NIOS Class 12 Chemistry Sample Paper-7

Duration: 180 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **43** Questions. The paper is divided into two sections: **Section A – 40** marks, **Section B – 40** marks.
- **Section A** consists of
  - **Q.No. 1 to 16** – Multiple Choice type questions (MCQs) carrying 1 mark each. Select and write the most appropriate option out of the four options given in each of these questions. An internal choice has been provided in some of these questions. You have to attempt only one of the given choices in such questions.
  - **Q. No. 17 to 28** – Objective type questions. Q. No. 17 to 28 carry 02 marks each (with 2 sub- parts of 1 mark each). Attempt these questions as per the instructions given for each of the questions 17 –28.
- **Section B** consists of
  - **Q.No. 29 to 37** – Very Short questions carrying 02 marks each to be answered in the range of 30 to 50 words.
  - **Q.No. 38 to 41** – Short Answer type questions carrying 03 marks each to be answered in the range of 50 to 80 words.
  - **Q.No. 42 and 43** – Long Answer type questions carrying 05 marks each to be answered in the range of 80 to 120 words.
- There is **No Negative marking**.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Section: A

Q1. The number of chloride ions present in 0.25 mol of $CaCl_2$ is: **(1)**

(A) 3.011×10^{23}

(B) 6.022×10^{23}

(C) 1.5055×10^{23}

(D) 1.2044×10^{24}

Q2. The empirical formula of hydrogen peroxide, H_2O_2, is: **(1)**

(A) H_2O_2

(B) HO

(C) H_2O

(D) OH_2

Q3. The maximum number of electrons that can be accommodated in the shell with principal quantum number $n = 3$ is: **(1)**

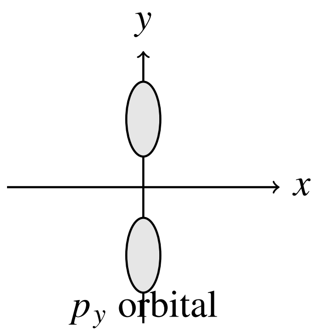
(A) 8

(B) 10

(C) 18

(D) 32

Q4. The orientation of atomic orbitals in space depends on the: **(1)**



p_y orbital

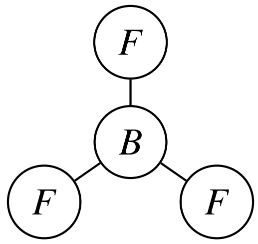
(A) Principal quantum number

(B) Azimuthal quantum number

(C) Spin quantum number

(D) Magnetic quantum number

Q5. The molecular shape of BF_3 is: **(1)**



(A) Trigonal planar

(B) Bent

(C) Tetrahedral

(D) Trigonal pyramidal

Q6. A 0.50 molal solution means: **(1)**

(A) 0.50 mole of solute in 1 litre of solution

(B) 0.50 mole of solute in 1 kg of solvent

(C) 0.50 gram of solute in 1 kg of solvent

(D) 1 mole of solute in 0.50 litre of solution

Q7. A process is spontaneous at constant temperature and pressure when: **(1)**

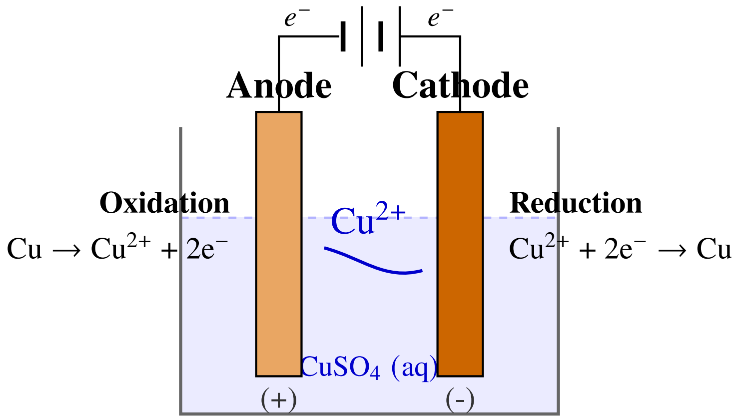
(A) $\Delta G > 0$

(B) $\Delta G = 0$

(C) $\Delta G < 0$

(D) $\Delta H > 0$ always

Q8. In the electrolytic cell shown below, copper is deposited at the: **(1)**



(A) Salt bridge

(B) Anode

(C) Wire above the cell

(D) Cathode

Q9. For a first-order reaction, the half-life is: **(1)**

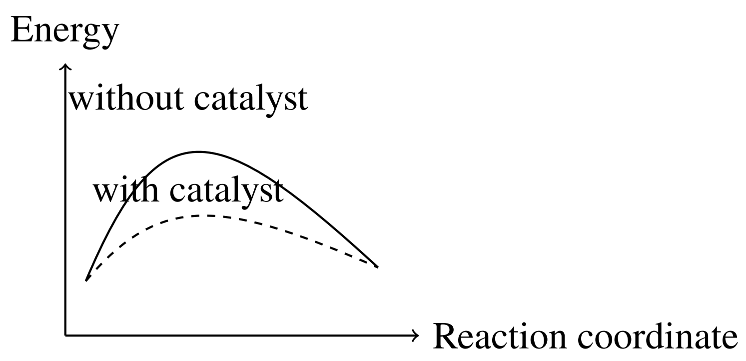
(A) Independent of initial concentration

(B) Directly proportional to initial concentration

(C) Inversely proportional to initial concentration

(D) Equal to twice the initial concentration

Q10. The energy profile shown below indicates that the catalyst: **(1)**



(A) Increases activation energy and decreases ΔH

(B) Decreases activation energy but does not change ΔH

(C) Increases both activation energy and ΔH

(D) Decreases both activation energy and ΔH

Q11. The oxidation state of chromium in $K_2Cr_2O_7$ is: **(1)**

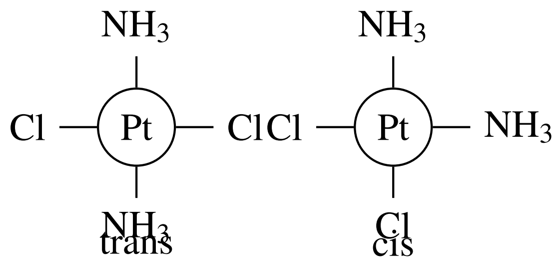
(A) +2

(B) +3

(C) +6

(D) +7

Q12. The compound $[Pt(NH_3)_2Cl_2]$ shows: **(1)**



(A) Optical isomerism only

(B) Linkage isomerism

(C) Ionisation isomerism

(D) Geometrical isomerism

Q13. Ester is formed by the reaction between: **(1)**

(A) A carboxylic acid and an alcohol

(B) An alcohol and a base

(C) A ketone and an alkane

(D) An amine and a salt

Q14. Which reagent is commonly used to distinguish an aldehyde from a ketone? **(1)**

(A) Bromine water

(B) Tollens' reagent

(C) Sodium chloride solution

(D) Dilute sodium hydroxide

Q15. Which of the following is an essential amino acid? **(1)**

(A) Glycine

(B) Alanine

(C) Lysine

(D) Serine

Q16. Which of the following substances is commonly used as an antacid? **(1)**

(A) Aspirin

(B) Penicillin

(C) Vitamin C

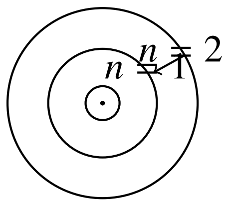
(D) Magnesium hydroxide

Note: Q. No. 17 to 28 are the objective type questions of 2 marks each.

Q17. Complete the following by using the options given below:
(empirical formula, Avogadro constant, molar mass, stoichiometry) **(2)**

1. The simplest whole-number ratio of atoms in a compound is called its . . .
2. The mass in grams of one mole of a substance is called its . . . .

Q18. Read the passage given below and answer the following questions:
Bohr proposed that electrons in an atom revolve around the nucleus only in certain permitted circular orbits called stationary states. Each orbit is associated with a fixed energy. When an electron jumps from a higher energy orbit to a lower energy orbit, radiation is emitted. **(2)**



1. What is the principal quantum number of the K-shell?
2. When an electron falls from a higher orbit to a lower orbit, is radiation emitted or absorbed?

Q19. Write TRUE (T) for the correct statement and FALSE (F) for the incorrect statement: **(2)**

1. Sigma bond is generally stronger than a pi bond.
2. Molecules with sp hybridisation at the central atom are linear.

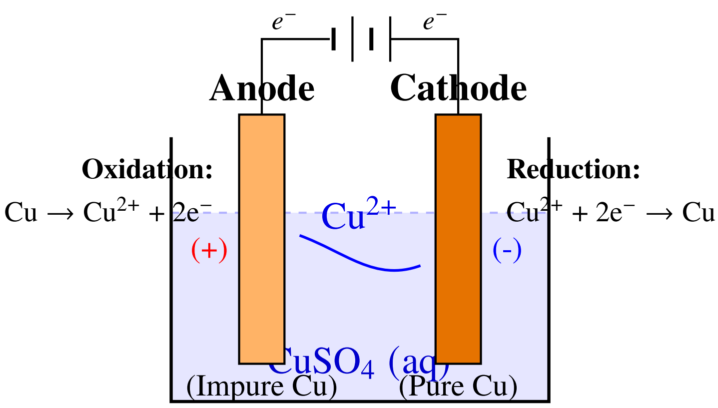
Q20. Complete the following by using the options given below:
(group, period, valence electrons, isotopes) **(2)**

1. The vertical columns in the periodic table are called ....
2. Elements in the same group generally have the same number of ....

Q21. Complete the following by using the options given below:
(absence of *d*-orbitals, amphoteric, acidic, basic) **(2)**

1. Nitrogen does not form pentahalides due to ....
2. Al_2O_3 is an example of an .... oxide.

Q22. Read the passage given below and answer the following questions:
During electrolysis of aqueous copper sulphate using copper electrodes, copper ions from the solution move towards the cathode where they gain electrons and get deposited as copper metal. Simultaneously, copper from the anode dissolves into solution as copper ions. **(2)**



1. What happens at the cathode during this process?
2. Does the mass of the copper anode increase or decrease?

Q23. Read the passage given below and answer the following questions:
Coordination compounds contain a central metal atom or ion surrounded by molecules or ions called ligands. The number of donor atoms directly attached to the central metal is called the coordination number. Some square planar complexes show cis–trans isomerism. **(2)**

1. What is the coordination number of cobalt in $[Co(NH_3)_6]Cl_3$?

2. What type of isomerism is shown by $[Pt(NH_3)_2Cl_2]$?

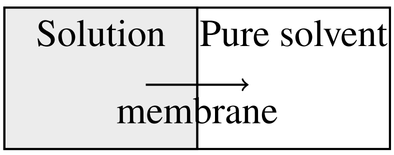
Q24. Match the items given in Column I with the most appropriate items in Column II: **(2)**

Column I	**Column II**
(a) Mole fraction	(i) s^{-1} for first-order rate constant
(b) pH	(ii) Ratio of moles of one component to total moles
(c) Half-life of first-order reaction	(iii) Measure of acidity or alkalinity
(d) Unit of k for first order	(iv) $0.693/k$

Q25. Complete the following reaction equations: **(2)**

1. $CH_3COOH + C_2H_5OH \rightleftharpoons +H_2O$
2. $C_6H_5N_2^+Cl^- \xrightarrow{CuBr} +N_2$

Q26. Read the passage given below and answer the following questions:
Reverse osmosis is a process in which a pressure greater than the osmotic pressure is applied to a solution so that solvent molecules are forced to move through a semipermeable membrane in the reverse direction. This principle is used in desalination and water purification. **(2)**



1. In ordinary osmosis, solvent moves from which side to which side?
2. State one practical use of reverse osmosis.

Q27. Write TRUE (T) for the correct statement and FALSE (F) for the incorrect statement: **(2)**

1. Proteins are polymers of α-amino acids.

2. Glucose is a non-reducing sugar.

Q28. Read the passage given below and answer the following questions:
Vitamins are organic compounds required in small quantities for normal growth and metabolism. Vitamin C and members of vitamin B complex are water-soluble, while vitamins A, D, E and K are fat-soluble. Deficiency of vitamin A may lead to night blindness. **(2)**

1. Name one water-soluble vitamin.
2. Which deficiency disease is associated with vitamin A?

Section: B

Q29. (i) Explain the terms: (a) Raoult's law, (b) ideal solution.
OR
(ii) Define osmosis and osmotic pressure. **(2)**

Q30. Explain how entropy influences the spontaneity of a process. **(2)**

Q31. (i) A gas expands against a constant external pressure of 2 atm from 5 L to 8 L. Calculate the work done by the system.
OR
(ii) State the sign of q and w when (a) heat is supplied to the system, (b) work is done on the system. **(2)**

Q32. (i) Distinguish between enthalpy change and internal energy change.
OR
(ii) Why are bond enthalpies usually given as average values? **(2)**

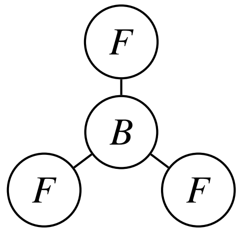
Q33. Explain the Bronsted–Lowry acid–base concept with one suitable example. **(2)**

Q34. What is the effect of increase in temperature on the rate constant and the rate of a chemical reaction? **(2)**

Q35. (i) Why does fluorine show only the −1 oxidation state in its compounds?

OR

(ii) Draw the structure of BF_3 molecule. **(2)**



Q36. How would you convert ethanol into ethanoic acid and then into ethyl ethanoate? **(2)**

Q37. Complete the following reaction equations: **(2)**

(a) $CH_3CHO + H_2 \xrightarrow{Ni}$

(b) $CH_3COOH + SOCl_2 \longrightarrow +SO_2 + HCl$

Q38. Define the following terms:

A. Molarity

B. Mole fraction

C. van't Hoff factor **(3)**

Q39. (i) What is reverse osmosis? Explain one use of this phenomenon in desalination of water.

OR

(ii) Calculate the molality of a solution containing 9.2 g glycerol ($C_3H_8O_3$) dissolved in 100 g water. **(3)**

Q40. Explain the relation between pH and pOH. How do these values help to decide whether a solution is acidic, neutral or basic? **(3)**

Q41. (i) Why does oxygen show anomalous behaviour compared with the other elements of group 16?

OR

(ii) Comment on the acidic or basic nature of p-block oxides across a period and down a group. **(3)**

Q42. (i) Answer the following:

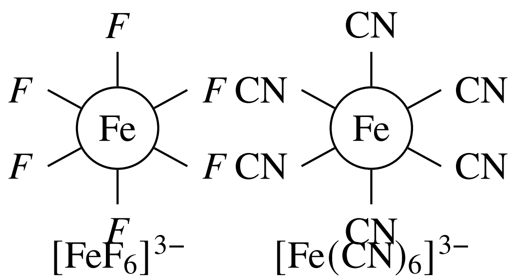
A. Write the IUPAC name of the complex $[Co(NH_3)_5Br]SO_4$.

B. What type of isomerism is shown by $[Pt(NH_3)_2Cl_2]$?

C. Explain why $[FeF_6]^{3-}$ is paramagnetic whereas $[Fe(CN)_6]^{3-}$ has fewer unpaired electrons.

OR

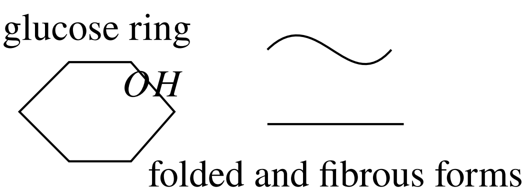
(ii) Explain the hybridisation, shape and magnetic behaviour of $[CoF_6]^{3-}$ and $[Co(CN)_6]^{3-}$ on the basis of valence bond theory. **(5)**



Q43. (i) What are reducing sugars? Explain why glucose is called a reducing sugar and differentiate between starch and cellulose.

OR

(ii) Differentiate between water-soluble and fat-soluble vitamins. Also explain denaturation of proteins with one example. **(5)**



Detailed Solutions

Q1.

Solution

Concept: Avogadro's number converts moles into number of particles. Each formula unit of $CaCl_2$ contains two chloride ions.

Step 1 — Number of formula units in 0.25 mol is:

$$0.25 \times 6.022 \times 10^{23} = 1.5055 \times 10^{23}$$

Step 2 — Each formula unit gives 2 chloride ions.

$$2 \times 1.5055 \times 10^{23} = 3.011 \times 10^{23}$$

Step 3 — Thus the number of chloride ions is 3.011×10^{23}.

Why other options are wrong:

- **Option B:** This would be the count for 0.50 mol of chloride ions, not for the given compound amount.
- **Option C:** This is only the number of formula units, not chloride ions.
- **Option D:** This is four times the number of formula units and is too large.

Final Answer: $\boxed{3.011 \times 10^{23}}$ (Option A)

Answer: (A) **Go Back to Question 1**

Q2.

Solution

Concept: The empirical formula is the simplest whole-number ratio of atoms present in a compound.

Step 1 — In H_2O_2, the atom ratio is 2 : 2.

Step 2 — Divide both subscripts by 2:

$$H_2O_2 \rightarrow HO$$

Step 3 — Therefore the empirical formula is HO.

Why other options are wrong:

- **Option A:** This is the molecular formula, not the empirical formula.
- **Option C:** This is the formula of water, not hydrogen peroxide.
- **Option D:** This is only a rearranged incorrect writing, not the proper empirical formula.

Final Answer: $\boxed{\text{HO}}$ (Option B)

Answer: (B) Go Back to Question 2

Q3.

Solution

Concept: The maximum number of electrons in a shell is given by the formula $2n^2$.

Step 1 — Here $n = 3$.

$$2n^2 = 2 \times 3^2$$

Step 2 — Therefore,

$$2n^2 = 2 \times 9 = 18$$

Step 3 — Hence the shell can hold a maximum of 18 electrons.

Why other options are wrong:

- **Option A:** This corresponds to the second shell.
- **Option B:** This is not obtained from $2n^2$.
- **Option D:** This corresponds to the fourth shell rule when misapplied.

Final Answer: $\boxed{18}$ (Option C)

Answer: (C) Go Back to Question 3

Q4.

Solution

Concept: The magnetic quantum number m_l determines the orientation of an orbital in space.

Step 1 — The principal quantum number tells us the shell or energy level.

Step 2 — The azimuthal quantum number tells us the subshell and general shape.

Step 3 — The magnetic quantum number distinguishes different orientations of the same type of orbital in space.

Why other options are wrong:

- **Option A:** Gives shell size and energy level, not orientation.
- **Option B:** Gives subshell or shape, not orientation.
- **Option C:** Refers to electron spin only.

Final Answer: Magnetic quantum number (Option D)

Answer: (D) Go Back to Question 4

Q5.

Solution

Concept: In BF_3, boron forms three sigma bonds and has no lone pair. The three electron domains arrange themselves in one plane.

Step 1 — Boron in BF_3 is sp^2 hybridised.

Step 2 — Three bond pairs around the central atom repel equally and orient at about 120°.

Step 3 — Therefore the molecular shape is trigonal planar.

Why other options are wrong:

- **Option B:** Bent shape requires lone-pair distortion.
- **Option C:** Tetrahedral requires four electron domains.
- **Option D:** Trigonal pyramidal requires one lone pair and three bonds.

Final Answer: Trigonal planar (Option A)

Answer: (A) Go Back to Question 5

Q6.

Solution

Concept: Molality is defined as moles of solute per kilogram of solvent.

Step 1 — The word molal refers to a mass-based concentration scale.

Step 2 — Therefore a 0.50 molal solution means 0.50 mole of solute dissolved in 1 kg of solvent.

Step 3 — Since the denominator is mass of solvent, molality is independent of temperature-related volume changes.

Why other options are wrong:

- **Option A:** This describes molarity, not molality.
- **Option C:** Uses grams rather than moles.
- **Option D:** Incorrectly mixes amount with volume.

Final Answer: $\boxed{\text{0.50 mole of solute in 1 kg of solvent}}$ (Option B)

Answer: (B) Go Back to Question 6

Q7.

Solution

Concept: The criterion for spontaneity at constant temperature and pressure is the sign of Gibbs free energy change.

Step 1 — If a process has

$$\Delta G < 0$$

then it can proceed spontaneously.

Step 2 — If $\Delta G = 0$, the system is at equilibrium.

Step 3 — If $\Delta G > 0$, the process is non-spontaneous in the forward direction.

Why other options are wrong:

- **Option A:** Positive Gibbs energy means non-spontaneous forward change.
- **Option B:** Zero indicates equilibrium, not spontaneous change.
- **Option D:** Positive enthalpy does not by itself decide spontaneity.

Final Answer: $\boxed{\Delta G < 0}$ (Option C)

Answer: (C) Go Back to Question 7

Q8.

Solution

Concept: In electrolysis, reduction takes place at the cathode. For copper sulphate solution, copper ions gain electrons at the cathode and get deposited as copper metal.

Step 1 — The relevant cathode reaction is:

$$Cu^{2+} + 2e^{-} \rightarrow Cu$$

Step 2 — This reaction occurs at the cathode because the cathode is the site of reduction.

Step 3 — Therefore copper gets deposited at the cathode.

Why other options are wrong:

- **Option A:** A salt bridge is not part of this simple electrolytic cell deposition step.
- **Option B:** Oxidation occurs at the anode, so deposition does not occur there.
- **Option C:** The wire is only an external conductor, not the site of deposition.

Final Answer: Cathode (Option D)

Answer: (D) Go Back to Question 8

Q9.

Solution

Concept: For a first-order reaction,

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

so half-life is independent of initial concentration.

Step 1 — Write the standard first-order half-life relation.

Step 2 — Observe that initial concentration is absent from the expression.

Step 3 — Therefore the half-life remains constant for different initial concentrations of the same first-order reaction.

Why other options are wrong:

- **Option B:** This is not true for first-order kinetics.
- **Option C:** Inverse proportionality to initial concentration applies to some higher-order cases, not first order.
- **Option D:** Half-life is certainly not twice the concentration.

Final Answer: Independent of initial concentration (Option A)

Answer: (A) Go Back to Question 9

Q10.

Solution

Concept: A catalyst lowers the activation energy by providing an alternative path. The enthalpy change depends only on the energy difference between reactants and products.

Step 1 — The lower peak of the catalysed path shows that the activation energy has decreased.

Step 2 — The starting and final energy levels remain the same in both paths.

Step 3 — Hence ΔH is unchanged although the activation energy is reduced.

Why other options are wrong:

- **Option A:** A catalyst does not increase activation energy.
- **Option C:** Neither statement in this option is correct.
- **Option D:** A catalyst does not change ΔH.

Final Answer: Decreases activation energy but does not change ΔH (Option B)

Answer: (B) Go Back to Question 10

Q11.

Solution

Concept: The sum of oxidation numbers in a neutral compound equals zero.

Step 1 — Let oxidation state of chromium be x in $K_2Cr_2O_7$.

Step 2 — Potassium is +1 and oxygen is −2, so:

$$2(+1) + 2x + 7(-2) = 0$$

Step 3 — Solving,

$$2 + 2x - 14 = 0 \Rightarrow 2x = 12 \Rightarrow x = +6$$

Why other options are wrong:

- **Option A:** Too low to balance the oxygen atoms.
- **Option B:** Still does not satisfy charge balance.
- **Option D:** This is the oxidation state in permanganate for manganese, not chromium here.

Final Answer: +6 (Option C)

Answer: (C) Go Back to Question 11

Q12.

Solution

Concept: Square planar complexes of the type $[MA_2B_2]$ can form cis and trans arrangements, giving geometrical isomerism.

Step 1 — In $[Pt(NH_3)_2Cl_2]$, the two chloride ions may be adjacent to each other or opposite to each other.

Step 2 — These two arrangements are chemically distinct and cannot be converted into each other by simple rotation in a square planar structure.

Step 3 — Therefore the complex exhibits geometrical isomerism.

Why other options are wrong:

- **Option A:** Optical isomerism is not the standard feature represented here.
- **Option B:** Linkage isomerism requires ambidentate ligands.
- **Option C:** Ionisation isomerism involves exchange of ions inside and outside the coordination sphere.

Final Answer: Geometrical isomerism (Option D)

Answer: (D) Go Back to Question 12

Q13.

Solution

Concept: Esterification is the reaction between a carboxylic acid and an alcohol, usually in the presence of an acid catalyst.

Step 1 — A carboxylic acid contributes the acyl part of the ester.

Step 2 — An alcohol contributes the alkoxy part.

Step 3 — Therefore an ester is formed by reaction between a carboxylic acid and an alcohol.

Why other options are wrong:

- **Option B:** Acid and base give neutralisation products.
- **Option C:** Ketone and alkane do not form ester this way.
- **Option D:** Amine and salt do not directly form esters.

Final Answer: A carboxylic acid and an alcohol (Option A)

Answer: (A) Go Back to Question 13

Q14.

Solution

Concept: Aldehydes are easily oxidised and can reduce Tollens' reagent to metallic silver, whereas ketones generally cannot.

Step 1 — Add Tollens' reagent to the sample and warm gently.

Step 2 — An aldehyde gives a silver mirror by reducing the silver complex.

Step 3 — A ketone usually does not respond under the same conditions.

Why other options are wrong:

- **Option A:** Bromine water is not the standard selective reagent for this comparison.
- **Option C:** Sodium chloride does not differentiate them.
- **Option D:** Sodium hydroxide alone is not a diagnostic test.

Final Answer: Tollens' reagent (Option B)

Answer: (B) Go Back to Question 14

Q15.

Solution

Concept: Essential amino acids must be supplied in diet because the body cannot synthesise them adequately.

Step 1 — Glycine, alanine and serine can be synthesised in the body and are therefore non-essential.

Step 2 — Lysine is one of the essential amino acids.

Step 3 — Therefore the correct option is lysine.

Why other options are wrong:

- **Option A:** Glycine is non-essential.
- **Option B:** Alanine is non-essential.
- **Option D:** Serine is non-essential.

Final Answer: Lysine (Option C)

Answer: (C) Go Back to Question 15

Q16.

Solution

Concept: Antacids are mild bases used to neutralise excess hydrochloric acid in the stomach.

Step 1 — Magnesium hydroxide is a weak base widely used in antacid formulations.

Step 2 — Aspirin is an analgesic, penicillin is an antibiotic and vitamin C is a vitamin.

Step 3 — Hence the commonly used antacid is magnesium hydroxide.

Why other options are wrong:

- **Option A:** Aspirin is not an antacid.
- **Option B:** Penicillin is not an antacid.
- **Option C:** Vitamin C is not an antacid.

Final Answer: $\boxed{Mg(OH)_2}$ (Option D)

Answer: (D) Go Back to Question 16

Q17.

Solution

Concept: The empirical formula gives the simplest atom ratio, and molar mass is the mass of one mole of a substance.

Step 1 — The simplest whole-number ratio of atoms in a compound is called its empirical formula.

Step 2 — The mass in grams of one mole of a substance is called its molar mass.

Step 3 — Therefore the correct completions are empirical formula and molar mass.

Final Answer: empirical formula; molar mass

Answer: (See above) Go Back to Question 17

Q18.

Solution

Concept: In Bohr's model, the K-shell is the first shell, and electron transition from higher to lower energy emits radiation.

Step 1 — The K-shell corresponds to the first permitted orbit, so its principal quantum number is $n = 1$.

Step 2 — When an electron falls from a higher energy orbit to a lower energy orbit, the energy difference is released.

Step 3 — Therefore radiation is emitted during the downward transition.

Final Answer: 1; radiation is emitted

Answer: (See above) Go Back to Question 18

Q19.

Solution

Concept: Sigma overlap is stronger than sidewise pi overlap, and sp hybridisation gives a linear geometry because two hybrid orbitals orient themselves 180° apart.

Step 1 — Statement 1 is true because sigma bonds arise from direct axial overlap and are generally stronger than pi bonds.

Step 2 — Statement 2 is also true because the two sp hybrid orbitals orient linearly.

Step 3 — Hence both statements are true.

Final Answer: T; T

Answer: (See above) Go Back to Question 19

Q20.

Solution

Concept: Groups are the vertical columns of the periodic table, and elements in the same group usually have similar valence-shell configurations.

Step 1 — The vertical columns are called groups.

Step 2 — Members of the same group usually have the same number of valence electrons.

Step 3 — Therefore the blanks are group and valence electrons.

Final Answer: group; valence electrons

Answer: (See above) Go Back to Question 20

Q21.

Solution

Concept: Nitrogen cannot expand its octet because it lacks vacant d-orbitals, and Al_2O_3 reacts with both acids and bases and is therefore amphoteric.

Step 1 — Nitrogen belongs to the second period and has no d-orbitals in its valence shell. Hence it does not form pentahalides.

Step 2 — Aluminium oxide reacts with acids as a base and with bases as an acid, so it is amphoteric.

Step 3 — Therefore the correct completions are absence of d-orbitals and amphoteric.

Final Answer: absence of d-orbitals; amphoteric

Answer: (See above) Go Back to Question 21

Q22.

Solution

Concept: In copper sulphate electrolysis with copper electrodes, copper is deposited at the cathode and copper dissolves from the anode.

Step 1 — At the cathode, copper ions gain electrons:

$$Cu^{2+} + 2e^{-} \rightarrow Cu$$

So copper is deposited there.

Step 2 — At the anode, copper metal loses electrons:

$$Cu \rightarrow Cu^{2+} + 2e^{-}$$

Therefore the anode gradually dissolves.

Step 3 — Hence the mass of the anode decreases.

Final Answer: Copper is deposited at the cathode; anode mass decreases

Answer: (See above) Go Back to Question 22

Q23.

Solution

Concept: Coordination number counts the donor atoms attached to the central metal, and square planar $[MA_2B_2]$ complexes show cis–trans isomerism.

Step 1 — In $[Co(NH_3)_6]Cl_3$, six ammonia molecules are directly attached to cobalt, so the coordination number is 6.

Step 2 — The complex $[Pt(NH_3)_2Cl_2]$ shows geometrical isomerism because the ligands can be arranged in cis and trans forms.

Step 3 — Therefore the answers are 6 and geometrical isomerism.

Final Answer: 6; geometrical isomerism

Answer: (See above) Go Back to Question 23

Q24.

Solution

Concept: Matching is done by recalling the standard definition of each term.

Step 1 — Mole fraction is ratio of moles of one component to total moles, so (a) matches (ii).

Step 2 — pH is a measure of acidity or alkalinity, so (b) matches (iii). Half-life of a first-order reaction is $0.693/k$, so (c) matches (iv).

Step 3 — The unit of first-order rate constant is s^{-1}, so (d) matches (i).

Final Answer: *a-ii, b-iii, c-iv, d-i*

Answer: (See above) Go Back to Question 24

Q25.

Solution

Concept: Ethanoic acid and ethanol give an ester, and diazonium salts with cuprous bromide give bromobenzene by Sandmeyer reaction.

Step 1 — Esterification gives:

$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

Step 2 — Sandmeyer reaction gives:

$$C_6H_5N_2^+Cl^- \xrightarrow{CuBr} C_6H_5Br + N_2$$

Step 3 — Hence the completed products are ethyl ethanoate and bromobenzene.

Final Answer: $\boxed{CH_3COOC_2H_5;\ C_6H_5Br}$

Answer: (See above) Go Back to Question 25

Q26.

Solution

Concept: In ordinary osmosis, solvent moves through a semipermeable membrane from lower solute concentration to higher solute concentration. Reverse osmosis is used in water purification.

Step 1 — In ordinary osmosis, solvent moves from the pure solvent side or dilute solution side to the more concentrated solution side.

Step 2 — In reverse osmosis, a pressure greater than osmotic pressure is applied to force solvent back in the reverse direction.

Step 3 — One common practical use is desalination of seawater or purification of drinking water.

Final Answer: Solvent moves from dilute to concentrated side; used in desalination or water purification.

Answer: (See above) Go Back to Question 26

Q27.

Solution

Concept: Proteins are polypeptides of α-amino acids, and glucose is a reducing sugar because its open-chain form contains an aldehydic group.

Step 1 — Statement 1 is true: proteins are polymers of α-amino acids linked by peptide bonds.

Step 2 — Statement 2 is false because glucose is actually a reducing sugar.

Step 3 — Therefore the correct sequence is True and False.

Final Answer: T; F

Answer: (See above) Go Back to Question 27

Q28.

Solution

Concept: Vitamin C and vitamin B complex are water-soluble, while vitamin A deficiency causes night blindness.

Step 1 — One water-soluble vitamin is vitamin C. Any member of the vitamin B complex is also acceptable.

Step 2 — Deficiency of vitamin A leads to night blindness.

Step 3 — Therefore the required answers are vitamin C and night blindness.

Final Answer: Vitamin C; night blindness

Answer: (See above) Go Back to Question 28

Q29.

Solution

Concept: Raoult's law relates vapour pressure of a component to its mole fraction in an ideal solution. Osmosis and osmotic pressure describe solvent flow through a semipermeable membrane.

Step 1 — Alternative (i): Raoult's law states that the partial vapour pressure of a volatile component in a solution is equal to the product of its mole fraction and vapour pressure in the pure state.

Step 2 — An ideal solution is a solution that obeys Raoult's law over the entire range of composition and shows no enthalpy or volume change on mixing.

Step 3 — Alternative (ii): Osmosis is the spontaneous flow of solvent through a semipermeable membrane from lower solute concentration to higher solute concentration. Osmotic pressure is the minimum pressure that must be applied to the solution side to stop osmosis.

Final Answer: Raoult's law and ideal solution, or osmosis and osmotic pressure, as defined above

Answer: (See above) Go Back to Question 29

Q30.

Solution

Concept: Entropy measures randomness or disorder. A process becomes more spontaneous when the total entropy change of the universe tends to increase or when ΔG becomes negative.

Step 1 — Processes that produce greater dispersal of matter or energy usually involve an increase in entropy.

Step 2 — At constant temperature and pressure, entropy contributes to spontaneity through:

$$\Delta G = \Delta H - T\Delta S$$

Step 3 — A positive ΔS makes the term $-T\Delta S$ more negative, helping to make ΔG negative and the process spontaneous.

Final Answer: Higher entropy favours spontaneity by helping make $\Delta G < 0$

Answer: (See above) Go Back to Question 30

Q31.

Solution

Concept: Work done at constant external pressure is given by $w = -P_{\text{ext}}\Delta V$. Sign conventions in thermodynamics indicate whether energy enters or leaves the system.

Step 1 — Alternative (i): The volume change is:

$$\Delta V = 8 - 5 = 3 \text{ L}$$

So,

$$w = -P_{\text{ext}}\Delta V = -2 \times 3 = -6 \text{ L atm}$$

If converted to joule,

$$1 \text{ L atm} \approx 101.3 \text{ J}$$

so

$$w \approx -608 \text{ J}$$

Step 2 — The negative sign shows that work is done by the system on the surroundings.

Step 3 — Alternative (ii): If heat is supplied to the system, q is positive. If work is done on the system, w is positive under the chemistry sign convention.

Final Answer: $w = -6$ L atm ≈ -608 J; $q > 0$ for heat supplied, $w > 0$ for work done on the system.

Answer: (See above) Go Back to Question 31

Q32.

Solution

Concept: Internal energy refers to total energy content of the system, while enthalpy includes the pressure–volume term. Bond enthalpies are averaged because measured bond-breaking processes occur in different molecular environments.

Step 1 — Alternative (i): Internal energy change is denoted by ΔU and includes all microscopic energy changes within the system. Enthalpy change is denoted by ΔH and is related to internal energy by:

$$\Delta H = \Delta U + \Delta(PV)$$

At constant pressure for many chemical reactions, ΔH corresponds to the heat exchanged.

Step 2 — Alternative (ii): Bond enthalpies are given as average values because the strength of a particular bond changes depending on the rest of the molecule. Successive bond dissociation steps occur in different chemical environments.

Step 3 — Therefore average bond enthalpy is a practical representative value rather than an exactly identical value for every bond in all molecules.

Final Answer: ΔU and ΔH differ by pressure–volume term; bond enthalpies are average values because actual bond strengths vary with environment.

Answer: (See above) Go Back to Question 32

Q33.

Solution

Concept: According to Bronsted–Lowry theory, an acid is a proton donor and a base is a proton acceptor.

Step 1 — Consider the reaction:

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

Here HCl donates a proton and acts as an acid.

Step 2 — Water accepts the proton and acts as a base.

Step 3 — Thus Bronsted–Lowry theory explains acid–base behaviour in terms of proton transfer rather than simply hydroxide formation.

Final Answer: Acid donates H^+ and base accepts H^+; $HCl + H_2O \longrightarrow H_3O^+ + Cl^-$

Answer: (See above) Go Back to Question 33

Q34.

Solution

Concept: According to the Arrhenius equation, increase in temperature increases the rate constant and thereby increases the rate of reaction.

Step 1 — The Arrhenius relation is:

$$k = Ae^{-E_a/RT}$$

Step 2 — As temperature T increases, the exponential factor becomes larger, so the value of k increases.

Step 3 — Since reaction rate depends on the rate constant, the reaction generally becomes faster at higher temperature.

Final Answer: Increase in temperature increases k and hence increases the reaction rate

Answer: (See above) **Go Back to Question 34**

Q35.

Solution

Concept: Fluorine is the most electronegative element and has no vacant d-orbitals, so it almost always shows the oxidation state -1. BF_3 has trigonal planar geometry due to three bond pairs around boron.

Step 1 — Alternative (i): Fluorine has very high electronegativity and a small size. It gains one electron to complete its octet and does not show positive oxidation states in normal compounds. Also, it lacks vacant valence d-orbitals.

Step 2 — Alternative (ii): In BF_3, boron forms three sigma bonds and has no lone pair. The molecule is trigonal planar with bond angles of about 120°.

Step 3 — Therefore fluorine is restricted to -1 oxidation state and BF_3 is trigonal planar.

Final Answer: Fluorine shows only -1 due to extreme electronegativity; BF_3 is trigonal planar

Answer: (See above) **Go Back to Question 35**

Q36.

Solution

Concept: Ethanol is first oxidised to ethanoic acid, and then the acid reacts with ethanol in presence of an acid catalyst to give the ester ethyl ethanoate.

Step 1 — Oxidise ethanol using an oxidising agent such as acidified potassium dichromate or potassium permanganate:

$$CH_3CH_2OH \xrightarrow{[O]} CH_3COOH$$

Step 2 — React ethanoic acid with ethanol in presence of concentrated sulphuric acid:

$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

Step 3 — The ester formed is ethyl ethanoate.

Final Answer: $\boxed{CH_3CH_2OH \longrightarrow CH_3COOH \longrightarrow CH_3COOC_2H_5}$

Answer: (See above) **Go Back to Question 36**

Q37.

Solution

Concept: Catalytic hydrogenation of ethanal gives ethanol. Thionyl chloride converts carboxylic acids into acid chlorides.

Step 1 — Reduction of ethanal:

$$CH_3CHO + H_2 \xrightarrow{Ni} CH_3CH_2OH$$

Step 2 — Action of thionyl chloride on acetic acid:

$$CH_3COOH + SOCl_2 \longrightarrow CH_3COCl + SO_2 + HCl$$

Step 3 — Hence the products are ethanol and acetyl chloride.

Final Answer: $\boxed{CH_3CH_2OH;\ CH_3COCl}$

Answer: (See above) **Go Back to Question 37**

Q38.

Solution

Concept: Molarity, mole fraction and van't Hoff factor are standard concentration and colligative-property terms.

Step 1 — Molarity: Moles of solute present in one litre of solution.

$$M = \frac{\text{moles of solute}}{\text{volume of solution in litre}}$$

Step 2 — Mole fraction: Ratio of moles of one component to total moles in the mixture.

$$X_i = \frac{n_i}{\sum n_i}$$

Step 3 — van't Hoff factor: Ratio of actual number of particles in solution after dissociation or association to the expected number if the solute behaved ideally.

Final Answer: Definitions of molarity, mole fraction and van't Hoff factor as given above

Answer: (See above) Go Back to Question 38

Q39.

Solution

Concept: Reverse osmosis uses external pressure to force solvent opposite to the natural osmotic direction. Molality is moles of solute per kilogram of solvent.

Step 1 — Alternative (i): Reverse osmosis is the process in which pressure greater than osmotic pressure is applied to a solution so that solvent is forced from the concentrated side through the semipermeable membrane toward the pure solvent side. It is used in desalination of seawater and purification of drinking water.

Step 2 — Alternative (ii): Molar mass of glycerol $C_3H_8O_3$ is:

$$3(12) + 8(1) + 3(16) = 36 + 8 + 48 = 92 \text{ g mol}^{-1}$$

Moles of glycerol:

$$\frac{9.2}{92} = 0.1 \text{ mol}$$

Step 3 — Mass of water is 100 g = 0.100 kg. Therefore,

$$m = \frac{0.1}{0.100} = 1.0 \text{ mol kg}^{-1}$$

Final Answer: Reverse osmosis is used in desalination; molality of glycerol solution $= 1.0$ m

Answer: (See above) Go Back to Question 39

Q40.

Solution

Concept: The pH scale measures hydrogen ion concentration, and pOH measures hydroxide ion concentration. At 25°C their sum is 14.

Step 1 — The definitions are:

$$\mathrm{pH} = -\log[\mathrm{H}^+], \qquad \mathrm{pOH} = -\log[\mathrm{OH}^-]$$

Step 2 — At 25°C,

$$\mathrm{pH} + \mathrm{pOH} = 14$$

Step 3 — If pH is less than 7, the solution is acidic. If pH equals 7, it is neutral. If pH is greater than 7, it is basic or alkaline. Correspondingly, low pOH means high basicity.

Final Answer: $\boxed{\mathrm{pH} + \mathrm{pOH} = 14;\ pH < 7 \text{ acidic}, pH = 7 \text{ neutral}, pH > 7 \text{ basic}}$

Answer: (See above) **Go Back to Question 40**

Q41.

Solution

Concept: Oxygen behaves anomalously because of its small size, high electronegativity and absence of vacant *d*-orbitals. The acid–base character of p-block oxides changes systematically with metallic and non-metallic character.

Step 1 — Alternative (i): Oxygen differs from heavier group 16 elements because it is much smaller, more electronegative and capable of strong hydrogen bonding. It also has no vacant *d*-orbitals. Therefore its compounds and behaviour often differ from sulphur, selenium and tellurium.

Step 2 — Alternative (ii): Across a period, metallic character decreases and non-metallic character increases, so oxides change from basic to amphoteric to acidic. Down a group, metallic character generally increases, so oxides become more basic.

Step 3 — This trend explains why many p-block non-metal oxides are acidic, while oxides of more metallic members can be amphoteric or basic.

Final Answer: Oxygen is anomalous because of small size and high electronegativity; p-block oxides become more acidic across a period and more basic down a group.

Answer: (See above) **Go Back to Question 41**

Q42.

Solution

Concept: Naming, isomerism and magnetic behaviour of coordination compounds depend on oxidation state, ligand type and the strength of the ligand field.

Step 1 — Alternative (iA): In $[Co(NH_3)_5Br]SO_4$, the complex cation is $[Co(NH_3)_5Br]^{2+}$. Since ammonia is neutral and bromido inside the sphere is -1, cobalt is in the $+3$ oxidation state. The IUPAC name is pentaamminebromidocobalt(III) sulphate.

Step 2 — Alternative (iB): $[Pt(NH_3)_2Cl_2]$ shows geometrical isomerism because cis and trans forms are possible.

Step 3 — Alternative (iC): In $[FeF_6]^{3-}$, fluoride is a weak-field ligand. Iron is Fe^{3+} with $3d^5$ configuration. Weak-field ligands do not force pairing, so more unpaired electrons remain and the complex is strongly paramagnetic. In $[Fe(CN)_6]^{3-}$, cyanide is a strong-field ligand, so electron pairing occurs to a greater extent and the number of unpaired electrons is reduced.

Step 4 — Alternative (ii): For $[CoF_6]^{3-}$, cobalt is $3d^6$ and fluoride is weak-field, giving an outer-orbital complex with sp^3d^2 hybridisation, octahedral geometry and paramagnetic nature. For $[Co(CN)_6]^{3-}$, cyanide is strong-field, electron pairing occurs, and the complex becomes an inner-orbital d^2sp^3 octahedral complex with fewer or no unpaired electrons depending on the pairing state described by VBT treatment.

Final Answer: pentaamminebromidocobalt(III) sulphate; geometrical isomerism; weak-field and strong-field ligands explain the magnetic difference.

Answer: (See above) **Go Back to Question 42**

Q43.

Solution

Concept: Reducing sugars can reduce mild oxidising agents because they possess or can generate a free aldehydic or ketonic group. Vitamins are grouped by solubility, and proteins lose native structure on denaturation.

Step 1 — Alternative (i): A reducing sugar is one that can reduce reagents such as Tollens' reagent or Fehling's solution. Glucose is called a reducing sugar because in solution its cyclic form is in equilibrium with an open-chain form containing an aldehydic group.

Step 2 — Starch and cellulose are both polysaccharides of glucose, but they differ in linkage and structure. Starch mainly contains α-glycosidic linkages and serves as a storage polysaccharide in plants. Cellulose has β-glycosidic linkages and serves as a structural material in plant cell walls. Human digestive enzymes can hydrolyse starch but not cellulose efficiently.

Step 3 — Alternative (ii): Water-soluble vitamins include vitamin C and vitamin B complex. They are not stored efficiently and are excreted more readily. Fat-soluble vitamins include A, D, E and K; they can be stored in the body, especially in fatty tissues. Denaturation of proteins is the loss of their native three-dimensional structure and biological activity due to heat, pH change or chemicals. For example, coagulation of egg white on heating is denaturation.

Step 4 — In both alternatives, the key idea is that structure determines function: the structure of glucose explains reducing behaviour, the structure of polysaccharides explains their properties, and the structure of proteins controls biological activity.

Final Answer: Glucose is reducing because its open-chain form has an aldehydic group; starch and cellulose differ in linkage and function; water-soluble and fat-soluble vitamins differ in storage; denaturation destroys native protein structure.

Answer: (See above) Go Back to Question 43

Answer Key

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