JEE Main Chemistry

Sample Paper – 14

Duration: 60 Minutes **Maximum Marks: 100**

Instructions

- This paper contains **30 questions** modelled on the Chemistry portion of **JEE Main** entrance examination.
- **Section A** (Q1–Q20): 20 Single Correct Multiple Choice Questions. **+4 marks** for correct answer; **−1 mark** for wrong answer; **0** for unattempted.
- **Section B** (Q21–Q30): 10 Numerical Value Questions. Attempt **any 5**. **+4 marks** for correct answer; **0 marks** for incorrect or unattempted.
- Syllabus: Class 11 & 12 NCERT Chemistry (JEE Main official syllabus).
- Personal calculators, log tables, and electronic gadgets are strictly prohibited. A simple on-screen virtual calculator is provided in the CBT interface.
- Rough sheets will be provided at the examination centre. Write your roll number on every sheet.

Section A — Single Correct
MCQ (Q1–Q20) [+4 / −1]

Q1. Consider the first ionisation energies of the Period 2 elements. Despite oxygen (O, $Z = 8$) having a higher nuclear charge than nitrogen (N, $Z = 7$), the first ionisation energy of oxygen is **less** than that of nitrogen. Which of the following **correctly** explains this observation?

(A) Oxygen has more protons, making its electrons more tightly bound, so the anomaly does not exist.

(B) Nitrogen has a half-filled $2p$ sub-shell that is *less* stable than oxygen's configuration, so nitrogen's electrons are easier to remove.

(C) Oxygen has a completely filled $2p$ sub-shell, making it extra stable and harder to ionise.

(D) Oxygen has one paired $2p$ electron that experiences extra electron–electron repulsion, making it easier to remove than any electron from nitrogen's half-filled $2p^3$ configuration.

Q2. According to Fajan's rules, covalent character in an ionic compound increases with (i) smaller and more highly charged cation and (ii) larger anion. Which of the following pairs of compounds correctly lists the one with **more** covalent character **first**?

(A) $AlCl_3$ has more covalent character than NaCl, because Al^{3+} is small and triply charged, polarising the Cl^- anion strongly.

(B) NaCl has more covalent character than $AlCl_3$, because Na^+ is larger and distorts Cl^- more.

(C) Both $AlCl_3$ and NaCl have identical covalent character since both contain Cl^-.

(D) $AlCl_3$ has less covalent character than NaCl because the higher charge on Al^{3+} increases the ionic character.

Q3. Which of the following statements about the **critical temperature** (T_c) of a real gas is **correct**?

(A) Above T_c, a gas can always be liquefied by applying sufficiently high pressure.

(B) Above T_c, a gas cannot be liquefied regardless of how much pressure is applied, because the kinetic energy of molecules exceeds the intermolecular attractive forces at all pressures.

(C) T_c is the temperature at which the gas obeys the ideal gas law perfectly.

(D) At T_c, the gas spontaneously liquefies without any applied pressure.

Q4. Kirchhoff's equation relates the enthalpy of a reaction at two different temperatures. For a reaction with $\Delta C_p = \sum C_p(\text{products}) - \sum C_p(\text{reactants}) > 0$, which statement is **correct**?

(A) ΔH decreases as temperature increases because higher temperature always favours exothermic reactions.

(B) ΔH remains constant regardless of temperature because enthalpy is a state function.

(C) ΔH increases as temperature increases: $\Delta H(T_2) = \Delta H(T_1) + \Delta C_p(T_2 - T_1)$ when $\Delta C_p > 0$.

(D) ΔH becomes zero at very high temperatures because the product and reactant heat capacities equalise.

Q5. An inert (non-reacting) gas is added to the following gaseous equilibrium system in a **rigid container** (constant volume):

$$\mathrm{N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g)}$$

What is the effect on the equilibrium?

(A) The equilibrium shifts to the right (towards NH_3) because the total pressure increases.

(B) The equilibrium shifts to the left (towards reactants) because the mole fraction of each reacting species decreases.

(C) The equilibrium shifts to the right because the inert gas dilutes the reactants less than the products.

(D) The equilibrium does **not** shift, because at constant volume the partial pressures of all reacting species remain unchanged.

Q6. Sodium acetate (CH_3COONa) is dissolved in water at 25°C. Which of the following **correctly** describes the nature of the resulting solution?

(A) The solution is basic (pH > 7) because CH_3COO^- is the conjugate base of the weak acid CH_3COOH and hydrolyses to produce OH^-.

(B) The solution is acidic (pH < 7) because Na^+ is a Lewis acid that donates a proton to water.

(C) The solution is neutral (pH $= 7$) because both Na^+ and CH_3COO^- are spectator ions.

(D) The solution is acidic because acetic acid is a weak acid and its salt always gives an acidic solution.

Q7. Kohlrausch's law states that the limiting molar conductance Λ_m° of an electrolyte equals the sum of the limiting ionic conductances of its constituent ions. Which of the following is a **correct** application of Kohlrausch's law?

(A) It can only be used for strong electrolytes because weak electrolytes do not fully dissociate even at infinite dilution.

(B) It allows Λ_m° of weak electrolytes (e.g., acetic acid) to be calculated from the Λ_m° values of strong electrolytes (e.g., HCl, NaCl, CH_3COONa).

(C) It states that the molar conductance of a solution increases indefinitely with dilution for all electrolytes.

(D) It predicts that the conductance of a solution is independent of the nature of the ions present.

Q8. A reaction has an activation energy $E_a = 40\,\text{kJ/mol}$. Using the Arrhenius equation, calculate the ratio k_2/k_1 when the temperature is raised from $T_1 = 300\,\text{K}$ to $T_2 = 310\,\text{K}$. (Use $R = 8.314\,\text{J mol}^{-1}\,\text{K}^{-1}$; $e^{0.52} \approx 1.68$)

(A) $k_2/k_1 \approx 1.10$

(B) $k_2/k_1 \approx 2.50$

(C) $k_2/k_1 \approx 1.68$

(D) $k_2/k_1 \approx 0.60$

Q9. Henry's law describes the solubility of gases in liquids. Which of the following **correctly** states Henry's law and gives a valid application?

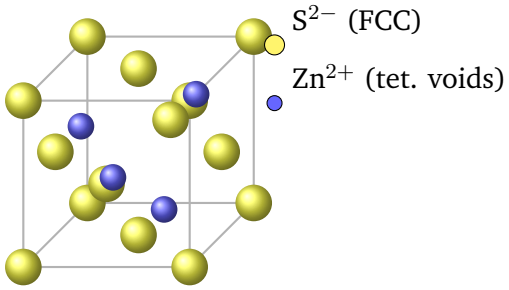
(A) The partial pressure of a gas above a solution is inversely proportional to the mole fraction of the dissolved gas; hence carbonated drinks are sealed under low pressure to keep CO_2 dissolved.

(B) The solubility of a gas in a liquid is independent of the partial pressure of the gas above the liquid.

(C) Henry's law states that the vapour pressure of a solution equals the mole fraction of the solvent times the vapour pressure of the pure solvent.

(D) The partial pressure of a gas above a solution is directly proportional to the mole fraction of the gas dissolved in the liquid: $p = K_H \cdot \chi_{\text{gas}}$; hence CO_2 stays dissolved in a carbonated drink only when the bottle is sealed under high pressure.

Q10. In the zinc-blende (sphalerite) structure of ZnS, the S^{2-} ions form a **face-centred cubic (FCC)** lattice, and the Zn^{2+} ions occupy a fraction of the tetrahedral voids. Which of the following **correctly** describes the structure?



(A) Zn^{2+} occupy *half* of the tetrahedral voids; the coordination number of both Zn^{2+} and S^{2-} is 4 (tetrahedral).

(B) Zn^{2+} occupy all of the octahedral voids; coordination number of Zn^{2+} is 6.

(C) Zn^{2+} occupy all of the tetrahedral voids; coordination number of Zn^{2+} is 4 and of S^{2-} is 8.

(D) The structure of ZnS is the same as NaCl (rock salt), with each ion in 6-coordinate octahedral sites.

Q11. Surfactants (emulsifiers) are used to stabilise emulsions. Which of the following **correctly** describes the mechanism by which a surfactant such as soap (sodium stearate) stabilises an oil-in-water emulsion?

(A) Surfactant molecules are entirely hydrophilic and form a thick aqueous shell around oil droplets that prevents coalescence by increasing the viscosity of the aqueous phase.

(B) Surfactant molecules are amphiphilic: the hydrophobic tail inserts into the oil droplet while the hydrophilic (ionic) head faces the water, creating a charged layer around each droplet that prevents coalescence.

(C) Surfactant molecules coat the oil droplet with a hydrophobic layer, making the droplet miscible with water by converting it into a solid particle.

(D) Surfactants work by completely dissolving the oil into the aqueous phase, forming a true solution rather than an emulsion.

Q12. When quicklime (CaO) is added to water, which of the following **correctly** describes the observation and the product formed?

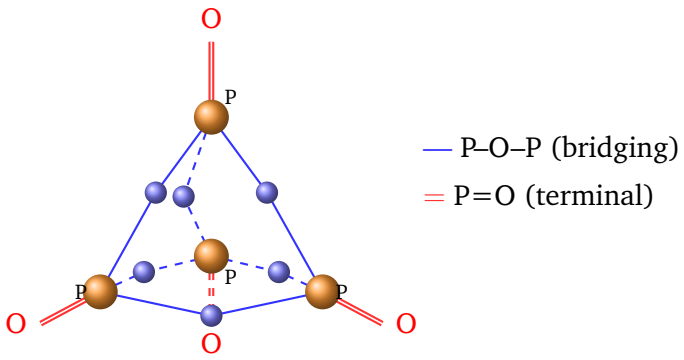
(A) CaO dissolves freely and completely in water to give a clear, colourless solution of $Ca(OH)_2$ at room temperature without any temperature change.

(B) CaO reacts with water to produce $CaCO_3$ (chalk) and CO_2 gas.

(C) CaO reacts vigorously with water with the evolution of a large amount of heat to form $Ca(OH)_2$ (slaked lime), which is sparingly soluble in water.

(D) CaO does not react with water at room temperature; it requires heating above 500°C.

Q13. Phosphorus pentoxide (P_4O_{10}) has a cage-like structure. Which of the following **correctly** describes the bonding in P_4O_{10}?



(A) P_4O_{10} has 4 terminal P–O single bonds and 6 bridging P=O double bonds; each phosphorus is tetrahedral.

(B) P_4O_{10} consists of four isolated PO_4^{3-} tetrahedra linked by calcium ions and has no P–O–P bridges.

(C) P_4O_{10} has 10 terminal P=O bonds and no P–O–P bridges; phosphorus is hypervalent.

(D) P_4O_{10} has 6 bridging P–O–P bonds (6 bridging oxygen atoms) and 4 terminal P=O bonds (4 terminal oxygen atoms); each P is in a tetrahedral environment and has oxidation state $+5$.

Q14. The Mond process is used for the purification of nickel. Which of the following **correctly** describes the Mond process?

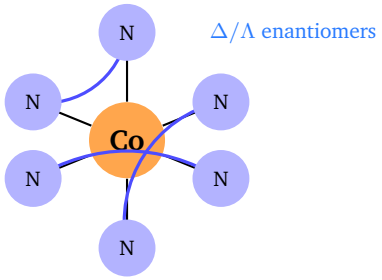
(A) Impure nickel is treated with CO at $\approx 60^\circ$C to form the volatile complex nickel tetracarbonyl, $Ni(CO)_4$, which is then decomposed at $\approx 180^\circ$C to deposit pure nickel and regenerate CO.

(B) Nickel ore is reduced with coke in a blast furnace at 1500°C to give molten nickel, which is then electrolytically refined.

(C) Impure nickel is dissolved in HCl and the solution is electrolysed, depositing pure nickel at the cathode.

(D) Nickel is purified by zone refining, in which a narrow molten zone is passed along a nickel rod to sweep impurities to one end.

Q15. The complex $[Co(en)_3]^{3+}$ (where en = ethylenediamine, a bidentate ligand) is octahedral. Which type of isomerism does it exhibit, and why?



$[Co(en)_3]^{3+}$: three bidentate en ligands

(A) Geometric (cis/trans) isomerism, because the three en ligands can arrange themselves in different spatial positions relative to each other.

(B) Optical isomerism (chirality), because the complex belongs to the D_3 point group, has no plane or centre of symmetry, and exists as non-superimposable Λ (left-handed) and Δ (right-handed) enantiomers.

(C) Ionisation isomerism, because the en ligands can dissociate and re-coordinate in different ways.

(D) No isomerism, because all three en ligands are identical and the complex is symmetric.

Q16. In crystal field theory, the crystal field splitting in **tetrahedral** complexes (Δ_t) is related to the splitting in **octahedral** complexes (Δ_o) for the same metal and ligands by:

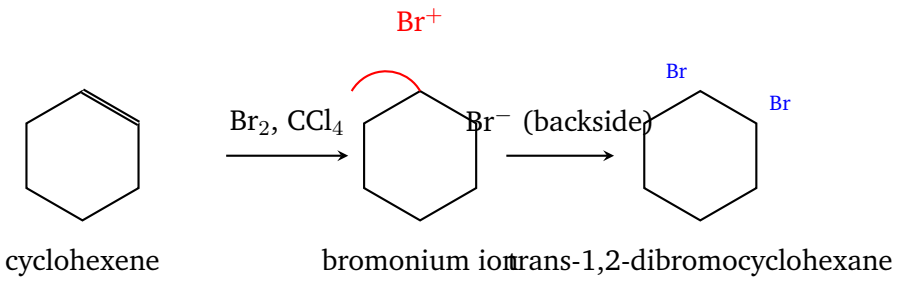
(A) $\Delta_t = \Delta_o$ (the splitting is the same in both geometries)

(B) $\Delta_t = \frac{2}{3}\,\Delta_o$

(C) $\Delta_t = \frac{4}{9}\,\Delta_o$

(D) $\Delta_t = 2\,\Delta_o$

Q17. When cyclohexene is treated with bromine (Br_2) in an inert solvent (e.g., CCl_4), the reaction proceeds via a **bromonium ion** intermediate. Which of the following is the **major product**?



(A) cis-1,2-Dibromocyclohexane (syn addition), because the bromonium ion opens with retention of configuration.

(B) 1-Bromocyclohex-2-ene formed by allylic bromination.

(C) Cyclohexane, formed by addition of HBr across the double bond.

(D) trans-1,2-Dibromocyclohexane (anti addition), because Br^- attacks the bromonium ion from the side opposite to the bridging Br^+.

Q18. Acetic acid is treated with ethanol in the presence of concentrated H_2SO_4 as catalyst. The reaction is:

$$CH_3COOH + C_2H_5OH \underset{\Delta}{\overset{H^+}{\rightleftharpoons}} CH_3COOC_2H_5 + H_2O$$

Which of the following statements about this **Fischer esterification** is **correct**?

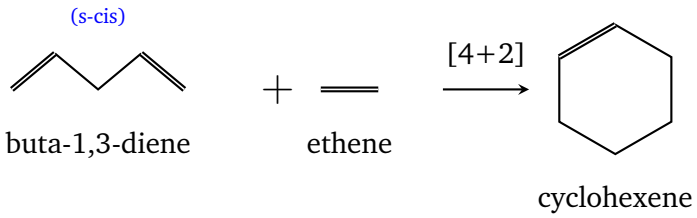
(A) The reaction is reversible; the yield of ester can be increased by using excess alcohol or by removing water from the reaction mixture.

(B) The reaction is irreversible; once ester is formed it cannot be hydrolysed back to acid and alcohol.

(C) H_2SO_4 acts as a reactant and is consumed during the reaction.

(D) The oxygen in the ester product comes from the alcohol, not from the carboxylic acid.

Q19. The Diels-Alder reaction is a [4+2] cycloaddition between a conjugated diene and a dienophile. Which of the following **correctly** describes the reaction of buta-1,3-diene with ethene?



(A) The reaction produces benzene, because three double bonds condense with loss of H_2.

(B) The reaction is a concerted [4+2] cycloaddition giving cyclohexene as the product, with formation of two new σ bonds in a single step.

(C) The reaction proceeds via a free radical mechanism and gives a mixture of acyclic products.

(D) The reaction requires a Lewis acid catalyst and proceeds through a carbocation intermediate.

Q20. BUNA-S is a synthetic rubber widely used as a substitute for natural rubber. Which of the following **correctly** describes BUNA-S?

(A) BUNA-S is a homopolymer of buta-1,3-diene; no styrene is involved.

(B) BUNA-S is a copolymer of butadiene and acrylonitrile (used for oil-resistant applications).

(C) BUNA-S (styrene–butadiene rubber, SBR) is a copolymer of buta-1,3-diene and styrene ($C_6H_5CH{=}CH_2$), used as a general-purpose synthetic rubber.

(D) BUNA-S is obtained by the vulcanisation of natural rubber with sulphur.

Section B — Numerical Value Questions (Q21–Q30) [Attempt Any 5]

Q21. Propene ($CH_2{=}CH{-}CH_3$) contains both σ (sigma) and π (pi) bonds. How many **sigma bonds** are present in one molecule of propene? (Count all C–H and C–C single bonds, and the sigma component of the C=C double bond.)

(Enter the exact numerical value as your answer.)

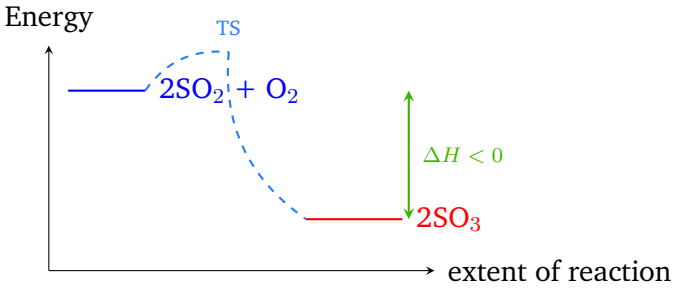
Q22. Calculate the **pH** of a 0.001 M aqueous solution of nitric acid (HNO_3). HNO_3 is a strong acid that is completely dissociated in water. (Use $-\log(10^{-3}) = 3$)

(Enter the exact numerical value as your answer.)

Q23. How many **unpaired electrons** are present in the Cr^{3+} ion? (Atomic number of Cr $= 24$; electronic configuration of Cr $= [\text{Ar}]3d^5\,4s^1$)

(Enter the exact numerical value as your answer.)

Q24. For the reaction $2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g)$, the equilibrium constant $K_c = 800$ at temperature T. Given that $RT = 10\,\text{L atm mol}^{-1}$ at this temperature, calculate K_p for this reaction.



(Enter the exact numerical value as your answer.)

Q25. Calculate the number of moles of water (H_2O) produced when **2 moles** of methane (CH_4) undergo complete combustion according to:

$$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(g)$$

(Enter the exact numerical value as your answer.)

Q26. Calculate the **degree of unsaturation** (index of hydrogen deficiency, IHD) of phenol (C_6H_5OH). Use the formula: IHD $= \frac{2C+2-H}{2}$ for a compound C_nH_m (oxygen does not affect IHD).

(Enter the exact numerical value as your answer.)

Q27. In the NaCl (rock salt) crystal structure, what is the **coordination number** of the Na^+ ion (i.e., how many Cl^- ions directly surround each Na^+)?

(Enter the exact numerical value as your answer.)

Q28. The magnetic moment μ of a transition metal ion is given by $\mu = \sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons. For the Ni^{2+} ion (atomic number of Ni $= 28$; configuration of Ni $= [Ar]3d^8\,4s^2$), calculate the value of $n(n+2)$.

(Enter the exact numerical value as your answer.)

Q29. A first-order reaction has a rate constant $k = 0.0231\ \text{min}^{-1}$. Calculate the **half-life** (in minutes) of this reaction. (Use $\ln 2 = 0.693$)

(Enter the exact numerical value as your answer.)

Q30. XeF_4 (xenon tetrafluoride) has a square planar molecular geometry. How many **lone pairs** are present on the central Xe atom in XeF_4?

(Enter the exact numerical value as your answer.)

Detailed Solutions

Q1.

Solution

Concept — Ionisation Energy Anomaly in Period 2 (IE of O $<$ IE of N): Across a period, IE generally increases with atomic number due to increasing nuclear charge. However, oxygen ($1s^2 2s^2 2p^4$) has a *lower* first IE than nitrogen ($1s^2 2s^2 2p^3$) because nitrogen has a half-filled 2p sub-shell (extra stability) whereas oxygen has one *paired* electron in a 2p orbital.

Step 1 — Electronic configurations:

- N: $[\text{He}]\, 2s^2\, 2p_x^1\, 2p_y^1\, 2p_z^1$ — all three 2p electrons are unpaired (half-filled 2p, extra exchange energy stability).
- O: $[\text{He}]\, 2s^2\, 2p_x^2\, 2p_y^1\, 2p_z^1$ — one 2p orbital is *doubly occupied*; the paired electrons repel each other.

Step 2 — Why O has lower IE: The paired electron in O's $2p_x$ orbital experiences extra electron–electron repulsion from its partner. This repulsion lowers the energy needed to remove that electron, so IE(O) $<$ IE(N) despite the higher Z of O.

Why other options are wrong:

- Option A: The anomaly is well-established; higher nuclear charge alone does not guarantee higher IE.
- Option B: The half-filled 2p sub-shell of N is *more* stable (not less stable) than O's configuration, making N's electrons *harder* to remove.
- Option C: O does *not* have a completely filled 2p sub-shell; it has $2p^4$ (four electrons in three orbitals — one pair, two singles).

Final Answer: O has a paired 2p electron with extra repulsion $\Rightarrow$ Option D

Answer: (D) Go Back to Q#1

Q2.

Solution

Concept — Fajan's Rules and Covalent Character: An ionic compound acquires covalent character when the cation *polarises* the electron cloud of the anion. Polarising power of cation increases with: (i) smaller size, (ii) higher positive charge. Polarisability of anion increases with larger size.

Step 1 — Compare Al^{3+} (in $AlCl_3$) and Na^+ (in NaCl):

- Al^{3+}: ionic radius ≈ 53 pm, charge $+3 \Rightarrow$ very high charge density, very high polarising power.
- Na^+: ionic radius ≈ 102 pm, charge $+1 \Rightarrow$ low charge density, low polarising power.

Step 2 — Conclusion: $AlCl_3$ has far greater covalent character than NaCl. In practice, $AlCl_3$ is a covalent/molecular compound (exists as Al_2Cl_6 dimers) whereas NaCl is a typical ionic solid.

Why other options are wrong:

- Option B: Na^+ is *larger*, not smaller, and has lower charge; NaCl has *less* covalent character.
- Option C: They do not have identical covalent character; Al^{3+} polarises Cl^- far more strongly.
- Option D: Higher charge on Al^{3+} *increases* polarising power and thus *increases* covalent character, not ionic character.

Final Answer: $AlCl_3$ has more covalent character than NaCl $\Rightarrow$ Option A

Answer: (A) Go Back to Q#2

Q3.

Solution

Concept — Critical Temperature of Real Gases: Every real gas has a critical temperature T_c above which it *cannot* be liquefied no matter how high the pressure applied. Below T_c, sufficient pressure can cause liquefaction. For van der Waals gas: $T_c = \frac{8a}{27Rb}$.

Step 1 — Physical meaning of T_c: Above T_c, the kinetic energy of molecules is so high that intermolecular attractions cannot hold them together in the liquid phase, even under enormous pressure. Increasing pressure above T_c only compresses the

gas (gives a supercritical fluid) without producing a distinct liquid phase.

Why other options are wrong:

- Option A: This is the *opposite* of the correct statement; above T_c, liquefaction is impossible at any pressure.
- Option C: T_c is not the temperature of ideal-gas behaviour. Gases approach ideal behaviour at very high temperatures and low pressures.
- Option D: At T_c alone, the gas does not spontaneously liquefy; both T_c and P_c (critical pressure) must be reached together to observe the critical state.

Final Answer: Above T_c, a gas cannot be liquefied at any pressure $\Rightarrow$ Option B

Answer: (B) Go Back to Q#3

Q4.

Solution

Concept — Kirchhoff's Law (Temperature Dependence of ΔH): Kirchhoff's equation states:

$$\Delta H(T_2) = \Delta H(T_1) + \Delta C_p(T_2 - T_1)$$

where $\Delta C_p = \sum C_p(\text{products}) - \sum C_p(\text{reactants})$.

Step 1 — Apply the condition $\Delta C_p > 0$: If $\Delta C_p > 0$ and $T_2 > T_1$, then $\Delta C_p(T_2 - T_1) > 0$, so $\Delta H(T_2) > \Delta H(T_1)$. The enthalpy of reaction *increases* (becomes less negative for exothermic, or more positive for endothermic) as temperature rises.

Why other options are wrong:

- Option A: The direction of ΔH change depends on ΔC_p, not on whether the reaction is exothermic; if $\Delta C_p > 0$, $|\Delta H|$ of an exothermic reaction *decreases* in magnitude.
- Option B: ΔH is temperature-dependent (Kirchhoff's law); it is constant only if $\Delta C_p = 0$.
- Option D: ΔH does not become zero simply at high T; it approaches zero only under special circumstances.

Final Answer: With $\Delta C_p > 0$, ΔH increases as T increases $\Rightarrow$ Option C

Answer: (C) Go Back to Q#4

Q5.

Solution

Concept — Effect of Adding Inert Gas at Constant Volume: At constant volume, adding an inert gas increases the total pressure, but the *partial pressures* (and concentrations) of the reacting species remain *unchanged* (the volume is fixed and no reacting gas is added). Therefore the reaction quotient Q does not change, and the equilibrium is undisturbed.

Step 1 — Key distinction (constant volume vs. constant pressure):

- At **constant volume**: $p_i = n_i RT/V$; adding inert gas changes total P but not p_i of reactants/products $\Rightarrow$ no shift.
- At **constant pressure**: adding inert gas increases total moles, reducing mole fractions and hence partial pressures of reacting gases $\Rightarrow$ equilibrium shifts towards more moles of gas.

Why other options are wrong:

- Option A: Total pressure increases, but K_p and partial pressures of reactants/products are unchanged.
- Option B: This is the behaviour at constant pressure, not constant volume.
- Option C: There is no preferential dilution; the inert gas affects all species equally in terms of volume (but at constant V, it affects none of the partial pressures).

Final Answer: Equilibrium does not shift at constant volume $\Rightarrow$ Option D

Answer: (D) Go Back to Q#5

Q6.

Solution

Concept — Hydrolysis of Salt of Weak Acid and Strong Base: Sodium acetate (CH_3COONa) is the salt of a weak acid (CH_3COOH, $K_a \approx 1.8 \times 10^{-5}$) and a strong base (NaOH). The acetate ion undergoes hydrolysis:

$$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$$

Step 1 — Nature of Na^+ in water: Na^+ is the cation of a strong base (NaOH); it does not hydrolyse and has no acidic character.

Step 2 — Net effect: CH_3COO^- produces OH^- on hydrolysis $\Rightarrow$ solution is **basic**, pH > 7.

Why other options are wrong:

- Option B: Na^+ does not act as a Lewis acid or donate protons; it is a spectator cation.
- Option C: CH_3COO^- is *not* a spectator ion; it hydrolyses to make the solution basic.
- Option D: The salt of a weak acid and strong base always gives a basic solution, not an acidic one.

Final Answer: CH_3COONa solution is basic, pH $> 7 \Rightarrow$ Option A

Answer: (A) Go Back to Q#6

Q7.

Solution

Concept — Kohlrausch's Law of Independent Migration of Ions: At infinite dilution, each ion makes an independent contribution to the molar conductance. For an electrolyte $M_\nu{}^+X_\nu{}^-$:

$$\Lambda_m^\circ = \nu_+\lambda_+^\circ + \nu_-\lambda_-^\circ$$

Key application: Λ_m° of weak electrolytes (e.g., CH_3COOH) *cannot* be obtained by extrapolation of conductance vs. $\sqrt{c}$ plots (Kohlrausch equation), but can be calculated indirectly using strong electrolyte data:

$$\Lambda_m^\circ(CH_3COOH) = \Lambda_m^\circ(HCl) + \Lambda_m^\circ(CH_3COONa) - \Lambda_m^\circ(NaCl)$$

Why other options are wrong:

- Option A: Kohlrausch's law *is* applied to weak electrolytes; it allows their Λ_m° to be determined indirectly.
- Option C: Molar conductance increases with dilution for weak electrolytes (more dissociation) and approaches Λ_m° at infinite dilution; it does not increase indefinitely.
- Option D: Conductance depends on the nature, charge, and mobility of specific ions; different ions have different λ° values.

Final Answer: Kohlrausch's law enables calculation of Λ_m° for weak electrolytes

from strong electrolyte data $\Rightarrow$ Option B

Answer: (B) Go Back to Q#7

Q8.

Solution

Concept — Arrhenius Equation: The temperature dependence of the rate constant is:

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Step 1 — Substitute values: $E_a = 40{,}000\,\text{J/mol}$, $T_1 = 300\,\text{K}$, $T_2 = 310\,\text{K}$, $R = 8.314\,\text{J mol}^{-1}\,\text{K}^{-1}$.

$$\frac{1}{T_1} - \frac{1}{T_2} = \frac{1}{300} - \frac{1}{310} = \frac{310 - 300}{300 \times 310} = \frac{10}{93000} = 1.075 \times 10^{-4}\,\text{K}^{-1}$$

Step 2 — Calculate the exponent:

$$\ln \frac{k_2}{k_1} = \frac{40000}{8.314} \times 1.075 \times 10^{-4} = 4810.2 \times 1.075 \times 10^{-4} \approx 0.517 \approx 0.52$$

Step 3 — Evaluate the ratio:

$$\frac{k_2}{k_1} = e^{0.52} \approx \mathbf{1.68}$$

Why other options are wrong:

- Option A (≈ 1.10): This would require a much smaller exponent ($\ln 1.10 \approx 0.095$), inconsistent with the given E_a.
- Option B (≈ 2.50): This would require $\ln(k_2/k_1) \approx 0.92$, which corresponds to a higher E_a or larger ΔT.
- Option D (≈ 0.60): A ratio less than 1 would mean the rate *decreases* with increasing temperature, which contradicts Arrhenius behaviour.

Final Answer: $k_2/k_1 = e^{0.52} \approx 1.68 \Rightarrow$ Option C

Answer: (C) Go Back to Q#8

Q9.

Solution

Concept — Henry's Law: At constant temperature, the partial pressure of a gas in equilibrium with a solution is directly proportional to the mole fraction of the dissolved gas:

$$p = K_H \cdot \chi_{\text{gas}}$$

where K_H is Henry's law constant (specific to gas–solvent pair and temperature). Higher pressure above the liquid $\Rightarrow$ more gas dissolves.

Application to carbonated drinks: CO_2 is dissolved under high pressure (K_H is large for CO_2 in water at low temperature). When the bottle is opened, the partial pressure of CO_2 above the liquid drops sharply, and dissolved CO_2 escapes as bubbles.

Why other options are wrong:

- Option A: The statement says "inversely proportional" and "low pressure to keep CO_2 dissolved" — both are *incorrect*. High pressure keeps CO_2 dissolved.
- Option B: Solubility of a gas *does* depend on partial pressure; this contradicts Henry's law.
- Option C: This describes Raoult's law (vapour pressure of solvent), not Henry's law (dissolved gas).

Final Answer: $p = K_H \cdot \chi_{\text{gas}}$; high pressure keeps CO_2 dissolved $\Rightarrow$ Option D

Answer: (D) Go Back to Q#9

Q10.

Solution

Concept — Zinc Blende (Sphalerite) Structure of ZnS: In the zinc-blende structure, S^{2-} ions form an FCC lattice. There are 8 tetrahedral voids per unit cell in an FCC arrangement (2 per formula unit of FCC). Zn^{2+} ions occupy *half* of these tetrahedral voids (4 per unit cell). The formula ZnS thus has a 1:1 ratio.

Step 1 — Tetrahedral voids in FCC: An FCC unit cell with $Z = 4$ formula units has $2 \times Z = 8$ tetrahedral voids. Half are occupied by Zn^{2+} $\Rightarrow$ 4 Zn^{2+} per unit cell, matching 4 S^{2-} per unit cell.

Step 2 — Coordination numbers: Each Zn^{2+} is surrounded by 4 S^{2-} in a tetrahedral arrangement (CN = 4). By symmetry, each S^{2-} is also surrounded by 4 Zn^{2+}

in a tetrahedral arrangement (CN = 4).

Why other options are wrong:

- Option B: Octahedral voids are occupied in NaCl, not in ZnS (zinc-blende); CN would be 6, not 4.
- Option C: If all tetrahedral voids were filled, the formula would be Zn_2S, not ZnS; also CN of S would not be 8.
- Option D: The NaCl structure has CN = 6 for both ions; ZnS (zinc-blende) has CN = 4, different structure.

Final Answer: Zn^{2+} occupy half the tetrahedral voids; CN of both ions $= 4 \Rightarrow$ Option A

Answer: (A) Go Back to Q#10

Q11.

Solution

Concept — Surfactants and Emulsion Stabilisation: Surfactant molecules have a **hydrophilic head** (ionic or polar group, e.g., COO^- Na^+ in soap) and a **hydrophobic tail** (long hydrocarbon chain). In an oil-in-water emulsion, the hydrophobic tails insert into oil droplets while the charged heads project into the surrounding water, forming a protective charged layer (electrical double layer) that prevents droplets from coalescing.

Step 1 — Orientation at oil–water interface: Soap molecules assemble at the interface with the hydrocarbon tail in the oil and the carboxylate head in water, reducing interfacial tension. The electrostatic repulsion between like-charged surfaces of neighbouring droplets prevents coalescence.

Why other options are wrong:

- Option A: Surfactants are *not* entirely hydrophilic; their dual nature (amphiphilic) is essential.
- Option C: A hydrophobic coating would make oil droplets aggregate, not become miscible with water.
- Option D: Oil is *not* dissolved into a true solution; an emulsion is a colloidal dispersion, not a molecular-level mixture.

Final Answer: Amphiphilic surfactant forms a protective charged layer around oil droplets $\Rightarrow$ Option B

Answer: (B) Go Back to Q#11

Q12.

Solution

Concept — Reaction of CaO (Quicklime) with Water: CaO is a basic oxide that reacts exothermically with water to form calcium hydroxide (slaked lime):

$$\mathrm{CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s) + heat}$$

The reaction is vigorous and releases sufficient heat to make the water boil and crack the solid. $Ca(OH)_2$ is sparingly soluble (solubility ≈ 1.5 g/L at 25°C), giving a milky suspension called lime water.

Why other options are wrong:

- Option A: $Ca(OH)_2$ is *sparingly* soluble, not freely soluble; the solution appears milky, not clear. The reaction is highly exothermic.
- Option B: CaO does not produce $CaCO_3$ on reaction with water; $CaCO_3$ forms when $Ca(OH)_2$ absorbs CO_2 from air.
- Option D: CaO is highly reactive with water even at room temperature; no heating is required.

Final Answer: $\mathrm{CaO + H_2O \rightarrow Ca(OH)_2}$ + heat (vigorous, exothermic) $\Rightarrow$ Option C

Answer: (C) Go Back to Q#12

Q13.

Solution

Concept — Structure of P_4O_{10}: P_4O_{10} is the anhydride of phosphoric acid. It has a cage structure based on a P_4 tetrahedron:

- 6 bridging P–O–P oxygen atoms (one on each edge of the P_4 tetrahedron, linking pairs of P atoms).
- 4 terminal P=O bonds (one on each phosphorus atom, pointing outward).
- Total oxygen atoms: $6 + 4 = 10$ (hence the formula P_4O_{10}).
- Each P atom: bonded to 3 bridging O and 1 terminal O $\Rightarrow$ tetrahedral, oxidation state $+5$.

Step 1 — Verify with oxidation state: Let OS of P be x: in P_4O_{10}, $4x + 10(-2) =$

$0 \Rightarrow x = +5$. Consistent with phosphorus pentoxide.

Why other options are wrong:

- Option A: Terminal bonds are P=O (double), not P–O (single); bridging bonds are P–O–P (single), not double.
- Option B: P_4O_{10} is a covalent molecular cage; it has no Ca^{2+} ions or separate PO_4^{3-} tetrahedra.
- Option C: There are 4 terminal P=O and 6 bridging P–O–P bonds, not 10 terminal bonds with no bridges.

Final Answer: 6 bridging P–O–P + 4 terminal P=O; each P is tetrahedral, OS $= +5 \Rightarrow$ Option D

Answer: (D) Go Back to Q#13

Q14.

Solution

Concept — Mond Process for Nickel Purification: The Mond process is an industrially important method for obtaining pure nickel. It exploits the ability of nickel to form a volatile, thermally unstable carbonyl complex:

Step 1 — Formation of $Ni(CO)_4$:

$$\text{Ni(impure)} + 4\,\text{CO} \xrightarrow{330\,\text{K}} \text{Ni(CO)}_4 \quad \text{(colourless liquid/gas, volatile)}$$

Impurities (Fe, Cu, Co) do not form volatile carbonyls under these conditions.

Step 2 — Decomposition to pure Ni:

$$\text{Ni(CO)}_4 \xrightarrow{450\,\text{K}} \text{Ni(pure)} + 4\,\text{CO} \quad \text{(CO recycled)}$$

Pure metallic nickel deposits as a solid; CO is recycled.

Why other options are wrong:

- Option B: This describes blast furnace iron smelting, not Ni purification. Ni is not refined in a blast furnace.
- Option C: Electrolytic refining uses the impure metal as anode and pure metal deposits at cathode; it does not use HCl dissolution and is a different technique.
- Option D: Zone refining is used for semiconductors (Si, Ge) and does not involve carbonyl formation; it is not the Mond process.

Final Answer: Ni + 4CO $\rightarrow$ $Ni(CO)_4$ (volatile, $\sim 60^\circ$C) $\rightarrow$ pure Ni (deposited at $\sim 180^\circ$C) $\Rightarrow$ Option A

Answer: (A) Go Back to Q#14

Q15.

Solution

Concept — Optical Isomerism in Tris(ethylenediamine)cobalt(III): The complex $[Co(en)_3]^{3+}$ has an octahedral geometry with three bidentate en ligands wrapping around the cobalt centre. Key symmetry analysis:

Step 1 — Symmetry elements: The complex belongs to the chiral D_3 point group. It possesses:

- A C_3 rotation axis (three-fold rotation through the Co centre along the axis bisecting the complex).
- Three C_2 axes perpendicular to C_3.
- *No* mirror planes (σ) and *no* centre of inversion (i).

The absence of any improper rotation axis (S_n, including $\sigma = S_1$ and $i = S_2$) makes the complex **chiral**.

Step 2 — The two enantiomers: The Λ (lambda, left-propeller) and Δ (delta, right-propeller) enantiomers are non-superimposable mirror images. They rotate plane-polarised light in opposite directions (optical activity). They are *not* interconvertible without breaking metal–ligand bonds.

Why other options are wrong:

- Option A: Geometric isomerism requires different arrangements of ligands in the same positions (e.g., cis/trans). With three identical bidentate ligands, geometric isomerism is not possible.
- Option C: Ionisation isomerism requires a ligand to exchange with a counter-ion; en is firmly coordinated and does not exchange this way.
- Option D: The complex *is* chiral, as shown by its D_3 symmetry; the three identical en ligands do not make it achiral.

Final Answer: $[Co(en)_3]^{3+}$ shows optical isomerism (Λ and Δ enantiomers) $\Rightarrow$ Option B

Answer: (B) Go Back to Q#15

Q16.

Solution

Concept — Crystal Field Splitting: Tetrahedral vs. Octahedral: In an octahedral complex, the d-orbitals split into t_{2g} (lower, 3 orbitals) and e_g (upper, 2 orbitals) sets, with splitting Δ_o. In a tetrahedral complex, the splitting is smaller because:

- There are only 4 ligands instead of 6 (fewer ligand–metal interactions).
- The ligands in a tetrahedral complex do not point directly at the d-orbitals (less overlap).

The quantitative relationship (derived from crystal field theory for the same metal–ligand system) is:

$$\Delta_t = \frac{4}{9}\,\Delta_o$$

Consequence: Since $\Delta_t \approx 0.44\,\Delta_o < P$ (pairing energy) for most ligands, tetrahedral complexes are almost always **high-spin**.

Why other options are wrong:

- Option A ($\Delta_t = \Delta_o$): Incorrect; the geometry of ligand approach changes the splitting drastically.
- Option B ($\Delta_t = \frac{2}{3}\Delta_o$): This is an incorrect fraction; the correct ratio is $4/9$.
- Option D ($\Delta_t = 2\Delta_o$): Tetrahedral splitting is always *less* than octahedral, not double.

Final Answer: $\Delta_t = \frac{4}{9}\,\Delta_o \Rightarrow$ Option C

Answer: (C) Go Back to Q#16

Q17.

Solution

Concept — Anti Addition of Br_2 to Alkenes (Bromonium Ion Mechanism): Bromine adds to alkenes via an electrophilic addition mechanism involving a cyclic **bromonium ion** intermediate. This intermediate prevents free rotation and forces the incoming Br^- nucleophile to attack from the side *opposite* to the bridging Br, giving an **anti** (trans) product.

Step 1 — Mechanism:

1. Br_2 approaches the π system of cyclohexene; the π electrons attack one Br,

forming a three-membered cyclic bromonium ion with the other Br leaving as Br^-.
2. Br^- attacks the back face (anti to the Br^+ bridge) at one of the two ring carbons.
3. The result is *trans*-1,2-dibromocyclohexane (the two Br atoms on opposite faces of the ring).

Step 2 — Stereochemical outcome: In cyclohexane ring notation, the two Br atoms added anti give a *trans* (diaxial or diequatorial) product. The trans isomer is the only product; the cis isomer is not formed.

Why other options are wrong:

- Option A: cis addition (syn addition) would require the Br^- to attack from the *same* side as the Br^+; the bromonium ion physically blocks this face.
- Option B: Allylic bromination requires NBS (N-bromosuccinimide) and UV/light (radical mechanism), not Br_2 in CCl_4 with an unconjugated alkene.
- Option C: HBr addition (Markovnikov) gives bromocyclohexane, not Br_2 addition; also the reagent is Br_2, not HBr.

Final Answer: Anti addition gives *trans*-1,2-dibromocyclohexane $\Rightarrow$ Option D

Answer: (D) Go Back to Q#17

Q18.

Solution

Concept — Fischer Esterification (Acid-Catalysed): Fischer esterification is the reversible, acid-catalysed condensation of a carboxylic acid with an alcohol to give an ester and water. The mechanism involves protonation of the carbonyl oxygen, nucleophilic attack by the alcohol, proton transfers, and loss of water. The reaction is an equilibrium:

$$\text{RCOOH} + \text{R'OH} \underset{\Delta}{\overset{H^+}{\rightleftharpoons}} \text{RCOOR'} + H_2O$$

Step 1 — Reversibility and Le Chatelier's principle: Since water is a product, the reaction can be pushed to the right (higher ester yield) by:

- Using excess alcohol (shifts equilibrium by increasing reactant concentration).
- Removing water as it forms (e.g., azeotropic distillation, molecular sieves, or Dean–Stark apparatus).

Why other options are wrong:

- Option B: The reaction is *reversible*; ester hydrolysis (saponification with base, or acid hydrolysis) is well known.
- Option C: H_2SO_4 is a *catalyst*; it is not consumed. It speeds up both forward and reverse reactions equally.
- Option D: In Fischer esterification, the C–OH bond of the *acid* breaks (acyl–oxygen fission). The oxygen in the ester (C–O–C) originates from the *alcohol*, and the water molecule takes the OH from the acid. Isotope labelling (^{18}O) confirms this: the ester oxygen comes from the alcohol.

Final Answer: Fischer esterification is reversible; excess alcohol or water removal increases yield $\Rightarrow$ Option A

Answer: (A) Go Back to Q#18

Q19.

Solution

Concept — Diels-Alder Reaction ([4+2] Cycloaddition): The Diels-Alder reaction is a **pericyclic** (concerted, no intermediate) [4+2] cycloaddition between:

- A **diene** in the *s-cis* conformation (4 π electrons).
- A **dienophile** (electron-poor alkene or alkyne; 2 π electrons).

Two new σ bonds form simultaneously at the terminal carbons of the diene and the two carbons of the dienophile, giving a six-membered ring.

Step 1 — Apply to buta-1,3-diene + ethene:

$$CH_2{=}CH{-}CH{=}CH_2 + CH_2{=}CH_2 \xrightarrow{\Delta} \text{cyclohexene}$$

The product **cyclohexene** contains one π bond (from the central portion of the diene) and a new six-membered ring. Two new C–C σ bonds form in the single concerted step.

Why other options are wrong:

- Option A: Benzene requires loss of H_2 (aromatisation); the Diels-Alder product is cyclohexene, not benzene.
- Option C: Diels-Alder is a *pericyclic* (thermal, concerted) reaction, not a radical chain mechanism.

- Option D: No Lewis acid catalyst is required for the basic Diels-Alder reaction (though Lewis acids can accelerate it); the mechanism is concerted, not ionic.

Final Answer: Concerted [4+2] cycloaddition gives cyclohexene $\Rightarrow$ Option B

Answer: (B) Go Back to Q#19

Q20.

Solution

Concept — BUNA-S (Styrene-Butadiene Rubber, SBR): BUNA-S is one of the most important synthetic rubbers. The name comes from **BU**tadiene (German: Butadien) + **NA**trium (sodium, the polymerisation initiator) + **S**tyrene. It is produced by **emulsion copolymerisation** of:

- Buta-1,3-diene ($CH_2{=}CH{-}CH{=}CH_2$): provides elasticity and flexibility.
- Styrene ($C_6H_5CH{=}CH_2$): provides rigidity and abrasion resistance.

Typical composition: $\approx 75\%$ butadiene, 25% styrene. SBR is the most widely used synthetic rubber (e.g., automobile tyres).

Why other options are wrong:

- Option A: BUNA-S is a *co*polymer of butadiene *and* styrene; a homopolymer of butadiene alone would be poly(butadiene), not BUNA-S.
- Option B: This describes **BUNA-N** (nitrile rubber, NBR), the copolymer of butadiene and acrylonitrile used for oil resistance; BUNA-S uses styrene.
- Option D: Vulcanisation of natural rubber gives vulcanised rubber (with S–S crosslinks), not SBR. SBR is a distinct synthetic copolymer.

Final Answer: BUNA-S = copolymer of buta-1,3-diene and styrene (SBR) $\Rightarrow$ Option C

Answer: (C) Go Back to Q#20

Q21.

Solution

Concept — Counting Sigma Bonds in a Molecule: Every single bond is a σ bond. A double bond consists of 1 σ + 1 π bond. Count all σ bonds systematically.

Step 1 — Structure of propene: CH_2=CH–CH_3

- C1=C2 double bond: 1 σ bond (and 1 π bond).
- C2–C3 single bond: 1 σ bond.
- C1 (=CH_2): 2 C–H bonds $\Rightarrow$ 2 σ bonds.
- C2 (=CH–): 1 C–H bond $\Rightarrow$ 1 σ bond.
- C3 (–CH_3): 3 C–H bonds $\Rightarrow$ 3 σ bonds.

Step 2 — Total:

$$\sigma(\text{C=C}) + \sigma(\text{C–C}) + \sigma(\text{C1–H}) + \sigma(\text{C2–H}) + \sigma(\text{C3–H}) = 1 + 1 + 2 + 1 + 3 = \boxed{8}$$

Answer: (8) Go Back to Q#21

Q22.

Solution

Concept — pH of Strong Acid: HNO_3 is a strong acid, fully dissociated: $HNO_3 \rightarrow H^+ + NO_3^-$.

Step 1 — Find [H^+]:

$$[\text{H}^+] = 0.001\ \text{mol/L} = 10^{-3}\ \text{mol/L}$$

Step 2 — Calculate pH:

$$\text{pH} = -\log[\text{H}^+] = -\log(10^{-3}) = \boxed{3}$$

Answer: (3) Go Back to Q#22

Q23.

Solution

Concept — Electronic Configuration of Cr^{3+}: Chromium has the anomalous configuration $[Ar]3d^5\,4s^1$ (not $3d^4\,4s^2$) due to the extra stability of the half-filled d sub-shell.

Step 1 — Remove 3 electrons to form Cr^{3+}: Electrons are removed in the order $4s$ first, then $3d$:

$$Cr : [Ar]\,3d^5\,4s^1 \xrightarrow{-3e^-} Cr^{3+} : [Ar]\,3d^3$$

Step 2 — Count unpaired electrons in $3d^3$: With 3 electrons in 5 d orbitals, each goes into a separate orbital (Hund's rule): $\uparrow \mid \uparrow \mid \uparrow \mid \mid$

$$n = \boxed{3} \text{ unpaired electrons}$$

(Magnetic moment $\mu = \sqrt{3(3+2)} = \sqrt{15} \approx 3.87$ BM.)

Answer: (3) Go Back to Q#23

Q24.

Solution

Concept — Relationship between K_p and K_c:

$$K_p = K_c \times (RT)^{\Delta n_g}$$

where Δn_g = moles of gaseous products − moles of gaseous reactants.

Step 1 — Calculate Δn_g:

$$2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g)$$

$$\Delta n_g = 2 - (2+1) = 2 - 3 = -1$$

Step 2 — Calculate K_p:

$$K_p = K_c \times (RT)^{\Delta n_g} = 800 \times (10)^{-1} = 800 \times 0.1 = \boxed{80}$$

Answer: (80) Go Back to Q#24

Q25.

Solution

Concept — Stoichiometry of Combustion: The balanced equation $CH_4 + 2\,O_2 \rightarrow CO_2 + 2\,H_2O$ shows that 1 mole of CH_4 produces 2 moles of H_2O.

Step 1 — Scale to 2 moles of CH_4:

$$n(H_2O) = 2\,\text{mol } CH_4 \times \frac{2\,\text{mol } H_2O}{1\,\text{mol } CH_4} = \boxed{4}\,\text{mol } H_2O$$

Answer: (4) Go Back to Q#25

Q26.

Solution

Concept — Degree of Unsaturation (IHD): For a compound $C_nH_mO_p$ (oxygen does not change IHD):

$$\text{IHD} = \frac{2n + 2 - m}{2}$$

Step 1 — Molecular formula of phenol: Phenol = $C_6H_5OH = C_6H_6O$. So $n = 6$, $m = 6$.

Step 2 — Calculate IHD:

$$\text{IHD} = \frac{2(6) + 2 - 6}{2} = \frac{14 + 2 - 6}{2} = \frac{8}{2} = \boxed{4}$$

This corresponds to 3 degrees of unsaturation from the benzene ring's 3 double bonds + 1 degree from the ring itself = 4 total (the benzene ring contributes 4 IHD: 3 π bonds + 1 ring).

Answer: (4) Go Back to Q#26

Q27.

Solution

Concept — NaCl (Rock Salt) Crystal Structure: In the NaCl structure, each ion is surrounded by 6 ions of the opposite charge arranged at the corners of a regular octahedron.

Step 1 — Coordination environment of Na^+: Na^+ sits at the edge centres and body centre of the unit cell. In any of these sites, the 6 nearest Cl^- neighbours are

located along the $\pm x$, $\pm y$, and $\pm z$ directions from Na^+ (octahedral coordination).

$$\text{Coordination number of } Na^+ = \boxed{6}$$

(Equivalently, each Cl^- is surrounded by 6 Na^+ ions.)

Answer: (6) Go Back to Q#27

Q28.

Solution

Concept — Magnetic Moment of Ni^{2+}:

Step 1 — Electronic configuration of Ni^{2+}: Ni (Z= 28): $[Ar]\,3d^8\,4s^2$. Remove 2 electrons (from $4s$ first):

$$Ni^{2+} : [Ar]\,3d^8$$

Step 2 — Number of unpaired electrons in $3d^8$: Filling 5 d orbitals with 8 electrons (Hund's rule): $\uparrow\downarrow \mid \uparrow\downarrow \mid \uparrow\downarrow \mid \uparrow \mid \uparrow$. Three orbitals are paired; two orbitals have one electron each.

$$n = 2 \text{ unpaired electrons}$$

Step 3 — Calculate $n(n+2)$:

$$n(n+2) = 2 \times (2+2) = 2 \times 4 = \boxed{8}$$

(Magnetic moment $\mu = \sqrt{8} \approx 2.83$ BM.)

Answer: (8) Go Back to Q#28

Q29.

Solution

Concept — Half-Life of First-Order Reaction: For a first-order reaction, the half-life is:

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

The half-life is independent of initial concentration.

Step 1 — Substitute values:

$$t_{1/2} = \frac{0.693}{0.0231\ \text{min}^{-1}} = \frac{0.693}{0.0231} = \boxed{30}\ \text{min}$$

Answer: (30) Go Back to Q#29

Q30.

Solution

Concept — VSEPR and Lone Pairs in XeF_4: Xe has 8 valence electrons. In XeF_4, 4 are used for bonding (4 Xe–F bonds), leaving 4 non-bonding electrons $= 2$ lone pairs.

Step 1 — Electron pair count for Xe in XeF_4:

$$\text{Total electron pairs around Xe} = \frac{8}{2} = 4\ \text{(bonding)} + \frac{8 - 4 \times 1}{2}$$

More carefully: Xe has 8 valence e^-; forms 4 bonds (uses $4e^-$); remaining $= 8 - 4 = 4e^- = 2$ lone pairs.

Step 2 — Geometry: Total electron pairs $= 4$ (bonding) $+2$ (lone) $= 6 \Rightarrow$ octahedral electron-pair geometry. The 2 lone pairs occupy axial positions (180° apart) to minimise repulsion, giving the 4 F atoms in a **square planar** arrangement.

$$\text{Number of lone pairs on Xe in } XeF_4 = \boxed{2}$$

Answer: (2) Go Back to Q#30

Answer Key

Section A (MCQ):

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	D	2	A	3	B	4	C	5	D
6	A	7	B	8	C	9	D	10	A
11	B	12	C	13	D	14	A	15	B
16	C	17	D	18	A	19	B	20	C

Section B (Numerical Value):

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
21	8	22	3						
23	3	24	80						
25	4	26	4						
27	6	28	8						
29	30	30	2						