JCECE Chemistry Sample Paper – 4

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. The percentage by mass of nitrogen in ammonium nitrate $\mathrm{NH_4NO_3}$ (molar mass $= 80$ g/mol, atomic mass of N $= 14$) is:

(A) 17.5%

(B) 28.0%

(C) 35.0%

(D) 14.0%

Q2. The energy of a photon of radiation whose frequency is 5.0×10^{14} Hz (taking $h = 6.6 \times 10^{-34}$ J s) is:

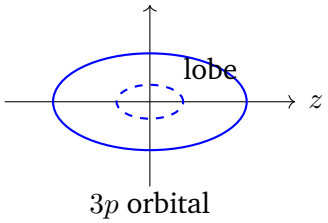
(A) 1.32×10^{-19} J

(B) 3.30×10^{-19} J

(C) 6.60×10^{-19} J

(D) 3.30×10^{-48} J

Q3. For the $3p$ orbital (one boundary surface lobe sketched), the total number of nodes (radial + angular) is:



(A) 0

(B) 1

(C) 2

(D) 3

Q4. The root-mean-square (rms) speed of oxygen molecules ($M = 32 \times 10^{-3}$ kg/mol) at 300 K, using $u_{rms} = \sqrt{\dfrac{3RT}{M}}$ with $R = 8.314$ J mol^{-1}K^{-1}, is closest to:

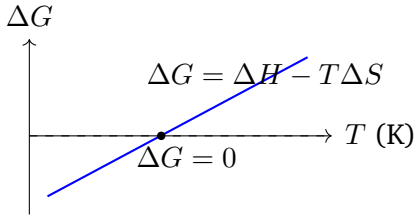
(A) 193 m/s

(B) 310 m/s

(C) 620 m/s

(D) 483 m/s

Q5. For a reaction $\Delta H = -92$ kJ and $\Delta S = -200$ J K^{-1}. Using the energy relation shown, the temperature above which the reaction becomes non-spontaneous ($\Delta G > 0$) is:



(A) 460 K

(B) 200 K

(C) 92 K

(D) 1840 K

Q6. The lattice enthalpy of KCl is $+715$ kJ/mol and its enthalpy of hydration is -685 kJ/mol. The enthalpy of solution of KCl is:

(A) -1400 kJ/mol

(B) -30 kJ/mol

(C) $+1400$ kJ/mol

(D) $+30$ kJ/mol

Q7. For the exothermic equilibrium $2\mathrm{SO_2(g)} + \mathrm{O_2(g)} \rightleftharpoons 2\mathrm{SO_3(g)}$, increasing the pressure (decreasing the volume) at constant temperature shifts the equilibrium:

(A) to the left (more $\mathrm{SO_2}$)

(B) to the right (more $\mathrm{SO_3}$)

(C) no shift, only K changes

(D) it depends only on temperature

Q8. 10 mL of a 0.1 M HCl solution is diluted with water to a total volume of 100 mL. The pH of the diluted solution is:

(A) 1

(B) 3

(C) 2

(D) 4

Q9. The K_{sp} of AgCl is 1.0×10^{-10}. Its molar solubility in 0.1 M NaCl solution (common-ion effect) is:

(A) 1.0×10^{-9} mol/L

(B) 1.0×10^{-5} mol/L

(C) 1.0×10^{-10} mol/L

(D) 1.0×10^{-11} mol/L

Q10. When 0.5 mol of a non-volatile solute is dissolved in 4.5 mol of water, the relative lowering of vapour pressure $\left(\frac{p^\circ - p}{p^\circ}\right)$ of the solution is:

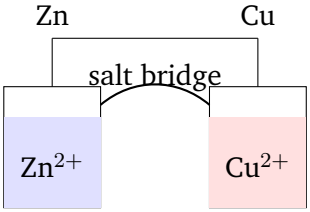
(A) 0.05

(B) 0.10

(C) 0.50

(D) 0.90

Q11. For the cell shown, the standard EMF is $E^\circ_{cell} = +1.10\,\text{V}$ and $n = 2$ electrons are transferred. Taking $F = 96500\ \text{C mol}^{-1}$, the standard Gibbs energy change $\Delta G^\circ = -nFE^\circ$ is:



(A) -106 kJ/mol

(B) $+212$ kJ/mol

(C) $+106$ kJ/mol

(D) -212 kJ/mol

Q12. A conductivity cell has electrodes of area $1.5\ \text{cm}^2$ separated by a distance of 0.75 cm. Its cell constant $\left(\frac{l}{A}\right)$ is:

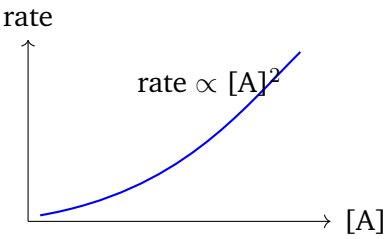
(A) $0.5\ \text{cm}^{-1}$

(B) $2.0\ \text{cm}^{-1}$

(C) $1.5\ \text{cm}^{-1}$

(D) $1.125\ \text{cm}^{-1}$

Q13. For a reaction the rate law is rate $= k[\text{A}]^2$. From the rate-versus-concentration curve shown, doubling the concentration of A multiplies the rate by a factor of:



(A) 2

(B) 8

(C) 4

(D) 1

Q14. The rate of a reaction approximately doubles for every 10°C rise in temperature. If the temperature is raised from 20°C to 50°C, the rate increases by a factor of approximately:

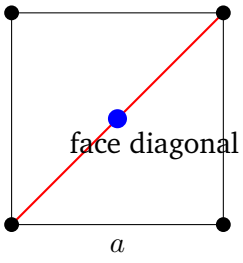
(A) 4

(B) 8

(C) 6

(D) 16

Q15. In a face-centred cubic (fcc) lattice with edge length a, the atoms touch along the face diagonal as shown. The relation between the atomic radius r and edge a is:



(A) $r = \dfrac{a}{2}$

(B) $r = \dfrac{\sqrt{3}}{4}a$

(C) $r = \dfrac{a}{4}$

(D) $r = \dfrac{a}{2\sqrt{2}}$

Q16. In acidic medium $KMnO_4$ (molar mass 158 g/mol) is reduced from Mn($+7$) to Mn($+2$). Its equivalent weight in this reaction is:

(A) 52.7 g/equiv

(B) 31.6 g/equiv

(C) 79.0 g/equiv

(D) 158 g/equiv

Q17. A solution is prepared by dissolving 20 g of glucose in 80 g of water. The mass percent (% w/w) of glucose in the solution is:

(A) 25%

(B) 80%

(C) 20%

(D) 4%

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

(A) 2-methylbutanal

(B) 3-methylbutanal

(C) 3-methylbutan-1-ol

(D) 2-methylbutan-1-al

Q19. Diethyl ether (C_2H_5–O–C_2H_5) and methyl propyl ether (CH_3–O–C_3H_7) are an example of which type of structural isomerism?

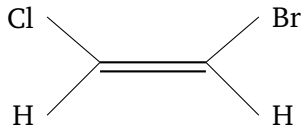
(A) chain isomerism

(B) position isomerism

(C) functional isomerism

(D) metamerism

Q20. For the alkene shown, with higher-priority groups (Cl on the left carbon, Br on the right carbon) on the same side of the double bond, the configuration is:



(A) Z (same side, higher priorities cis)

(B) E (opposite sides)

(C) neither E nor Z

(D) optically active only

Q21. The correct order of stability of the following carbocations (most stable first) is:

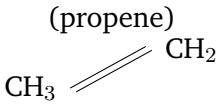
(A) $CH_3^+ > CH_3CH_2^+ > (CH_3)_2CH^+ > (CH_3)_3C^+$

(B) $(CH_3)_2CH^+ > (CH_3)_3C^+ > CH_3CH_2^+ > CH_3^+$

(C) $CH_3CH_2^+ > CH_3^+ > (CH_3)_3C^+ > (CH_3)_2CH^+$

(D) $(CH_3)_3C^+ > (CH_3)_2CH^+ > CH_3CH_2^+ > CH_3^+$

Q22. When propene (shown) reacts with HBr in the presence of organic peroxide, the major product (anti-Markovnikov / peroxide effect) is:



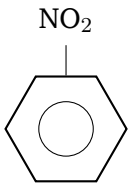
(A) 1-bromopropane

(B) 2-bromopropane

(C) 1,2-dibromopropane

(D) 2,2-dibromopropane

Q23. When nitrobenzene (shown) undergoes further electrophilic substitution (e.g. nitration), the incoming group is directed mainly to the:



(A) ortho position only

(B) para position only

(C) meta position ($-NO_2$ is deactivating, meta-directing)

(D) it does not undergo substitution at all

Q24. When ethyl bromide (CH_3CH_2Br) is boiled with aqueous KOH, the organic product formed (nucleophilic substitution) is:

(A) ethanol

(B) ethene

(C) ethane

(D) diethyl ether

Q25. On oxidation with acidified $K_2Cr_2O_7$, a secondary alcohol (e.g. propan-2-ol) is converted mainly to:

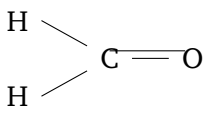
(A) a carboxylic acid

(B) an aldehyde

(C) a ketone (propanone)

(D) an ether

Q26. The carbonyl compound shown is warmed with Tollens' reagent (ammoniacal $AgNO_3$). The species that gives a silver mirror is:



(A) formaldehyde ($HCHO$, an aldehyde)

(B) acetone (CH_3COCH_3, a ketone)

(C) diethyl ketone

(D) benzophenone

Q27. When acetic acid is heated with ethanol in the presence of a little concentrated H_2SO_4 (Fischer esterification), the product is:

(A) acetaldehyde

(B) ethyl acetate (ethyl ethanoate)

(C) sodium acetate

(D) ethane

Q28. A primary amine, when warmed with chloroform and alcoholic KOH, gives a foul-smelling isocyanide. This test (used to detect 1° amines) is called the:

(A) Hinsberg test

(B) azo-coupling test

(C) Tollens' test

(D) carbylamine (isocyanide) test

Q29. Which of the following correctly describes a difference between DNA and RNA?

(A) DNA contains ribose; RNA contains deoxyribose

(B) DNA contains thymine; RNA contains uracil in its place

(C) both contain only the sugar ribose

(D) DNA is single-stranded; RNA is double-stranded

Q30. The monomer (repeating unit) of natural rubber is:

(A) ethene

(B) chloroprene

(C) isoprene (2-methylbuta-1,3-diene)

(D) vinyl chloride

Q31. In the acid-catalysed addition of HCl to propene, the more stable intermediate carbocation that determines the Markovnikov product is:

(A) the primary carbocation $CH_3CH_2CH_2^+$

(B) the secondary carbocation $CH_3\overset{+}{C}HCH_3$

(C) a methyl carbocation CH_3^+

(D) a free radical, not a carbocation

Q32. Benzene reacts with CH_3COCl in the presence of anhydrous $AlCl_3$ to give acetophenone ($C_6H_5COCH_3$). This reaction is known as:

(A) Wurtz–Fittig reaction

(B) Cannizzaro reaction

(C) Reimer–Tiemann reaction

(D) Friedel–Crafts acylation

Q33. A compound gives a violet (purple) colouration with neutral ferric chloride ($FeCl_3$) solution. The functional group present is most likely:

(A) a phenolic $-OH$ (phenol)

(B) an aldehyde $-CHO$

(C) a carboxylic acid $-COOH$

(D) a simple ether $-O-$

Q34. The reagent that converts toluene ($C_6H_5CH_3$) into benzoic acid (C_6H_5COOH) by side-chain oxidation is:

(A) dilute HCl

(B) hot alkaline $KMnO_4$ (then H^+)

(C) anhydrous $AlCl_3$

(D) $LiAlH_4$

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

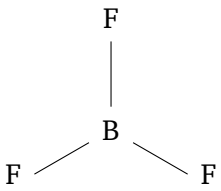
(A) $C > N > O > F$

(B) $N > F > O > C$

(C) $O > F > N > C$

(D) $F > O > N > C$

Q36. According to VSEPR theory, the molecular shape of boron trifluoride BF_3 (shown) is:



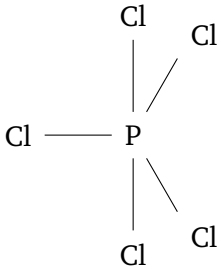
(A) pyramidal

(B) bent

(C) trigonal planar

(D) tetrahedral

Q37. The hybridization of the central phosphorus atom in phosphorus pentachloride PCl_5 (trigonal bipyramidal geometry shown) is:



(A) sp^3

(B) sp^3d

(C) sp^3d^2

(D) sp^2

Q38. Among the alkaline-earth metal carbonates, the thermal stability (resistance to decomposition on heating) increases in the order:

(A) $\mathrm{MgCO_3} < \mathrm{CaCO_3} < \mathrm{SrCO_3} < \mathrm{BaCO_3}$

(B) $\mathrm{BaCO_3} < \mathrm{SrCO_3} < \mathrm{CaCO_3} < \mathrm{MgCO_3}$

(C) all decompose at the same temperature

(D) $\mathrm{CaCO_3} < \mathrm{MgCO_3} < \mathrm{BaCO_3} < \mathrm{SrCO_3}$

Q39. In the structure of diborane $\mathrm{B_2H_6}$, the two bridging B–H–B bonds are described as:

(A) normal two-centre two-electron bonds

(B) ionic bonds

(C) three-centre two-electron (3c–2e) banana bonds

(D) coordinate bonds from H to B

Q40. Silicones are synthetic polymers whose backbone consists of a repeating chain of:

(A) $-\mathrm{C}-\mathrm{C}-$ carbon atoms

(B) $-\mathrm{Si}-\mathrm{Si}-$ silicon atoms

(C) $-\mathrm{Si}-\mathrm{C}-$ alternating atoms

(D) $-\mathrm{Si}-\mathrm{O}-\mathrm{Si}-\mathrm{O}-$ silicon–oxygen linkages

Q41. Dilute nitric acid reacts with copper, but no $\mathrm{H_2}$ gas is evolved. Instead the gas mainly liberated is:

(A) nitric oxide, NO

(B) hydrogen, $\mathrm{H_2}$

(C) ammonia, $\mathrm{NH_3}$

(D) chlorine, Cl_2

Q42. In the Contact process for manufacturing sulphuric acid, the key catalysed step (over V_2O_5) is the oxidation of:

(A) SO_2 to SO_3

(B) H_2S to SO_2

(C) SO_3 to H_2SO_4

(D) S to SO_3 directly

Q43. The interhalogen compound ClF_3 has the molecular shape:

(A) trigonal planar

(B) pyramidal

(C) T-shaped (bent T)

(D) tetrahedral

Q44. The noble gases are chemically inert mainly because they have:

(A) very large atomic radii

(B) low ionization enthalpies

(C) incomplete outer shells

(D) completely filled valence shells (stable ns^2np^6 octet)

Q45. Transition metals and their compounds often act as good catalysts mainly because they:

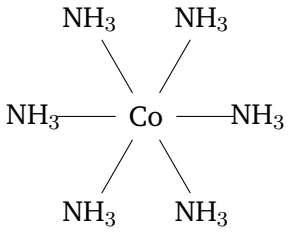
(A) show variable oxidation states and can form intermediate complexes / adsorb reactants on their surface

(B) have completely filled d orbitals

(C) are all radioactive

(D) have very low melting points

Q46. For the octahedral complex $[Co(NH_3)_6]^{3+}$ shown (Co atomic number $= 27$), the effective atomic number (EAN) of cobalt is:



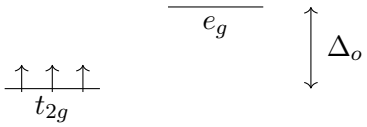
(A) 33

(B) 36

(C) 27

(D) 30

Q47. For an octahedral complex with a d^3 metal ion (e.g. Cr^{3+}, electrons shown filling t_{2g}), the crystal field stabilization energy (CFSE), ignoring pairing, is:



(A) $-0.4\,\Delta_o$

(B) $-0.8\,\Delta_o$

(C) $-1.2\,\Delta_o$

(D) $0\,\Delta_o$

Q48. In the extraction of iron from its oxide ore in the blast furnace, the principal reducing agent that reduces Fe_2O_3 in the higher-temperature zones is:

(A) silica, SiO_2

(B) nitrogen, N_2

(C) limestone, $CaCO_3$

(D) carbon monoxide, CO (and coke, C)

Q49. "Heavy water", used as a moderator in nuclear reactors, is:

(A) ordinary water at high pressure

(B) hydrogen peroxide, H_2O_2

(C) deuterium oxide, D_2O

(D) water containing dissolved heavy metal salts

Q50. In the brown-ring test, a brown ring confirms the presence of the nitrate ion. The brown-coloured species responsible for the ring is:

(A) $[Fe(H_2O)_5NO]^{2+}$ (a nitrosyl iron complex)

(B) $Fe(OH)_3$

(C) $FeSO_4$

(D) Fe_2O_3

Detailed Solutions

Q1.

Solution

Concept — Percentage composition: Mass % of an element $= \dfrac{\text{total mass of that element in the formula}}{\text{molar mass}} \times 100$.

Step 1 — Count N atoms: NH_4NO_3 has 2 nitrogen atoms.

Step 2 — Mass of N: $2 \times 14 = 28$ g.

Step 3 — Write the ratio: % N $= \dfrac{28}{80} \times 100$.

Step 4 — Evaluate: $\dfrac{28}{80} = 0.35$, so % N $= 35.0\%$.

Why other options are wrong:

- (A) counts only one N atom $(14/80)$.
- (B) uses mass 28 over 100 instead of 80.
- (D) uses a single N over a wrong base.

Final Answer: % N $= 35.0\% \Rightarrow$ C

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Photon energy: The energy of one photon is $E = h\nu$, where h is Planck's constant and ν the frequency.

Step 1 — List data: $h = 6.6 \times 10^{-34}$ J s, $\nu = 5.0 \times 10^{14}$ Hz.

Step 2 — Write the formula: $E = h\nu$.

Step 3 — Multiply the coefficients: $6.6 \times 5.0 = 33$.

Step 4 — Combine powers of ten: $10^{-34} \times 10^{14} = 10^{-20}$.

Step 5 — Assemble: $E = 33 \times 10^{-20} = 3.30 \times 10^{-19}$ J.

Why other options are wrong:

- (A) halves the correct value.
- (C) doubles it.

- (D) adds the exponents wrongly ($-34-14$).

Final Answer: $E = 3.30 \times 10^{-19}$ J $\Rightarrow$ B

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Nodes in an orbital: Total nodes $= n-1$; of these, angular nodes $= l$ and radial nodes $= n-l-1$.

Step 1 — Identify n and l: for $3p$, $n=3$ and $l=1$.

Step 2 — Total nodes: $n-1 = 3-1 = 2$.

Step 3 — Cross-check: angular nodes $= l = 1$; radial nodes $= n-l-1 = 3-1-1 = 1$; sum $= 1+1 = 2$.

Step 4 — Conclude: the $3p$ orbital has 2 total nodes.

Why other options are wrong:

- (A) is for a $1s$ orbital.
- (B) counts only the angular node.
- (D) uses n instead of $n-1$.

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

Answer: (C) 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: $\dfrac{7482.6}{0.032} = 233{,}831$.

Step 4 — Take the square root: $\sqrt{233831} \approx 483$ m/s.

Why other options are wrong:

- (A) forgets the factor 3.
- (B) uses M in g/mol incorrectly.
- (C) doubles the correct value.

Final Answer: $u_{rms} \approx 483$ m/s $\Rightarrow$ D

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Spontaneity: $\Delta G = \Delta H - T\Delta S$. The reaction is at the borderline ($\Delta G = 0$) when $T = \dfrac{\Delta H}{\Delta S}$; above this T it becomes non-spontaneous (when both ΔH and ΔS are negative).

Step 1 — Convert units: $\Delta H = -92$ kJ $= -92000$ J; $\Delta S = -200$ J/K.

Step 2 — Set $\Delta G = 0$: $0 = \Delta H - T\Delta S \Rightarrow T = \dfrac{\Delta H}{\Delta S}$.

Step 3 — Substitute: $T = \dfrac{-92000}{-200}$.

Step 4 — Evaluate: $T = 460$ K.

Step 5 — Interpret: above 460 K, $T\Delta S$ (negative) makes $\Delta G > 0$, so the reaction is non-spontaneous.

Why other options are wrong:

- (B) quotes ΔS as a temperature.
- (C) quotes ΔH in kJ as a temperature.
- (D) multiplies instead of dividing.

Final Answer: $T = 460$ K $\Rightarrow$ A

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Enthalpy of solution: $\Delta H_{sol} = \Delta H_{lattice} + \Delta H_{hydration}$.

Step 1 — List data: $\Delta H_{lattice} = +715$ kJ/mol, $\Delta H_{hyd} = -685$ kJ/mol.

Step 2 — Write the formula: $\Delta H_{sol} = \Delta H_{lattice} + \Delta H_{hyd}$.

Step 3 — Substitute: $\Delta H_{sol} = 715 + (-685)$.

Step 4 — Evaluate: $\Delta H_{sol} = 715 - 685 = +30$ kJ/mol.

Why other options are wrong:

- (A) adds the magnitudes with a negative sign.
- (B) has the wrong sign.
- (C) adds the magnitudes positively.

Final Answer: $\Delta H_{sol} = +30$ kJ/mol $\Rightarrow$ D

Answer: (D) Go Back to Q6

Q7.

Solution

Concept — Le Chatelier (pressure): Increasing pressure shifts the equilibrium toward the side with fewer gas moles.

Step 1 — Count moles of gas: left side $= 2 + 1 = 3$ mol; right side $= 2$ mol.

Step 2 — Compare: the product side (SO_3) has fewer gas moles.

Step 3 — Apply the principle: higher pressure favours the fewer-mole side, i.e. the forward direction.

Step 4 — Conclude: equilibrium shifts to the right, forming more SO_3.

Why other options are wrong:

- (A) is the opposite direction.
- (C) pressure changes do shift the position; only temperature changes K.
- (D) ignores the pressure effect.

Final Answer: shifts to the right (more SO_3) $\Rightarrow$ B

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Dilution of a strong acid: Moles of H^+ are conserved; the new concentration $= \dfrac{\text{moles}}{\text{new volume}}$, then $\text{pH} = -\log[H^+]$.

Step 1 — Moles of HCl: $0.1\ \text{M} \times 0.010\ \text{L} = 1.0 \times 10^{-3}$ mol.

Step 2 — New concentration: $\dfrac{1.0 \times 10^{-3}}{0.100\ \text{L}} = 1.0 \times 10^{-2}$ M.

Step 3 — $[H^+]$: HCl is strong, so $[H^+] = 1.0 \times 10^{-2}$ M.

Step 4 — pH: $\text{pH} = -\log(10^{-2}) = 2$.

Why other options are wrong:

- (A) is the pH before dilution.
- (B) over-dilutes by $100\times$.
- (D) dilutes by $1000\times$.

Final Answer: $\text{pH} = 2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept — Common-ion effect: In 0.1 M NaCl, $[Cl^-] \approx 0.1$ M is fixed; the solubility s of AgCl satisfies $K_{sp} = [Ag^+][Cl^-] = s \times 0.1$.

Step 1 — Write K_{sp}: $K_{sp} = [Ag^+][Cl^-]$.

Step 2 — Substitute the fixed $[Cl^-]$: $1.0 \times 10^{-10} = s \times 0.1$.

Step 3 — Solve for s: $s = \dfrac{1.0 \times 10^{-10}}{0.1}$.

Step 4 — Evaluate: $s = 1.0 \times 10^{-9}$ mol/L.

Why other options are wrong:

- (B) is the solubility in pure water ($\sqrt{K_{sp}}$), ignoring the common ion.
- (C) just quotes K_{sp}.
- (D) divides by 10 once too often.

Final Answer: $s = 1.0 \times 10^{-9}$ mol/L $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Relative lowering of VP (Raoult): $\frac{p^\circ - p}{p^\circ} = x_{solute} = \frac{n_{solute}}{n_{solute} + n_{solvent}}$.

Step 1 — List moles: $n_{solute} = 0.5$ mol, $n_{solvent} = 4.5$ mol.

Step 2 — Total moles: $0.5 + 4.5 = 5.0$ mol.

Step 3 — Mole fraction of solute: $x_{solute} = \frac{0.5}{5.0}$.

Step 4 — Evaluate: $x_{solute} = 0.10$.

Why other options are wrong:

- (A) uses $0.5/10$.
- (C) takes the solute moles directly.
- (D) gives the solvent mole fraction.

Final Answer: relative lowering $= 0.10 \Rightarrow$ B

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Gibbs energy of a cell: $\Delta G^\circ = -nFE^\circ_{cell}$.

Step 1 — List data: $n = 2$, $F = 96500$ C/mol, $E^\circ = +1.10$ V.

Step 2 — Write the formula: $\Delta G^\circ = -nFE^\circ$.

Step 3 — Multiply: $nFE^\circ = 2 \times 96500 \times 1.10 = 212300$ J.

Step 4 — Apply the sign and convert: $\Delta G^\circ = -212300$ J $= -212.3$ kJ ≈ -212 kJ/mol.

Why other options are wrong:

- (A) uses $n = 1$.
- (B) and (C) have the wrong sign (a positive E° gives a negative ΔG°).

Final Answer: $\Delta G^\circ \approx -212$ kJ/mol $\Rightarrow$ D

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — Cell constant: cell constant $G^* = \dfrac{l}{A}$, where l is the electrode separation and A the electrode area.

Step 1 — List data: $l = 0.75$ cm, $A = 1.5$ cm^2.

Step 2 — Write the formula: $G^* = \dfrac{l}{A}$.

Step 3 — Substitute: $G^* = \dfrac{0.75}{1.5}$.

Step 4 — Evaluate: $G^* = 0.5$ cm^{-1}.

Why other options are wrong:

- (B) inverts the ratio (A/l).
- (C) just quotes the area.
- (D) multiplies instead of dividing.

Final Answer: cell constant $= 0.5$ cm^{-1} $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Effect of concentration on rate: For rate $= k[\text{A}]^2$, the rate is proportional to the square of $[\text{A}]$.

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

Step 2 — Double the concentration: new rate $r_2 = k(2[\text{A}])^2$.

Step 3 — Expand: $r_2 = k \times 4[\text{A}]^2 = 4\,r_1$.

Step 4 — Conclude: the rate becomes 4 times larger.

Why other options are wrong:

- (A) is the factor for a first-order reaction.
- (B) is the factor for a third-order (2^3) case.
- (D) is for a zero-order reaction.

Final Answer: rate $\times 4 \Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

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

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

Step 2 — Number of 10° steps: $\dfrac{30}{10} = 3$.

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

Step 4 — Evaluate: $2^3 = 8$.

Why other options are wrong:

- (A) is for a 20° rise (2^2).
- (C) is not a power of 2.
- (D) is for a 40° rise (2^4).

Final Answer: rate increases $\approx 8\times \Rightarrow$ B

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — fcc geometry: In an fcc cell, atoms touch along the face diagonal, whose length is $\sqrt{2}\,a$ and equals $4r$.

Step 1 — Face-diagonal length: a square face of side a has diagonal $\sqrt{2}\,a$.

Step 2 — Relate to radius: four atomic radii lie along this diagonal, so $4r = \sqrt{2}\,a$.

Step 3 — Solve for r: $r = \dfrac{\sqrt{2}\,a}{4}$.

Step 4 — Simplify: $\dfrac{\sqrt{2}}{4} = \dfrac{1}{2\sqrt{2}}$, so $r = \dfrac{a}{2\sqrt{2}}$.

Why other options are wrong:

- (A) is the simple-cubic relation.
- (B) is the bcc relation ($4r = \sqrt{3}\,a$).

- (C) drops the $\sqrt{2}$ factor.

Final Answer: $r = \dfrac{a}{2\sqrt{2}} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Equivalent weight (redox): equivalent weight $= \dfrac{\text{molar mass}}{n\text{-factor}}$, where the n-factor is the number of electrons gained or lost per formula unit.

Step 1 — Find the oxidation-state change: Mn goes from $+7$ to $+2$, a change of 5.

Step 2 — n-factor: 5 electrons are gained, so n-factor $= 5$.

Step 3 — Write the formula: equivalent weight $= \dfrac{158}{5}$.

Step 4 — Evaluate: $\dfrac{158}{5} = 31.6$ g/equiv.

Why other options are wrong:

- (A) uses n-factor $= 3$ (neutral medium).
- (C) uses n-factor $= 2$.
- (D) uses the full molar mass (no division).

Final Answer: equivalent weight $= 31.6$ g/equiv $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept — Mass percent: % w/w of solute $= \dfrac{\text{mass of solute}}{\text{mass of solution}} \times 100$.

Step 1 — Mass of solute: glucose $= 20$ g.

Step 2 — Mass of solution: solute $+$ solvent $= 20 + 80 = 100$ g.

Step 3 — Write the ratio: % w/w $= \dfrac{20}{100} \times 100$.

Step 4 — Evaluate: % w/w $= 20\%$.

Why other options are wrong:

- (A) uses $20/80$ (mass of solvent as base).
- (B) quotes the solvent percentage.
- (D) divides by an extra factor of 5.

Final Answer: mass percent $= 20\% \Rightarrow$ C

Answer: (C) Go Back to Q17

Q18.

Solution

Concept — IUPAC naming of aldehydes: The $-\mathrm{CHO}$ carbon is C-1; the suffix is "-al" and substituent locants are taken from that end.

Step 1 — Identify the chain: $\mathrm{CH_3}$–$\mathrm{CH(CH_3)}$–$\mathrm{CH_2}$–CHO has a 4-carbon chain ending in $-\mathrm{CHO}$ (butanal).

Step 2 — Number from the CHO end: C-1 is CHO, C-2 is $\mathrm{CH_2}$, C-3 bears the methyl branch, C-4 is the terminal $\mathrm{CH_3}$.

Step 3 — Locate the branch: the methyl group is on C-3.

Step 4 — Assemble the name: 3-methylbutanal.

Why other options are wrong:

- (A) numbers from the wrong end.
- (C) wrongly uses the "-ol" (alcohol) suffix.
- (D) is a non-standard form of the name.

Final Answer: 3-methylbutanal $\Rightarrow$ B

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Metamerism: Metamers have the same molecular formula and same functional group but differ in the distribution of carbon atoms on either side of the functional group (e.g. around the ether oxygen).

Step 1 — Same formula: both ethers are $C_4H_{10}O$.

Step 2 — Same functional group: both are ethers ($-O-$).

Step 3 — Difference: the alkyl groups on the oxygen differ (C_2H_5/C_2H_5 vs CH_3/C_3H_7).

Step 4 — Conclude: this is metamerism.

Why other options are wrong:

- (A) chain isomerism differs in carbon skeleton only.
- (B) position isomerism differs in the position of a group on the same chain.
- (C) functional isomerism needs different functional groups.

Final Answer: metamerism $\Rightarrow$ $\boxed{D}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — E/Z nomenclature: Assign CIP priorities on each double-bond carbon. If the two higher-priority groups are on the same side, the configuration is Z; if on opposite sides, E.

Step 1 — Priorities on the left carbon: Cl ($>$) H, so Cl is the higher priority.

Step 2 — Priorities on the right carbon: Br ($>$) H, so Br is the higher priority.

Step 3 — Check sides: the diagram shows Cl and Br on the same side of the double bond.

Step 4 — Assign: higher priorities on the same side $\Rightarrow$ Z.

Why other options are wrong:

- (B) E would require them on opposite sides.
- (C) every such disubstituted alkene is either E or Z.

- (D) the molecule has no chiral centre, so it is not described by optical activity here.

Final Answer: Z configuration $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q20

Q21.

Solution

Concept — Carbocation stability: Stability rises with alkyl substitution (more hyperconjugation and $+I$): tertiary $>$ secondary $>$ primary $>$ methyl.

Step 1 — Classify each cation: $(CH_3)_3C^+$ tertiary; $(CH_3)_2CH^+$ secondary; $CH_3CH_2^+$ primary; CH_3^+ methyl.

Step 2 — Apply the stability order: more alkyl groups give more stabilisation.

Step 3 — Write the order: $(CH_3)_3C^+ > (CH_3)_2CH^+ > CH_3CH_2^+ > CH_3^+$.

Why other options are wrong:

- (A) fully reverses the trend.
- (B) swaps the top two and misplaces methyl.
- (C) is scrambled.

Final Answer: $(CH_3)_3C^+ > (CH_3)_2CH^+ > CH_3CH_2^+ > CH_3^+ \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept — Peroxide (anti-Markovnikov) effect: With HBr and a peroxide, addition follows a free-radical mechanism, so Br adds to the carbon bearing more H atoms (opposite to Markovnikov).

Step 1 — Identify the alkene carbons: in propene CH_3–$CH{=}CH_2$ the terminal CH_2 has more H atoms.

Step 2 — Place Br (anti-Markovnikov): Br adds to the terminal carbon.

Step 3 — Place H: H adds to the internal carbon.

Step 4 — Name the product: $CH_3CH_2CH_2Br$ is 1-bromopropane.

Why other options are wrong:

- (B) is the Markovnikov product (no peroxide).
- (C) and (D) are dihalides, not formed by single HBr addition.

Final Answer: 1-bromopropane $\Rightarrow$ A

Answer: (A) Go Back to Q22

Q23.

Solution

Concept — Directing effect of $-NO_2$: The nitro group is strongly electron-withdrawing, so it deactivates the ring and directs incoming electrophiles to the meta position.

Step 1 — Classify the group: $-NO_2$ is a $-M/-I$ (deactivating) substituent.

Step 2 — Determine the directing pattern: deactivating groups (except halogens) are meta-directing.

Step 3 — Conclude: the next group enters mainly at the meta position.

Why other options are wrong:

- (A) and (B) ortho/para directing applies to activating groups.
- (D) the ring still reacts, just more slowly and meta-selectively.

Final Answer: meta position (deactivating, meta-directing) $\Rightarrow$ C

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Hydrolysis of alkyl halides: With *aqueous* KOH, the OH^- acts as a nucleophile and substitutes the halogen, giving an alcohol.

Step 1 — Identify the reagent: aqueous KOH supplies OH^- as nucleophile.

Step 2 — Substitution: OH^- replaces Br on CH_3CH_2Br.

Step 3 — Product: CH_3CH_2OH, ethanol.

Why other options are wrong:

- (B) ethene needs *alcoholic* KOH (elimination).
- (C) ethane would need reduction.
- (D) diethyl ether is not formed under these conditions.

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

Answer: (A) Go Back to Q24

Q25.

Solution

Concept — Oxidation of alcohols: A primary alcohol oxidises to an aldehyde then acid; a secondary alcohol oxidises to a ketone (which resists further oxidation).

Step 1 — Classify the alcohol: propan-2-ol $(CH_3)_2CHOH$ is a secondary alcohol.

Step 2 — Apply the rule: secondary alcohols give ketones on oxidation.

Step 3 — Identify the product: $(CH_3)_2C{=}O$, propanone (acetone).

Why other options are wrong:

- (A) carboxylic acids come from primary alcohols.
- (B) aldehydes come from primary alcohols (partial oxidation).
- (D) ethers are not oxidation products of alcohols.

Final Answer: a ketone (propanone) $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q25

Q26.

Solution

Concept — Tollens' test: Only aldehydes (with a $-CHO$ group) reduce Tollens' reagent to give a silver mirror; ketones do not.

Step 1 — Identify the structure: the drawn $H_2C{=}O$ is formaldehyde (HCHO), an aldehyde.

Step 2 — Apply the test: aldehydes are oxidised, reducing Ag^+ to metallic Ag.

Step 3 — Conclude: formaldehyde gives the silver mirror.

Why other options are wrong:

- (B), (C) and (D) are ketones, which do not give a silver mirror with Tollens'.

Final Answer: formaldehyde (an aldehyde) $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

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

Step 1 — Identify the reactants: acetic acid (CH_3COOH) and ethanol (C_2H_5OH).

Step 2 — Role of H_2SO_4: it catalyses the esterification (and removes water).

Step 3 — Form the ester: $CH_3COOC_2H_5$, ethyl acetate, plus H_2O.

Why other options are wrong:

- (A) acetaldehyde is an oxidation/reduction product, not from esterification.
- (C) sodium acetate forms with NaOH, not this route.
- (D) ethane is unrelated.

Final Answer: ethyl acetate $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept — Carbylamine test: A primary amine heated with $CHCl_3$ and alcoholic KOH forms a foul-smelling isocyanide (carbylamine); this is a confirmatory test for 1° amines.

Step 1 — Identify the reagents: $CHCl_3$ + alcoholic KOH + 1° amine.

Step 2 — Product: an isocyanide (R–NC) with an offensive smell.

Step 3 — Name the test: carbylamine (isocyanide) test.

Why other options are wrong:

- (A) Hinsberg test uses benzenesulphonyl chloride.
- (B) azo coupling involves diazonium salts and phenols.
- (C) Tollens' is for aldehydes.

Final Answer: carbylamine test $\Rightarrow$ D

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — DNA vs RNA: DNA uses deoxyribose sugar and the base thymine; RNA uses ribose sugar and uracil in place of thymine.

Step 1 — Compare sugars: DNA = deoxyribose; RNA = ribose.

Step 2 — Compare bases: both have A, G, C; DNA additionally has thymine (T) while RNA has uracil (U).

Step 3 — Pick the correct statement: "DNA contains thymine; RNA contains uracil in its place" is true.

Why other options are wrong:

- (A) reverses the sugars.
- (C) only RNA uses ribose.
- (D) DNA is double-stranded; RNA is generally single-stranded.

Final Answer: DNA has thymine, RNA has uracil $\Rightarrow$ B

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Natural rubber: Natural rubber is a polymer of isoprene (2-methylbuta-1,3-diene), specifically cis-1,4-polyisoprene.

Step 1 — Recall the monomer: the repeating unit comes from isoprene.

Step 2 — Write it: isoprene = 2-methylbuta-1,3-diene.

Step 3 — Conclude: the monomer of natural rubber is isoprene.

Why other options are wrong:

- (A) ethene gives polyethene.
- (B) chloroprene gives neoprene (synthetic).
- (D) vinyl chloride gives PVC.

Final Answer: isoprene $\Rightarrow$ C

Answer: (C) Go Back to Q30

Q31.

Solution

Concept — Markovnikov via carbocation: Acid addition proceeds through the more stable carbocation; protonation of propene gives a secondary cation rather than a primary one.

Step 1 — Protonate the alkene: H^+ adds to give either a primary or a secondary carbocation.

Step 2 — Compare stabilities: the secondary cation $CH_3\overset{+}{C}HCH_3$ is more stable than the primary one.

Step 3 — Determine the product: Cl^- adds to the secondary cation, giving 2-chloropropane (Markovnikov product).

Why other options are wrong:

- (A) the primary cation is less stable and not the major pathway.
- (C) a methyl cation does not form here.
- (D) acid addition is ionic (carbocation), not radical.

Final Answer: secondary carbocation $CH_3\overset{+}{C}HCH_3 \Rightarrow$ B

Answer: (B) Go Back to Q31

Q32.

Solution

Concept — Friedel–Crafts acylation: An acyl halide ($RCOCl$) with anhydrous $AlCl_3$ introduces an acyl ($RCO-$) group onto an aromatic ring.

Step 1 — Identify the reagents: benzene + CH_3COCl with $AlCl_3$.

Step 2 — Recognise the transformation: an acetyl group is added, giving acetophenone.

Step 3 — Name it: this is Friedel–Crafts acylation.

Why other options are wrong:

- (A) Wurtz–Fittig couples aryl/alkyl halides with Na.

- (B) Cannizzaro is for aldehydes lacking α-H.
- (C) Reimer–Tiemann formylates phenol.

Final Answer: Friedel–Crafts acylation $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Neutral $FeCl_3$ test: Phenols form coloured (violet/blue/green) iron–phenolate complexes with neutral ferric chloride, giving a characteristic colour.

Step 1 — Recall the test: a violet colour with neutral $FeCl_3$ indicates a phenolic group.

Step 2 — Identify the group: the $-OH$ attached to an aromatic ring (phenol).

Step 3 — Conclude: the compound contains a phenolic $-OH$.

Why other options are wrong:

- (B) aldehydes are detected by Tollens'/Fehling's.
- (C) carboxylic acids give effervescence with $NaHCO_3$.
- (D) simple ethers give no colour with $FeCl_3$.

Final Answer: a phenolic $-OH$ $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — Side-chain oxidation: A strong oxidant such as hot alkaline $KMnO_4$ oxidises the methyl side chain of toluene to a $-COOH$ group, giving benzoic acid (after acidification).

Step 1 — Goal: convert $-CH_3$ on the ring to $-COOH$.

Step 2 — Choose the reagent: hot alkaline $KMnO_4$, then H^+.

Step 3 — Product: benzoic acid, C_6H_5COOH.

Why other options are wrong:

- (A) dilute HCl does not oxidise.

- (C) $AlCl_3$ is a Friedel–Crafts catalyst, not an oxidant.
- (D) $LiAlH_4$ is a reducing agent.

Final Answer: hot alkaline $KMnO_4 \Rightarrow$ B

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Electronegativity trend: Electronegativity increases across a period; among C, N, O and F, fluorine is the most electronegative element.

Step 1 — Recall the values (Pauling): F ≈ 4.0, O ≈ 3.5, N ≈ 3.0, C ≈ 2.5.

Step 2 — Order decreasing: $F > O > N > C$.

Step 3 — Conclude: F is highest, C is lowest.

Why other options are wrong:

- (A) fully reverses the trend.
- (B) and (C) misplace F (F must be highest).

Final Answer: $F > O > N > C \Rightarrow$ D

Answer: (D) Go Back to Q35

Q36.

Solution

Concept — VSEPR for AB_3 (no lone pair): Three bond pairs and no lone pair give a trigonal planar shape with 120° angles.

Step 1 — Count electron domains: B in BF_3 has 3 bond pairs and 0 lone pairs.

Step 2 — Assign geometry: 3 domains, no lone pair $\Rightarrow$ trigonal planar.

Step 3 — Conclude: BF_3 is trigonal planar.

Why other options are wrong:

- (A) pyramidal needs one lone pair (e.g. NH_3).
- (B) bent needs two lone pairs (e.g. H_2O).
- (D) tetrahedral is for 4 bond pairs.

Final Answer: trigonal planar $\Rightarrow$ C

Answer: (C) Go Back to Q36

Q37.

Solution

Concept — Hybridization from geometry: A central atom with five sigma bonds and no lone pair is sp^3d hybridised (trigonal bipyramidal).

Step 1 — Count sigma bonds: in PCl_5, P forms 5 P–Cl bonds.

Step 2 — Count lone pairs: 0 on phosphorus.

Step 3 — Assign hybridization: 5 electron domains $\Rightarrow$ sp^3d.

Why other options are wrong:

- (A) sp^3 is for 4 domains.
- (C) sp^3d^2 is for 6 domains (e.g. SF_6).
- (D) sp^2 is for 3 domains.

Final Answer: $sp^3d \Rightarrow$ B

Answer: (B) Go Back to Q37

Q38.

Solution

Concept — Thermal stability of group-2 carbonates: Stability increases down the group as the cation size grows (larger cations stabilise the large carbonate anion better).

Step 1 — Order cation size: $Mg^{2+} < Ca^{2+} < Sr^{2+} < Ba^{2+}$.

Step 2 — Relate to stability: larger cation $\Rightarrow$ more stable carbonate.

Step 3 — Write the order (increasing stability): $MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$.

Why other options are wrong:

- (B) reverses the trend.
- (C) they do not decompose at the same temperature.
- (D) is scrambled.

Final Answer: $MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q38

Q39.

Solution

Concept — Diborane bonding: In B_2H_6 the two bridging hydrogens form three-centre two-electron (3c–2e) "banana" bonds, in which two electrons bind three atoms (B–H–B).

Step 1 — Identify the bridge: each B–H–B bridge shares one pair of electrons over three atoms.

Step 2 — Classify the bond: this is a three-centre two-electron bond.

Step 3 — Conclude: the bridging bonds are 3c–2e banana bonds.

Why other options are wrong:

- (A) the terminal B–H bonds are normal 2c–2e, but the bridges are not.
- (B) the bonding is covalent (electron-deficient), not ionic.
- (D) it is not a simple coordinate bond.

Final Answer: 3c–2e banana bonds $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q39

Q40.

Solution

Concept — Silicones: Silicones (polysiloxanes) have a backbone of alternating silicon and oxygen atoms, with organic groups (e.g. CH_3) on the silicon.

Step 1 — Recall the structure: the repeating unit is $-Si(R)_2 - O-$.

Step 2 — Identify the backbone: $-Si - O - Si - O-$.

Step 3 — Conclude: the backbone is silicon–oxygen.

Why other options are wrong:

- (A) a C–C backbone describes ordinary organic polymers.
- (B) Si–Si chains are silanes, not silicones.
- (C) the backbone is not alternating Si–C.

Final Answer: $-\mathrm{Si}-\mathrm{O}-\mathrm{Si}-\mathrm{O}-$ linkages $\Rightarrow$ D

Answer: (D) Go Back to Q40

Q41.

Solution

Concept — Oxidising action of $\mathrm{HNO_3}$: Nitric acid is a strong oxidiser, so its $\mathrm{H^+}$ is not reduced to $\mathrm{H_2}$; instead the nitrate is reduced. With dilute $\mathrm{HNO_3}$ and Cu, nitric oxide (NO) is the main gas.

Step 1 — Recall the reaction: dilute $\mathrm{HNO_3}$ + Cu gives $\mathrm{Cu(NO_3)_2}$, water and NO.

Step 2 — Identify the gas: the nitrogen-containing gas evolved is NO (which turns brown as $\mathrm{NO_2}$ in air).

Step 3 — Conclude: the main gas is nitric oxide, NO.

Why other options are wrong:

- (B) $\mathrm{H_2}$ is not liberated because $\mathrm{HNO_3}$ is oxidising.
- (C) $\mathrm{NH_3}$ would need very dilute acid with an active metal, not Cu.
- (D) chlorine is unrelated.

Final Answer: nitric oxide, NO $\Rightarrow$ A

Answer: (A) Go Back to Q41

Q42.

Solution

Concept — Contact process: The key catalysed step is the oxidation of $\mathrm{SO_2}$ to $\mathrm{SO_3}$ over a $\mathrm{V_2O_5}$ catalyst: $2\mathrm{SO_2} + \mathrm{O_2} \rightleftharpoons 2\mathrm{SO_3}$.

Step 1 — Recall the sequence: S (or sulphide) $\rightarrow$ $\mathrm{SO_2}$ $\rightarrow$ $\mathrm{SO_3}$ $\rightarrow$ oleum $\rightarrow$ $\mathrm{H_2SO_4}$.

Step 2 — Identify the catalysed equilibrium: the $\mathrm{V_2O_5}$ catalyst speeds the $\mathrm{SO_2} \rightarrow \mathrm{SO_3}$ step.

Step 3 — Conclude: the key step is $\mathrm{SO_2}$ to $\mathrm{SO_3}$.

Why other options are wrong:

- (B) the $\mathrm{H_2S} \rightarrow \mathrm{SO_2}$ burning step is not the catalysed equilibrium.

- (C) $SO_3 \rightarrow H_2SO_4$ is an absorption step, not catalysed by V_2O_5.
- (D) the conversion to SO_3 does not go directly from S.

Final Answer: SO_2 to $SO_3 \Rightarrow$ A

Answer: (A) Go Back to Q42

Q43.

Solution

Concept — Shape of ClF_3: Cl has 3 bond pairs and 2 lone pairs (5 electron domains, sp^3d); the two lone pairs occupy equatorial positions, giving a T-shaped molecule.

Step 1 — Count domains: 3 bond pairs + 2 lone pairs = 5 domains.

Step 2 — Place lone pairs: both go equatorial (least repulsion).

Step 3 — Resulting shape: the three F atoms form a bent-T (T-shaped) arrangement.

Why other options are wrong:

- (A) trigonal planar would need no lone pairs.
- (B) pyramidal is for one lone pair (e.g. NH_3).
- (D) tetrahedral has no lone pairs and four bonds.

Final Answer: T-shaped $\Rightarrow$ C

Answer: (C) Go Back to Q43

Q44.

Solution

Concept — Inertness of noble gases: Their valence shells are completely filled (ns^2np^6, or $1s^2$ for He), giving a very stable octet, high ionization enthalpy and almost no tendency to gain or lose electrons.

Step 1 — Recall the configuration: noble gases have full s and p subshells.

Step 2 — Consequence: no energetic incentive to form bonds.

Step 3 — Conclude: the completely filled valence shell explains their inertness.

Why other options are wrong:

- (A) atomic radius is not the key reason.
- (B) noble gases actually have very high ionization enthalpies.
- (C) their outer shells are complete, not incomplete.

Final Answer: completely filled valence shells $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q44

Q45.

Solution

Concept — Catalytic activity of transition metals: Their variable oxidation states and partly filled d orbitals let them form unstable intermediates / provide surfaces that adsorb reactants, lowering the activation energy.

Step 1 — Variable oxidation states: allow the metal to accept and donate electrons in the catalytic cycle.

Step 2 — Surface adsorption: reactant molecules adsorb on the metal surface, weakening their bonds.

Step 3 — Conclude: these together explain the catalytic activity.

Why other options are wrong:

- (B) completely filled d orbitals would reduce catalytic ability.
- (C) they are not all radioactive.
- (D) transition metals usually have high, not low, melting points.

Final Answer: variable oxidation states / surface adsorption $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q45

Q46.

Solution

Concept — Effective atomic number (EAN): EAN $=$ (atomic number $-$ oxidation state) $+ 2\times$(number of ligand donor pairs).

Step 1 — Oxidation state of Co: in $[\text{Co}(\text{NH}_3)_6]^{3+}$ it is $+3$.

Step 2 — Electrons left on Co: $27 - 3 = 24$.

Step 3 — Add ligand electrons: six NH_3 each donate a lone pair $= 6 \times 2 = 12$.

Step 4 — Sum: EAN $= 24 + 12 = 36$ (the krypton configuration).

Why other options are wrong:

- (A) forgets to subtract the oxidation state.
- (C) just quotes the atomic number.
- (D) miscounts the donated electrons.

Final Answer: EAN $= 36 \Rightarrow$ B

Answer: (B) Go Back to Q46

Q47.

Solution

Concept — CFSE for octahedral fields: CFSE $= [-0.4\,n(t_{2g}) + 0.6\,n(e_g)]\Delta_o$, where n are the electron counts in each set.

Step 1 — Fill the d^3 ion: all three electrons go into t_{2g}, none into e_g.

Step 2 — Apply the formula: CFSE $= [-0.4 \times 3 + 0.6 \times 0]\Delta_o$.

Step 3 — Evaluate: $-0.4 \times 3 = -1.2$, so CFSE $= -1.2\,\Delta_o$.

Step 4 — Conclude: CFSE $= -1.2\,\Delta_o$.

Why other options are wrong:

- (A) is for d^1.
- (B) is for d^2.
- (D) implies no stabilisation, which is wrong for d^3.

Final Answer: CFSE $= -1.2\,\Delta_o \Rightarrow$ C

Answer: (C) Go Back to Q47

Q48.

Solution

Concept — Reduction in the blast furnace: Fe_2O_3 is reduced mainly by carbon monoxide (and by coke/carbon at higher temperatures) to metallic iron.

Step 1 — Source of CO: coke burns in air and reacts with CO_2 to give CO.

Step 2 — Reduction step: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$.

Step 3 — Conclude: the principal reducing agent is CO (with coke at the hottest zone).

Why other options are wrong:

- (A) SiO_2 is a flux, removing gangue as slag.
- (B) N_2 is inert here.
- (C) limestone provides CaO (flux), not the reductant.

Final Answer: carbon monoxide, CO (and coke) $\Rightarrow$ $\boxed{D}$

Answer: (D) Go Back to Q48

Q49.

Solution

Concept — Heavy water: "Heavy water" is deuterium oxide, D_2O, in which ordinary hydrogen is replaced by its isotope deuterium. It is used as a neutron moderator.

Step 1 — Recall the composition: hydrogen (^1H) is replaced by deuterium ($^2H = D$).

Step 2 — Write the formula: D_2O.

Step 3 — Conclude: heavy water is D_2O.

Why other options are wrong:

- (A) high pressure does not make ordinary water "heavy".
- (B) H_2O_2 is hydrogen peroxide, not heavy water.
- (D) dissolved heavy-metal salts do not define heavy water.

Final Answer: deuterium oxide, D_2O $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q49

Q50.

Solution

Concept — Brown-ring test: For nitrate, $FeSO_4$ reacts with the nitrate (reduced by H_2SO_4) to form the brown nitrosyl complex $[Fe(H_2O)_5NO]^{2+}$, seen as a brown ring at the acid–solution interface.

Step 1 — Recall the reaction: NO_3^- is reduced to NO by Fe^{2+} in acidic medium.

Step 2 — Form the complex: NO coordinates to iron giving $[Fe(H_2O)_5NO]^{2+}$.

Step 3 — Observe: this complex is brown and forms the ring.

Why other options are wrong:

- (B) $Fe(OH)_3$ is a brown precipitate but not the ring species.
- (C) $FeSO_4$ is the reagent, not the coloured ring.
- (D) Fe_2O_3 is not formed in this test.

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

Answer: (A) Go Back to Q50

Answer Key

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