AL HUDA SCIENCE ACADEMY

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Solved Exercise of CHEMISTRY Class 10

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Unit 14: States of Matter

A. Multiple Choice Questions

1. According to kinetic theory, the basic difference between solid, liquid and gas is due to:

- **(a) the difference in the movements of the particles. ✓**
- (b) the chemical properties of the particles.
- (c) the size of the particles.
- (d) the shape of the particles.

2. Upon heating the rate of evaporation:

- (a) decreases
- **(b) increases ✓**
- (c) remains the same
- (d) initially decreases and then increases upon further heating

3. The inter-particle attractions are the strongest in:

- **(a) Solids ✓**
- (b) Liquids
- (c) Plasma
- (d) Gas

4. Cooling the vapours of some gases change them directly into solid state. This phenomenon is called:

- (a) evaporation
- (b) condensation
- (c) sublimation
- **(d) deposition ✓**

5. Physical state in which the particles possess the maximum energy:

- (a) Solid
- (b) Liquid
- **(c) Gaseous ✓**
- (d) Vapour

6. How does the process of evaporation depend on the force of attraction present among the molecules of a liquid?

- **(a) It decreases with the increasing strength of attraction. ✓**
- (b) It increases with the increasing strength of attraction.
- (c) It is independent of the strength of the force of attraction.
- (d) It first increases and then decreases with the increasing strength of the force of attraction.

7. Which gas will diffuse at the fastest rate?

- **(a) HCl ✓**
- (b) SO_2
- (c) CO_2
- (d) H_2S

8. The phase changes A and B in gas → liquid → solid are:

- (a) Melting, evaporating
- (b) Condensation, melting
- **(c) Condensation, freezing ✓**
- (d) Boiling, freezing

9. A student noticed frost falling on the ground at 6.30 am and disappearing by 8.30 am. Which phase change was responsible for changing the frost into water vapours?

- (a) Melting
- (b) Evaporation
- **(c) Sublimation ✓**
- (d) Deposition

B. Short Answer Questions

14.1 From where does the energy come when a liquid evaporates?

Answer: The energy required for evaporation comes from the liquid itself, as high-energy molecules absorb heat from surrounding molecules to overcome intermolecular forces and escape. This leaves the remaining molecules with lower average kinetic energy, which is why evaporation causes a cooling effect.

14.2 Is condensation an endothermic process?

Answer: No, condensation is an exothermic process because it involves gas molecules losing kinetic energy and releasing heat to the surroundings. As the thermal energy is liberated, the particles slow down and pull closer together to transition into a liquid state.

14.3 Why naphthalene balls (used to repel insects) disappear after sometime?

Answer: Naphthalene balls disappear because they undergo sublimation, a process where a solid converts directly into a gas without passing through a liquid state. Over time, the solid molecules gain ambient thermal energy and completely vaporize into the air.

14.4 Why does the temperature remain constant during a phase change?

Answer: During a phase change, the heat energy supplied does not increase the kinetic energy of the particles; instead, it is entirely consumed as potential energy to break or form intermolecular forces. Consequently, the temperature remains perfectly constant until the phase transition is completely finished.

14.5 Is it possible to compress a liquid like a gas?

Answer: No, it is not possible to compress a liquid like a gas because liquid particles are already packed closely together with very little empty space between them. While gases have large intermolecular gaps that allow high compressibility, liquids possess a fixed volume and resist compression.

14.6 Can you change the temperature at which water boils in an experiment in your lab?

Answer: Yes, you can change the boiling point of water by altering the external atmospheric pressure in the laboratory. By lowering the surrounding pressure (such as using a vacuum pump), water will boil at a temperature lower than 100°C, whereas increasing the pressure raises its boiling point.

14.7 In which season the wet clothes get dry after a relatively longer time?

Answer: Wet clothes take a longer time to dry during the winter or rainy (monsoon) season due to low temperature and high humidity in the air, which slows down the rate of evaporation.

14.8 When a solid is heated, what happens to its particles which are vibrating?

Answer: When a solid is heated, its particles gain kinetic energy, causing them to vibrate more rapidly and aggressively around their fixed positions. As the heating continues, these vibrations become strong enough to overcome the rigid intermolecular forces, initiating the melting process.

14.9 Do solids and liquids also diffuse just like gases?

Answer: Solids and liquids do undergo diffusion, but their rates are significantly slower compared to gases. While liquid particles can slide past one another to mix gradually, solid diffusion is extremely slow and negligible because particles are locked into tight, rigid structures.

14.10 Why dew is formed in the early hours of the morning?

Answer: During the early hours of the morning, the air temperature drops significantly, reducing its capacity to hold moisture. As a result, water vapor present in the atmosphere cools down, condenses, and deposits as liquid droplets on cold surfaces like leaves and grass.

C. Constructed Response Questions

14.1 Differentiate between evaporation and boiling.

Answer: Evaporation is a spontaneous surface phenomenon that occurs at any temperature, where only surface molecules with high kinetic energy escape into the vapor phase. Boiling, conversely, is a bulk phenomenon that happens only at a specific temperature called the boiling point, where vapor bubbles form throughout the entire volume of the liquid.

14.2 Describe how boiling is related to the external pressure.

Answer: Boiling occurs when the vapor pressure of a liquid equals the external atmospheric pressure acting upon its surface. If the external pressure is increased, a liquid requires more thermal energy to raise its vapor pressure to match, resulting in a higher boiling point; conversely, lower external pressure reduces the boiling point.

14.3 Why the process of evaporation does not need the input of energy?

Answer: Evaporation does not require an external heat source because it utilizes the internal thermal energy of the liquid itself. Molecules at the surface naturally collect enough kinetic energy through random collisions with neighboring particles to break free and transition into vapor.

14.4 Why the heating and cooling curves for the phase changes adopt the same path?

Answer: The heating and cooling curves follow the exact same thermodynamic path because the amount of energy absorbed during a phase forward transition is exactly equal to the energy released during its reverse transition. The melting/boiling points and freezing/condensation points occur at identical temperatures for any pure substance under stable pressure.

14.5 Why ice melts when the pressure is exerted on it?

Answer: Ice melts under pressure because water expands when it freezes, meaning ice has a lower density and a larger volume than liquid water. Applying external pressure forces the crystalline structure of ice to contract into a smaller volume, favoring the denser liquid state and lowering its melting point.

14.6 Why do phase changes occur?

Answer: Phase changes occur because of variations in thermal energy and pressure, which directly alter the kinetic energy of particles and the distance between them. When heat is added or removed, it changes the balance between particle movement and the intermolecular forces holding them together, forcing a transition into a different physical state.

D. Descriptive Questions

14.1 Explain the difference in the rates of diffusion of two gases based on kinetic theory.

Answer:
Kinetic Energy and Velocity Relation: According to the kinetic molecular theory, all gases at the same

temperature possess the same average kinetic energy. Since kinetic energy depends on both mass and velocity (KE = ½ mv^2), lighter gas molecules must move with greater average speeds than heavier molecules to maintain the same energy level.

Impact of Molecular Mass on Diffusion Rate: Because lighter gas particles move with a higher velocity, they collide and spread out through space much faster than heavier particles. Therefore, gases with lower molecular masses diffuse at a significantly higher rate than gases with higher molecular masses, as described by Graham's Law of Diffusion.

14.2 How does the process of sublimation helpful in printing and in the usage of air freshener?

Answer:
Helpfulness in Printing (Dye-Sublimation): In dye-sublimation printing, solid pigments on a ribbon are rapidly heated until they turn instantly into gas, bypassing the liquid phase completely. This gaseous dye permeates the surface of the paper or fabric and solidifies, producing high-quality, smudge-free, and highly durable images.

Helpfulness in Air Fresheners: Solid air fresheners utilize sublimation to continuously release pleasant scents into the atmosphere without melting into a messy liquid. The solid components slowly sublimate at room temperature, gradually releasing a consistent vapor of fragrance molecules directly into the room over an extended period.

14.3 Draw heating curve for the physical changes water undergoes with change in temperature.

Answer:

- **Solid Phase to Melting Transition:** The curve starts with solid ice warming up below 0°C. Once it reaches 0°C, the temperature plateaus horizontally while the heat energy breaks down the ice crystal lattice to transform it completely into liquid water.
- **Liquid Phase to Boiling Transition:** Once all ice has melted, the temperature rises steadily up to 100°C as the liquid water absorbs heat; at 100°C, a second horizontal plateau occurs where the temperature remains constant while the water converts entirely into steam.

Key Milestones on the Curve:

- **Solid Ice Warming Up:** The temperature increases until it reaches the melting point at 0°C.
- **Melting (Solid to Liquid):** The temperature remains constant at 0°C while the ice absorbs heat to break its crystalline lattice.
- **Liquid Water Warming Up:** Once completely melted, the temperature rises steadily up to 100°C.
- **Boiling (Liquid to Gas):** The temperature flattens out again at 100°C as energy is used to break intermolecular forces and convert water into steam.
- **Steam Warming Up:** After vaporization is complete, the temperature of the gas continues to rise.

Unit 15: Stoichiometry

A. Multiple Choice Questions

1. Volume occupied by 15 moles of ammonia gas at RTP:

- (a) 224 dm^3
- (b) 160 dm^3
- **(c) 360 dm^3 ✓**
- (d) 265 dm^3

2. How many moles of natural gas CH_4 will be present in a cylinder if its volume is 18 dm^3 at RTP?

- **(a) 0.75 mol ✓**
- (b) 0.67 mol
- (c) 0.85 mol
- (d) 0.56 mol

3. What will the molar concentration of potassium hydroxide solution if 2.0 g of it are dissolved in 100 cm^3 of solution?

- (a) 0.36 mol/dm^3
- **(b) 0.53 mol/dm^3 ✓**
- (c) 0.70 mol/dm^3
- (d) 0.45 mol/dm^3

4. What will be the mass of NaCl needed to make up 15 dm^3 of its solution with a concentration of 0.7 g/dm^3?

- **(a) 21 g ✓**
- (b) 10.5 g
- (c) 31.5 g
- (d) 5.4 g

5. Find out the concentration of H_2SO_4 in mol/dm^3 if its 10 cm^3 react with 20 cm^3 of NaOH solution having concentration 0.1 mol/dm^3.

- (a) 0.01 mol/dm^3
- (b) 0.001 mol/dm^3
- **(c) 0.1 mol/dm^3 ✓**

- (d) 0.15 mol/dm³

6. If the molar mass of a compound is 178 g/mol and its empirical formula is $C_3H_5O_4$. What is its molecular formula?

- (a) $C_3H_5O_3$
- (b) $C_6H_{10}O_6$
- **(c) $C_9H_{15}O_9$ ✓**
- (d) $C_8H_{10}O_8$

7. When natural gas burns in air, which component is the limiting reactant?

- (a) Both components
- (b) Neither component is a limiting reactant
- **(c) Air ✓**
- (d) Natural gas

B. Short Answer Questions

15.1. What is the molar volume of a gas at RTP?

Answer: Molar volume at RTP (Room Temperature and Pressure) is the volume occupied by one mole of any gas under standard room conditions (usually 25°C and 1 atm). Its precise value is 24 dm³ (or 24 liters) per mole of gas.

15.2. How does the concept of molar volume useful for us?

Answer: Molar volume allows chemists to easily convert a measured volume of gas directly into moles without needing to weigh it. This simplifies stoichiometric calculations for chemical reactions involving gaseous reactants or products.

15.3. How does the molar volume relate to the Avogadro's law?

Answer: Avogadro's law states that equal volumes of all gases contain an equal number of moles under identical conditions. Molar volume directly reflects this by ensuring that exactly one mole of any gas occupies identical spacing (24 dm³ at RTP).

15.4. Why two different compounds may show the same empirical formula?

Answer: Different compounds can share the same empirical formula because it represents only the simplest whole-number ratio of atoms, not their absolute numbers. For example, both acetylene (C_2H_2) and benzene (C_6H_6) share the identical simple empirical ratio of CH.

15.5. Why is percentage yield important?

Answer: Percentage yield determines the efficiency and practical success of a chemical manufacturing process by comparing actual results to ideal calculations. A higher percentage yield indicates minimized waste, optimized reaction conditions, and lower financial costs.

15.6. What is the concentration of a solution in mol/dm³ if it contains 49 g of H_2SO_4 in one dm³ of solution?

Answer: The molar mass of H_2SO_4 is 98 g/mol, meaning 49 g represents exactly 0.5 moles of solute. Since these 0.5 moles are dissolved in a total volume of 1 dm³, the final concentration of the solution is 0.5 mol/dm³.

C. Constructed Response Questions

15.1. How would you identify the limiting reactant in a chemical reaction?

Answer: To identify the limiting reactant, calculate the number of moles of each reactant initially present. Then, determine how many moles of product each can theoretically create based on balanced reaction ratios; the reactant yielding the lowest amount of product is limiting.

15.2. Why is it important to find the purity of a compound which is used as a medicine?

Answer: Determining purity in pharmaceuticals is vital because hidden impurities can reduce therapeutic efficacy or trigger dangerous, toxic side effects in patients. Precise quantification ensures accurate, reliable clinical dosing and maintains rigorous safety standard regulations.

15.3. Will there be a limiting reactant in a reversible reaction?

Answer: No, a typical limiting reactant does not completely disappear in a reversible reaction because the system achieves dynamic equilibrium where forward and backward processes run simultaneously. Reactants are constantly being regenerated, preventing any single species from reaching absolute exhaustion.

15.4. How do you know if a formula is empirical or not?

Answer: A formula is empirical if the subscripts representing the atoms are reduced to their lowest possible whole-number mathematical ratio. If the subscripts can be divided further by a common whole number factor (like changing $C_6H_{12}O_6$ into CH_2O), it is a molecular formula instead.

15.5. Write down one method to find out the molecular mass of a compound without knowing its molecular formula.

Answer: One classic method is using Mass Spectrometry, which ionizes the compound and measures its mass-to-charge ratio to reveal the exact molecular ion peak. Alternatively, physical methods like measuring colligative properties (e.g., freezing point depression) can calculate experimental molar mass.

D. Numerical Problems

15.1. Calculate the number of moles, volume and number of molecules in 4.0 g of CH_4 at RTP.

Given:

- Mass of CH_4 = 4.0 g
- Molar mass of CH_4 = 12 + 4(1) = 16 g/mol
- Molar volume at RTP = 24 dm^3/mol

Solution:

1. Moles = 4.0 g / 16 g/mol = 0.25 mol
2. Volume = 0.25 mol × 24 dm^3/mol = 6.0 dm^3
3. Molecules = 0.25 × 6.02 × 10^{23} = 1.505 × 10^{23} molecules

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15.2. What mass of NaCl need to be dissolved in 150 cm^3 of a solution if the concentration of the solution is 0.4 mol/dm^3?

Given:

- Volume = 150 cm^3 = 0.15 dm^3
- Concentration = 0.4 mol/dm^3
- Molar mass of NaCl = 23 + 35.5 = 58.5 g/mol

Solution:

1. Moles of NaCl = 0.4 × 0.15 = 0.06 mol
2. Mass of NaCl = 0.06 × 58.5 = 3.51 g

15.3. Find out the percentage of sodium in $NaHCO_3$.

Given: Compound: Sodium bicarbonate ($NaHCO_3$)
Atomic masses: Na = 23, H = 1, C = 12, O = 16

Solution:

1. Molar Mass = 23 + 1 + 12 + 3(16) = 84 g/mol
2. Percentage of Na = (23/84) × 100 = 27.38%

15.4. A sulphide of iron contains 1.926 g of sulphur and 2.333 g of iron. Find out the empirical formula of this compound.

Given:

- Mass of Fe = 2.333 g

- Mass of S = 1.926 g

Solution:

1. Moles of Fe = 2.333/55.85 = 0.0418 mol
   Moles of S = 1.926/32.06 = 0.0601 mol
2. Divide by smallest (0.0418):
   Fe = 0.0418/0.0418 = 1
   S = 0.0601/0.0418 = 1.44 ≈ 1.5
3. Multiply by 2: Fe = 2, S = 3

Empirical formula: Fe_2S_3

15.5. A compound contains by mass, 40.0% C, 6.71% H and 53.3% oxygen. A 0.320 mole of this compound weighs 28.8 g. What is the molecular formula of this compound?

Given:

- Percentage: C = 40.0%, H = 6.71%, O = 53.3%
- 0.320 mol = 28.8 g

Solution:

1. Empirical formula:
   C = 40/12 = 3.33, H = 6.71/1 = 6.71, O = 53.3/16 = 3.33
   Ratio = CH_2O (Empirical mass = 30 g/mol)
2. Molar Mass = 28.8/0.320 = 90 g/mol
3. Multiplier n = 90/30 = 3

Molecular formula: $C_3H_6O_3$

15.6. The formation of ammonia gas is given by the following equation:
$3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$
If you start reacting 12 g of H_2 with 64 g of N_2, which will be the limiting reactant?

Given:

- Mass of H_2 = 12 g
- Mass of N_2 = 64 g
- Molar masses: H_2 = 2 g/mol, N_2 = 28 g/mol

Solution:

1. Moles of H_2 = 12/2 = 6 mol
   Moles of N_2 = 64/28 = 2.285 mol
2. From equation: 6 mol H_2 need 6/3 = 2 mol N_2
3. We have 2.285 mol N_2 (more than required)

Limiting reactant: H_2

15.7. When 305 g of $AgNO_3$ is reacted with excess of $MgCl_2$, it produces 23.7 g of $Mg(NO_3)_2$. What is the percentage yield of the reaction?
$2AgNO_3 + MgCl_2 \rightarrow Mg(NO_3)_2 + 2AgCl$

Given:

- Mass of $AgNO_3$ = 305 g
- Actual yield of $Mg(NO_3)_2$ = 23.7 g
- Molar masses: $AgNO_3$ = 170 g/mol, $Mg(NO_3)_2$ = 148.3 g/mol

Solution:

1. Moles of $AgNO_3$ = 305/170 = 1.794 mol
2. Theoretical moles of product = 1.794/2 = 0.897 mol
   Theoretical mass = 0.897 × 148.3 = 133.02 g
3. Percentage Yield = (23.7/133.02) × 100 = 17.82%

15.8. A sample of metal has a total mass of 3.66 kg and contains 2.45 kg of gold. What is the percentage purity of gold in this sample?

Given:

- Total mass = 3.66 kg
- Pure gold = 2.45 kg

Solution:
Percentage Purity = (2.45/3.66) × 100 = 66.94%

Unit 16: Electrochemistry

A. Multiple Choice Questions

1. The oxidation number of Mn in K_2MnO_4:

- (a) +7
- (b) +5
- **(c) +6 ✓**
- (d) -6

2. Which element in the following reaction is being reduced?
$4HBr + MnO_2 \rightarrow MnBr_2 + Br_2 + 2H_2O$

- (a) Br
- **(b) Mn ✓**
- (c) H
- (d) Both Mn and H

3. During electrolysis of dilute solution of H_2SO_4 using Pt electrodes, which process takes place at the cathode?

- **(a) Reduction ✓**
- (b) Neither oxidation nor reduction
- (c) Oxidation
- (d) First oxidation and then reduction

4. Which product you will get at the anode when an aqueous solution of $CuSO_4$ is electrolysed using copper electrodes?

- (a) Cu
- (b) O_2
- (c) H_2
- **(d) No product, instead copper metal will go into the solution as Cu^{2+} ✓**

5. Which of the following statements is NOT correct about Zn-Cu electrochemical cell?

- (a) Anode is negatively charged
- **(b) Reduction occurs at anode ✓**
- (c) Cathode is positively charged

- (d) Reduction occurs at cathode

6. Which product will be obtained at the anode when a concentrated solution of NaCl will be electrolysed?

- **(a) Cl_2 ✓**
- (b) O_2
- (c) More O_2 and less Cl_2
- (d) More Cl_2 and less O_2

7. When a dilute aqueous solution of $ZnCl_2$ is electrolysed, which product you will get at the cathode?

- **(a) H_2 ✓**
- (b) Zn
- (c) O_2
- (d) Zn and O_2

8. What is produced at the cathode in hydrogen-oxygen fuel cell?

- Water (H_2O)

9. Which of the following metals is highest in the electrochemical series?

- (a) Tin
- (b) Iron
- (Potassium is highest in the series)

B. Short Answer Questions

16.1 What happens when electricity is passed through an aqueous solution of NaCl?

Answer: When electricity passes through a concentrated aqueous solution of NaCl, chloride ions are oxidized to chlorine gas at the anode while water molecules are reduced to hydrogen gas at the cathode. This leaves behind sodium ions and hydroxide ions in the solution, forming sodium hydroxide.

16.2 What are the main objectives of electroplating?

Answer: The main objectives of electroplating are to protect the underlying base metal from corrosion and rust by coating it with a non-reactive metal. Additionally, it enhances the surface appearance of objects, making inexpensive metals look decorative and attractive.

16.3 Mention one difference between an electrolytic cell and a galvanic cell.

Answer: An electrolytic cell utilizes external electrical energy to drive a non-spontaneous chemical redox reaction. Conversely, a galvanic cell converts chemical energy stored within its substances into electrical energy through a spontaneous redox reaction.

16.4 Through which electrode, electrons leave the electrolytic cell?

Answer: Electrons enter the electrolytic cell from the external power source through the negative cathode. They complete the circuit by traveling through the electrolyte and leaving the cell through the positive anode.

16.5 How does an electrolyte conduct electricity?

Answer: An electrolyte conducts electricity through the physical migration of its freely moving ions when in a molten state or dissolved in aqueous solution. When a voltage is applied, positive cations migrate toward the cathode and negative anions move toward the anode.

16.6 What will happen if a strip of Cu metal is dipped in $FeSO_4$ solution?

Answer: No chemical reaction will occur because copper is positioned lower than iron in the reactivity series. Since copper is less reactive, it cannot displace iron ions from the iron sulfate solution.

16.7 Why fuel cells are regarded as environment friendly?

Answer: Fuel cells are considered environment-friendly because their primary reaction byproduct is clean water vapor and heat rather than harmful greenhouse gases. They convert chemical fuels directly into electricity efficiently and operate quietly without combustion.

C. Constructed Response Questions

16.1 Calculate the oxidation number of chlorine atom in $Ca(ClO_3)_2$.

Given: Formula is $Ca(ClO_3)_2$. Standard O.N are Ca = +2 and O = -2.

Solution:
(O.N of Ca) + 2[(O.N of Cl) + 3(O.N of O)] = 0
+2 + 2[Cl + 3(-2)] = 0
+2 + 2Cl - 12 = 0 → 2Cl - 10 = 0
2Cl = +10 → **Cl = +5**

16.2 How can H_2O_2 behave as an oxidizing agent?

Answer: Hydrogen peroxide holds an oxygen atom in an unstable -1 oxidation state, allowing it to readily accept electrons from other substances. By gaining electrons, the oxygen is reduced to a stable -2 state in water, causing the opposing substance to oxidize.

16.3 Why different products are formed at the electrodes when a dilute and concentrated aqueous solutions of NaCl are electrolysed?

Answer: In a concentrated solution, chloride ions vastly outnumber hydroxide ions, allowing them to preferentially discharge at the anode to produce chlorine gas. In a dilute solution, water molecules or

hydroxide ions undergo preferential discharge instead due to the lower concentration of halide ions, yielding oxygen gas.

16.4 Why corrosion becomes fast during rainy season?

Answer: The rainy season provides continuous atmospheric moisture and water droplets on metal surfaces, forming the electrolyte layer required for an electrochemical corrosion cell. Furthermore, rainwater contains dissolved carbon dioxide which increases its conductivity and accelerates rusting.

16.5 If a galvanic cell is established between Cu and Ag, what reactions do you expect at the electrodes?

Answer: Since copper is more reactive than silver, copper acts as the anode undergoing oxidation, while silver acts as the cathode undergoing reduction.

- **Anode Reaction:** $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$
- **Cathode Reaction:** $2Ag^+(aq) + 2e^- \rightarrow 2Ag(s)$

16.6 What is the function of a porous partition in a galvanic cell?

Answer: The porous partition allows ions to migrate between the two half-cells to maintain electrical neutrality in the internal circuit. Concurrently, it physically separates the two electrolyte solutions to prevent them from mixing directly and releasing heat instead of electricity.

16.7 How do fuel cells produce electricity?

Answer: Fuel cells generate electricity by facilitating a continuous electrochemical redox reaction between an ongoing supply of fuel and an oxidant. The fuel oxidizes at the anode releasing electrons, which travel through an external circuit to the cathode where the oxidant reduces.

16.8 How can the chemical reactivity of metals be compared by using electrochemical series?

Answer: Metals placed higher in the electrochemical series possess a greater tendency to lose electrons and undergo oxidation. This higher tendency makes them highly chemically reactive compared to metals placed lower in the series.

D. Descriptive Questions

16.1 Explain with examples how the formula of ionic compound can be written using oxidation numbers.

Answer:

- **Identify Oxidation Numbers:** Write the chemical symbols for the positive metal cation and the negative non-metal anion along with their respective oxidation numbers or charges.
- **Cross-Multiply Subscripts:** Drop the mathematical signs (+ or -) and cross-multiply the numerical values of the oxidation states to serve as subscripts for the opposite ion.
- **Reduce to Lowest Ratio:** Simplify the resulting subscripts into their lowest whole-number ratio to construct the final neutral empirical chemical formula.

16.2 Find the oxidation numbers of the indicated elements in the following compounds.

For N in $Al(NO_3)_3$:
+3 + 3[N + 3(-2)] = 0 → +3 + 3N - 18 = 0 → 3N = +15 → **N = +5**

For S in $H_2S_2O_7$:
2(+1) + 2(S) + 7(-2) = 0 → +2 + 2S - 14 = 0 → 2S = +12 → **S = +6**

For S in $Na_2S_2O_3$:
2(+1) + 2(S) + 3(-2) = 0 → +2 + 2S - 6 = 0 → 2S = +4 → **S = +2**

16.3 Write down the formulae of the following compounds using ionic charges.

- **Sodium hypochlorite:** NaClO
- **Calcium oxalate:** CaC_2O_4
- **Ammonium phosphate:** $(NH_4)_3PO_4$
- **Calcium nitrite:** $Ca(NO_2)_2$

16.4 Describe the working of a fuel cell.

Answer:

- **Anode Side Oxidation:** Hydrogen fuel gas continuously diffuses into the anode catalytic surface, where it loses electrons and oxidizes into hydrogen ions.
- **External Power Generation:** The liberated electrons travel away from the anode through an external wire circuit, generating an electric current to run appliances.
- **Cathode Side Reduction:** Oxygen gas introduced at the cathode accepts the incoming circuit electrons and combines with hydrogen ions to produce pure water byproduct.

16.5 Discuss the electrolysis of concentrated solutions of metal halides.

Answer:

- **Anodic Halogen Generation:** Due to high concentration, halide ions easily outcompete water molecules at the anode, oxidizing directly to release halogen gas.
- **Cathodic Hydrogen Generation:** Active metal cations stay dissolved in solution because hydrogen ions from water have a lower discharge potential and reduce into hydrogen gas.
- **Formation of Hydroxide Base:** As halide and hydrogen ions escape as gases, hydroxide ions accumulate with remaining metal cations to turn the solution alkaline.

16.6 Explain electroplating giving examples.

Answer:

- **Setup of the Cell:** The clean object intended for plating is made the negative cathode, while a rod of the coating metal serves as the positive anode.

- **Anode Dissolution:** Passing an electrical current causes the pure coating metal at the anode to oxidize, dissolving continuously into the electrolyte as metal ions.
- **Cathode Deposition Layer:** These dissolved metal cations migrate toward the negative object at the cathode, gaining electrons to deposit a sleek metal layer (e.g., silver plating cutlery).

16.7 What is corrosion? Explain the reactions involved in corrosion of iron.

Answer:

- **Definition of Corrosion:** Corrosion is the gradual chemical or electrochemical breakdown of a metal surface due to spontaneous reactions with its surrounding environment.
- **Anodic Iron Degradation:** A specific damaged area on the iron surface acts as an anode, where metallic iron oxidizes to release mobile electrons:
  $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$
- **Cathodic Reduction to Rust:** Electrons migrate to a cathodic spot to reduce atmospheric oxygen into water, which further reacts with Fe^{2+} to form hydrated iron oxide (rust):
  $4Fe^{2+} + O_2 + (4+2x)H_2O \rightarrow 2[Fe_2O_3 \cdot xH_2O] + 8H^+$

Unit 17: Chemical Kinetics

A. Multiple Choice Questions

1. The number of collisions per unit volume of the reaction mixture is called:

- (a) Collision energy
- (b) Activation energy
- **(c) Collision frequency ✓**
- (d) Collision force

2. If the reactants possess an energy higher than the activation energy, then the reaction will be:

- (a) Slow
- (b) Fast
- (c) Not affected
- **(d) Instantaneous ✓**

3. Which of the following explains the increase in rate of reaction in the presence of a catalyst?

- (a) Catalyst provides extra energy to the reactant molecules
- **(b) Catalyst provides an alternative pathway which lowers the activation energy ✓**
- (c) Catalyst increases the collision frequency
- (d) Catalyst decreases the collision frequency

4. Which of the following statements is correct?

- **(a) Collisions with energy equal to or greater than the activation energy lead to reaction ✓**
- (b) Collision frequency is not related to the reaction rate
- (c) All collisions lead to a reaction
- (d) Collisions with energy less than the activation energy lead to the reaction

5. When a reaction proceeds ahead, how the concentrations of reactants and products change?

- (a) Concentration of reactants increases and that of the products decreases
- **(b) Concentration of reactants decreases and that of the products increases ✓**
- (c) Concentration of both reactants and products decreases
- (d) Concentration of both reactants and products increases

B. Short Answer Questions

17.1 What is a successful collision?

Answer: A successful collision is one where colliding reactant particles possess energy equal to or greater than the activation energy and are oriented in the correct geometric direction. This allows existing chemical bonds to break and new bonds to form, successfully converting the reactants into products.

17.2 How does increase in the temperature increase the rate of a reaction?

Answer: An increase in temperature raises the average kinetic energy of the reactant particles, causing them to move faster and collide more frequently. More importantly, it increases the fraction of molecules that possess the minimum required activation energy, drastically raising the rate of successful collisions.

17.3 Define activation energy.

Answer: Activation energy is the minimum amount of additional energy required by reactant molecules to overcome the energy barrier and undergo a successful chemical reaction. It represents the energy gap between the initial energy of the reactants and the high-energy activated complex.

17.4 Why does the burning of sulphur proceed slower in air than in pure oxygen?

Answer: Air contains only about 21% oxygen, meaning the concentration of oxygen molecules is significantly lower than in pure oxygen. The lower concentration reduces the collision frequency between sulphur and oxygen particles, resulting in a slower reaction rate.

17.5 Why a catalyst used in a reaction is preferably taken in the powdered form?

Answer: Using a catalyst in powdered form drastically increases its total surface area, exposing many more active sites for the reactant molecules. This enhancement maximizes the contact frequency between the reactants and the catalyst, thereby increasing the overall rate of the reaction.

17.6 Why is the rate of a reaction often very fast at the beginning of the reaction?

Answer: At the very beginning of a reaction, the concentration of reactant particles is at its maximum level. According to collision theory, a higher concentration leads to the highest frequency of particle collisions, which naturally yields a very rapid initial reaction rate.

17.7 Magnesium does not react with air at room temperature but it reacts very fast at high temperature giving intense white light. Explain.

Answer:

- **At room temperature:** The reactant particles lack the necessary activation energy to overcome the high chemical energy barrier required to break bonds, leaving the magnesium unreactive.
- **At high temperature:** The intense heat provides the required activation energy to a large fraction of molecules, inducing rapid, highly exothermic oxidation that produces a brilliant white flame.

17.8 What happens to the reactants after they climb the energy hill during a reaction?

Answer: Once the reactants climb the energy hill, they form a highly unstable, temporary molecular arrangement known as the activated complex or transition state. This complex immediately decomposes by breaking old bonds and forming new ones, releasing energy as it transitions into stable product molecules.

17.9 How does a catalyst lower the activation energy of a reaction?

Answer: A catalyst lowers the activation energy by providing an entirely alternative chemical mechanism or pathway for the reaction to take place. This new route requires a much lower transition-state energy barrier, allowing a greater fraction of reactant molecules to successfully react at ordinary temperatures.

17.10 Give any two features of the catalytic action of an enzyme.

Answer:

- **High Specificity:** Enzymes are highly specific biological catalysts, meaning a single enzyme typically catalyzes only one specific biochemical reaction or acts on a precise substrate.
- **Extreme Efficiency:** They operate with exceptional efficiency under highly specific physiological conditions (like optimum body temperature and pH), accelerating reaction rates up to millions of times.

C. Constructed Response Questions

17.1 In what different ways you can increase the successful collisions between the particles of the reactants?

Answer: Successful collisions can be boosted by increasing the temperature, which gives particles more kinetic energy to surpass the activation energy barrier. Additionally, you can increase reactant concentrations or gas pressure to pack particles closer together, or powder solid reactants to maximize their reactive surface area.

17.2 Give an example of a reaction which proceeds with the gain in mass.

Answer: The heating or burning of magnesium metal in the presence of atmospheric oxygen is a reaction that shows an apparent gain in solid mass. The solid product formed, magnesium oxide (MgO), weighs more than the original magnesium strip because gaseous oxygen atoms have chemically bonded into the solid structure.

17.3 From where do molecules get energy to attain higher energy state?

Answer: Molecules acquire the necessary energy to attain a higher energy state primarily through thermal energy supplied by environmental heating or direct ignition. They absorb this energy through continuous, high-speed collisions with surrounding molecules, which converts kinetic energy into potential energy during impact.

17.4 How does the presence of V_2O_5 catalyst lower the activation energy of the following reaction?
$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

Answer: The vanadium pentoxide (V_2O_5) catalyst provides an alternative physical surface where sulfur dioxide and oxygen molecules can temporarily adsorb. This surface interaction weakens the internal chemical bonds of the reactants through intermediate steps, creating a new reaction pathway that demands a significantly lower activation energy.

17.5 Explain the catalytic action of an enzyme.

Answer: Enzymes function via a highly specific "lock-and-key" mechanism where substrate molecules bind precisely into the enzyme's active site. This temporary binding stabilizes the transition state and stretches molecular bonds, lowering the activation energy barrier needed to convert the substrates into products before releasing them.

17.6 If you desire to stop a reaction going on at 60°C, what action you will take?

Answer: To effectively halt the reaction, you should rapidly cool or freeze the reaction mixture down to a near 0°C temperature. This drastic drop removes thermal energy, plunging the kinetic energy of the particles well below the required activation threshold and dropping the collision rate to a negligible minimum.

D. Descriptive Questions

17.1 Explain the effect of surface area on the rate of a reaction.

Answer:

- **Particle Size and Exposure:** Breaking a solid reactant into smaller pieces or a fine powder dramatically increases its total exposed surface area. This exposes a much larger number of atoms or molecules that were previously hidden deep inside the solid bulk.
- **Collision Frequency:** With significantly more surface particles exposed, incoming reactant fluid molecules can collide with the solid simultaneously. This massive spike in contact points accelerates the frequency of successful collisions, causing the reaction rate to rise sharply.

17.2 Describe the main points of the collision theory of reaction rate.

Answer:

- **Collision Requirement:** For a chemical reaction to take place, the reactant particles (atoms, ions, or molecules) must physically collide with one another; no reaction can happen without contact.
- **Activation Energy Threshold:** Not all collisions lead to a reaction; colliding particles must possess a minimum threshold of kinetic energy, called the activation energy, to effectively break existing chemical bonds.

- **Proper Spatial Orientation:** The reacting particles must also collide with a specific, correct geometric orientation in space so that the reactive centers align perfectly to form new chemical bonds.

17.3 Discuss the following factors affecting the rate of a reaction:

(a) Effect of concentrations of the reactants:

- **Crowding and Collision Rate:** Increasing the concentration of reactants increases the total number of reacting particles packed within a given unit volume of space.
- **Reaction Acceleration:** Because particles are crowded closer together, they hit each other much more frequently, leading to a higher number of successful collisions per second and a faster reaction rate.

(b) Effect of temperature at which a reaction is carried out:

- **Kinetic Energy Boost:** Raising the temperature imparts greater thermal energy to the system, causing the reactant molecules to move with significantly higher velocities and hit each other harder.
- **Overcoming the Energy Barrier:** The primary effect is that a much larger fraction of the colliding molecules now possess the necessary activation energy to successfully crest the energy hill, causing the reaction rate to grow exponentially.

17.4 How does chemical kinetics play an important role in the food industry?

Answer:

- **Preservation Strategies:** Food scientists use kinetics to study how variables like temperature, light, and air moisture change the rate of food spoilage reactions. This knowledge enables the design of effective freezing, vacuum packing, and preservation methods.
- **Shelf-Life Optimization:** By measuring the precise rate laws of lipid oxidation or enzymatic degradation, manufacturers can compute accurate expiration dates. It also helps formulate antioxidants that safely retard these spoilage reactions during transit.

17.5 Write briefly about the role enzymes play in our body as biological catalysts.

Answer:

- **Metabolic Sustenance:** Enzymes act as highly specialized protein catalysts that accelerate vital biochemical reactions—like digestion, cellular respiration, and DNA replication—by up to a million-fold. Without them, these metabolic reactions would occur too slowly to sustain human life.
- **Homeostatic Control:** They allow complex physiological processes to proceed smoothly at standard body temperature (37°C) and mild pH levels. Their activity is tightly regulated by the body to maintain constant internal balance and respond directly to cellular demands.

Unit 18: Salts

A. Multiple Choice Questions

1. Which base is not soluble in water?

- (a) KOH
- **(b) $Mg(OH)_2$ ✓**
- (c) NaOH
- (d) Na_2CO_3

2. The shape of the crystal of NaCl is:

- **(a) Cubic ✓**
- (b) Hexagonal
- (c) Rombic
- (d) Trigonal

3. Which salts are always soluble in water?

- (a) Chlorides
- (b) Sulphates
- **(c) Nitrates ✓**
- (d) Carbonates

4. Which salt will be formed when marble pieces react with dilute nitric acid?

- (a) Sodium nitrate
- **(b) Calcium nitrate ✓**
- (c) Potassium nitrate
- (d) Magnesium nitrate

5. Water insoluble salt is:

- **(a) Calcium sulphate ✓**
- (b) Sodium sulphate
- (c) Potassium sulphate
- (d) Magnesium sulphate

B. Short Answer Questions

18.1. Which factors are responsible for the strength of electrostatic forces between ions?

Answer: The strength of electrostatic forces between ions is determined by the magnitude of the ionic charges and the distance between them (ionic radii). Higher charges and smaller ionic sizes result in significantly stronger attractive forces.

18.2. Is lead (II) chloride soluble in water? Give comments.

Answer: Lead (II) chloride ($PbCl_2$) is generally insoluble in cold water but is soluble in hot water. It precipitates out of a cold solution as a white crystalline solid when lead ions react with chloride ions.

18.3. Which lead salts are insoluble in water?

Answer: Most lead salts are insoluble in water, including lead sulphate ($PbSO_4$), lead chloride ($PbCl_2$ in cold water), lead carbonate ($PbCO_3$), and lead chromate ($PbCrO_4$).

18.4. Name two insoluble carbonates.

Answer: Two common water-insoluble carbonates are calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$).

18.5. What is a crystal lattice?

Answer: A crystal lattice is a highly ordered, three-dimensional geometric arrangement of atoms, ions, or molecules in a crystalline solid. This repeating structural pattern defines the symmetrical shape of the crystal.

C. Constructed Response Questions

18.1. Why are melting points of ionic salts generally very high?

Answer: Ionic salts are held together by exceptionally strong electrostatic forces of attraction between oppositely charged ions in a giant lattice structure. A massive amount of thermal energy is required to overcome these strong bonds and break the lattice, resulting in high melting points.

18.2. Why ionic salts exist in solid state?

Answer: Ionic salts exist as solids because their constituent cations and anions are tightly locked into a fixed, rigid three-dimensional arrangement by strong electrostatic forces. This prevents the ions from moving freely past one another at room temperature.

18.3. How will you prepare calcium sulphate in the laboratory?

Answer: Calcium sulphate is an insoluble salt prepared by the method of precipitation (double displacement). Mixing aqueous solutions of a soluble calcium salt, like $Ca(NO_3)_2$, with a soluble sulphate salt, like Na_2SO_4, forms a solid precipitate of $CaSO_4$ which can then be filtered and dried.

18.4. Compare the melting points of NaCl and $MgCl_2$.

Answer: The melting point of $MgCl_2$ is higher than that of NaCl. This is because the magnesium ion (Mg^{2+}) carries a higher charge and has a smaller ionic radius than the sodium ion (Na^+), leading to stronger electrostatic lattice forces that require more heat energy to break.

18.5. How would you prepare pure crystals of copper sulfate in the laboratory?

Answer: Pure copper sulphate crystals are prepared by reacting dilute sulphuric acid with an excess of copper (II) oxide or carbonate. The mixture is heated and filtered to remove unreacted copper compound. The filtrate is then evaporated slowly, cooled, and the pure blue crystals of $CuSO_4 \cdot 5H_2O$ are collected.

D. Descriptive Questions

18.1. Explain the formation of sodium chloride crystal.

Answer: Sodium chloride crystals form through the complete transfer of valence electrons from sodium atoms to chlorine atoms, generating positive Na^+ ions and negative Cl^- ions. These oppositely charged ions attract each other tightly due to strong electrostatic forces, arranging themselves into a rigid, highly stable, three-dimensional cubic lattice structure.

18.2. Explain the methods of preparation of two soluble salts.

Answer: Soluble salts can be prepared by reacting an acid with an active metal, where the metal displaces hydrogen gas to form a salt solution (e.g., $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$). Another method involves neutralizing an acid with a soluble base (alkali) to yield a salt and water, which is then crystallized by gentle evaporation.

18.3. How are the following salts prepared?
K_2SO_4, $CuCl_2$, $CaCl_2$

Answer:

- **Potassium sulphate (K_2SO_4):** Prepared via neutralization by reacting potassium hydroxide with dilute sulphuric acid.
- **Copper chloride ($CuCl_2$):** Formed by reacting insoluble copper hydroxide or copper oxide with dilute hydrochloric acid.
- **Calcium chloride ($CaCl_2$):** Prepared by reacting calcium carbonate (marble) with dilute hydrochloric acid.

18.4. Describe which salts are soluble in water and which are insoluble.

Answer: Generally, all salts of sodium, potassium, and ammonium, as well as all nitrates and acetates, are highly soluble in water. On the other hand, most carbonates, phosphates, and hydroxides are completely insoluble, with the exception of those formed by alkali metals and ammonium.

Unit 19: Chemistry of the Atmosphere

A. Multiple Choice Questions

1. The reason for maintaining higher temperature for the production of ammonia is:

- **(a) activation energy of the reaction is very high ✓**
- (b) activation energy of the reaction is very low
- (c) nitrogen and hydrogen are both gases
- (d) at low temperature nitrogen and hydrogen change into liquids

2. The contact process used for the industrial production of H_2SO_4 is sensitive to the impurities present in SO_2 and O_2 because the impurities:

- (a) affect the capability of the catalyst
- **(b) affect the purity of H_2SO_4 ✓**
- (c) do not let SO_2 to react with oxygen
- (d) decrease the rate of reaction appreciably

3. Which of the following oxides is neutral in character?

- (a) Al_2O_3
- (b) SO_2
- (c) CO_2
- **(d) NO ✓**

4. Sodium is considered more reactive than magnesium because:

- **(a) It is more electropositive than magnesium ✓**
- (b) It reacts with water slowly
- (c) It is present in second group
- (d) It is the less metallic

5. Secondary pollutants present in the atmosphere are:

- (a) Oxides of nitrogen
- (b) Oxides of Sulphur
- **(c) Ozone and PAN ✓**
- (d) Oxides of Carbon

6. SO_3 is absorbed in H_2SO_4 rather than H_2O during the production of sulphuric acid because:

- (a) SO_3 does not react with H_2O
- **(b) reaction of SO_3 with H_2O is highly exothermic producing mist of H_2SO_4 which is difficult to condense ✓**
- (c) It gives better yield of H_2SO_4
- (d) reaction of SO_3 with H_2O can cause explosion

7. Oxides formed when oxygen reacts with metals:

- (a) Acidic
- **(b) Basic ✓**
- (c) Both basic and amphoteric
- (d) Neutral

8. Major components of acid rain are:

- **(a) H_2SO_4 and HNO_3 ✓**
- (b) H_2SO_3 and HNO_2
- (c) H_2SO_4 and HCl
- (d) Acetic acid and HNO_3

B. Short Answer Questions

19.1 How is nitrogen obtained from air?

Answer: Nitrogen is obtained from air commercially through the fractional distillation of liquid air. Because nitrogen has a lower boiling point (-196°C) than oxygen, it boils off and is collected first as a gas.

19.2 How is hydrogen produced from methane?

Answer: Hydrogen is produced by reacting methane gas with steam at high temperatures (700°C to 1100°C) in the presence of a nickel catalyst. This process is called steam-methane reforming and yields hydrogen and carbon monoxide.

19.3 Which conditions are used to oxidize SO_2 to SO_3?

Answer: The oxidation of SO_2 to SO_3 requires a temperature of about 400°C to 450°C and a pressure of 1 to 2 atmospheres. A vanadium pentoxide (V_2O_5) catalyst is utilized to speed up the reaction.

19.4 Why CO_2 is called an acidic oxide while CO is called a neutral oxide?

Answer: CO_2 is an acidic oxide because it reacts with water to form carbonic acid and neutralizes bases to form salts. CO is a neutral oxide because it does not react with water, acids, or bases to form salts.

19.5 How do magnesium and calcium differ with each other towards their reactions with water?

Answer: Magnesium is less reactive and only reacts very slowly with hot water (or rapidly with steam) to form magnesium oxide or hydroxide. Calcium is more reactive and reacts vigorously with cold water to produce calcium hydroxide and hydrogen gas.

19.6 How are the reactivities of metals determined?

Answer: The reactivities of metals are determined by observing how vigorously they react with water, air, and acids. It can also be determined by measuring their tendency to lose electrons and form positive ions.

19.7 Which secondary pollutants are produced by oxides of nitrogen?

Answer: Oxides of nitrogen react with other atmospheric compounds to produce secondary pollutants like ozone (O_3) and Peroxyacetyl Nitrate (PAN). They also form nitric acid (HNO_3), which contributes to acid rain.

C. Constructed Response Questions

19.1 Why ammonia is regarded as an important chemical?

Answer: It is highly vital because it serves as the essential raw material for manufacturing nitrogenous fertilizers like urea. It is heavily used globally in the production of nitric acid, plastics, explosives, and various industrial cleaning agents.

19.2 How SO_2 present in the atmosphere is converted to SO_3?

Answer: Atmospheric SO_2 reacts slowly with oxygen gas in the air in the presence of sunlight to form SO_3. This conversion is often catalyzed by the presence of particulate matter or other primary pollutants like oxides of nitrogen.

19.3 The burning of fossil fuels in a car engine is responsible for the production of oxides of nitrogen. Explain.

Answer: Inside a car engine, the high temperature and pressure cause atmospheric nitrogen and oxygen to chemically bond. This direct combination yields nitric oxide (NO), which is further oxidized in the air to form hazardous nitrogen dioxide (NO_2).

19.4 The metals present at the top of the reactivity series are regarded as more reactive than those present at the bottom. Comment on this statement.

Answer: Top metals have a very high tendency to lose their valence electrons easily and form stable positive ions. Conversely, bottom metals hold onto their valence electrons tightly, resisting oxidation and remaining chemically unreactive.

19.5 How fossil fuels produce SO_2?

Answer: Most fossil fuels naturally contain small amounts of sulfur impurities trapped within their organic structures. When these fuels undergo combustion, the sulfur compounds burn in atmospheric oxygen to form sulfur dioxide gas.

D. Descriptive Questions

19.1 Explain the production of ammonia on industrial scale.

Answer:

- **Process overview:** Ammonia is produced on a mass scale using the Haber Process, which synthesizes it directly from elemental gases.
- **Raw materials:** Nitrogen gas is separated from the atmosphere, while hydrogen gas is derived from natural gas (methane) through steam reforming.
- **Reaction conditions:** The synthesis requires a high pressure of 200 atm, a temperature of 450°C, and an iron catalyst to optimize the yield.

19.2 Describe the contact process for the production of sulphuric acid.

Answer:

- **Production of sulfur dioxide:** Sulfur or sulfide ores are burned in excess air to produce sulfur dioxide (SO_2) gas.
- **Catalytic oxidation:** The SO_2 is purified and oxidized to sulfur trioxide (SO_3) using a vanadium pentoxide (V_2O_5) catalyst at 450°C.
- **Absorption:** The SO_3 is absorbed in concentrated H_2SO_4 to form oleum, which is then diluted with water to produce pure sulphuric acid.

19.3 Explain the formation and properties of acidic and basic oxides.

Answer:

- **Acidic oxides:** Formed when non-metals react with oxygen; they dissolve in water to make acids and neutralize bases to form salts.
- **Basic oxides:** Formed when metals react with oxygen; they react with acids to form salt and water, and turn red litmus paper blue.
- **Chemical differences:** Acidic oxides contain covalent bonds and accept electron pairs, whereas basic oxides are ionic solids containing oxide ions (O^{2-}).

19.4 Differentiate between first and second group metals based on their reactivities with oxygen and water.

Answer:

- **Reaction with oxygen:** Group 1 metals tarnish rapidly in air forming oxides, peroxides, or superoxides, while Group 2 metals react slower and form normal oxides.
- **Reaction with water:** Group 1 metals react violently with cold water to yield strong alkalis, whereas Group 2 metals react much milder or require hot water/steam.
- **Electronic cause:** Group 1 metals need to lose only one valence electron, making them significantly more electropositive and reactive than Group 2 metals.

19.5 Describe the role of oxides of nitrogen in the formation of PAN and the acid rain.

Answer:

- **PAN formation:** Nitrogen oxides react with unburnt volatile organic compounds (hydrocarbons) under sunlight to generate photochemical smog, producing toxic Peroxyacetyl Nitrate (PAN).
- **Acid rain formation:** Nitrogen dioxide gas combines with atmospheric water vapor and oxygen to turn into nitric acid (HNO_3).
- **Environmental delivery:** This generated nitric acid dissolves cleanly into rain droplets, falling to the earth's surface as destructive acid rain.

Unit 20: Water

A. Multiple Choice Questions

1. The pH of distilled water is:

- (a) 6.5
- (b) 8.5
- **(c) 7 ✓**
- (d) 7.5

2. The unpleasant odours in water can be removed by:

- (a) adding chlorine
- **(b) treating it with activated charcoal ✓**
- (c) sedimentation
- (d) filtration

3. The source of harmful microbes in natural water:

- **(a) human and animal wastes ✓**
- (b) fertilizers used for crops
- (c) industrial waste-water
- (d) microbes in rocks

4. Which gases are dissolved in natural water from the atmosphere through diffusion?

- (a) O_2 and CO_2
- (b) N_2 and CO_2
- (c) O_2 and N_2
- **(d) O_2, N_2 and CO_2 ✓**

5. The fertilizer harmful to paddy rice is:

- (a) Super phosphate
- **(b) Ammonium nitrate ✓**
- (c) Urea
- (d) Potassium sulphate

6. Fertilizers which increase the resistance of plants towards diseases and make plants strong by healthy root development are:

- (a) Nitrogenous fertilizers
- (b) Phosphate fertilizers
- **(c) Potassium fertilizers ✓**
- (d) Magnesium fertilizers

B. Short Answer Questions

20.1 Name two methods to check the purity of water.

Answer: Two common methods to check the purity of water are measuring its electrical conductivity and determining its boiling point. Pure water does not conduct electricity easily and boils precisely at 100°C under normal atmospheric pressure.

20.2 What is the main difference between tap water and distilled water?

Answer: Tap water contains dissolved minerals, gases, and potential impurities accumulated through municipal piping networks. In contrast, distilled water is pure H_2O that has been boiled into vapor and condensed back into liquid to remove all dissolved substances.

20.3 How water is distilled in the laboratory?

Answer: In a laboratory, water is distilled by heating it in a flask until it vaporizes, leaving behind solid impurities. The resulting steam is then passed through a water-cooled Liebig condenser, which cools the gas back into pure liquid water collected in a separate flask.

20.4 Name useful and harmful substances present in water.

Answer: Useful substances present in water include dissolved oxygen necessary for aquatic life and essential minerals like calcium and magnesium. Harmful substances include pathogenic bacteria, viruses, toxic heavy metals (like lead and mercury), nitrates, and industrial chemicals.

20.5 How would you remove harmful bacteria and other microbes present in water?

Answer: Harmful bacteria and microbes can be removed at a household level by boiling the water thoroughly for several minutes. On a larger scale, chemical disinfection methods like chlorination or treating the water with ultraviolet (UV) radiation are used to destroy pathogens.

20.6 What is the difference between sedimentation and filtration?

Answer: Sedimentation is a gravity-based process where heavy suspended particles are allowed to naturally settle to the bottom of a container over time. Filtration is a physical separation technique where water is passed through a porous barrier, like filter paper or sand, to trap remaining suspended solids.

20.7 Name any three water-borne diseases.

Answer: Three common water-borne diseases caused by consuming contaminated water are cholera, typhoid fever, and hepatitis A. These illnesses are typically transmitted when water resources become polluted with human or animal wastes.

20.8 Why fertilizers containing nitrogen element are added into the soil?

Answer: Nitrogenous fertilizers are added to accelerate vegetative growth and development, helping plants achieve a healthy green appearance. Nitrogen is a core component of chlorophyll and protein structures, which are vital for enhancing both the quality and yield of agricultural crops.

20.9 What is trachoma disease?

Answer: Trachoma is a contagious bacterial infection of the eyes that is primarily spread through poor sanitation and limited access to clean water. It causes severe inflammation on the inner surface of the eyelids and can lead to permanent blindness if left untreated.

C. Constructed Response Questions

20.1 Describe the negative effects of using plastics in every day life.

Answer: Plastics are non-biodegradable and persist in the environment for centuries, clogging drainage systems and causing severe soil and water pollution. Furthermore, burned plastic releases highly toxic gases into the atmosphere, while microplastics break down and accumulate inside the food chain, threatening animal and human health.

20.2 Explain one method to remove dissolved impurities present in water.

Answer: Distillation is an effective method used to eliminate dissolved impurities by utilizing the difference in boiling points between water and its contaminants. When the polluted water is boiled, pure water turns into steam and transfers to a condenser to be reclaimed as liquid, leaving all nonvolatile dissolved impurities behind in the original vessel.

20.3 Why urea is regarded as a good nitrogenous fertilizer?

Answer: Urea is regarded as an excellent nitrogenous fertilizer because it contains a remarkably high percentage of nitrogen (around 46%) compared to other solid fertilizers. It is highly soluble in water, easily absorbed by crops, leaves no harmful residual chemical accumulation in the soil matrix, and is relatively safe to store and handle.

20.4 Why Pakistan is facing a severe shortage of water?

Answer: Pakistan faces critical water scarcity due to rapid population growth and rapid urbanization increasing total demand against a static natural supply. This crisis is worsened by deficient infrastructure causing immense water wastage during transmission, climate-driven changes in seasonal rainfall patterns, and the critical lack of large-scale storage reservoirs or dams.

D. Descriptive Questions

20.1 How domestic water supply can be made fit for drinking?

Answer:

- **Aeration and Sedimentation:** The raw water is first mixed with air to remove dissolved gases and foul odors, then held in large settling basins so that heavy suspended particulate matter sinks to the bottom.
- **Coagulation and Filtration:** Alum is added to clump fine impurities together into larger particles that are easily filtered out by passing the water through layers of sand and gravel.
- **Disinfection:** Chlorination or ozone treatment is applied as a final step to kill pathogenic bacteria, viruses, and other disease-causing microorganisms, making it entirely safe for household consumption.

20.2 Which measures should be taken to avoid water-borne disease?

Answer:

- **Water Purification:** All community members must ensure domestic drinking water is thoroughly boiled, chlorinated, or filtered through reliable household purification units before consumption.
- **Sanitation and Hygiene:** Proper sewage disposal systems must be maintained to prevent human or animal wastes from mixing with natural groundwater reserves and open water bodies.
- **Public Awareness:** Educational programs should teach personal hygiene habits, like washing hands with soap and keeping domestic water storage containers clean and tightly covered.

20.3 What are fertilizers? Mention the essential qualities of a good fertilizer.

Answer:

- **Definition:** Fertilizers are natural or synthetic chemical substances added to soil or plant tissues to supply one or more essential nutrients necessary for optimum plant growth.
- **Nutrient Availability:** A good fertilizer must be highly soluble in water so that its essential nutrients can be easily and rapidly absorbed by the plant's root system.
- **Safety and Stability:** It must be non-toxic to crops, regular soil microorganisms, and humans, must not alter soil pH harmfully, and should remain stable during storage and transit.

20.4 What are the main functions of nitrogenous, phosphatic and potassium fertilizers?

Answer:

- **Nitrogenous Fertilizers:** These promote rapid vegetative growth, enhance the development of healthy green leaves, and assist in protein and chlorophyll synthesis within the plant.

- **Phosphatic Fertilizers:** These stimulate early root development, accelerate flowering, strengthen stalks, and play a fundamental role in energy transformation and cellular division processes.
- **Potassium Fertilizers:** These aid in starch and sugar formation, enhance crop resistance against diseases, build strong root systems, and assist in the proper ripening of fruits, seeds, and cereals.

20.5 How can you avoid the negative effects of pollutants present in water?

Answer:

- **Industrial Waste Regulation:** Factory effluents must undergo strict chemical treatment in specialized water treatment plants to neutralize hazardous toxins before being discharged into rivers or lakes.
- **Agricultural Management:** Farmers should minimize the overuse of synthetic fertilizers and chemical pesticides, opting instead for organic alternatives to prevent agricultural runoff into local water bodies.
- **Pollution Prevention:** Public laws must strictly prohibit the dumping of domestic garbage, plastics, and untreated sewage into open water pathways, alongside organizing regular water cleanup campaigns.

Unit 21: Organic Chemistry

A. Multiple Choice Questions

1. Choose the correct IUPAC name for the compound $H_2C=CH-CH_2-CH_3$:

- (a) But-3-ene
- **(b) But-1-ene ✓**
- (c) But-2-ene
- (d) Butene

2. Select a branched chain compound:

- (a) $CH_2=CH-CH_2-CH_3$
- **(b) $CH_2=C(CH_3)-CH_2-CH_3$ ✓**
- (c) $CH_3-CH=CH-CH_3$
- (d) $CH_3-CH=CH-CH_2-CH_3$

3. Which is the displayed formula of ethanol?

- (a) C_2H_5OH
- (b) CH_3-CH_2-OH
- (c) Full structure showing all bonds to OH
- **(d) Full structure showing all covalent bonds explicit including the O-H bond ✓**

4. Identify the aldehyde functional group among the following:

- (a) -COOH
- (b) -OH
- (c) -C(=O)-
- **(d) -CHO ✓**

5. Select the general formula of alkane family:

- (a) CnH2n+1
- **(b) CnH2n+2 ✓**
- (c) CnH2n-2
- (d) CnH2n-1

6. How many structural isomers will there be for a saturated hydrocarbon having five carbon atoms?

- (a) 2
- **(b) 3 ✓**
- (c) 4
- (d) 5

7. Which ester among the following will be called ethyl propanoate?

- (a) CH_3-C(=O)-OCH_3
- (b) CH_3-CH_2-C(=O)-OCH_3
- (c) CH_3-C(=O)-OC_2H_5
- **(d) CH_3-CH_2-C(=O)-OC_2H_5 ✓**

8. Which functional group is present in alkenes?

- (a) No functional group
- (b) Carbon-carbon triple bond
- **(c) Carbon-carbon double bond ✓**
- (d) Carbon-carbon single bond

B. Short Answer Questions

21.1 What is the difference between saturated and unsaturated hydrocarbons?

Answer: Saturated hydrocarbons contain only single covalent bonds between carbon atoms (alkanes). Unsaturated hydrocarbons contain at least one carbon-carbon double or triple covalent bond (alkenes and alkynes).

21.2 Write down the structural formula of Butan-2-ol.

Answer: CH_3-CH(OH)-CH_2-CH_3

21.3 Why is ethylamine CH_3-CH_2-NH_2 called an organic compound?

Answer: It is called an organic compound because it contains a covalently bonded carbon skeleton (C-C backbone) directly bonded to hydrogen and a nitrogen-containing functional group.

21.4 Write down the formula of an ester called ethyl methanoate.

Answer: H-C(=O)-O-CH_2-CH_3 or $HCOOC_2H_5$

21.5 Define structural isomerism.

Answer: Structural isomerism is a phenomenon where compounds share the exact same molecular formula but possess completely different structural arrangements of atoms.

21.6 Give IUPAC name to CH_3-CH_2-CH_2-CH_3.

Answer: The IUPAC name for this continuous four-carbon unbranched alkane chain is butane (or n-butane).

21.7 What is common in carboxyl group, amide functional group and ester functional group?

Answer: All three of these functional groups contain a central carbonyl group (C=O) bonded directly to an oxygen or nitrogen atom.

C. Constructed Response Questions

21.1 Why the members of a homologous series have similar chemical properties?

Answer: They possess the exact same functional group, which dictates chemical behavior. Furthermore, they share a regular structural graduation, differing only by a fixed -CH_2- unit.

21.2 How are the properties of 2-methylpropane different from n-butane, both containing the same number of carbon atoms?

Answer:

- **Boiling Point:** 2-methylpropane is branched, reducing its surface area and lowering its boiling point compared to straight-chain n-butane.
- **Chemical/Physical packing:** The compact branched shape of 2-methylpropane alters its intermolecular interactions and packing efficiency in solids/liquids.

21.3 Write down the structural formulae of isomers shown by saturated hydrocarbon containing five carbon atoms.

Answer:

- **n-pentane:** CH_3-CH_2-CH_2-CH_2-CH_3
- **Isopentane (2-methylbutane):** CH_3-$CH(CH_3)$-CH_2-CH_3
- **Neopentane (2,2-dimethylpropane):** $(CH_3)_4C$

21.4 Write down the structural formulae of the isomers shown by butene.

Answer:

- **But-1-ene:** CH_2=CH-CH_2-CH_3
- **But-2-ene:** CH_3-CH=CH-CH_3
- **2-Methylprop-1-ene:** CH_2=$C(CH_3)$-CH_3

21.5 Explain the difference among functional groups present in aldehyde, ketone and carboxylic acid.

Answer:

- **Aldehyde:** Contains a carbonyl group bonded to at least one hydrogen atom (-CHO).
- **Ketone:** Contains a carbonyl group bonded to two distinct carbon fragments (-C(=O)-).
- **Carboxylic Acid:** Contains a carbonyl group bound directly to a hydroxyl cluster (-COOH).

D. Descriptive Questions

21.1 What is an organic compound? How organic compounds are classified based on the type of carbon chain present in them?

Answer:

- **Organic Compound Definition:** Hydrocarbons and their derivatives containing covalently bound carbon atoms.
- **Open-chain / Acyclic Classification:** Straight or branched open skeletons containing no closed loops.
- **Closed-chain / Cyclic Classification:** Compounds containing atoms arranged in one or more closed rings.

21.2 Explain structural formula giving examples.

Answer:

- **Definition:** A structural formula indicates the exact spatial arrangement and connectivity of atoms within a molecule.
- **Example 1 (Alkane):** Propane is expressed as CH_3-CH_2-CH_3, demonstrating carbon chain links.
- **Example 2 (Alcohol):** Ethanol is written as CH_3-CH_2-OH, highlighting the distinct active functional group position.

21.3 Write down five characteristics of a homologous series.

Answer:

- **General Formula:** All members of a specific series can be represented by a single general formula.
- **Successive Difference:** Adjacent members differ from one another by a fixed -CH_2- molecular formula unit.
- **Chemical Similarity:** Members exhibit comparable chemical properties because they contain identical active functional groups.
- **Physical Graduation:** Physical traits (e.g., boiling points) change systematically with increasing molecular mass.
- **Preparation Methods:** Most members can typically be synthesized using similar general laboratory methods.

21.4 Give IUPAC rules for naming alcohols.

Answer:

- **Parent Chain Selection:** Identify the longest continuous carbon chain that directly contains the -OH group.
- **Numbering Chain:** Number the chain from the end closer to the carbon bearing the hydroxyl functional group.
- **Suffix Replacement:** Change the parent alkane ending from "-e" to "-ol" and indicate the hydroxyl position number.

21.5 Name the following compounds.

(a) CH_3-CH_2-CH_2OH
Answer: Propan-1-ol

(b) CH_3-CH_2-CHO
Answer: Propanal

(c) CH_3-CH_2-CH_2-COOH
Answer: Butanoic acid

(d) CH_3-CH_2-CO-O-CH_3
Answer: Methyl propanoate

Unit 22: Hydrocarbons

A. Multiple Choice Questions

1. Which of the following compounds is expected to give addition reaction?

- (a) CH_3-CH_3
- **(b) CH_2=CH_2 ✓**
- (c) CH_4
- (d) CH_3-CH_2-CH_3

2. Which of the following is not used as a fuel?

- (a) LPG
- (b) CNG
- (c) Diesel
- **(d) Asphalt ✓**

3. Indicate the type of the following reaction:
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

- (a) Substitution
- **(b) Oxidation ✓**
- (c) Reduction
- (d) Addition

4. Which species acts as a reducing agent in the reaction between ethene and $KMnO_4$?

- (a) H_2O
- **(b) CH_2=CH_2 ✓**
- (c) $KMnO_4$
- (d) NaOH

5. The product which will be formed when propane reacts with bromine molecule.

- (a) 1,2-Dibromopropane
- **(b) 1,1-Dibromopropane ✓**
- (c) 2,3-Dibromopropane
- (d) 1,3-Dibromopropane

6. Select the name of the petroleum fraction which generates electricity in power plants.

- (a) Bitumen
- (b) Lubricating oil
- (c) Kerosene oil
- **(d) Fuel oil ✓**

7. The molecule eliminated in the following reaction is:
CH_3-CH_2-Br + KOH (alcoholic) → CH_2=CH_2 + KBr + H_2O

- (a) Br_2
- (b) H_2
- **(c) HBr ✓**
- (d) H_2O

8. Fractional distillation of petroleum is based on:

- (a) Viscosity
- **(b) Boiling point range ✓**
- (c) Flammability
- (d) Melting point range

B. Short Answer Questions

22.1 Give two examples of addition reactions.

Answer:

- **Example 1 (Hydrogenation):** Ethene + H_2 → Ethane
  CH_2=CH_2 + H_2 → Ni/Δ → CH_3-CH_3
- **Example 2 (Bromination):** Ethene + Br_2 → 1,2-Dibromoethane
  CH_2=CH_2 + Br_2 → CH_2Br-CH_2Br

22.2 Give the names of the compounds obtained from coal tar and petroleum.

Answer:

- **From Coal Tar:** It yields valuable aromatic compounds like benzene, toluene, xylene, phenol, and naphthalene after fractional distillation.
- **From Petroleum:** It provides vital hydrocarbons like methane, ethane, propane, butane, and complex liquid fractions like gasoline, kerosene, and diesel fuel.

22.3 How ethene is oxidized by cold aqueous solution of potassium permanganate.

Answer: Ethene reacts with a cold, dilute, alkaline aqueous solution of potassium permanganate ($KMnO_4$) known as Baeyer's reagent. The purple color of $KMnO_4$ decolourizes as a brown precipitate of MnO_2 forms, and ethene is oxidized into ethylene glycol (ethane-1,2-diol):
$3CH_2=CH_2 + 2KMnO_4 + 4H_2O \rightarrow 3CH_2(OH)\text{-}CH_2(OH) + 2MnO_2 + 2KOH$

22.4 Differentiate between elimination and addition reactions.

Answer:

- **Addition Reactions:** Two or more reactant molecules combine to form a single, larger saturated product, typically seen in unsaturated alkenes and alkynes.
- **Elimination Reactions:** A single saturated reactant splits apart into two or more products, losing atoms or groups to form a new unsaturated compound (double or triple bond).

22.5 Name the starting materials used to generate oxyacetylene flame.

Answer: The primary starting chemical materials required are ethyne gas (commonly known as acetylene, C_2H_2) and pure oxygen gas (O_2). When these two compressed gases are mixed and ignited in a specialized welding torch, they undergo a highly exothermic combustion reaction.

22.6 How can an alkene be identified?

Answer: An alkene can be identified by adding red-brown bromine water; if the compound is an alkene, it instantly decolourizes the solution via an addition reaction. Alternatively, it will decolourize the purple color of a cold, alkaline aqueous solution of potassium permanganate ($KMnO_4$), leaving a brown precipitate.

C. Constructed Response Questions

22.1 What is the difference between the terms dehydration and dehydrohalogenation?

Answer:

- **Dehydration:** Refers to the specific chemical process where a molecule of water (H_2O) is removed from a reactant, such as heating an alcohol with concentrated H_2SO_4.
- **Dehydrohalogenation:** Refers to the removal of both a hydrogen atom and a halogen atom (as a hydrogen halide, HX) from adjacent carbons, typically using alcoholic KOH.

22.2 You have got two test tubes A and B containing a saturated and unsaturated compound (Alkene). How will you identify the two?

Answer: Add a few drops of red-brown bromine water into both test tubes; the tube containing the unsaturated alkene will rapidly decolourize the solution. The test tube containing the saturated compound will show no immediate reaction, and the red-brown color of the bromine solution will persist.

22.3 Why is oxyacetylene flame so hot?

Answer: The flame reaches temperatures up to 3500°C because ethyne (C_2H_2) possesses an exceptionally high energy triple bond that releases massive amounts of heat upon breaking. Mixing it with pure, concentrated oxygen ensures complete combustion into CO_2 and H_2O, preventing any heat loss to atmospheric nitrogen or incomplete burning.

22.4 Do you expect ethyne to decolourize a cold solution of $KMnO_4$?

Answer: Yes, ethyne is an unsaturated hydrocarbon containing a reactive carbon-carbon triple bond that readily undergoes oxidation. When mixed with a cold, alkaline $KMnO_4$ solution, ethyne will break its bonds to form oxalic acid, rapidly turning the purple solution colorless with a brown MnO_2 precipitate.

22.5 How do chlorine and hydrogen chloride add to ethene?

Answer:

- **Chlorine Addition:** $Cl_2 + CH_2=CH_2 \rightarrow CH_2Cl\text{-}CH_2Cl$ (1,2-dichloroethane)
- **Hydrogen Chloride Addition:** $HCl + CH_2=CH_2 \rightarrow CH_3\text{-}CH_2Cl$ (chloroethane)

D. Descriptive Questions

22.1 Describe two methods of preparation for ethene.

Answer:

- **Method 1 (Dehydration of Alcohols):** Ethene is prepared by heating ethanol ($CH_3\text{-}CH_2\text{-}OH$) with excess concentrated sulfuric acid (H_2SO_4) acting as a dehydrating agent at around 170°C, which removes a water molecule to generate a carbon-carbon double bond.
- **Method 2 (Dehydrohalogenation of Alkyl Halides):** Ethene is produced when an ethyl halide, like bromoethane ($CH_3\text{-}CH_2\text{-}Br$), is boiled with a concentrated solution of alcoholic potassium hydroxide (KOH), eliminating a molecule of hydrogen bromide.

22.2 Describe the fractional distillation of petroleum.

Answer: Fractional distillation of petroleum separates crude oil into different fractions based on their boiling point ranges. The crude oil is heated in a furnace and pumped into a tall fractionating column. As the vapors rise, they cool and condense at different heights depending on their boiling points. The lighter fractions with lower boiling points condense at the top of the column, while the heavier fractions with higher boiling points condense at the bottom. This process yields useful fractions like gasoline, kerosene, diesel, lubricating oil, and fuel oil.

22.3 Which properties of petroleum fractions change with their boiling points?

Answer:

- **Volatility and Viscosity:** As the boiling point increases, the volatility decreases (fractions become harder to vaporize), while the viscosity increases significantly, making the liquids thicker and heavier.
- **Flammability and Molecular Size:** Fractions with higher boiling points possess larger hydrocarbon molecular chains with greater intermolecular forces, making them much harder to ignite compared to lighter, lower-boiling fractions.

22.4 Explain with examples the cracking of alkanes.

Answer:

- **Definition:** Cracking is the chemical process where heavy, long-chain hydrocarbons with high boiling points are broken down into smaller, more volatile, and highly useful shorter-chain alkanes and alkenes.
- **Example:** A long-chain alkane like hexadecane ($C_{16}H_{34}$) can be thermally or catalytically cracked into lower alkanes like octane (C_8H_{18}) and valuable alkene fragments like ethene (C_2H_4) or propene (C_3H_6).

22.5 Give uses of acetylene.

Answer:

- **Industrial Welding:** It is predominantly burned with pure oxygen in torches to generate the intense oxyacetylene flame required for cutting and welding metals.
- **Chemical Feedstock:** It serves as a vital starting material in chemical industries for synthesis manufacturing, including polymers like PVC, synthetic rubber, acrylic plastics, and organic solvents.

Unit 23: Alcohols

A. Multiple Choice Questions

1. Which conditions are considered best for the fermentation of glucose?

- **(a) 35°C, fresh yeast, absence of oxygen ✓**
- (b) 45°C, yeast
- (c) 45°C, absence of oxygen
- (d) 35°C, fresh yeast

2. Which catalyst other than H_3PO_4 can also be used for hydration of alkenes?

- (a) NaOH
- **(b) H_2SO_4 ✓**
- (c) CH_3COOH
- (d) Ni

3. Alcohol which has the maximum heat of combustion is:

- (a) $CH_3CH_2CH_2OH$
- (b) CH_3CH_2OH
- (c) CH_3OH
- **(d) $CH_3CH_2CH_2CH_2OH$ ✓**

4. The most environment friendly fuel is:

- (a) coal
- (b) kerosene oil
- **(c) ethanol ✓**
- (d) wood

5. Which property or properties of ethanol make it suitable to be used in cosmetic industry?

- (a) Easily Flammable
- **(b) Highly volatile and deodorizing ✓**
- (c) Antipyretic
- (d) Sedative

6. Which is the correct name of the following alcohol:
CH_3-CH(OH)-CH_2-CH(CH_3)-CH_3

- (a) 2-Methylpentan-4-ol
- **(b) 4-Methylpentan-2-ol ✓**
- (c) Hexan-2-ol
- (d) Hexan-4-ol

7. Which property of ethanol makes it suitable for cleaning wounds?

- (a) Good solvent
- (b) Volatility
- **(c) Antiseptic ✓**
- (d) Deodorizing

8. Which alcohol is used to accomplish all the following tasks: It is added in petrol to improve combustion. It serves as a feedstock to prepare vinegar and many other organic compounds.

- (a) Propanol
- (b) Propan-2-ol
- **(c) Ethanol ✓**
- (d) Methanol

B. Short Answer Questions

23.1 Give two advantages of burning of alcohols over the burning of fossil fuel.

Answer:

- Alcohols burn much more cleanly and completely than fossil fuels, resulting in significantly fewer greenhouse gas and particulate emissions.
- Alcohols like ethanol are renewable resources produced from agricultural crops, unlike finite, depleting fossil fuels.

23.2 Which properties of ethyl alcohol make it useful for cosmetic industry?

Answer:

- Its high volatility allows it to evaporate very rapidly upon application, leaving a cooling and clean sensation on the skin.
- It possesses strong deodorizing and antimicrobial properties that help preserve cosmetic formulations.

- It acts as an excellent solvent for dissolving aromatic oils and other cosmetic ingredients.

23.3 How is ethyl alcohol important for pharmaceutical industry?

Answer:

- It serves as a powerful antiseptic and disinfectant in first aid kits for cleaning and dressing wounds.
- It acts as an effective solvent to dissolve organic medicinal compounds that are completely insoluble in water.
- It is used as a preservative in liquid medications and as an antidote for certain poisonings.

23.4 Give any two disadvantages of fermentation reactions.

Answer:

- Fermentation is a slow batch process that yields a relatively low concentration and impure mixture of alcohol.
- Large amounts of agricultural land and crop resources are consumed to produce the biomass needed for fermentation.

23.5 Write the conditions involved in the hydration of ethene.

Answer: The process requires reacting ethene with steam at a high temperature of about 300°C and a pressure of approximately 60-70 atm. An acid catalyst, typically concentrated phosphoric acid (H_3PO_4) or sulfuric acid (H_2SO_4), must be present to facilitate the reaction.

C. Constructed Response Questions

23.1 How ethanol is obtained as a by-product in sugar industry?

Answer: During the extraction of sugar from sugarcane, a thick, dark brown residual liquid called molasses is left behind. This leftover molasses contains high amounts of un-crystallized sucrose, which is subsequently fermented using yeast to produce ethanol.

23.2 Why do we get relatively impure alcohol in the fermentation process?

Answer: Yeast enzymes become inactive and die when the concentration of alcohol reaches about 12% to 15% during the reaction. Consequently, the process leaves behind a large volume of water, leftover sugars, and cellular debris, requiring fractional distillation to purify it.

23.3 How do properties of ethyl alcohol help us to utilize it as fuel?

Answer:

- It has a high flammability and a clean-burning profile, making it a high-efficiency alternative fuel to drive vehicles.

- It easily mixes with petrol to improve combustion efficiency while releasing fewer environmental pollutants compared to traditional fossil fuels.

D. Descriptive Questions

23.1 Give a comparison of fermentation reaction and catalytic hydration of ethene for the preparation of ethanol.

Answer:

- **Raw Materials and Methodology:** Fermentation uses renewable agricultural biomass like molasses and natural yeast enzymes, whereas hydration uses non-renewable ethene derived from petroleum gases.
- **Reaction Conditions:** Fermentation operates under mild conditions (35°C, atmospheric pressure), while hydration requires extreme industrial parameters (300°C and 60-70 atm pressure).
- **Rate and Purity:** Fermentation is a slow, batch process yielding dilute, impure ethanol, whereas catalytic hydration is a rapid, continuous process yielding highly pure ethanol directly.

23.2 Describe the preparation of ethanol by fermentation process.

Answer:

- **Source Material Preparation:** Sugarcane molasses or starch materials are diluted with water to an optimum sugar concentration suitable for biological breakdown.
- **Enzymatic Fermentation:** Fresh yeast is added to the mixture at a controlled temperature of around 35°C in an oxygen-free environment to allow anaerobic respiration.
- **Distillation and Purification:** The yeast enzymes convert glucose into ethanol and carbon dioxide, producing a dilute mixture that is later fractionally distilled to obtain pure alcohol.

23.3 Describe the applications of ethanol in pharmaceutical and cosmetic industries.

Answer:

- **Pharmaceutical Applications:** It is heavily utilized as a household antiseptic (methylated spirit) for treating wounds and as an antidote for specific toxins like snake bites. Additionally, it serves as a critical solvent for preparing liquid medicines and dissolving water-insoluble organic compounds.
- **Cosmetic Applications:** It is integrated into hair styling products, foundation creams, and deodorants due to its refreshing, antimicrobial, and anti-inflammatory traits. Its high volatility allows rapid evaporation in perfumes and aftershave lotions without leaving an oily residue.

Unit 24: Carboxylic Acids and Esters

A. Multiple Choice Questions

1. Identify the ester functional group:
(a) -COOR ✓
(b) -COOH
(c) C=O
(d) $-CH_2$ - OH

2. During the oxidation of ethanol by acidified $KMnO_4$, which element is reduced?
(a) K
(b) O
(c) Mn ✓
(d) H

3. Fermentation of foodstuff in the presence of acetic acid bacteria needs a sufficient supply of oxygen. What is the role of oxygen in this process?
(a) It enhances the reactivity of bacteria
(b) It oxidizes ethanol which is formed during the reaction ✓
(c) It inhibits the destruction of bacteria
(d) It inhibits the oxidation of acetic acid

4. Which organic acid is used as a component of food?
(a) Formic acid
(b) Oxalic acid
(c) Propanoic acid
(d) Acetic acid ✓

5. Which of the following acids is present in apples?
(a) Citric acid
(b) Tartaric acid
(c) Acetic acid
(d) Malic acid ✓

6. Which substances will react to produce CH_3-CH_2-CH_2-$COOC_2H_5$?
(a) $CH_3CH_2CH_2COOH$ and CH_3OH
(b) CH_3CH_2COOH and CH_3CH_2OH
(c) $CH_3CH_2CH_2COOH$ and CH_3CH_2OH ✓
(d) $CH_3CH_2CH_2COOH$ and CH_3OH

7. What is the formula of ester formed by the reaction of methanol with propanoic acid?
(a) $CH_3COOCH_2CH_3$
(b) $CH_3CH_2COCH_3$
(c) $CH_3CH_2COOCH_3$ ✓
(d) $CH_3CH_2OCOCH_3$

8. Which polymer is made by reacting a diol and a dicarboxylic acid?
(a) Polyethene
(b) Polyester ✓
(c) Polystyrene
(d) Polyamide

9. Which compound is used as a synthetic fiber?
(a) Methyl acetate
(b) Polyester ✓
(c) Resin
(d) n-Amyl acetate

B. Short Answer Questions

24.1 What is an esterification reaction?

An esterification reaction is a chemical process where a carboxylic acid reacts with an alcohol in the presence of an acid catalyst to produce an ester and water. It is characterized by the formation of a sweet-smelling ester compound.

24.2 Name an oxidizing agent used to oxidize alcohols.

Acidified potassium permanganate ($KMnO_4$) or acidified potassium dichromate ($K_2Cr_2O_7$) are commonly used oxidizing agents to oxidize alcohols into carboxylic acids.

24.3 Why sufficient oxygen is provided during fermentation to prepare acetic acid from ethanol?

Sufficient oxygen is required because the conversion of ethanol to acetic acid by *Acetobacter* bacteria is an aerobic oxidation process. Oxygen acts as the oxidizing agent necessary to chemically transform the alcohol group into a carboxylic acid group.

24.4 What is the role of carboxylic acids in the preparation of beverages?

Carboxylic acids are added to beverages to provide a pleasant, sharp, tangy taste and act as acidity regulators. Additionally, they function as natural preservatives that inhibit microbial growth, extending the shelf life of the drink.

24.5 Give a practical example in which an acid or an ester is used as a flavouring agent.

Acetic acid is used in vinegar to impart a sour flavor to foods, while the ester ethyl butyrate is widely utilized in the food industry to replicate a realistic pineapple flavor in candies and drinks.

24.6 Which carboxylic acids are very often used as flavour enhancers?

Citric acid (found in citrus profiles) and acetic acid (found in vinegar) are very frequently used as flavor enhancers to add sharpness, tartness, and depth to various culinary products.

24.7 Which property of acetic acid does make it suitable to act as preservative in pickle?

The acidic property of acetic acid lowers the pH of the pickle medium, creating a highly inhospitable, acidic environment. This effectively inhibits the growth of spoilage-causing bacteria and fungi, preserving the food.

C. Constructed Response Questions

24.1 How does ethanol react with propanoic acid?

Ethanol reacts with propanoic acid in the presence of a concentrated sulfuric acid catalyst via a reversible condensation reaction. The reaction eliminates a water molecule to produce a sweet-smelling ester called ethyl propanoate ($CH_3CH_2COOCH_2CH_3$).

24.2 How does acetic acid react with Mg and $MgCO_3$?

Acetic acid reacts vigorously with magnesium metal to liberate highly flammable hydrogen gas and form a soluble salt called magnesium acetate. When reacting with magnesium carbonate, it produces magnesium acetate, water, and brisk effervescence of carbon dioxide gas.

24.3 How carboxylic acids are used as solvents?

Carboxylic acids, particularly lower members like acetic acid, are excellent solvents because their polar nature allows them to dissolve both polar and non-polar substances. They are heavily utilized in laboratory recrystallizations and industrial chemical manufacturing processes.

24.4 How carboxylic acid are used in daily life?

In daily life, carboxylic acids are primarily used as vinegar (acetic acid) for cooking, food preservation, and household cleaning. They are also encountered daily as citric acid in citrus fruits used for flavoring, and as lactic acid in sour milk products like yogurt.

D. Descriptive Questions

24.1 Explain fermentation reaction which is used to prepare acetic acid on commercial scale.

Answer:

- **Biological Process:** Globally, commercial production relies on the aerobic fermentation of ethanol solutions by using Acetobacter bacteria.
- **Chemical Reaction:** The bacteria utilize atmospheric oxygen to systematically oxidize ethanol into acetaldehyde, which is further oxidized into dilute acetic acid (vinegar).
- **Industrial Conditions:** The process is maintained in large, aerated vats at optimal temperatures around 25°C to 30°C with a continuous, abundant supply of oxygen.

24.2 Describe the industrial applications of carboxylic acids and esters.

Answer:

- **Carboxylic Acid Uses:** Industrially, they serve as crucial starting precursors for manufacturing polymers, pharmaceuticals, dyes, and textile finishes.
- **Ester Uses:** Esters are extensively manufactured for use as industrial solvents for paints, lacquers, and adhesives due to their excellent volatility.
- **Synthetic Polymers:** Both components are combined on a massive industrial scale to manufacture synthetic polyester fibers used worldwide in clothing.

24.3 What are flavouring agents? Which carboxylic acids are used as flavourings agents.

Answer:

- **Definition:** Flavouring agents are natural or synthetic chemical substances added to food and beverages to alter, mimic, or enhance their taste and aroma.
- **Citric & Tartaric Acids:** Citric acid is widely used to give a sour, citrusy taste, while tartaric acid is used to impart a sharp taste in baked goods.
- **Acetic & Malic Acids:** Acetic acid provides the classic sourness in condiments, and malic acid is added to confectionery to mimic the tart flavor of apples.

24.4 Explain the reactions of carboxylic acids with metals and carbonates.

Answer:

- **Reaction with Metals:** Carboxylic acids react slowly with reactive metals (like Mg or Zn) to form a metal carboxylate salt and evolve hydrogen gas.
- **Reaction with Carbonates:** They react with metal carbonates to form a carboxylate salt, water, and produce characteristic bubbling due to carbon dioxide emission.
- **Chemical Nature:** Both sets of reactions clearly demonstrate the acidic character of the carboxyl group through the displacement of its hydrogen ion.

24.5 Describe applications of esters in daily life.

Answer:

- **Food Flavorings:** Esters are utilized in everyday food products, ice creams, and candies to provide artificial fruit flavors like banana, apple, and orange.
- **Perfumes and Cosmetics:** Because of their pleasant, sweet, and fruity fragrances, they are fundamental ingredients in perfumes, body lotions, and cosmetics.
- **Nail Polish Removers:** Ethyl acetate, a very common ester, is used daily as the primary solvent in commercial nail polish removers.

Unit 25: Biochemistry

A. Multiple Choice Questions

1. Functional groups present in fructose are:

- (a) Hydroxyl and aldehyde
- **(b) Hydroxyl and Ketone ✓**
- (c) Hydroxyl and ester
- (d) Hydroxyl and amide

2. Which functional group is present in a fat?

- (a) Carboxyl group
- **(b) Ester group ✓**
- (c) Carbonyl group
- (d) Hydroxyl group

3. Which function is not performed by proteins in our body?

- (a) They serve as chemical messengers
- (b) They serve as storage of energy-rich fuel
- **(c) They store genetic information ✓**
- (d) They serve as catalysts for biochemical reactions

4. Which functional groups react to produce a peptide linkage in proteins?

- (a) Carboxyl group and hydroxyl group
- **(b) Carboxyl group and amino group ✓**
- (c) Carbonyl group and amino group
- (d) Carboxyl group and carbonyl group

5. The test performed to detect cancer in early stages is:

- (a) Genetic test
- (b) Urine test
- **(c) Galleri test ✓**
- (d) Electrolyte test

6. Fatigue and depression are caused by deficiency of:

- (a) Vitamin A
- (b) Vitamin C
- (c) Vitamin D
- **(d) Vitamin B_1 ✓**

B. Short Answer Questions

25.1 What is the difference between glucose and fructose?

Answer: Glucose is an aldohexose sugar containing an aldehyde functional group at the first carbon, whereas fructose is a ketohexose sugar containing a ketone functional group at the second carbon. Both share the same molecular formula, but they differ structurally in their functional groups and spatial arrangements.

25.2 Give two examples of denaturation of proteins.

Answer: Two common examples are the coagulation of egg white (albumin) when it is boiled or cooked, and the curdling of milk when an acid like lemon juice or vinegar is added, which precipitates the casein protein.

25.3 What are the sources of vitamin D?

Answer: The primary natural source is sunlight exposure, which triggers vitamin D synthesis in the skin. Dietary sources include fatty fish (like salmon and mackerel), fish liver oils, egg yolks, fortified milk, and dairy products.

25.4 What is the role of enzymes in our body?

Answer: Enzymes act as highly specific biological catalysts that accelerate essential metabolic and biochemical reactions in the body, such as digestion and cellular respiration. They lower the activation energy required for these processes without being consumed themselves.

25.5 Which commercial products are obtained from oils and fats?

Answer: Major commercial products obtained from oils and fats include soaps, detergents, glycerin, margarine, shortening, cosmetics, and biodiesel fuels produced through processes like saponification and hydrogenation.

25.6 Which vitamin helps in blood clotting?

Answer: Vitamin K is the essential fat-soluble vitamin that helps in blood clotting by synthesizing the specific proteins and coagulation factors necessary to stop bleeding from injuries.

C. Constructed Response Questions

25.1 What is the function of DNA?

Answer: DNA functions as the primary storage repository for the genetic blueprint and hereditary instructions of an organism. It directs cellular growth, reproduction, and the synthesis of all necessary proteins required for the development and maintenance of life.

25.2 Write down three important functions played by proteins in our body.

Answer:

- **Catalytic Activity:** Proteins function as enzymes that accelerate biochemical reactions required for metabolism and life preservation.
- **Structural Support:** They provide essential structure, strength, and framework to cellular components, tissues, muscles, skin, and bones.
- **Transport and Signaling:** They act as chemical messengers (hormones) and transport carriers, moving vital molecules like oxygen throughout the bloodstream.

25.3 Fatty acids serve as building blocks of lipids just like amino acids are for proteins. Comment on this statement.

Answer: This statement is accurate because lipids (such as triglycerides) are macro-biomolecules formed by the chemical bonding of fatty acid chains to a glycerol backbone. Similarly, proteins are long polymeric chains synthesized from individual amino acid units linked together by peptide bonds.

25.4 Write down about the sources of vitamin C. Which diseases are caused by its deficiency?

Answer: Vitamin C is primarily sourced from citrus fruits (like oranges, lemons, and grapefruits), strawberries, kiwis, bell peppers, and fresh green leafy vegetables. Its prolonged deficiency leads to scurvy, a disease characterized by bleeding gums, severe skin hemorrhages, and poor wound healing.

25.5 Write down the names of two polymeric carbohydrates.

Answer: Two prominent examples of polymeric carbohydrates (polysaccharides) composed of repeating glucose units are starch, which serves as energy storage in plants, and cellulose, which forms plant cell walls.

D. Descriptive Questions

25.1 What are the sources of fructose, maltose and lactose?

Answer:

- **Fructose Sources:** Naturally occurring in high amounts in sweet fruits (like apples, grapes, and berries), honey, and root vegetables.
- **Maltose Sources:** Found abundantly in germinating grains (malt), cereal products, and as an intermediate product during the enzymatic breakdown of starch.
- **Lactose Sources:** Found exclusively in mammalian milk and dairy products such as cheese, butter, yogurt, and whey.

25.2 Draw open chain structures of glucose and fructose.

Answer:

- **Glucose Structure:** Consists of a straight six-carbon chain with a terminal aldehyde group (-CHO) at carbon-1, a primary alcohol group (-CH_2OH) at carbon-6, and hydroxyl groups (-OH) pointing in specific stereochemical orientations on carbons 2, 3, 4, and 5.
- **Fructose Structure:** Consists of a straight six-carbon chain with a ketone group (-C=O) at carbon-2, two primary alcohol groups (-CH_2OH) at carbons 1 and 6, and hydroxyl groups (-OH) situated on carbons 3, 4, and 5.

25.3 Construct peptide linkage and explain the structure of a polypeptide.

Answer:

- **Peptide Linkage Construction:** Formed via a condensation reaction when the carboxylic acid group (-COOH) of one amino acid reacts with the amino group (-NH_2) of another, releasing a water molecule (H_2O) to form a covalent -CONH- amide bond.
- **Polypeptide Structure:** A polypeptide is a continuous, unbranched polymer chain consisting of many amino acid residues linked sequentially by these peptide bonds. The linear sequence of these amino acids dictates how the chain folds into functional three-dimensional protein configurations.

25.4 What are DNA and RNA? Describe the role played by them in our body.

Answer:

- **DNA and RNA Identity:** DNA (Deoxyribonucleic Acid) is a double-stranded nucleic acid containing deoxyribose sugar, while RNA (Ribonucleic Acid) is typically a single-stranded nucleic acid containing ribose sugar.
- **Role of DNA:** Serves as the permanent molecular archive storing the complete set of genetic codes and hereditary instructions needed to build and operate an organism.
- **Role of RNA:** Acts as a dynamic messenger and functional tool that reads, transfers, and translates the genetic blueprint from DNA to synthesize specific proteins in ribosomes.

25.5 Compare the roles played by carbohydrates, proteins and lipids in our body.

Answer:

- **Role of Carbohydrates:** Act as the body's primary, immediate, and most accessible source of chemical energy to fuel daily cellular operations and metabolic activities.
- **Role of Proteins:** Serve primarily as functional and structural components used for growth, tissue repair, immune defense, and biological catalysis as enzymes.
- **Role of Lipids:** Act as concentrated, long-term energy reserves, provide thermal insulation and physical cushioning to vital organs, and form the structural matrix of cellular membranes.

Unit 26: Polymers

A. Multiple Choice Questions

1. Which of the following polymer is a synthetic polymer:

- (a) Starch
- (b) Cellulose
- (c) Animal fat
- **(d) Polyester ✓**

2. Which polymer has an amide linkage:

- (a) Polyester
- **(b) Polyamide ✓**
- (c) Polyethene
- (d) Polystyrene

3. Identify an ester linkage:

- **(a) R-C-O-R ✓**
- (b) R-C-R
- (c) R-C-O-NH-R
- (d) R-C-NH-R

4. The structure of the monomer of the following polymer is: $[-CH_2-CH-]_n$

- (a) $CH_2=CH_2$
- (b) $CH_2=CH_2-CH_3$
- **(c) $CH_2=CH-OCOCH_3$ ✓**
- (d) $CH_2=CH-CO-O-CH_3$

5. Which of the following polymers can be recycled?

- **(a) PET ✓**
- (b) Polystyrene
- (c) PVC
- (d) Epoxy

6. Which of the following polymers is biodegradable?

- (a) Polyamide
- (b) Polyester
- **(c) Starch ✓**
- (d) PET

7. Which of the following polymers is obtained by condensation polymerization?

- (a) Polyvinyl chloride
- (b) Polystyrene
- **(c) Polyamide ✓**
- (d) Polyethene

B. Short Answer Questions

26.1. Give two examples each of addition polymers and condensation polymers.

Answer:

- **Addition Polymers:** Polyethene and Polyvinyl chloride (PVC).
- **Condensation Polymers:** Polyamide (Nylon) and Polyester (PET).

26.2. How polymers are useful for us?

Answer: Polymers are essential daily materials used to manufacture clothing, packaging, electronics, and medical equipment. Their lightweight, durable, and flexible nature makes them ideal for building materials, household items, and modern industrial applications.

26.3. How synthetic fibers are different from natural fibers?

Answer: Synthetic fibers are man-made chemical structures engineered to be highly durable, elastic, wrinkle-resistant, and quick-drying. Natural fibers, obtained directly from plants or animals, are highly breathable and biodegradable but degrade more rapidly.

26.4. Are natural polymers hazardous for the environment? Explain why?

Answer: No, natural polymers are generally safe for the environment because they are entirely biodegradable. Microorganisms can naturally decompose their structures back into the ecosystem without accumulating toxic compounds.

26.5. Draw the structures of the following polymers.

Answer:

- **(a) Polypropylene:** $[\text{-}CH_2\text{-}CH(CH_3)\text{-}]_n$
- **(b) Polystyrene:** $[\text{-}CH_2\text{-}CH(C_6H_5)\text{-}]_n$

C. Constructed Response Questions

26.1. Why is it dangerous to burn discarded articles made of plastics?

Answer: Burning discarded plastic items releases highly toxic, hazardous gases such as dioxins and furans into the atmosphere. These emissions severely pollute the air and present major respiratory and carcinogenic health risks to living organisms.

26.2. Why is it not advisable to dump discarded synthetic articles in oceans?

Answer: Synthetic articles are non-biodegradable and persist in aquatic environments for hundreds of years, breaking down into harmful microplastics. Marine life frequently mistakes this debris for food or gets entangled in it, causing widespread fatalities and food chain contamination.

26.3. What is the role of catalyst in addition polymerization?

Answer: The catalyst initiates the polymerization process by generating highly reactive free radicals or ions that open up double bonds in monomers. It significantly accelerates the chain reaction, allowing rapid polymer growth under controlled temperature and pressure parameters.

26.4. Deduce the monomer from the following addition polymers.

Answer:

- **(i)** $[-CH_2-CH(Cl)-]_n$
  Monomer: Vinyl chloride ($CH_2=CH-Cl$)
- **(ii)** $[-CH_2-CH(CN)-]_n$
  Monomer: Acrylonitrile ($CH_2=CH-CN$)

D. Descriptive Questions

26.1. How is PET formed? Can you recycle this polymer?

Answer:

- **Formation:** PET (Polyethylene terephthalate) is formed via a condensation polymerization reaction between ethylene glycol and terephthalic acid, producing an ester linkage alongside a water byproduct.
- **Recyclability:** Yes, PET is a thermoplastic polymer that can be readily melted down, reprocessed, and recycled into new containers or synthetic fibers.

26.2. Differentiate between addition and condensation polymerizations.

Answer:

- **Addition Polymerization:** Monomers containing double bonds join end-to-end without losing any structural pieces, creating the polymer as the sole product.

- **Condensation Polymerization:** Monomers with distinct functional groups react to link together by eliminating a small molecule (like water or methanol) as a byproduct.

26.3. Write down reactions along with the conditions to prepare polyamide and polyester.

Answer:

- **Polyamide Preparation:** Formed by heating diamines and dicarboxylic acids (or amino acids) under high temperature and high-pressure conditions to form recurring amide bonds.
- **Polyester Preparation:** Synthesized by reacting diols with dicarboxylic acids in the presence of an acid catalyst at elevated temperatures to link ester chains together.

26.4. Describe the role of synthetic polymers in the textile industry.

Answer:

- **Fiber Production:** Synthetic polymers provide the base material for structural synthetic fibers like nylon, acrylic, and polyester that replace or blend with traditional cotton.
- **Fabric Enhanced Features:** These engineered materials yield lightweight, highly durable garments that provide water resistance, high elasticity, and structural immunity to wrinkling or shrinking.

26.5. Describe the effects of synthetic polymers on the environment.

Answer:

- **Waste Accumulation:** Because synthetic polymers resist natural decay, discarded objects accumulate indefinitely in landfills, soil systems, and water networks.
- **Toxic Pollution:** Incinerating plastic waste generates destructive atmospheric gases, while long-term ocean dumping leaks microplastics that fatally degrade delicate marine ecosystems.