3

(B) sp^3d

(C) sp^3d^2

(D) sp^3d^3

Q38. Down group 2 (alkaline-earth metals), the solubility of the hydroxides $M(OH)_2$ in water:

(A) decreases from Be to Ba

(B) increases from Be to Ba

(C) remains constant

(D) first increases then decreases

Q39. Boric acid H_3BO_3 behaves as a weak monobasic acid in water. This is because it:

(A) accepts an OH^- ion from water, releasing H^+ (acts as a Lewis acid)

(B) donates all three of its protons readily

(C) is a strong Arrhenius acid

(D) is a reducing agent

Q40. Down group 14, the relative stability of the $+2$ oxidation state compared with $+4$:

(A) decreases down the group

(B) remains unchanged

(C) is highest for carbon

(D) increases down the group (greatest for lead)

Q41. The bond angle in ammonia NH_3 (107°) is larger than that in phosphine PH_3 ($\approx 94^\circ$). The best reason is:

(A) nitrogen is less electronegative than phosphorus

(B) phosphine has no lone pair

(C) nitrogen is more electronegative and smaller, so its bond pairs are closer and repel more, widening the angle

(D) ammonia is non-polar

Q42. Among the oxides SO_2, SO_3, Na_2O and MgO, the pair that is acidic in nature is:

(A) Na_2O and MgO

(B) MgO and SO_2

(C) Na_2O and SO_3

(D) SO_2 and SO_3

Q43. Bleaching powder, used as a disinfectant, has the chemical formula:

(A) $Ca(OCl)Cl$

(B) $CaCl_2$

(C) $Ca(OH)_2$

(D) $CaCO_3$

Q44. In xenon difluoride XeF_2, the central Xe atom has two bond pairs and three lone pairs. The molecular shape of XeF_2 is therefore:

(A) bent (angular)

(B) linear

(C) trigonal planar

(D) T-shaped

Q45. In acidic medium, when $KMnO_4$ acts as an oxidising agent, the oxidation state of manganese changes from:

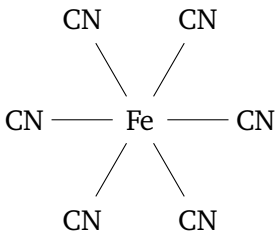
(A) $+7$ to $+2$

(B) $+7$ to $+4$

(C) $+6$ to $+2$

(D) $+4$ to $+2$

Q46. The net charge n on the complex ion $[Fe(CN)_6]^{n}$, in which iron is in the $+3$ state surrounded by six CN^- ligands, is:



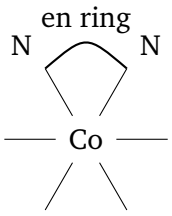
(A) -4

(B) -3

(C) $+3$

(D) 0

Q47. The octahedral complex $[Co(en)_3]^{3+}$ (en = ethylenediamine, a bidentate ligand; one chelate ring shown) exhibits which type of stereoisomerism?



(A) geometrical (cis/trans) only

(B) no isomerism

(C) optical isomerism (two non-superimposable mirror images)

(D) linkage isomerism

Q48. The process of heating a sulphide ore strongly in a regular supply of air, below its melting point, to convert it into the metal oxide is called:

(A) calcination

(B) roasting

(C) smelting

(D) leaching

Q49. Which of the following is an example of an ionic (saline) hydride?

(A) CH_4

(B) NH_3

(C) NaH

(D) HCl

Q50. A salt solution gives a curdy white precipitate with silver nitrate ($AgNO_3$) solution which is soluble in dilute ammonia. The anion present in the salt is:

(A) bromide (Br^-)

(B) iodide (I^-)

(C) sulphate (SO_4^{2-})

(D) chloride (Cl^-)

Detailed Solutions

Q1.

Solution

Concept — Molality: Molality $m = \dfrac{\text{moles of solute}}{\text{mass of solvent in kg}}$.

Step 1 — Find moles of glucose: $n = \dfrac{18}{180}$.

Step 2 — Evaluate moles: $n = 0.10$ mol.

Step 3 — Convert solvent mass to kg: 500 g $= 0.500$ kg.

Step 4 — Apply formula: $m = \dfrac{0.10}{0.500}$.

Step 5 — Evaluate: $m = 0.20$ mol/kg.

Why other options are wrong:

- (A) uses 1 kg of solvent instead of 0.5 kg.
- (B) halves the moles as well.
- (D) doubles the moles wrongly.

Final Answer: $m = 0.20$ m $\Rightarrow$ C

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Ionization energy of a hydrogen-like ion: The energy of the $n = 1$ level scales as Z^2, so IE $= 13.6\, Z^2$ eV.

Step 1 — Identify Z: For Li^{2+}, $Z = 3$.

Step 2 — Square Z: $Z^2 = 9$.

Step 3 — Substitute: IE $= 13.6 \times 9$.

Step 4 — Evaluate: IE $= 122.4$ eV.

Why other options are wrong:

- (A) multiplies by Z $(= 3)$ instead of Z^2.
- (C) ignores the Z^2 factor.
- (D) uses $Z = \sqrt{2}$ logic $(\times 2)$.

Final Answer: IE $= 122.4$ eV $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Electronic configuration of an ion: For transition-metal cations, remove electrons first from the $4s$ orbital, then from $3d$.

Step 1 — Neutral Fe: $Z = 26$, so Fe is $[\text{Ar}]\, 3d^6 4s^2$.

Step 2 — Remove $4s$ electrons first: losing 2 electrons gives $\text{Fe}^{2+} = [\text{Ar}]\, 3d^6$.

Step 3 — Remove one more ($3d$) electron: losing a third electron gives $\text{Fe}^{3+} = [\text{Ar}]\, 3d^5$.

Step 4 — Confirm: the five singly-occupied $3d$ boxes match the half-filled $3d^5$ shown.

Why other options are wrong:

- (B) $3d^6$ is Fe^{2+}, not Fe^{3+}.
- (C) is neutral Fe.
- (D) $3d^3$ removes too many d electrons.

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

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — rms speed: $u_{rms} = \sqrt{\dfrac{3RT}{M}}$ with M in kg/mol.

Step 1 — List data: $R = 8.314$, $T = 300$ K, $M = 32 \times 10^{-3}$ kg/mol.

Step 2 — Numerator: $3RT = 3 \times 8.314 \times 300 = 7482.6$.

Step 3 — Divide by M: $\dfrac{7482.6}{32 \times 10^{-3}} = 233{,}831$.

Step 4 — Take the square root: $u_{rms} = \sqrt{233831} \approx 484$ m/s.

Why other options are wrong:

- (A) forgets the factor 3 and mis-roots.
- (B) uses $M = 32$ (g/mol) directly, giving the wrong magnitude.
- (C) is the value of $u_{rms}^2/10^3$, not the speed.

Final Answer: $u_{rms} \approx 484$ m/s $\Rightarrow$ D

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Entropy of a reversible phase change: $\Delta S = \dfrac{\Delta H}{T}$ at the transition temperature.

Step 1 — List data: $\Delta H_{fus} = 6.0$ kJ/mol $= 6000$ J/mol, $T = 273$ K.

Step 2 — Write the formula: $\Delta S = \dfrac{\Delta H_{fus}}{T}$.

Step 3 — Substitute: $\Delta S = \dfrac{6000}{273}$.

Step 4 — Evaluate: $\Delta S \approx 22.0$ J K^{-1}mol^{-1}.

Why other options are wrong:

- (A) halves the correct value.
- (C) doubles it.
- (D) forgets to divide by T (and the kJ$\rightarrow$J conversion).

Final Answer: $\Delta S \approx 22.0$ J K^{-1}mol^{-1} $\Rightarrow$ B

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Resonance energy: Resonance energy = (calculated ΔH for the localized structure) $-$ (experimental ΔH). The molecule is more stable (less energy released on hydrogenation) than expected.

Step 1 — Calculated value: for three isolated C=C, $\Delta H_{calc} = 3 \times (-120) = -360$ kJ/mol.

Step 2 — Experimental value: $\Delta H_{exp} = -208$ kJ/mol.

Step 3 — Resonance energy: $\Delta H_{calc} - \Delta H_{exp} = (-360) - (-208)$.

Step 4 — Evaluate: $= -360 + 208 = -152$ kJ/mol; the magnitude of stabilization is 152 kJ/mol.

Step 5 — Interpret: benzene is 152 kJ/mol more stable than the hypothetical cyclohexatriene.

Why other options are wrong:

- (A) reports the signed difference, not the resonance (stabilization) energy magnitude.
- (B) adds the magnitudes.
- (D) just quotes the experimental value.

Final Answer: resonance energy $= 152$ kJ/mol $\Rightarrow$ C

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Reaction quotient: $Q_c = \dfrac{[SO_3]^2}{[SO_2]^2[O_2]}$, using the instantaneous concentrations.

Step 1 — List concentrations: $[SO_2] = 2$, $[O_2] = 1$, $[SO_3] = 4$.

Step 2 — Numerator: $[SO_3]^2 = 4^2 = 16$.

Step 3 — Denominator: $[SO_2]^2[O_2] = 2^2 \times 1 = 4$.

Step 4 — Divide: $Q_c = \dfrac{16}{4} = 4$.

Why other options are wrong:

- (A) forgets to square the terms.
- (B) squares only $[SO_2]$.
- (C) forgets to square $[SO_2]$ in the denominator.

Final Answer: $Q_c = 4 \Rightarrow$ D

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — pOH: $\text{pOH} = -\log[\text{OH}^-]$.

Step 1 — Find $[\text{OH}^-]$: $[\text{OH}^-] = 1 \times 10^{-3}$ M.

Step 2 — Apply pOH formula: $\text{pOH} = -\log(1 \times 10^{-3})$.

Step 3 — Use log: $\log(10^{-3}) = -3$.

Step 4 — Evaluate: $\text{pOH} = -(-3) = 3$.

Why other options are wrong:

- (A) is the pH, not the pOH.
- (B) uses 10^{-1}.
- (D) quotes the concentration, not the pOH.

Final Answer: $\text{pOH} = 3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

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

Step 1 — Write the relation: $K_{sp} = [\text{Ag}^+][\text{Br}^-] = s \times s = s^2$.

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

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

Step 4 — Evaluate the root: $\sqrt{10^{-13}} = \sqrt{10 \times 10^{-14}} = 3.16 \times 10^{-7}$.

Step 5 — Multiply: $s = 2.0 \times 3.16 \times 10^{-7} = 6.3 \times 10^{-7}$ mol/L.

Why other options are wrong:

- (B) quotes K_{sp} itself.
- (C) takes $\sqrt{4} \times 10^{-7}$ wrongly without the $\sqrt{10}$ factor.
- (D) squares instead of square-rooting.

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

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Molar mass from boiling-point elevation: $\Delta T_b = \dfrac{K_b\, w_2 \times 1000}{M_2\, w_1}$, so $M_2 = \dfrac{K_b\, w_2 \times 1000}{\Delta T_b\, w_1}$.

Step 1 — List data: $K_b = 0.52$, $w_2 = 3.0$ g, $w_1 = 100$ g, $\Delta T_b = 0.156$ K.

Step 2 — Numerator: $K_b\, w_2 \times 1000 = 0.52 \times 3.0 \times 1000 = 1560$.

Step 3 — Denominator: $\Delta T_b\, w_1 = 0.156 \times 100 = 15.6$.

Step 4 — Divide: $M_2 = \dfrac{1560}{15.6} = 100$ g/mol.

Why other options are wrong:

- (A) halves the result.
- (C) doubles it.
- (D) uses $\Delta T_b = 0.104$ wrongly.

Final Answer: $M_2 = 100$ g/mol $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Nernst equation: $E_{cell} = E^\circ_{cell} - \dfrac{0.059}{n} \log \dfrac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$, with $n = 2$.

Step 1 — Form the ratio: $\dfrac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} = \dfrac{1}{0.01} = 100$.

Step 2 — Take the log: $\log 100 = 2$.

Step 3 — Compute the correction: $\dfrac{0.059}{2} \times 2 = 0.059$ V.

Step 4 — Apply Nernst: $E_{cell} = 1.10 - 0.059$.

Step 5 — Evaluate: $E_{cell} = 1.041$ V.

Why other options are wrong:

- (B) adds the correction instead of subtracting.
- (C) ignores the concentration term.
- (D) wrongly halves E°.

Final Answer: $E_{cell} = 1.041$ V $\Rightarrow$ A

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Kohlrausch's law of independent migration: $\Lambda_m^\circ(CH_3COOH) = \Lambda_m^\circ(HCl) + \Lambda_m^\circ(CH_3COONa) - \Lambda_m^\circ(NaCl)$.

Step 1 — Identify the combination: adding HCl and CH_3COONa and removing NaCl leaves $H^+ + CH_3COO^-$.

Step 2 — Substitute: $\Lambda_m^\circ = 426 + 91 - 126$.

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

Step 4 — Subtract NaCl: $517 - 126 = 391$.

Step 5 — State result: $\Lambda_m^\circ(CH_3COOH) = 391$ S cm^{2}mol^{-1}.

Why other options are wrong:

- (A) adds NaCl instead of subtracting.
- (C) subtracts CH_3COONa instead of NaCl.
- (D) uses the wrong combination entirely.

Final Answer: $\Lambda_m^\circ = 391$ S cm^{2}mol^{-1} $\Rightarrow$ B

Answer: (B) Go Back to Q12

Q13.

Solution

Concept — Effect of concentration on rate: For rate $= k[A]^2$, multiplying $[A]$ by a factor f multiplies the rate by f^2.

Step 1 — Initial rate: $r_1 = k[A]^2$.

Step 2 — Double the concentration: new $[A] = 2[A]$.

Step 3 — New rate: $r_2 = k(2[A])^2 = 4k[A]^2$.

Step 4 — Form the ratio: $\dfrac{r_2}{r_1} = 4$.

Why other options are wrong:

- (A) would hold only for zero order.
- (B) would hold for first order.
- (C) corresponds to no simple integer order.

Final Answer: rate becomes four times $\Rightarrow$ D

Answer: (D) Go Back to Q13

Q14.

Solution

Concept — Temperature coefficient: If the rate doubles per 10°C, then for a rise of ΔT the factor is $2^{(\Delta T/10)}$.

Step 1 — Find the temperature rise: $\Delta T = 50 - 20 = 30^\circ$C.

Step 2 — Count the 10°C steps: $\dfrac{30}{10} = 3$ steps.

Step 3 — Apply the factor: factor $= 2^3$.

Step 4 — Evaluate: $2^3 = 8$.

Why other options are wrong:

- (B) counts only two steps.
- (C) uses 2^4 (four steps).
- (D) is not a power of 2.

Final Answer: factor $= 8 \Rightarrow$ A

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Packing efficiency: It is the fraction of unit-cell volume occupied by the atoms. For fcc (and hcp) close packing this is a fixed value.

Step 1 — Atoms per fcc cell: $Z = 4$.

Step 2 — Edge–radius relation: for fcc, atoms touch along the face diagonal, giving $a = 2\sqrt{2}\,r$.

Step 3 — Volume ratio: efficiency $= \dfrac{4 \times \frac{4}{3}\pi r^3}{a^3} = \dfrac{4 \times \frac{4}{3}\pi r^3}{(2\sqrt{2}\,r)^3}$.

Step 4 — Evaluate: this simplifies to $\frac{\pi}{3\sqrt{2}} \approx 0.74$, i.e. 74%.

Why other options are wrong:

- (A) 52% is for simple cubic.
- (B) 68% is for bcc.
- (D) 32% is void fraction-style nonsense.

Final Answer: packing efficiency $= 74\% \Rightarrow$ C

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Electrons in a half-reaction: In a balanced half-reaction, the coefficient written before e^- gives the number of electrons gained (reduction) or lost (oxidation) per formula unit.

Step 1 — Read the half-reaction: $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$.

Step 2 — Track the oxidation state of Mn: in MnO_4^- manganese is $+7$; in Mn^{2+} it is $+2$.

Step 3 — Find the change: the drop is $7 - 2 = 5$ units, so 5 electrons are gained.

Step 4 — Confirm with the equation: the coefficient of e^- is 5, matching the change in oxidation state.

Why other options are wrong:

- (B) 3 would be the change for $Mn^{+7} \rightarrow Mn^{+4}$ (neutral/basic medium), not this reaction.
- (C) 2 ignores the full $+7 \rightarrow +2$ change.
- (D) 1 is far too small for this five-electron reduction.

Final Answer: 5 electrons $\Rightarrow$ A

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Molarity to molality: Take 1 L of solution. Find mass of solution, mass of solute, then mass of solvent; molality $= \dfrac{\text{mol solute}}{\text{kg solvent}}$.

Step 1 — Moles of solute in 1 L: for 1.0 M, $n = 1.0$ mol.

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

Step 3 — Mass of 1 L solution: volume $\times$ density $= 1000$ mL $\times\ 1.20 = 1200$ g.

Step 4 — Mass of solvent: $1200 - 40 = 1160$ g $= 1.160$ kg.

Step 5 — Molality: $m = \dfrac{1.0}{1.160} \approx 0.86 \approx 0.85$ mol/kg.

Why other options are wrong:

- (A) wrongly assumes molality equals molarity.
- (C) uses the density as the answer.
- (D) confuses solute mass-fraction with molality.

Final Answer: $m \approx 0.85$ m $\Rightarrow$ B

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — IUPAC naming of carboxylic acids: The $-\mathrm{COOH}$ carbon is C-1; choose the longest chain containing it and number to give the acid carbon the lowest locant.

Step 1 — Identify the chain: $\mathrm{CH_3}$–$\mathrm{CH(CH_3)}$–$\mathrm{CH_2}$–COOH has a four-carbon main chain ending in $-\mathrm{COOH}$ (butanoic acid).

Step 2 — Number from the acid carbon: COOH (C-1), $\mathrm{CH_2}$ (C-2), $\mathrm{CH(CH_3)}$ (C-3), $\mathrm{CH_3}$ (C-4).

Step 3 — Locate the substituent: a methyl group sits on C-3.

Step 4 — Assemble the name: 3-methylbutanoic acid.

Why other options are wrong:

- (A) ignores the methyl branch.

- (B) numbers from the wrong end.
- (C) uses a three-carbon chain (propanoic) incorrectly.

Final Answer: 3-methylbutanoic acid $\Rightarrow$ D

Answer: (D) Go Back to Q18

Q19.

Solution

Concept — Structural isomers of C_3H_8O: Count alcohols (position isomers) and ethers (functional isomers).

Step 1 — Alcohols: 1-propanol ($CH_3CH_2CH_2OH$) and 2-propanol ($CH_3CH(OH)CH_3$) $= 2$ isomers.

Step 2 — Ethers: methoxyethane (CH_3–O–CH_2CH_3) $= 1$ isomer.

Step 3 — Add them up: $2 + 1 = 3$ structural isomers.

Why other options are wrong:

- (A) counts only the two alcohols.
- (B) over-counts by inventing an extra ether.
- (D) over-counts further.

Final Answer: 3 isomers $\Rightarrow$ C

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Meso compound: A molecule with chiral centres but an internal plane of symmetry is optically inactive due to internal compensation; it is called the meso form.

Step 1 — Recognise the structure: tartaric acid has two similar stereocentres.

Step 2 — Symmetry check: one diastereomer has an internal mirror plane relating the two halves.

Step 3 — Consequence: the rotations of the two halves cancel, so the molecule is optically inactive though it has stereocentres.

Step 4 — Name it: this optically inactive, configurationally distinct form is the meso form.

Why other options are wrong:

- (B) a racemic mixture is a 1:1 mix of two enantiomers, not a single distinct compound.
- (C) an enantiomer would be optically active.
- (D) geometrical isomerism is not relevant here.

Final Answer: meso form $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q20

Q21.

Solution

Concept — Hyperconjugation and alkene stability: The greater the number of α-hydrogens (alkyl groups attached to the doubly-bonded carbons), the more stable the alkene.

Step 1 — Count alkyl substitution: 2,3-dimethyl-2-butene is tetrasubstituted (four methyl groups on the $\mathrm{C{=}C}$).

Step 2 — Compare: ethene (0 substituents) $<$ propene/1-butene (monosubstituted) $<$ tetrasubstituted alkene.

Step 3 — More α-H means more hyperconjugative structures: so the tetrasubstituted alkene is most stable.

Step 4 — Conclude: 2,3-dimethyl-2-butene is the most stable.

Why other options are wrong:

- (A) ethene has no α-alkyl groups, least stable.
- (B) and (D) are only monosubstituted.

Final Answer: 2,3-dimethyl-2-butene $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q21

Q22.

Solution

Concept — Catalytic hydrogenation: An alkene adds H_2 across the double bond over a Ni (or Pt/Pd) catalyst to give the corresponding alkane.

Step 1 — Write the reactant: propene, $CH_3CH{=}CH_2$.

Step 2 — Add H_2: one H adds to each carbon of the double bond.

Step 3 — Form the product: $CH_3CH_2CH_3$, propane.

Why other options are wrong:

- (B) propyne is more unsaturated, not a reduction product.
- (C) hydration (not hydrogenation) would give an alcohol.
- (D) no ring forms in simple hydrogenation.

Final Answer: propane $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q22

Q23.

Solution

Concept — Directing effect of $-OH$: The hydroxyl group is an activating, ortho/para-directing group because its lone pair is donated into the ring by resonance, increasing electron density at the ortho and para positions.

Step 1 — Classify the group: $-OH$ is a strong $+M$ (electron-donating by resonance) group.

Step 2 — Locate activated positions: resonance places negative charge at the ortho and para carbons.

Step 3 — Conclude: electrophiles attack mainly at the ortho and para positions.

Why other options are wrong:

- (A) meta-direction is typical of deactivating groups like $-NO_2$.
- (C) and (D) do not match the resonance pattern of $-OH$.

Final Answer: ortho and para $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept — Reactivity of alkyl halides in substitution: The weaker the C–X bond, the more easily it breaks; bond strength decreases C–F $>$ C–Cl $>$ C–Br $>$ C–I, so reactivity is the reverse.

Step 1 — Recall bond strengths: C–I is the weakest, C–F the strongest.

Step 2 — Easier bond cleavage means faster substitution: so CH_3I is most reactive.

Step 3 — Write the order: $CH_3I > CH_3Br > CH_3Cl > CH_3F$.

Why other options are wrong:

- (A) is exactly reversed.
- (B) and (C) misplace CH_3F and CH_3I.

Final Answer: $CH_3I > CH_3Br > CH_3Cl > CH_3F \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Lucas test: Alcohols react with Lucas reagent to form an insoluble alkyl chloride (turbidity). The rate follows carbocation stability: tertiary (immediate) $>$ secondary (5–10 min) $>$ primary (no reaction at room temperature).

Step 1 — Recall the mechanism: substitution proceeds via a carbocation; more stable carbocations form faster.

Step 2 — Tertiary alcohol: gives the most stable (3°) carbocation, so turbidity appears immediately.

Step 3 — Conclude: a tertiary alcohol gives immediate cloudiness.

Why other options are wrong:

- (A) primary alcohols do not react at room temperature.
- (C) secondary alcohols react slowly (turbidity in minutes).
- (D) methanol does not give turbidity at room temperature.

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

Answer: (B) Go Back to Q25

Q26.

Solution

Concept — Cannizzaro reaction: Aldehydes lacking an α-hydrogen, when treated with concentrated alkali, undergo self oxidation–reduction (disproportionation) to give an alcohol and a carboxylate salt.

Step 1 — Check for α-hydrogen: benzaldehyde (C_6H_5CHO) has no α-hydrogen.

Step 2 — Action of concentrated NaOH: one molecule is reduced to benzyl alcohol, another is oxidized to sodium benzoate.

Step 3 — Name the reaction: this disproportionation is the Cannizzaro reaction.

Why other options are wrong:

- (A) aldol condensation needs an α-hydrogen, which benzaldehyde lacks.
- (B) Clemmensen reduces $> C{=}O$ to CH_2, using Zn–Hg/HCl.
- (D) Wurtz couples alkyl halides, not aldehydes.

Final Answer: Cannizzaro reaction $\Rightarrow$ C

Answer: (C) Go Back to Q26

Q27.

Solution

Concept — $NaHCO_3$ test: Only acids stronger than carbonic acid (i.e. carboxylic acids) react with sodium bicarbonate to release CO_2.

Step 1 — Compare acidities: carboxylic acid ($pK_a \approx 4{-}5$) $>$ carbonic acid $>$ phenol ($pK_a \approx 10$) $>$ alcohol.

Step 2 — Apply the rule: acetic acid is stronger than carbonic acid, so it liberates CO_2.

Step 3 — Conclude: acetic acid gives brisk effervescence with $NaHCO_3$.

Why other options are wrong:

- (A) ethanol is far too weakly acidic.
- (B) phenol is weaker than carbonic acid, so no CO_2.
- (C) acetone is not acidic in this sense.

Final Answer: acetic acid $\Rightarrow$ D

Answer: (D) Go Back to Q27

Q28.

Solution

Concept — Basicity of amines in water: Basicity depends on the balance of the $+I$ effect, solvation of the cation, and steric factors. Aromatic amines are much weaker because the lone pair is delocalized into the ring.

Step 1 — Place aniline last: $C_6H_5NH_2$ is the weakest base (lone pair in resonance).

Step 2 — Among the aliphatic set: in water, $(CH_3)_2NH$ (secondary) is the strongest, then CH_3NH_2, then NH_3.

Step 3 — Assemble the order: $(CH_3)_2NH > CH_3NH_2 > NH_3 > C_6H_5NH_2$.

Why other options are wrong:

- (B) wrongly places aniline first.
- (C) puts NH_3 above the methylamines.
- (D) places aniline above ammonia, which is incorrect.

Final Answer: $(CH_3)_2NH > CH_3NH_2 > NH_3 > C_6H_5NH_2 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q28

Q29.

Solution

Concept — Glycosidic linkage: In di- and poly-saccharides, monosaccharide units are joined by an oxygen bridge formed between the anomeric carbon of one sugar and a hydroxyl of the next; this C–O–C bridge is the glycosidic linkage.

Step 1 — Recall the unit: a disaccharide is two monosaccharides condensed with loss of water.

Step 2 — Identify the bond: the resulting C–O–C bridge is the glycosidic linkage.

Step 3 — Conclude: sucrose and maltose are linked by a glycosidic linkage.

Why other options are wrong:

- (A) peptide linkages join amino acids in proteins.
- (C) phosphodiester linkages join nucleotides in nucleic acids.
- (D) hydrogen bonds are intermolecular, not the covalent linkage joining the units.

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

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Natural rubber monomer: Natural rubber is cis-1,4-polyisoprene; its repeating monomer is isoprene (2-methyl-1,3-butadiene).

Step 1 — Recall the structure: natural rubber is a polyterpene made of isoprene units.

Step 2 — Identify the monomer: isoprene, $\mathrm{CH_2{=}C(CH_3){-}CH{=}CH_2}$.

Step 3 — Conclude: the monomer is isoprene.

Why other options are wrong:

- (A) vinyl chloride gives PVC.
- (B) styrene is a monomer of polystyrene/Buna-S, not pure rubber.
- (C) ethene gives polyethene.

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

Answer: (D) Go Back to Q30

Q31.

Solution

Concept — S_N1 stereochemistry: An S_N1 reaction goes through a planar (sp^2) carbocation, which the nucleophile can attack from either face with nearly equal probability, giving a racemic mixture.

Step 1 — Form the intermediate: the tertiary halide ionizes to a planar carbocation.

Step 2 — Nucleophilic attack: water attacks from both faces equally.

Step 3 — Result: equal amounts of the two enantiomers form, i.e. a racemic mixture (optically inactive).

Why other options are wrong:

- (A) and (B) pure retention or inversion is characteristic of other mechanisms, not S_N1.

- (D) elimination is a competing $E1$ path, not the substitution product asked about.

Final Answer: racemic mixture $\Rightarrow$ C

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Cannizzaro reaction: An aldehyde without α-hydrogen, on heating with concentrated alkali, disproportionates into an alcohol and a carboxylate salt.

Step 1 — Check α-hydrogen: formaldehyde (HCHO) has no α-hydrogen.

Step 2 — Products with NaOH: methanol (CH_3OH) and sodium formate (HCOONa).

Step 3 — Name the reaction: this is the Cannizzaro reaction.

Why other options are wrong:

- (A) the aldol reaction needs an α-hydrogen.
- (C) Friedel–Crafts is an aromatic substitution.
- (D) Kolbe's reaction relates to phenol carboxylation.

Final Answer: Cannizzaro reaction $\Rightarrow$ B

Answer: (B) Go Back to Q32

Q33.

Solution

Concept — $NaHCO_3$ test: Only acids stronger than carbonic acid liberate CO_2 (brisk effervescence) from sodium bicarbonate. Carboxylic acids are strong enough; alcohols and phenols are not.

Step 1 — Recall the test: a compound that gives brisk CO_2 effervescence with aqueous $NaHCO_3$ must be more acidic than H_2CO_3.

Step 2 — Write the reaction: $RCOOH + NaHCO_3 \rightarrow RCOONa + H_2O + CO_2 \uparrow$.

Step 3 — Match the functional group: the $-COOH$ group of a carboxylic acid satisfies this condition.

Step 4 — Conclude: the group present is the carboxylic acid $-COOH$.

Why other options are wrong:

- (A) an alcohol $-OH$ is far too weak an acid to release CO_2.
- (B) phenol is weakly acidic but still does not give effervescence with $NaHCO_3$.
- (C) an aldehyde $-CHO$ is not acidic in this sense.

Final Answer: carboxylic acid $-COOH \Rightarrow$ D

Answer: (D) Go Back to Q33

Q34.

Solution

Concept — Fischer esterification: A carboxylic acid is converted to an ester by heating it with an alcohol in the presence of a small amount of concentrated H_2SO_4, which acts as catalyst and dehydrating agent.

Step 1 — Identify the target conversion: CH_3COOH (acid) is to be turned into ethyl ethanoate (an ester).

Step 2 — Choose the reagent: the alcohol C_2H_5OH with conc. H_2SO_4 supplies the ethyl group and drives the equilibrium.

Step 3 — Write the reaction: $CH_3COOH + C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$.

Step 4 — Conclude: the correct reagent is ethanol with concentrated H_2SO_4.

Why other options are wrong:

- (A) $LiAlH_4$ reduces the acid to an alcohol, not an ester.
- (B) $SOCl_2$ converts the acid to an acid chloride, not directly to the ester.
- (D) aqueous $NaOH$ forms the sodium salt (saponification), not the ester.

Final Answer: C_2H_5OH with conc. $H_2SO_4 \Rightarrow$ C

Answer: (C) Go Back to Q34

Q35.

Solution

Concept — Electronegativity trend: Across a period, electronegativity increases from left to right as nuclear charge increases and atomic size decreases.

Step 1 — Order the elements left to right: C, N, O, F (increasing atomic number in period 2).

Step 2 — Apply the trend: electronegativity increases in the same direction.

Step 3 — Write increasing order: $\mathrm{C} < \mathrm{N} < \mathrm{O} < \mathrm{F}$ (F is the most electronegative element).

Why other options are wrong:

- (A) is the exact reverse.
- (B) and (C) misplace O and F.

Final Answer: $\mathrm{C} < \mathrm{N} < \mathrm{O} < \mathrm{F} \Rightarrow \boxed{\mathrm{D}}$

Answer: (D) Go Back to Q35

Q36.

Solution

Concept — VSEPR for $\mathrm{CH_4}$: Carbon in methane has four bond pairs and no lone pairs (type $\mathrm{AX_4}$). Four bonding regions arrange themselves at 109.5° to minimize repulsion, giving a tetrahedral shape.

Step 1 — Count electron domains: 4 bond pairs $+ 0$ lone pairs $= 4$ domains.

Step 2 — Predict the geometry: four equivalent regions point to the corners of a regular tetrahedron.

Step 3 — State the bond angle: the H–C–H angle is 109.5°.

Step 4 — Resulting shape: the molecule is tetrahedral.

Why other options are wrong:

- (B) square planar needs two lone pairs ($\mathrm{AX_4E_2}$, e.g. $\mathrm{XeF_4}$).
- (C) trigonal pyramidal needs one lone pair ($\mathrm{AX_3E_1}$, e.g. $\mathrm{NH_3}$).
- (D) trigonal planar is for three bonding regions ($\mathrm{AX_3}$).

Final Answer: tetrahedral $\Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q36

Q37.

Solution

Concept — Hybridization from geometry: The number of σ bonds plus lone pairs on the central atom gives the steric number, which fixes the hybridization. Six regions correspond to sp^3d^2 (octahedral).

Step 1 — Count regions around S: six S–F bonds and no lone pairs on sulphur.

Step 2 — Find the steric number: 6 bonding regions $\Rightarrow$ steric number $= 6$.

Step 3 — Match to hybridization: six regions correspond to sp^3d^2 hybridization.

Step 4 — Geometry: sp^3d^2 gives the regular octahedral shape shown.

Why other options are wrong:

- (A) sp^3 corresponds to four regions (tetrahedral).
- (B) sp^3d corresponds to five regions (trigonal bipyramidal).
- (D) sp^3d^3 corresponds to seven regions, more than SF_6 has.

Final Answer: $sp^3d^2 \Rightarrow$ C

Answer: (C) Go Back to Q37

Q38.

Solution

Concept — Solubility of group 2 hydroxides: Down the group, lattice enthalpy falls faster than hydration enthalpy, so the hydroxides become more soluble.

Step 1 — Recall the data: $Be(OH)_2$ and $Mg(OH)_2$ are sparingly soluble, while $Ba(OH)_2$ is fairly soluble.

Step 2 — Identify the trend: solubility increases from Be to Ba.

Step 3 — Conclude: the hydroxides become more soluble down the group.

Why other options are wrong:

- (A) is the reverse of the actual trend.
- (C) solubility clearly changes down the group.
- (D) there is no maximum; it increases steadily.

Final Answer: increases from Be to Ba $\Rightarrow$ B

Answer: (B) Go Back to Q38

Q39.

Solution

Concept — Acidity of boric acid: H_3BO_3 is a weak monobasic Lewis acid: it does not donate its own protons but accepts a hydroxide ion from water, releasing one H^+.

Step 1 — Write the equilibrium: $B(OH)_3 + H_2O \rightleftharpoons [B(OH)_4]^- + H^+$.

Step 2 — Interpret: boron accepts an OH^- (Lewis acid behaviour), and the released H^+ makes the solution acidic.

Step 3 — Conclude: it is monobasic because only one H^+ is produced per molecule by this route.

Why other options are wrong:

- (B) it does not donate its three O–H protons directly.
- (C) it is weak, not strong.
- (D) acidity here is not a redox property.

Final Answer: accepts OH^- from water, a Lewis acid $\Rightarrow$ A

Answer: (A) Go Back to Q39

Q40.

Solution

Concept — Inert pair effect in group 14: Down the group, the ns^2 pair becomes increasingly reluctant to bond, so the $+2$ state grows more stable relative to $+4$.

Step 1 — Top of group: carbon and silicon strongly prefer $+4$.

Step 2 — Bottom of group: lead is most stable as Pb^{2+} $(+2)$.

Step 3 — State the trend: stability of $+2$ relative to $+4$ increases down the group, greatest for lead.

Why other options are wrong:

- (A) is the reverse trend.

- (B) it clearly changes down the group.
- (C) carbon favours $+4$, not $+2$.

Final Answer: increases down the group (greatest for lead) $\Rightarrow$ D

Answer: (D) Go Back to Q40

Q41.

Solution

Concept — Bond angle in NH_3 vs PH_3: Both are pyramidal with one lone pair, but bond angle depends on the central atom's electronegativity and size.

Step 1 — Compare central atoms: N is smaller and more electronegative than P.

Step 2 — Effect on bond pairs: in NH_3 the bonding electrons are held closer to the small, electronegative N, so adjacent bond pairs are nearer and repel more, opening the angle to $107°$.

Step 3 — In PH_3: P is larger and less electronegative, bond pairs are farther apart and repel less, so the angle is only $\approx 94°$.

Step 4 — Conclude: the larger angle in NH_3 is due to N being smaller and more electronegative.

Why other options are wrong:

- (A) states the electronegativity backwards.
- (B) PH_3 does have a lone pair.
- (D) ammonia is polar, and this is irrelevant to the angle reasoning.

Final Answer: N is more electronegative and smaller $\Rightarrow$ C

Answer: (C) Go Back to Q41

Q42.

Solution

Concept — Acidic vs basic oxides: Oxides of non-metals (here sulphur) are acidic; oxides of reactive metals (Na, Mg) are basic.

Step 1 — Classify each oxide: SO_2 and SO_3 are non-metal oxides (acidic); Na_2O and MgO are metal oxides (basic).

Step 2 — Confirm acidity: SO_2 gives sulphurous acid and SO_3 gives sulphuric

acid with water.

Step 3 — Select the acidic pair: SO_2 and SO_3.

Why other options are wrong:

- (A) Na_2O and MgO are basic.
- (B) mixes a basic oxide (MgO) with an acidic one.
- (C) mixes a basic oxide (Na_2O) with an acidic one.

Final Answer: SO_2 and $SO_3 \Rightarrow$ D

Answer: (D) Go Back to Q42

Q43.

Solution

Concept — Bleaching powder: Bleaching powder is calcium oxychloride, a mixed salt of chloride and hypochlorite, written $Ca(OCl)Cl$ (or $CaOCl_2$). It is made by passing Cl_2 over slaked lime.

Step 1 — Recall the preparation: $Ca(OH)_2 + Cl_2 \rightarrow Ca(OCl)Cl + H_2O$.

Step 2 — Identify the formula: the product contains one OCl^- and one Cl^- per calcium, i.e. $Ca(OCl)Cl$.

Step 3 — Conclude: the chemical formula of bleaching powder is $Ca(OCl)Cl$.

Why other options are wrong:

- (B) $CaCl_2$ is calcium chloride, not the bleaching agent.
- (C) $Ca(OH)_2$ is slaked lime, the starting material.
- (D) $CaCO_3$ is limestone/marble.

Final Answer: $Ca(OCl)Cl \Rightarrow$ A

Answer: (A) Go Back to Q43

Q44.

Solution

Concept — VSEPR for XeF_2: Xe has two bond pairs and three lone pairs (AX_2E_3). The three lone pairs occupy the equatorial positions of a trigonal-bipyramidal arrangement, leaving the two F atoms axial.

Step 1 — Count electron domains: 2 bond pairs $+$ 3 lone pairs $=$ 5 domains (trigonal-bipyramidal electron geometry).

Step 2 — Place lone pairs equatorially: this minimizes repulsion.

Step 3 — Resulting shape: the two F atoms are axial (opposite), so the molecule is linear.

Why other options are wrong:

- (A) bent would need fewer lone pairs or a different count.
- (C) trigonal planar does not apply.
- (D) T-shaped is AX_3E_2.

Final Answer: linear $\Rightarrow$ B

Answer: (B) Go Back to Q44

Q45.

Solution

Concept — $KMnO_4$ in acidic medium: In acid solution, the permanganate ion MnO_4^- is reduced all the way to Mn^{2+}, a five-electron change. So manganese goes from $+7$ to $+2$.

Step 1 — Find Mn in $KMnO_4$: K is $+1$, each O is -2; $1 + x + 4(-2) = 0$ gives $x = +7$.

Step 2 — Find Mn in the product: in acidic medium the product is Mn^{2+}, so Mn is $+2$.

Step 3 — State the change: the oxidation state of Mn changes from $+7$ to $+2$.

Step 4 — Conclude: this $+7 \rightarrow +2$ change is the acidic-medium behaviour of $KMnO_4$.

Why other options are wrong:

- (B) $+7$ to $+4$ (MnO_2) is the neutral/faintly basic medium result.

- (C) Mn in $KMnO_4$ is $+7$, not $+6$.
- (D) the starting oxidation state is $+7$, not $+4$.

Final Answer: $+7$ to $+2 \Rightarrow$ A

Answer: (A) Go Back to Q45

Q46.

Solution

Concept — Charge of a complex ion: The net charge = (oxidation state of the metal) + (sum of the ligand charges).

Step 1 — Metal contribution: iron is in the $+3$ state, contributing $+3$.

Step 2 — Ligand contribution: each CN^- carries -1; six of them give $6 \times (-1) = -6$.

Step 3 — Add the contributions: $n = (+3) + (-6)$.

Step 4 — Evaluate: $n = -3$, so the complex ion is $[Fe(CN)_6]^{3-}$.

Why other options are wrong:

- (A) -4 corresponds to Fe^{2+} ($+2 - 6 = -4$), not Fe^{3+}.
- (C) $+3$ ignores the six negative cyanide ligands.
- (D) 0 would require neutral ligands.

Final Answer: $n = -3 \Rightarrow$ B

Answer: (B) Go Back to Q46

Q47.

Solution

Concept — Optical isomerism in tris-chelate complexes: An octahedral complex with three symmetrical bidentate ligands, $[M(en)_3]^{n+}$, has no plane of symmetry and exists as two non-superimposable mirror images (Δ and Λ).

Step 1 — Identify the type: $[Co(en)_3]^{3+}$ is octahedral with three bidentate en ligands.

Step 2 — Symmetry test: the propeller-like arrangement is chiral (no internal mirror plane).

Step 3 — Consequence: it exists as a pair of enantiomers $\Rightarrow$ optical isomerism.

Why other options are wrong:

- (A) there is no cis/trans distinction for three identical bidentate ligands.
- (B) it certainly shows isomerism.
- (D) linkage isomerism needs an ambidentate ligand, which en is not.

Final Answer: optical isomerism (two enantiomers) $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q47

Q48.

Solution

Concept — Roasting: Roasting is the strong heating of a sulphide ore in the presence of excess air (below the melting point) to convert it into the metal oxide, expelling sulphur as SO_2.

Step 1 — Recall the condition: sulphide ore $+$ regular air $+$ heat below melting point.

Step 2 — Product: the metal oxide is formed (e.g. $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$).

Step 3 — Name the process: this is roasting.

Why other options are wrong:

- (A) calcination heats carbonate/hydrated ores in limited air.
- (C) smelting reduces the oxide to metal.
- (D) leaching is a chemical dissolution method.

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

Answer: (B) Go Back to Q48

Q49.

Solution

Concept — Ionic (saline) hydrides: The s-block metals (alkali and heavier alkaline-earth metals) react with hydrogen to give ionic hydrides containing the hydride ion H^-. Hydrides of non-metals are covalent.

Step 1 — Classify each species: CH_4, NH_3 and HCl are covalent (molecular) hydrides of non-metals.

Step 2 — Find the metal hydride: NaH is formed from sodium (an active s-block metal) and hydrogen.

Step 3 — Identify the bonding: NaH contains Na^+ and H^- ions, so it is an ionic (saline) hydride.

Step 4 — Conclude: NaH is the ionic hydride.

Why other options are wrong:

- (A) CH_4 is a covalent hydride of carbon.
- (B) NH_3 is a covalent hydride of nitrogen.
- (D) HCl is a covalent (polar) hydride of chlorine.

Final Answer: $NaH \Rightarrow$ C

Answer: (C) Go Back to Q49

Q50.

Solution

Concept — Confirmatory test for chloride: Cl^- gives a curdy white precipitate of AgCl with $AgNO_3$, and AgCl dissolves in dilute ammonia (forming $[Ag(NH_3)_2]^+$).

Step 1 — Identify the precipitate: curdy white with $AgNO_3$ suggests AgCl.

Step 2 — Test solubility in NH_3: AgCl dissolves in dilute ammonia, confirming chloride.

Step 3 — Conclude: the anion is chloride (Cl^-).

Why other options are wrong:

- (A) AgBr is pale yellow and only sparingly soluble in dilute ammonia.
- (B) AgI is yellow and insoluble in ammonia.
- (C) sulphate gives a white precipitate with $BaCl_2$, not this $AgNO_3/NH_3$ behaviour.

Final Answer: chloride (Cl^-) $\Rightarrow$ D

Answer: (D) Go Back to Q50

Answer Key

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