NIOS Class 12 Chemistry Sample Paper – 5

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. What is the mass of 3.011×10^{23} molecules of carbon dioxide? (Molar mass of CO_2 = 44 g mol^{-1}) **(1)**

(A) 11 g

(B) 22 g

(C) 44 g

(D) 33 g

Q2. A compound contains 40% carbon, 6.67% hydrogen and 53.33% oxygen by mass. Its empirical formula is: **(1)**

(A) CH_2O

(B) $C_2H_4O_2$

(C) CHO_2

(D) C_2H_2O

Q3. The number of unpaired electrons in a nitrogen atom (atomic number 7) in its ground state is: **(1)**

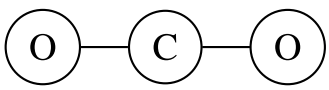
(A) 1

(B) 2

(C) 3

(D) 5

Q4. Which of the following molecules has a linear shape? **(1)**



CO_2 molecule

(A) H_2O

(B) CO_2

(C) NH_3

(D) CH_4

Q5. A sample of gas occupies 500 mL at 27°C and 1 atm pressure. What will be its volume at 327°C at the same pressure? **(1)**

(A) 1000 mL

(B) 750 mL

(C) 250 mL

(D) 1500 mL

Q6. Which of the following concentration terms is independent of temperature? **(1)**

(A) Molarity

(B) Normality

(C) Molality

(D) Volume percentage

Q7. For the reaction $C(s) + O_2(g) \longrightarrow CO_2(g)$, $\Delta H = -393.5\ \text{kJ mol}^{-1}$. The enthalpy of formation of $CO_2(g)$ is: **(1)**

(A) $+393.5$ kJ mol^{-1}

(B) -393.5 kJ mol^{-1}

(C) 0 kJ mol^{-1}

(D) -196.75 kJ mol^{-1}

Q8. For a reaction to be spontaneous at all temperatures, the conditions required are: **(1)**

(A) $\Delta H > 0$ and $\Delta S > 0$

(B) $\Delta H < 0$ and $\Delta S < 0$

(C) $\Delta H < 0$ and $\Delta S > 0$

(D) $\Delta H > 0$ and $\Delta S < 0$

Q9. In the electrolysis of molten NaCl using inert electrodes, the product formed at the cathode is: **(1)**

(A) Cl_2 gas

(B) Na metal

(C) H_2 gas

(D) O_2 gas

Q10. The unit of rate constant for a zero-order reaction is: **(1)**

(A) s^{-1}

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

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

(D) $mol^2\,L^{-2}\,s^{-1}$

Q11. Which of the following oxides of nitrogen is neutral in nature? **(1)**

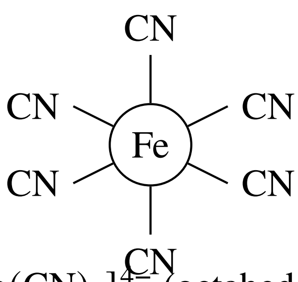
(A) N_2O_5

(B) NO_2

(C) N_2O

(D) NO

Q12. The hybridisation of the central metal ion in $[Fe(CN)_6]^{4-}$ is: **(1)**



$[Fe(CN)_6]^{4-}$ (octahedral)

(A) sp^3d^2

(B) sp^3

(C) d^2sp^3

(D) dsp^2

Q13. The IUPAC name of $CH_3CH_2COCH_3$ is: **(1)**

(A) Butanal

(B) Butan-2-one

(C) Butanone

(D) Both (B) and (C)

Q14. Which of the following reagents gives a silver mirror with acetaldehyde? **(1)**

(A) Fehling's solution

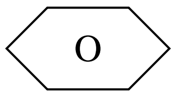
(B) Tollen's reagent

(C) Iodoform reagent

(D) Schiff's reagent

Q15. The pyranose form of glucose has a ring containing: **(1)**

glucose ring



(A) 4 carbon atoms and 1 oxygen atom

(B) 5 carbon atoms and 1 oxygen atom

(C) 6 carbon atoms and 1 oxygen atom

(D) 5 carbon atoms and 2 oxygen atoms

Q16. Which of the following drugs is used as an analgesic? **(1)**

(A) Chloramphenicol

(B) Paracetamol

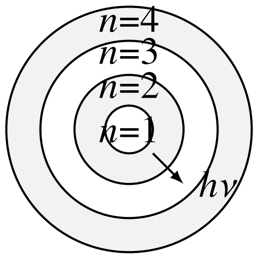
(C) Ranitidine

(D) Bithionol

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

Q17. Read the passage given below and answer the following questions:

In 1913, Niels Bohr proposed a model of the hydrogen atom in which the electron revolves around the nucleus in certain fixed circular orbits called stationary states. Each orbit is associated with a definite amount of energy. The electron can jump from a lower energy orbit to a higher energy orbit by absorbing a photon of suitable frequency. When it jumps back, it emits radiation of frequency ν given by $h\nu = E_2 - E_1$. **(2)**



1. State the condition under which an electron in a Bohr orbit does not radiate energy.
2. What determines the frequency of the radiation emitted when an electron jumps between two orbits?

Q18. Complete the following by using the options given below:
(trigonal bipyramidal, octahedral, square pyramidal, see-saw) **(2)**

1. In PCl_5, the central phosphorus atom has .... geometry.
2. In SF_4, the molecular shape is due to one equatorial lone pair on sulphur.

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

1. Real gases follow the ideal gas equation $PV = nRT$ at very high pressure and very low temperature.
2. The average kinetic energy of gas molecules depends only on the absolute temperature of the gas.

Q20. Complete the following by using the options given below:
(isotonic, hypotonic, hypertonic, osmotic pressure) **(2)**

1. Two solutions having the same osmotic pressure at a given temperature are called .... solutions.

2. When a cell is placed in a solution having higher osmotic pressure than the cell fluid, the solution is said to be .... relative to the cell fluid.

Q21. Complete the following by using the options given below:
(cathode, anode, salt bridge, electrolyte) **(2)**

1. In an electrochemical cell, reduction takes place at the ....
2. The device that maintains electrical neutrality by allowing the flow of ions between the two half-cells is called the ....

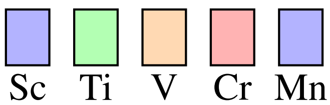
Q22. Read the passage given below and answer the following questions:

Drugs are chemical substances used to cure diseases and reduce suffering. Some drugs are obtained from natural sources while others are synthesised in laboratories. Antacids neutralise excess stomach acid. Analgesics relieve pain without causing loss of consciousness. Antibiotics kill or inhibit the growth of disease-causing microorganisms. However, misuse and overuse of antibiotics can lead to antibiotic resistance, which makes previously treatable infections difficult to cure. **(2)**

1. Differentiate between analgesics and antibiotics based on their function.
2. Why is overuse of antibiotics discouraged by medical professionals?

Q23. Read the passage given below and answer the following questions:

The d-block elements are located between groups 2 and 13 in the periodic table. These elements have partially filled d-orbitals in their ground state or in any of their common oxidation states. They are characterised by variable oxidation states, formation of coloured compounds, paramagnetism in many ions, and the ability to form coordination complexes. The transition elements also act as good catalysts due to their ability to adopt multiple oxidation states and provide suitable surfaces for reactions. **(2)**



first transition series

1. Why do transition elements exhibit variable oxidation states?
2. Give one reason why transition metals and their compounds act as good catalysts.

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

Column I	**Column II**
(a) O_3	(i) Used as a refrigerant
(b) NH_3	(ii) Protects earth from UV radiation
(c) CFC	(iii) Manufactured by Haber's process
(d) H_2SO_4	(iv) Manufactured by Contact process

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

1. $CH_3COOH + C_2H_5OH \xrightarrow[H^+]{\Delta} +H_2O$
2. $CH_3CH_2Br + KOH(alc.) \xrightarrow{\Delta} +KBr + H_2O$

Q26. Read the passage given below and answer the following questions:

Polymers are giant molecules formed by the linking together of a large number of small repeating units called monomers. Polymers can be classified as addition polymers and condensation polymers. Addition polymers are formed by the repeated addition of monomer molecules containing double bonds, without the elimination of any small molecule. Condensation polymers are formed by condensation reactions between two different functional groups with the elimination of small molecules like water, alcohol, or ammonia. Nylon and polyester are examples of condensation polymers. **(2)**

1. What is the key difference between addition and condensation polymerisation?

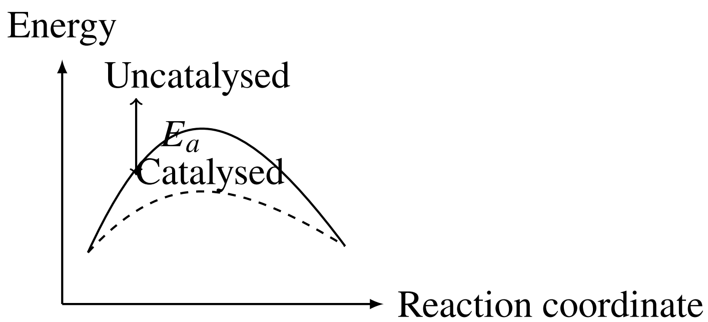
2. Name one condensation polymer along with its monomer units.

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

1. The number of significant figures in 0.00450 is three.
2. One atomic mass unit (amu) is defined as exactly one-twelfth the mass of one carbon-12 atom.

Q28. Read the passage given below and answer the following questions:

The rate of a chemical reaction depends on several factors including the concentration of reactants, temperature, surface area and the presence of a catalyst. According to the collision theory, for a reaction to occur, the reacting molecules must collide with sufficient kinetic energy and proper orientation. The minimum energy that the colliding molecules must possess for a successful collision is called the activation energy. A catalyst provides an alternative pathway with lower activation energy, thereby increasing the rate of reaction without itself being consumed. **(2)**



1. According to collision theory, what two conditions must be satisfied for reactant molecules to form products?
2. How does a catalyst increase the rate of a reaction without altering the equilibrium position?

Section: B

Q29. State the first law of thermodynamics and express it mathematically. What are its limitations? **(2)**

Q30. Define the term 'standard enthalpy of formation.' Write the thermochemical equation for the standard enthalpy of formation of liquid water. **(2)**

Q31. (i) Calculate the work done when 2 moles of an ideal gas expand isothermally and reversibly at 300 K from a volume of 10 L to 20 L. ($R = 8.314$ J K^{-1} mol^{-1})

OR

(ii) Explain why the enthalpy change of a reaction measured at constant pressure is different from the internal energy change. Derive the relationship between ΔH and ΔU. **(2)**

Q32. (i) Calculate the pH of a 0.001 M HCl solution.

OR

(ii) What is a buffer solution? Explain the action of an acidic buffer with a suitable example. **(2)**

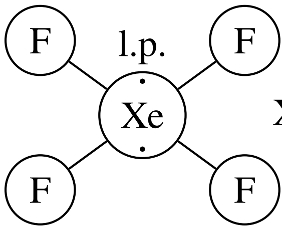
Q33. State Faraday's first law of electrolysis. How much charge is required to deposit 1 mole of copper from $CuSO_4$ solution? **(2)**

Q34. Distinguish between the order of a reaction and the molecularity of a reaction with a suitable example. **(2)**

Q35. (i) Draw the structure of XeF_4 molecule using VSEPR theory and state its shape.

OR

(ii) Explain why Mn^{3+} is a stronger oxidising agent than Fe^{3+} in aqueous solution. **(2)**



XeF_4

Q36. How will you convert the following?

(i) Ethanol to ethene

(ii) Phenol to benzene **(2)**

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

(a) $CH_3COCH_3 + H_2N - OH \xrightarrow[H^+]{\Delta} + H_2O$

(b) $C_6H_5NH_2 + NaNO_2 + 2HCl \xrightarrow[0-5^{\circ}C]{} + NaCl + 2H_2O$

Q38. Define the following terms with one example each:

A. Hybridisation

B. Bond order

C. Hydrogen bonding **(3)**

Q39. (i) A balloon is filled with 2.0 g of helium gas at 27°C and 1 atm pressure. Calculate the volume of the balloon. (R = 0.0821 L atm K^{-1} mol^{-1}, molar mass of He = 4 g mol^{-1})

OR

(ii) Calculate the molarity of a solution prepared by dissolving 5.85 g of NaCl in enough water to make 500 mL of solution. (Molar mass of NaCl = 58.5 g mol^{-1}) **(3)**

Q40. Explain the following terms with reference to electrochemistry:

A. Specific conductivity

B. Molar conductivity

C. How does molar conductivity vary with dilution for a weak electrolyte? **(3)**

Q41. (i) Explain the formation of $[Co(NH_3)_6]^{3+}$ on the basis of Valence Bond Theory. State its hybridisation, shape and magnetic behaviour.

OR

(ii) (a) What is lanthanoid contraction?

(b) Mention two consequences of lanthanoid contraction. **(3)**

Q42. (i) (a) Using Valence Bond Theory, explain the hybridisation, geometry and magnetic behaviour of $[Ni(CO)_4]$.

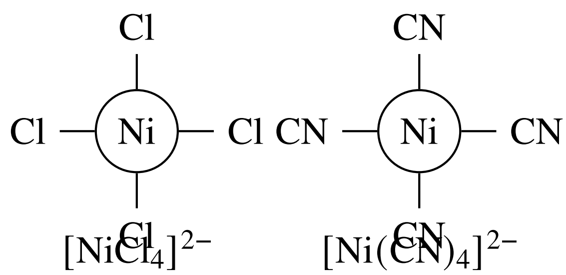
(b) Why is $[NiCl_4]^{2-}$ paramagnetic while $[Ni(CN)_4]^{2-}$ is diamagnetic?

OR

(ii) (a) How is ozone prepared in the laboratory? Write the chemical equation.

(b) Explain the oxidising behaviour of ozone with one example.

(c) How does ozone act as a protective shield for life on earth? **(5)**



$[NiCl_4]^{2-}$ $[Ni(CN)_4]^{2-}$

Q43. (i) (a) How will you distinguish between ethanol and ethanoic acid by a chemical test?

(b) Write the mechanism of acid-catalysed dehydration of ethanol to ethene.

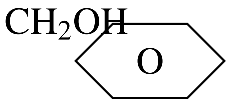
(c) How is ethanoic acid converted to ethanamide? Write the reaction.

OR

(ii) (a) What are reducing and non-reducing sugars? Give one example of each.

(b) Write the Haworth structure of α-D-glucopyranose.

(c) What is the difference between globular and fibrous proteins? Give one example of each. **(5)**



α-D-glucopyranose

Detailed Solutions

Q1.

Solution

Concept: One mole of any substance contains Avogadro's number (6.022×10^{23}) of molecules. The mass of one mole of a substance is its molar mass. Using the relationship, mass can be calculated from the given number of molecules.

Step 1 — Number of moles of $CO_2 = \dfrac{3.011 \times 10^{23}}{6.022 \times 10^{23}} = 0.50$ mol.

Step 2 — Mass of CO_2 = moles × molar mass = $0.50 \times 44 = 22$ g.

Step 3 — Therefore the mass is 22 g, which matches option B. Option A (11 g) corresponds to 0.25 mol and option C (44 g) corresponds to 1 mol.

Final Answer: 22 g (Option B)

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept: The empirical formula represents the simplest whole-number ratio of atoms in a compound. To find it, convert percentage composition to moles by dividing by atomic masses and then find the simplest ratio.

Step 1 — For 100 g of compound: C = 40 g, H = 6.67 g, O = 53.33 g.

Step 2 — Moles: C = 40/12 = 3.33, H = 6.67/1 = 6.67, O = 53.33/16 = 3.33.

Step 3 — Divide by smallest (3.33): C = 1, H = 2, O = 1. So empirical formula is CH_2O.

Final Answer: CH_2O (Option A)

Answer: (A)

Go Back to Question 2

Q3.

Solution

Concept: The electronic configuration of an atom is written using Aufbau principle, Hund's rule and Pauli exclusion principle. Unpaired electrons are those that occupy orbitals singly.

Step 1 — Nitrogen (Z = 7): electronic configuration is $1s^2\,2s^2\,2p^3$.

Step 2 — In the $2p$ subshell, there are three orbitals (p_x, p_y, p_z). According to Hund's rule, each orbital gets one electron before any pairing occurs. So all three $2p$ electrons are unpaired.

Step 3 — Thus nitrogen has 3 unpaired electrons in its ground state.

Final Answer: 3 (Option C)

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept: Molecular shape is determined by VSEPR theory. A molecule is linear when the central atom has two bond pairs and no lone pairs, or when lone pairs are arranged to give a linear geometry.

Step 1 — In CO_2, carbon has two double bonds (two bond domains) and no lone pairs. The electron domains repel to give a bond angle of 180°, making the molecule linear.

Step 2 — H_2O is bent (2 bond pairs + 2 lone pairs), NH_3 is trigonal pyramidal (3 bond pairs + 1 lone pair), CH_4 is tetrahedral (4 bond pairs).

Step 3 — Hence CO_2 is the linear molecule.

Final Answer: CO_2 (Option B)

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: Charles's law states that at constant pressure, the volume of a fixed mass of gas is directly proportional to its absolute temperature: $V_1/T_1 = V_2/T_2$.

Step 1 — Convert temperatures to Kelvin: $T_1 = 27 + 273 = 300$ K, $T_2 = 327 + 273 = 600$ K.

Step 2 — Using Charles's law: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$$\frac{500}{300} = \frac{V_2}{600}$$

$$V_2 = \frac{500 \times 600}{300} = 1000 \text{ mL}.$$

Step 3 — The volume doubles as the absolute temperature doubles.

Final Answer: 1000 mL (Option A)

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept: Concentration terms that depend on volume change with temperature because volume changes with temperature. Terms based on mass do not change because mass is temperature-independent.

Step 1 — Molarity and normality depend on volume of solution, which changes with temperature.

Step 2 — Molality is defined as moles of solute per kilogram of solvent, which is mass-based.

Step 3 — Therefore molality is independent of temperature.

Final Answer: Molality (Option C)

Answer: (C)

Go Back to Question 6

Q7.

Solution

Concept: The standard enthalpy of formation is defined as the enthalpy change when one mole of a compound is formed from its constituent elements in their standard states. Since the given reaction forms one mole of CO_2 from its elements in standard states, ΔH of this reaction equals the standard enthalpy of formation.

Step 1 — The reaction $C(s) + O_2(g) \to CO_2(g)$ forms exactly one mole of CO_2 from elemental carbon (graphite) and oxygen gas, both in standard states.

Step 2 — Therefore, $\Delta_f H^\circ(CO_2) = -393.5$ kJ mol^{-1}. The negative sign indicates an exothermic formation.

Final Answer: -393.5 kJ mol^{-1} (Option B)

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: Gibbs free energy change is given by $\Delta G = \Delta H - T\Delta S$. A reaction is spontaneous when $\Delta G < 0$. For spontaneity at all temperatures, ΔG must remain negative regardless of T.

Step 1 — If $\Delta H < 0$ (exothermic) and $\Delta S > 0$ (increase in disorder), then $\Delta G = \Delta H - T\Delta S$ will always be negative because both terms favour negativity.

Step 2 — Check each option: Option A: $\Delta H > 0$, $\Delta S > 0$ gives $\Delta G < 0$ only at high T. Option B: $\Delta H < 0$, $\Delta S < 0$ gives $\Delta G < 0$ only at low T. Option D: $\Delta H > 0$, $\Delta S < 0$ gives $\Delta G > 0$ always.

Step 3 — Only $\Delta H < 0$ and $\Delta S > 0$ ensures spontaneity at all temperatures.

Final Answer: $\Delta H < 0$ and $\Delta S > 0$ (Option C)

Answer: (C)

Go Back to Question 8

Q9.

Solution

Concept: In the electrolysis of molten NaCl, the ions present are Na^+ and Cl^-. At the cathode (negative electrode), reduction occurs and cations gain electrons. At the anode (positive electrode), oxidation occurs and anions lose electrons.

Step 1 — Cathode reaction (reduction): $Na^+ + e^- \rightarrow Na(l)$. Sodium metal is deposited.

Step 2 — Anode reaction (oxidation): $2Cl^- \rightarrow Cl_2(g) + 2e^-$. Chlorine gas is liberated.

Step 3 — H_2 gas would be produced only in aqueous NaCl, not in molten NaCl.

Final Answer: Na metal (Option B)

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: For a zero-order reaction, rate $= k[\text{reactant}]^0 = k$. The unit of rate is mol L^{-1} s^{-1}. Since rate equals k for zero order, the unit of k is the same as the unit of rate.

Step 1 — Rate has units of concentration per time = mol L^{-1} s^{-1}.

Step 2 — For zero-order: rate = k, so k has the same unit: mol L^{-1} s^{-1}.

Step 3 — Option A (s^{-1}) is for first-order, Option C (L mol^{-1} s^{-1}) is for second-order.

Final Answer: mol L^{-1} s^{-1} (Option B)

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept: Oxides can be classified as acidic, basic, amphoteric or neutral based on their reactions with acids and bases. Neutral oxides do not react with either acids or bases.

Step 1 — N_2O_5 is strongly acidic (forms HNO_3 with water). NO_2 is acidic (forms a mixture of HNO_2 and HNO_3).

Step 2 — N_2O (nitrous oxide) is neutral; it does not react with acids or bases and does not form any acid or base with water.

Step 3 — NO is neutral in dry form but can combine with oxygen to form NO_2.

Final Answer: N_2O (Option C)

Answer: (C)

Go Back to Question 11

Q12.

Solution

Concept: In $[Fe(CN)_6]^{4-}$, iron is in +2 oxidation state (Fe^{2+}, $3d^6$). Cyanide is a strong-field ligand that causes electron pairing in the $3d$ orbitals. According to Valence Bond Theory, the hybridisation is determined by which orbitals of the central metal ion participate in bonding.

Step 1 — Fe^{2+} has electronic configuration [Ar] $3d^6$. CN^- being a strong-field ligand forces pairing: all six $3d$ electrons occupy three $3d$ orbitals, freeing two $3d$ orbitals.

Step 2 — The two inner $3d$ orbitals, one $4s$ orbital, and three $4p$ orbitals hybridise to form six d^2sp^3 hybrid orbitals.

Step 3 — The six hybrid orbitals point toward the corners of an octahedron and accept electron pairs from six CN^- ligands. Hence the hybridisation is d^2sp^3.

Final Answer: d^2sp^3 (Option C)

Answer: (C)

Go Back to Question 12

Q13.

Solution

Concept: In IUPAC nomenclature, the longest carbon chain containing the principal functional group is identified. Ketones are named by replacing the terminal "-e" of the corresponding alkane with "-one". The position of the carbonyl group is indicated by a number.

Step 1 — $CH_3CH_2COCH_3$ has four carbon atoms. The carbonyl group (C=O) is on the second carbon.

Step 2 — The parent alkane is butane. Replacing "-e" with "-one" and indicating the position gives butan-2-one, commonly called butanone.

Step 3 — Both "butan-2-one" and "butanone" are acceptable. Since option D encompasses both (B) and (C), it is the most complete answer.

Final Answer: Both (B) and (C) (Option D)

Answer: (D)

Go Back to Question 13

Q14.

Solution

Concept: Tollens' reagent contains $[Ag(NH_3)_2]^+$ ions. Aldehydes reduce these silver ions to metallic silver, which deposits as a silver mirror on the inner wall of the test tube. Ketones generally do not give this test.

Step 1 — Acetaldehyde (CH_3CHO) is an aldehyde and therefore reduces Tollens' reagent to metallic silver, forming a silver mirror.

Step 2 — Fehling's solution also tests for aldehydes (gives a red precipitate of Cu_2O). Iodoform test is for methyl ketones. Schiff's reagent restores pink colour with aldehydes. However, the "silver mirror" test specifically refers to Tollens' reagent.

Step 3 — Option B, Tollens' reagent, is the correct answer that gives the characteristic silver mirror.

Final Answer: Tollens' reagent (Option B)

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept: Glucose exists predominantly in cyclic forms. The six-membered ring form is called the pyranose form because its structure resembles the heterocyclic compound pyran. In this ring, five carbon atoms and one oxygen atom form the six-membered ring.

Step 1 — In the pyranose ring of glucose, the ring closure involves the −OH group at C-5 adding to the carbonyl group at C-1, forming a hemiacetal.

Step 2 — The ring thus contains C-1, C-2, C-3, C-4, C-5 (five carbon atoms) and the oxygen atom from the original C-5 −OH group, making a six-membered ring.

Step 3 — Therefore the pyranose form has 5 carbon atoms and 1 oxygen atom in the ring.

Final Answer: 5 carbon atoms and 1 oxygen atom (Option B)

Answer: (B)

Go Back to Question 15

Q16.

Solution

Concept: Drugs are classified based on their therapeutic action. Analgesics relieve pain, antibiotics kill/inhibit microorganisms, antacids neutralise stomach acid, and antiseptics prevent infection.

Step 1 — Chloramphenicol is a broad-spectrum antibiotic, not an analgesic. Ranitidine is an antacid/anti-ulcer drug. Bithionol is an antiseptic.

Step 2 — Paracetamol (also known as acetaminophen) is a widely used analgesic and antipyretic that relieves pain and reduces fever.

Step 3 — Thus the analgesic among the options is paracetamol.

Final Answer: Paracetamol (Option B)

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept: According to Bohr's model, electrons revolve in stationary orbits without radiating energy. The frequency of emitted or absorbed radiation is determined by the energy difference between the two orbits involved in the transition.

Step 1 — (i) An electron does not radiate energy as long as it remains in a stationary orbit (a fixed energy level). Radiation occurs only when the electron jumps from one orbit to another. This is Bohr's postulate that overcomes the instability predicted by classical electrodynamics.

Step 2 — (ii) The frequency ν of the radiation emitted when an electron jumps from a higher energy orbit (E_2) to a lower energy orbit (E_1) is given by: $h\nu = E_2 - E_1$, or $\nu = (E_2 - E_1)/h$. The energy difference between the two orbits determines the frequency.

Final Answer: (i) Electron does not radiate while in a stationary orbit. (ii) The energy difference between the two orbits determines the frequency: $h\nu = E_2 - E_1$.

Answer: (See above)

Go Back to Question 17

Q18.

Solution

Concept: In PCl_5, phosphorus has five bond pairs and no lone pairs, so the electron pair geometry and molecular shape are both trigonal bipyramidal. In SF_4, sulphur has four bond pairs and one lone pair; the lone pair occupies an equatorial position, resulting in a see-saw shape.

Step 1 — PCl_5: P has 5 valence electrons, each Cl contributes one electron for bonding. Total 5 bond pairs, no lone pairs. VSEPR predicts trigonal bipyramidal geometry.

Step 2 — SF_4: S has 6 valence electrons, 4 are used in S–F bonds. Two electrons remain as one lone pair. With 4 bond pairs and 1 lone pair, the shape is see-saw.

Final Answer: trigonal bipyramidal; see-saw

Answer: (See above)

Go Back to Question 18

Q19.

Solution

Concept: Real gases deviate from ideal behaviour under certain conditions. The kinetic theory of gases relates molecular kinetic energy to absolute temperature.

Step 1 — Statement 1: Real gases approach ideal behaviour at low pressure (molecules far apart, negligible intermolecular forces) and high temperature (high kinetic energy overcomes attractive forces). At high pressure and low temperature, deviations are maximum. Thus the statement is FALSE.

Step 2 — Statement 2: According to kinetic molecular theory, average kinetic energy = $\frac{3}{2}kT$, which depends only on temperature, not on the nature of the gas. This statement is TRUE.

Final Answer: F; T

Answer: (See above)

Go Back to Question 19

Q20.

Solution

Concept: Tonicity compares the osmotic pressure of two solutions. Isotonic solutions have equal osmotic pressure. A hypertonic solution has higher osmotic pressure and draws water out of cells.

Step 1 — (i) Two solutions having the same osmotic pressure at a given temperature are isotonic solutions. Example: 0.9% NaCl solution is isotonic with human blood.

Step 2 — (ii) When a cell is placed in a solution of higher osmotic pressure, water moves out of the cell by osmosis, causing the cell to shrink. Such a solution is hypertonic relative to the cell fluid.

Final Answer: isotonic; hypertonic

Answer: (See above)

Go Back to Question 20

Q21.

Solution

Concept: In an electrochemical cell, the cathode is the electrode where reduction (gain of electrons) occurs. The salt bridge connects the two half-cells and allows ion flow to maintain electrical neutrality.

Step 1 — (i) Reduction (gain of electrons) always takes place at the cathode. For example, in a Daniell cell: $Cu^{2+} + 2e^{-} \rightarrow Cu$ at the cathode.

Step 2 — (ii) The salt bridge (typically a U-tube filled with KCl/KNO_3 in agar-agar gel) allows anions to move toward the anode half-cell and cations to move toward the cathode half-cell, maintaining electrical neutrality in both compartments.

Final Answer: cathode; salt bridge

Answer: (See above)

Go Back to Question 21

Q22.

Solution

Concept: Analgesics and antibiotics serve different therapeutic purposes. Antibiotic resistance is a serious public health concern caused by the overuse and misuse of antibiotics.

Step 1 — (i) Analgesics are drugs that relieve pain without causing loss of consciousness (e.g., aspirin, paracetamol). Antibiotics are chemical substances produced by microorganisms that kill or inhibit the growth of other microorganisms (e.g., penicillin, chloramphenicol). Analgesics treat symptoms; antibiotics treat infections.

Step 2 — (ii) Overuse of antibiotics promotes the survival and multiplication of resistant bacterial strains. These resistant bacteria no longer respond to standard antibiotic treatment, making infections harder to cure and leading to the spread of "superbugs". This is why medical professionals advocate judicious use of antibiotics.

Final Answer: (i) Analgesics relieve pain; antibiotics kill/inhibit microorganisms. (ii) Overuse leads to antibiotic resistance, making infections difficult to treat.

Answer: (See above)

Go Back to Question 22

Q23.

Solution

Concept: Transition elements have incompletely filled d-orbitals. The energy gap between $(n-1)d$ and ns orbitals is small, allowing electrons from both to participate in bonding, which leads to variable oxidation states. Their catalytic activity arises from this and from their ability to form unstable intermediates.

Step 1 — (i) In transition elements, the energies of $(n-1)d$ and ns orbitals are very close. Therefore, electrons from both ns and $(n-1)d$ orbitals can be lost progressively during compound formation, resulting in multiple possible oxidation states.

Step 2 — (ii) Transition metals act as good catalysts because they can adopt multiple oxidation states, which allows them to form unstable intermediate compounds with reactants. These intermediates then decompose to give products and regenerate the catalyst. Their ability to provide a surface for adsorption of reactants also contributes significantly.

Final Answer: (i) Small energy difference between $(n-1)d$ and ns orbitals allows variable oxidation states. (ii) They adopt multiple oxidation states and form unstable intermediates, lowering activation energy.

Answer: (See above)

Go Back to Question 23

Q24.

Solution

Concept: Each compound has characteristic properties and uses. Ozone absorbs UV radiation. Ammonia is produced via Haber's process. CFCs were used as refrigerants. Sulphuric acid is manufactured by the Contact process.

Step 1 — (a) O_3 (ozone) in the stratosphere absorbs harmful UV radiation from the sun, protecting life on earth. $\rightarrow$ (ii).

Step 2 — (b) NH_3 (ammonia) is manufactured industrially by Haber's process: $N_2 + 3H_2 \rightleftharpoons 2NH_3$. $\rightarrow$ (iii).

Step 3 — (c) CFCs (chlorofluorocarbons) were widely used as refrigerants. $\rightarrow$ (i). (d) H_2SO_4 is manufactured by the Contact process. $\rightarrow$ (iv).

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

Answer: (See above)

Go Back to Question 24

Q25.

Solution

Concept: Carboxylic acids react with alcohols (esterification) to form esters. Alkyl halides undergo dehydrohalogenation with alcoholic KOH to form alkenes.

Step 1 — (i) Ethanoic acid reacts with ethanol in presence of acid catalyst to form ethyl ethanoate (an ester): $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$.

Step 2 — (ii) Bromoethane on heating with alcoholic KOH undergoes β-elimination (dehydrohalogenation) to form ethene: $CH_3CH_2Br + KOH(alc.) \rightarrow CH_2{=}CH_2 + KBr + H_2O$.

Final Answer: (i) $CH_3COOC_2H_5$; (ii) $CH_2{=}CH_2$

Answer: (See above)

Go Back to Question 25

Q26.

Solution

Concept: Addition polymers form by repeated addition of monomers without elimination of small molecules (e.g., polythene from ethene). Condensation polymers form with elimination of small molecules (e.g., nylon from diamine and diacid, eliminating water).

Step 1 — (i) In addition polymerisation, monomers containing double bonds add to each other repeatedly without the loss of any atom or molecule. In condensation polymerisation, monomers with two different functional groups react with the elimination of small molecules such as water, alcohol or ammonia at each step.

Step 2 — (ii) Nylon-6,6 is a condensation polymer formed from hexamethylenediamine and adipic acid with the elimination of water molecules. Another example is polyester (terylene) from ethylene glycol and terephthalic acid.

Final Answer: (i) Addition: no elimination; Condensation: small molecules eliminated. (ii) Nylon-6,6 from hexamethylenediamine and adipic acid.

Answer: (See above)

Go Back to Question 26

Q27.

Solution

Concept: Significant figures are the meaningful digits in a measured quantity. The atomic mass unit is defined relative to the carbon-12 isotope.

Step 1 — Statement 1: In 0.00450, the leading zeros are not significant. The digits 4, 5, 0 (trailing zero after decimal) are significant. This gives three significant figures: 4, 5, and 0. So the statement is TRUE.

Step 2 — Statement 2: By definition, 1 amu (or 1 u) is exactly $\frac{1}{12}$ of the mass of one atom of carbon-12 isotope. This statement is TRUE.

Final Answer: T; T

Answer: (See above)

Go Back to Question 27

Q28.

Solution

Concept: Collision theory states that for a reaction to occur, molecules must collide with energy ≥ activation energy and with proper orientation. Catalysts lower activation energy without changing the thermodynamic parameters.

Step 1 — (i) According to collision theory, two conditions must be satisfied: (a) The colliding molecules must possess kinetic energy equal to or greater than the activation energy (E_a). (b) The molecules must collide with proper orientation so that the reacting atoms/functional groups come into contact in a way that allows bond breaking and bond formation.

Step 2 — (ii) A catalyst provides an alternative reaction pathway with lower activation energy. A larger fraction of molecules now possess energy ≥ the lowered E_a, so the rate increases. However, the catalyst does not change the initial or final states of the reaction, so ΔG and the equilibrium constant remain unchanged.

Final Answer: (i) Enough kinetic energy ($\geq E_a$) and proper orientation. (ii) Catalyst provides an alternative pathway with lower activation energy.

Answer: (See above)

Go Back to Question 28

Q29.

Solution

Concept: The first law of thermodynamics is the law of conservation of energy: energy can neither be created nor destroyed, only converted from one form to another.

Step 1 — Mathematical expression: $\Delta U = q + w$, where ΔU is the change in internal energy of the system, q is the heat absorbed by the system, and w is the work done on the system.

Step 2 — Limitations: (i) The first law does not predict the direction of a process or whether it is spontaneous. (ii) It does not tell us about the feasibility or extent to which a reaction can proceed.

Final Answer: First law: $\Delta U = q + w$. It is a statement of energy conservation. Limitations: It does not predict spontaneity or direction of processes.

Answer: (See above)

Go Back to Question 29

Q30.

Solution

Concept: Standard enthalpy of formation is the enthalpy change when one mole of a compound is formed from its constituent elements in their most stable standard states at 1 bar pressure and a specified temperature (usually 298 K).

Step 1 — The standard enthalpy of formation of liquid water is the enthalpy change when one mole of $H_2O(l)$ is formed from $H_2(g)$ and $O_2(g)$ in their standard states.

Step 2 — The thermochemical equation: $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l) \quad \Delta_f H^\circ = -285.8\,\text{kJ mol}^{-1}$.

Final Answer: Standard enthalpy of formation is ΔH when 1 mole of compound is formed from its elements in standard states. For water: $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$, $\Delta_f H^\circ = -285.8\,\text{kJ mol}^{-1}$.

Answer: (See above)

Go Back to Question 30

Q31.

Solution

Concept: For isothermal reversible expansion of an ideal gas, work done $w = -nRT\ln(V_2/V_1)$. The relationship $\Delta H = \Delta U + \Delta n_g RT$ connects enthalpy and internal energy.

Alternative (i): Step 1 — $w = -nRT\ln(V_2/V_1) = -2 \times 8.314 \times 300 \times \ln(20/10)$.

Step 2 — $w = -2 \times 8.314 \times 300 \times 0.693 = -3458.5$ J. The negative sign means work is done by the system.

Alternative (ii): Step 1 — At constant pressure, $\Delta H = q_p$, but $\Delta U = q - P\Delta V$. Some energy goes into expansion work ($P\Delta V$). So ΔH and ΔU differ by the $P\Delta V$ work term.

Step 2 — From $H = U + PV$, at constant pressure: $\Delta H = \Delta U + P\Delta V$. For ideal gases: $P\Delta V = \Delta n_g RT$. So $\Delta H = \Delta U + \Delta n_g RT$.

Final Answer: (i) $w = -3458.5$ J. (ii) $\Delta H = \Delta U + \Delta n_g RT$; they differ by the expansion work term.

Answer: (See above)

Go Back to Question 31

Q32.

Solution

Concept: pH = $-\log[H^+]$. For a strong monoprotic acid like HCl, $[H^+]$ equals the acid concentration. A buffer solution resists changes in pH upon addition of small amounts of acid or base.

Alternative (i): Step 1 — $[H^+] = 0.001$ M $= 10^{-3}$ M. pH $= -\log(10^{-3}) = 3$.

Alternative (ii): Step 1 — A buffer solution maintains nearly constant pH when small amounts of acid or base are added. An acidic buffer is a mixture of a weak acid and its salt with a strong base (e.g., $CH_3COOH + CH_3COONa$).

Step 2 — On adding a small amount of strong acid, H^+ reacts with CH_3COO^- to form CH_3COOH, minimising pH change. On adding base, OH^- reacts with CH_3COOH to form CH_3COO^- and water.

Final Answer: (i) pH = 3. (ii) A buffer resists pH change; acidic buffer e.g., CH_3COOH/CH_3COONa works by neutralising added acid/base.

Answer: (See above)

Go Back to Question 32

Q33.

Solution

Concept: Faraday's first law states that the mass of substance deposited or liberated at an electrode is directly proportional to the quantity of electricity passed. For copper deposition, $Cu^{2+} + 2e^- \rightarrow Cu$, so 2 moles of electrons are needed per mole of Cu.

Step 1 — Faraday's first law: $m = ZQ$, where m is mass deposited, Z is electrochemical equivalent, Q is charge passed. Alternatively: mass $\propto$ charge.

Step 2 — To deposit 1 mole of Cu, 2 moles of electrons are required. Charge = $nF = 2 \times 96500 =$ 193000 C (i.e., 2 Faraday).

Final Answer: First law: mass deposited $\propto$ quantity of electricity passed. Charge required for 1 mole Cu = 2F = 193000 C.

Answer: (See above)

Go Back to Question 33

Q34.

Solution

Concept: Order of a reaction is experimentally determined from the rate law, while molecularity is a theoretical concept representing the number of molecules colliding in an elementary step.

Step 1 — Order of reaction: The sum of the powers to which concentration terms are raised in the experimentally determined rate law. It can be zero, fractional or integer. Molecularity: The number of reacting species (atoms, ions or molecules) that collide simultaneously in an elementary reaction. It is always a whole number (1, 2 or 3).

Step 2 — Example: For the hydrolysis of ethyl acetate, rate = $k[CH_3COOC_2H_5]^1$ (pseudo first order, order = 1) but molecularity = 2 (involves ester and water molecules).

Final Answer: Order is experimental (can be fractional); molecularity is theoretical (always integer). Example: hydrolysis of ester – order = 1, molecularity = 2.

Answer: (See above)

Go Back to Question 34

Q35.

Solution

Concept: XeF_4 has Xe with 4 bond pairs and 2 lone pairs, giving square planar geometry. Mn^{3+} is a stronger oxidising agent than Fe^{3+} because Mn^{2+} has a stable half-filled d^5 configuration.

Alternative (i): Step 1 — Xe has 8 valence electrons. Four form bonds with F atoms; 4 electrons form 2 lone pairs. VSEPR: 6 electron domains (4 bp + 2 lp) give octahedral electron geometry. Lone pairs occupy opposite positions (axial), so the four F atoms lie in a square plane. Shape: square planar.

Alternative (ii): Step 1 — Mn^{3+} is $3d^4$; on reduction it forms Mn^{2+} ($3d^5$), which has a stable half-filled d-subshell. Fe^{3+} is $3d^5$ (already half-filled); on reduction it becomes Fe^{2+} ($3d^6$), which is less stable. Thus Mn^{3+} has a greater tendency to get reduced, making it a stronger oxidising agent.

Final Answer: (i) XeF_4 is square planar. (ii) Mn^{3+} reduces to stable Mn^{2+} (d^5), while Fe^{3+} goes to less stable Fe^{2+} (d^6).

Answer: (See above)

Go Back to Question 35

Q36.

Solution

Concept: Ethanol undergoes dehydration to form ethene. Phenol can be reduced to benzene by removing the hydroxyl group.

Step 1 — (i) Ethanol to ethene: Heat ethanol with concentrated H_2SO_4 at 443 K (or pass ethanol vapour over heated alumina). $CH_3CH_2OH \xrightarrow[443\text{ K}]{\text{conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$. This is an acid-catalysed dehydration reaction.

Step 2 — (ii) Phenol to benzene: Distil phenol with zinc dust. The zinc reduces phenol by removing the −OH group. $C_6H_5OH + Zn \xrightarrow{\Delta} C_6H_6 + ZnO$. The −OH group is replaced by hydrogen.

Final Answer: (i) Ethanol $\xrightarrow[443\text{ K}]{\text{conc. } H_2SO_4}$ ethene + H_2O. (ii) Phenol + Zn $\xrightarrow{\Delta}$ benzene + ZnO.

Answer: (See above)

Go Back to Question 36

Q37.

Solution

Concept: Ketones react with hydroxylamine to form oximes. Primary aromatic amines undergo diazotisation with $NaNO_2$ and HCl at low temperature to form diazonium salts.

Step 1 — (a) Acetone reacts with hydroxylamine to form acetone oxime: $CH_3COCH_3 + H_2NOH \rightarrow (CH_3)_2C{=}NOH + H_2O$.

Step 2 — (b) Aniline reacts with $NaNO_2$ and HCl at 0–5°C (diazotisation) to form benzene diazonium chloride: $C_6H_5NH_2 + NaNO_2 + 2HCl \rightarrow C_6H_5N_2^+Cl^- + NaCl + 2H_2O$.

Final Answer: (a) $(CH_3)_2C{=}NOH$ (acetone oxime); (b) $C_6H_5N_2^+Cl^-$ (benzene diazonium chloride)

Answer: (See above)

Go Back to Question 37

Q38.

Solution

Concept: Hybridisation involves mixing of atomic orbitals to form equivalent hybrid orbitals. Bond order indicates bond strength and stability. Hydrogen bonding is a special type of dipole-dipole attraction.

Step 1 — A. Hybridisation: The mixing and recasting of atomic orbitals of similar energy to form an equal number of new equivalent orbitals called hybrid orbitals. Example: In CH_4, carbon undergoes sp^3 hybridisation – one $2s$ and three $2p$ orbitals mix to form four equivalent sp^3 hybrid orbitals.

Step 2 — B. Bond order: The number of chemical bonds between a pair of atoms. It is calculated as (number of bonding electrons − number of antibonding electrons)/2 in molecular orbital theory. Example: In O_2, bond order = 2 (double bond). Higher bond order means shorter, stronger bond.

Step 3 — C. Hydrogen bonding: An electrostatic attraction between a hydrogen atom covalently bonded to a highly electronegative atom (F, O or N) and another electronegative atom. Example: H_2O molecules are associated through intermolecular H-bonds ($O - H \cdots O$), which explains its unusually high boiling point.

Final Answer: A. Hybridisation: mixing of orbitals, e.g., sp^3 in CH_4. B. Bond order: number of bonds between atoms, e.g., 2 in O_2. C. H-bonding: attraction between H attached to F/O/N and another electronegative atom, e.g., in H_2O.

Answer: (See above)

Go Back to Question 38

Q39.

Solution

Concept: The ideal gas law $PV = nRT$ relates pressure, volume, moles and temperature. Molarity is moles of solute per litre of solution.

Alternative (i): Step 1 — Moles of He = $2.0/4 = 0.50$ mol. $T = 27 + 273 = 300$ K, $P = 1$ atm.

Step 2 — $V = nRT/P = (0.50 \times 0.0821 \times 300)/1 = 12.315$ L.

Alternative (ii): Step 1 — Moles of NaCl = $5.85/58.5 = 0.10$ mol. Volume = 500 mL = 0.500 L.

Step 2 — Molarity = $0.10/0.500 = 0.20$ M.

Final Answer: (i) Volume = 12.315 L. (ii) Molarity = 0.20 M.

Answer: (See above)

Go Back to Question 39

Q40.

Solution

Concept: Conductivity quantifies a solution's ability to conduct electricity. Specific conductivity depends on ion concentration and nature, while molar conductivity normalises for concentration.

Step 1 — A. Specific conductivity (κ): The conductance of a solution contained between two electrodes of unit area separated by unit distance. It is the reciprocal of resistivity. Units: S cm^{-1} or S m^{-1}.

Step 2 — B. Molar conductivity (Λ_m): The conductivity of a solution containing one mole of electrolyte placed between electrodes separated by unit distance. $\Lambda_m = \kappa/c$, where c is concentration in mol m^{-3} or mol cm^{-3}. Units: S cm^2 mol^{-1}.

Step 3 — C. For a weak electrolyte, molar conductivity increases steeply with dilution because dilution shifts the dissociation equilibrium forward, producing more ions. Λ_m approaches the limiting value Λ_m° only at infinite dilution. This contrasts with strong electrolytes where the increase is gradual due to decreased interionic attractions.

Final Answer: A. κ: conductance of unit volume of solution. B. Λ_m: conductivity per unit concentration. C. For weak electrolytes, Λ_m increases steeply with dilution due to increased dissociation.

Answer: (See above)

Go Back to Question 40

Q41.

Solution

Concept: Valence Bond Theory explains bonding in complexes through hybridisation of metal orbitals. Lanthanoid contraction is the steady decrease in atomic/ionic size across the lanthanoid series.

Alternative (i): Step 1 — In $[Co(NH_3)_6]^{3+}$, Co is in +3 oxidation state: [Ar] $3d^6$. NH_3 is a strong-field ligand, causing electron pairing in $3d$.

Step 2 — Two $3d$, one $4s$ and three $4p$ orbitals hybridise to give d^2sp^3 hybridisation. Geometry: octahedral. All electrons are paired, so the complex is diamagnetic.

Alternative (ii): Step 1 — (a) Lanthanoid contraction: The steady and gradual decrease in atomic and ionic radii from La to Lu due to poor shielding of nuclear charge by $4f$ electrons.

Step 2 — (b) Consequences: (1) The second and third transition series elements have nearly equal atomic radii (e.g., Zr $\approx$ Hf). (2) It makes the separation of lanthanoids difficult because of very similar sizes and chemical properties.

Final Answer: (i) $[Co(NH_3)_6]^{3+}$: d^2sp^3, octahedral, diamagnetic. (ii) (a) Gradual size decrease from La to Lu. (b) Consequences: similar sizes of 2nd/3rd transition series; difficult lanthanoid separation.

Answer: (See above)

Go Back to Question 41

Q42.

Solution

Concept: VBT explains geometry and magnetism of complexes based on hybridisation and ligand field strength. Ozone is a strong oxidising agent and absorbs UV radiation.

Alternative (i): Step 1 — (a) $[Ni(CO)_4]$: Ni is in 0 oxidation state: [Ar] $3d^8 4s^2$. CO is a strong-field ligand; $4s$ electrons pair in $3d$, giving $3d^{10}$. One $4s$ and three $4p$ orbitals hybridise to sp^3 – tetrahedral geometry. All electrons paired – diamagnetic.

Step 2 — (b) $[NiCl_4]^{2-}$: Ni^{2+} is $3d^8$. Cl^- is a weak-field ligand, so no pairing. Four sp^3 hybrids form – tetrahedral, paramagnetic (2 unpaired electrons). $[Ni(CN)_4]^{2-}$: CN^- is strong-field, causes pairing of all $3d$ electrons. $3d$, $4s$ and $4p$ give dsp^2 – square planar, diamagnetic.

Alternative (ii): Step 1 — (a) Lab preparation: Pass silent electric discharge through dry oxygen. $3O_2 \rightarrow 2O_3$. Ozone is collected as a blue gas with a characteristic pungent smell.

Step 2 — (b) Ozone oxidises PbS (black) to $PbSO_4$ (white): $PbS + 4O_3 \rightarrow PbSO_4 + 4O_2$. This demonstrates its oxidising power.

Step 3 — (c) Ozone in the stratosphere absorbs harmful ultraviolet radiation (UV-B and UV-C) from the sun, preventing it from reaching the earth's surface. Without this ozone shield, UV radiation would cause skin cancer and damage to living organisms.

Final Answer: (i) (a) $[Ni(CO)_4]$: sp^3, tetrahedral, diamagnetic. (b) $[NiCl_4]^{2-}$ is paramagnetic (weak-field, tetrahedral); $[Ni(CN)_4]^{2-}$ is diamagnetic (strong-field, square planar). (ii) (a) $3O_2 \xrightarrow{\text{elec. discharge}} 2O_3$. (b) $PbS + 4O_3 \rightarrow PbSO_4 + 4O_2$. (c) Ozone absorbs harmful UV radiation.

Answer: (See above)

Go Back to Question 42

Q43.

Solution

Concept: Ethanol and ethanoic acid can be distinguished by chemical tests. Dehydration follows E1 mechanism. Sugars are classified based on reducing ability. Proteins differ in structure and function.

Alternative (i): Step 1 — (a) Ethanoic acid turns blue litmus red and reacts with $NaHCO_3$ to give effervescence of CO_2. Ethanol does not. $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + CO_2 + H_2O$.

Step 2 — (b) Mechanism: (1) Protonation of −OH group. (2) Loss of water to form carbocation ($CH_3CH_2^+$). (3) Loss of a proton from adjacent carbon to form ethene. Overall: $CH_3CH_2OH \xrightarrow[H^+]{\Delta} CH_2{=}CH_2 + H_2O$.

Step 3 — (c) $CH_3COOH + SOCl_2 \rightarrow CH_3COCl \xrightarrow{NH_3} CH_3CONH_2$ (ethanamide).

Alternative (ii): Step 1 — (a) Reducing sugars contain a free aldehyde or ketone group and reduce Tollens'/Fehling's reagent (e.g., glucose). Non-reducing sugars lack a free carbonyl group and do not reduce these reagents (e.g., sucrose).

Step 2 — (b) In α-D-glucopyranose, the −OH at C-1 is below the plane (opposite to CH_2OH at C-5 in the Haworth projection).

Step 3 — (c) Fibrous proteins: elongated, insoluble, structural (e.g., keratin in hair). Globular proteins: spherical, soluble, functional (e.g., haemoglobin in blood).

Final Answer: (i) (a) Ethanoic acid gives CO_2 with $NaHCO_3$. (b) E1: protonation → carbocation → loss of H^+. (c) Via CH_3COCl to CH_3CONH_2. (ii) (a) Reducing: glucose; Non-reducing: sucrose. (b) α-D-glucopyranose: −OH at C-1 below ring plane. (c) Fibrous: keratin (structural); Globular: haemoglobin (functional).

Answer: (See above)

Go Back to Question 43

Answer Key

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