NCERT CLASS 10 CHEMISTRY
HOTS AND LOGICAL EXAM QUESTIONS WITH SOLUTIONS

CHAPTER 1: CHEMICAL REACTIONS AND EQUATIONS

Q1. A reddish-brown metal X when heated in air forms a black-coloured compound Y. When hydrogen gas is passed over this hot black compound Y, the original metal X is recovered along with the formation of a liquid Z. Identify X, Y, and Z. Write the balanced chemical equations for both reactions and state which substance is oxidized and reduced in the second reaction.

Answer:
Identification:
Metal X is Copper (Cu), which is reddish-brown.
Black compound Y is Copper(II) Oxide (CuO), formed when copper reacts with oxygen.
Liquid Z is Water (H_2O), formed when hydrogen reduces copper oxide.

Chemical Equations:
Reaction 1 (Heating in air): $2Cu + O_2$ gives $2CuO$
Reaction 2 (Reduction with hydrogen): $CuO + H_2$ gives $Cu + H_2O$

Oxidation and Reduction analysis for Reaction 2:
Substance Oxidized: H_2 (Hydrogen gains oxygen to become H_2O).
Substance Reduced: CuO (Copper oxide loses oxygen to become Cu).

Q2. A student stored a solution of iron(II) sulphate in a copper container. After a few days, she noticed that the copper container remained completely unchanged, but when her classmate stored a copper sulphate solution in an iron container, the container developed holes and a brown coating appeared. Explain this observation logically based on reactivity principles.

Answer:
This observation is explained by the reactivity series of metals, where iron is highly reactive compared to copper.
When iron(II) sulphate is stored in a copper container, no reaction takes place because copper is less reactive than iron and cannot displace iron from its salt solution. Thus, the copper container remains safe and unchanged.
When copper sulphate solution is stored in an iron container, a displacement

reaction occurs. Iron, being more reactive, displaces copper from the solution:
Fe + CuSO4 gives FeSO4 + Cu.
The iron container dissolves slowly at the contact points to form soluble iron sulphate, which creates holes in the vessel. The displaced copper metal deposits on the surface of the iron container as a reddish-brown coating. Therefore, copper sulphate solutions must never be stored in iron containers.

Q3. Why do we apply paint on iron articles? Explain the chemical principle behind it and state how it differs fundamentally from the method of galvanization in protecting iron when a scratch occurs on the protective surface.

Answer:
Paint is applied to iron articles to create a physical barrier that prevents iron from coming into direct contact with atmospheric oxygen and moisture, which are the two essential conditions required for rusting (corrosion).
Difference during a scratch:
When a painted iron surface gets scratched, the underlying iron becomes exposed to air and moisture, and rusting begins immediately at that spot, spreading under the remaining paint.
In contrast, galvanization involves coating iron with a layer of zinc. If a galvanized surface is scratched, the underlying iron still does not rust. This is because zinc is more reactive than iron and acts sacrificially. Zinc loses electrons preferentially to protect the iron from oxidation, maintaining protection even when the coating is broken.

CHAPTER 2: ACIDS, BASES AND SALTS

Q1. A baker forgot to add a specific white powder X while preparing dough for cakes. As a result, the cake obtained was flat, hard, and lacked its characteristic fluffy texture. When the baker realized the mistake, he heated powder X intensely and noticed it evolved a gas that turned lime water milky, leaving behind a white residue Y. Identify X and Y. Explain why adding X makes the cake fluffy and write the relevant chemical equations.

Answer:
Identification:
White powder X is Baking Powder, which contains Sodium Hydrogen Carbonate ($NaHCO_3$) mixed with a mild edible acid like tartaric acid.
White residue Y is Sodium Carbonate (Na_2CO_3).

Chemical Explanation:
When baking powder (X) is heated or mixed with water in the dough, sodium hydrogen carbonate reacts with the hydrogen ions from the edible acid to release carbon dioxide gas: $NaHCO_3$ + H positive ions gives Na positive ions + H_2O + CO_2.
The carbon dioxide gas bubbles out through the wet dough, causing it to rise and expand, which leaves behind small pores that make the cake soft and fluffy.

Chemical Equation for intense heating of pure X:
$2NaHCO_3$ when heated gives Na_2CO_3 + H_2O + CO_2

Q2. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid (HCl) is added to test tube A, while acetic acid (CH_3COOH) of the same concentration and volume is added to test tube B. In which test tube will the fizzing occur more vigorously and why? Support your answer with a logical chemical explanation.

Answer:
The fizzing will occur much more vigorously in test tube A containing hydrochloric acid (HCl).
Reasoning:
Fizzing occurs due to the evolution of hydrogen gas when magnesium reacts with an acid: Mg + 2H positive ions gives Mg2 positive ions + H_2 gas.
Hydrochloric acid is a strong acid that completely dissociates into its constituent ions in an aqueous solution, providing a high concentration of hydrogen ions. This high concentration causes the chemical reaction to proceed at a very fast rate, producing hydrogen gas rapidly.
Acetic acid is a weak acid that only partially dissociates in water, resulting in a low concentration of hydrogen ions. The reaction proceeds slowly, leading to a mild evolution of gas bubbles.

Q3. A compound Z is a constituent of many plaster casts used to immobilize fractured bones. When compound Z is left exposed to air or mixed with an excess of water, it sets into a hard solid mass W which cannot be used for plastering anymore. Identify Z and W. Write the chemical equation to show the conversion of Z into W and state the precaution that must be taken while storing Z.

Answer:
Identification:
Compound Z is Plaster of Paris, chemically known as Calcium Sulphate Hemihydrate ($CaSO4.0.5H2O$).
Compound W is Gypsum, chemically known as Calcium Sulphate Dihydrate ($CaSO4.2H2O$).

Chemical Equation:
$CaSO4.0.5H2O + 1.5H2O$ gives $CaSO4.2H2O$

Storage Precaution:
Plaster of Paris (Z) must be stored in completely airtight and moisture-proof containers. If it absorbs moisture from the atmosphere, it slowly undergoes hydration and turns into the hard crystalline solid mass Gypsum (W), rendering the plaster useless for medical or decorative applications.

CHAPTER 3: METALS AND NON-METALS

Q1. An element metal M is found in nature in the form of its sulphide ore $M2S$. Describe logically the steps involved in extracting pure metal M from this ore if the metal lies near the bottom of the reactivity series. Write the chemical equations for the reactions involved.

Answer:
Metals near the bottom of the reactivity series (like copper or mercury) are unreactive. Their sulphide ores can be reduced to the metallic state by heating alone in the presence of oxygen.

Extraction Steps:
Step 1: Roasting: The sulphide ore is heated strongly in the presence of excess

air to convert it into its metal oxide.
Equation: $2M_2S + 3O_2$ when heated gives $2M_2O + 2SO_2$

Step 2: Self-Reduction: The supply of air is reduced, and continued heating causes the remaining unchanged sulphide ore to react directly with the newly formed metal oxide, reducing it to pure metal.
Equation: $2M_2O + M_2S$ when heated gives $6M + SO_2$

Q2. When a piece of zinc metal is added to a solution of copper sulphate, the blue colour of the solution fades. However, when a piece of copper metal is added to a solution of zinc sulphate, no change is observed. Explain the reason behind these contrasting observations and write the chemical equation for the feasible reaction.

Answer:
These observations are governed by the displacement rule of metals based on their relative chemical reactivity.
Zinc is placed higher than copper in the reactivity series, meaning it has a stronger tendency to lose electrons and form ions. When zinc is added to blue copper sulphate solution, it easily displaces copper ions from the solution to form colorless zinc sulphate and solid copper precipitate.
Equation: $Zn + CuSO_4$ gives $ZnSO_4 + Cu$
Conversely, copper is less reactive than zinc. When copper is added to a zinc sulphate solution, it does not possess enough reducing power to displace the highly stable zinc ions from the solution. As a result, no chemical reaction takes place, and the solution remains unchanged.

Q3. Give reasons for the following observations:
(a) Ionic compounds have high melting and boiling points.
(b) Gold and platinum are found in nature in their native or free state.
(c) Aluminium is a highly reactive metal, yet it is widely used to manufacture cooking utensils.

Answer:
(a) Ionic compounds are made of oppositely charged ions held together by extremely strong electrostatic forces of attraction. A huge amount of thermal energy is required to break these strong inter-ionic bonds and overcome the crystal lattice structure, resulting in high melting and boiling points.

(b) Gold and platinum are noble metals situated at the bottom of the reactivity series. They are chemically inert and do not react with atmospheric oxygen, moisture, carbon dioxide, or acids under normal conditions, allowing them to exist in their elemental free state.
(c) When aluminium is exposed to air, it reacts quickly with oxygen to form a thin, tough, and highly stable layer of aluminium oxide (Al_2O_3) on its surface. This oxide layer acts as a protective shield that completely seals the underlying metal from further contact with air or water, preventing corrosion and making it safe for cooking.

CHAPTER 4: CARBON AND ITS COMPOUNDS

Q1. An organic compound A having the molecular formula $C_2H_4O_2$ reacts with sodium metal to evolve a colorless and odorless gas B which burns with a pop sound. When compound A is heated with ethanol in the presence of a few drops of concentrated sulphuric acid, a sweet-smelling organic compound C is formed. Identify A, B, and C. Write the balanced chemical equations for both chemical processes.

Answer:
Identification:
Organic compound A is Ethanoic Acid (CH_3COOH), commonly called acetic acid.
Gas B is Hydrogen gas (H_2).
Sweet-smelling compound C is Ethyl Ethanoate ($CH_3COOC_2H_5$), which belongs to the ester functional group.

Chemical Equations:
Reaction 1 (With Sodium metal): $2CH_3COOH + 2Na$ gives $2CH_3COONa + H_2$ gas
Reaction 2 (Esterification reaction): $CH_3COOH + C_2H_5OH$ in the presence of concentrated H_2SO_4 gives $CH_3COOC_2H_5 + H_2O$

Q2. Explain logically why a hard water sample does not form a rich lather easily when treated with regular soap, but forms an insoluble curdy precipitate instead. How does switching to a synthetic detergent resolve this issue chemically?

Answer:
Hard water contains high concentrations of soluble calcium and magnesium salts. When regular soap (which consists of sodium salts of long-chain fatty acids) is added to hard water, the sodium ions in the soap molecule are immediately displaced by the calcium and magnesium ions present in the water.
This reaction forms calcium and magnesium salts of fatty acids, which are completely insoluble in water and separate out as a greyish, curdy precipitate called scum:
2Soap + Ca2 positive ions gives Scum precipitate + 2Na positive ions
A large amount of soap is wasted in precipitating these ions before any lather can form.

Synthetic detergents contain sodium salts of long-chain benzene sulphonates or alkyl sulphates. The calcium and magnesium salts of these detergent compounds are highly soluble in water. Consequently, detergents do not form an insoluble precipitate with hard water ions and create a rich lather easily in both soft and hard water.

Q3. What is a homologous series of carbon compounds? State any two distinct characteristic properties of a homologous series. Explain why the melting and boiling points of alkanes show a regular, gradual increase as the molecular mass increases within the series.

Answer:
A homologous series is a group or family of organic carbon compounds that share the same functional group, exhibit similar chemical properties, and where each successive member differs from the preceding one by a specific fixed group, which is a CH2 unit (corresponding to a mass difference of 14 unified mass units).

Two characteristic properties:

1. All members of a homologous series can be represented by a single common general formula (for example, CnH2n+2 for alkanes).
2. The members show a regular gradation in their physical properties such as density, solubility, melting point, and boiling point.

Reason for melting/boiling point increase:
As the molecular mass increases within the series, the length of the carbon chain grows. This increases the total surface area of the molecule, which increases the strength of the intermolecular Van der Waals forces of attraction between adjacent molecules. Since stronger forces require more thermal energy to break, the melting and boiling points increase gradually.
