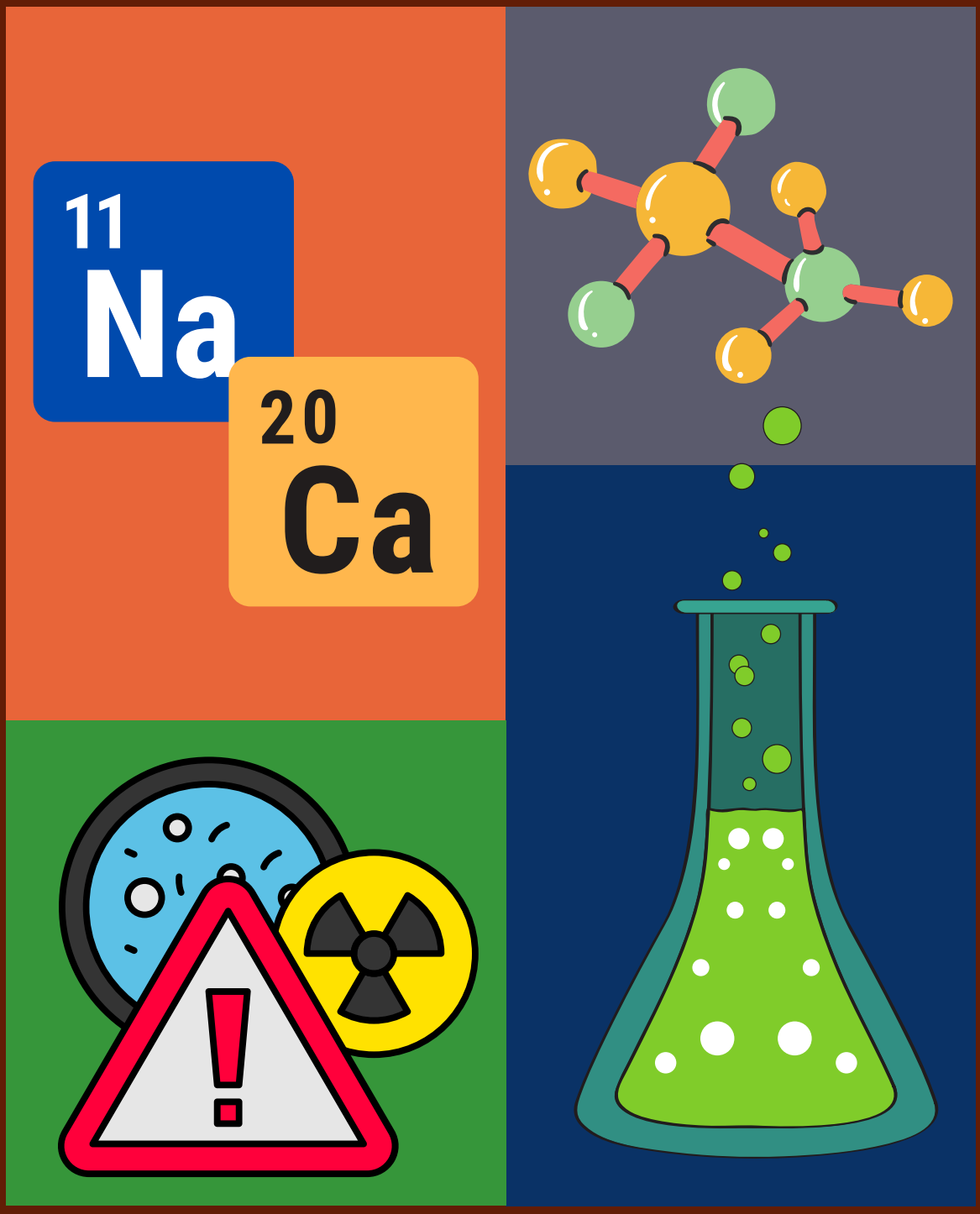

CLASS 10 NOTES

SCIENCE

Chemical Reaction

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Chemical Reaction:

It's a process where substances combine to create a new substance with unique properties.

Chemical Equation:

A chemical equation is the symbolic representation of a chemical reaction. Symbols and formulae of the reactants and products are used for the same.

Example: Zinc metal reacts with dilute sulphuric acid to form zinc sulfate and hydrogen gas.

Zinc+Sulphuric acid -----> Zinc sulfate+Hydrogen

$Zn(s) + H_2SO4(aq) \text{-----} > ZnSO_1\ (aq) + H2(g)$

Why is magnesium rubbed with sandpaper before burning?

Magnesium is a type of metal that reacts easily. When it's exposed to the air, it reacts with oxygen and creates a layer of magnesium oxide on its surface. That's why, before you burn it, you need to clean it with sandpaper to get rid of the oxide layer.

$2Mg(s) + O2(g) \text{------} > 2MgO(s)$

Balanced chemical equation:

A balanced chemical equation has an equal number of atoms of each element in the reactant and product side. The chemical equation is balanced to satisfy the law of conservation of mass in a chemical reaction.

Example: $Fe+H_2O \rightarrow Fe_3O_4+H_2$ **(Unbalanced)**

$3Fe+4H_2O \rightarrow Fe_3O_4+4H_2$ **(Balanced)**

Characteristics of chemical reactions:

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1. **Formation of a New Substance:**
   - Chemical reactions result in the formation of one or more new substances with different properties than the original substances.

2. **Change in Color:**
   - The color of substances involved in a chemical reaction may change, indicating a chemical change.
3. **Evolution of Gas:**
   - Gas production, such as bubbles or effervescence, is a common indicator of a chemical reaction.
4. **Evolution or Absorption of Heat:**
   - Chemical reactions often involve the release or absorption of heat, leading to temperature changes.
5. **Formation of a Precipitate:**
   - A precipitate, a solid that forms from a liquid mixture may appear due to a chemical reaction.
6. **Irreversibility:**
   - Many chemical reactions are irreversible, meaning it is challenging or impossible to revert the products to the original reactants.
7. **Change in State:**
   - Changes in the state of matter, such as solid to liquid or gas, can occur during chemical reactions.
8. **Change in Energy:**
   - Chemical reactions involve a change in energy, which can be **exothermic (release of energy)** or **endothermic (absorption of energy)**.

Activity 1.2

- Take lead nitrate solution in a test tube.
- Add potassium iodide solution to this.
- What do you observe?

When you add potassium iodide solution to lead nitrate solution in a test tube, a yellow precipitate of lead iodide (PbI_2) forms. This reaction can be represented as:

$$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$

Observation:

1. Formation of a yellow precipitate of lead iodide.
2. The color of the solution changes from colorless to yellow due to the presence of the lead iodide precipitate.

Explanation:

The yellow color indicates the formation of lead iodide, which is sparingly soluble in water and forms a precipitate. The reaction involves the exchange of ions between lead nitrate and potassium iodide, leading to the formation of lead iodide.

Combination Reaction:

Definition: A combination reaction, also known as a synthesis or addition reaction, is a chemical reaction in which two or more reactants combine to form a single product.

General Form: $A+B \rightarrow AB$

Examples:

1. Formation of Water **(Hydrogen and Oxygen):**

$$2H_2+O_2 \rightarrow 2H_2O$$

In this reaction, hydrogen gas (H_2) combines with oxygen gas (O_2) to form water (H_2O)

2. Formation of Calcium Oxide **(Calcium and Oxygen):**

$$2Ca+O2 \rightarrow 2CaO$$

Calcium (Ca) combines with oxygen gas $O2$ to form calcium oxide CaO

Decomposition Reaction:

Definition: A decomposition reaction is a chemical reaction in which a single reactant breaks down into two or more products.

General Form: $AB \rightarrow A+B$

Examples:

1. **Decomposition of Water (Electrolysis):**

$$2H2O \rightarrow 2H2+O2$$

In the process of electrolysis, water H_2O decomposes into hydrogen gas H_2 and oxygen gas O_2.

2. **Decomposition of Sodium Bicarbonate (Baking Soda):**

$$2NaHCO_3 \rightarrow Na_2CO_3+H_2O+CO_2$$

Baking soda $NaHCO_3$ decomposes when heated to form sodium carbonate Na_2CO_3 water H_2O and carbon dioxide gas CO_2

Activity 1.5

- Take about 2 g ferrous sulphate crystals in a dry boiling tube.
- Note the colour of the ferrous sulphate crystals.
- Heat the boiling tube over the flame of a burner or spirit lamp as shown in Fig. 1.4.
- Observe the colour of the crystals after heating.

Explanation:

Observation:

- Initially, ferrous sulphate crystals are pale green.
- Upon heating, the crystals turn into a white powder.

Explanation:

- The color change is due to the removal of water molecules, leading to the formation of anhydrous ferrous sulphate ($FeSO_4$).

Question:

- Why does the color change occur when ferrous sulphate crystals are heated?

This color change is a result of the dehydration process, indicating the removal of water of crystallization.

- **Thermal Decomposition:**

Definition: Thermal decomposition is a chemical reaction in which a substance breaks down into simpler substances when heated.

Example: $2H_2O_2 \rightarrow 2H_2O + O_2$

Key Concept: The process involves the breakdown due to the absorption of heat, leading to the formation of new compounds or elements.

Activity 1.6

- Take about 2 g lead nitrate powder in a boiling tube.
- Hold the boiling tube with a pair of tongs and heat it over a flame, as shown in Fig. 1.5.
- What do you observe? Note down the change, if any.

Explanation:

Observation:

- **Change in Color and Appearance:** The lead nitrate powder initially appears white. Upon heating, it decomposes, and a brown gas (nitrogen dioxide) is evolved. The residue in the boiling tube turns yellow, indicating the formation of lead(II) oxide.

Explanation:

- **Chemical Reaction:**

$2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

Lead nitrate decomposes upon heating to form lead(II) oxide, nitrogen dioxide, and oxygen.

- **Electrolytic Decomposition (Electrolysis):**

Definition: Electrolysis is the process where an electric current is passed through an electrolyte, causing it to decompose.

Process:

- Ions migrate to electrodes.
- At the anode, oxidation occurs.
- At the cathode, reduction occurs.
- Electrolyte breaks down into its constituents.

Example: Electrolysis of water produces hydrogen and oxygen:

$$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$$

Applications: Widely used in industry for metal extraction and chemical production.

Photochemical Decomposition (Photosynthesis):

Definition: Photosynthesis is a process in which plants use light energy to convert carbon dioxide and water into glucose and oxygen.

Process:

- Chlorophyll absorbs light, facilitating the conversion of CO_2 and H_2O.

Results in the production of glucose and oxygen.

Equation:

$$6CO_2 + 6H_2O + \text{Light energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

Importance: Crucial for plant growth and oxygen release.

Activity 1.8

- Take about 2 g silver chloride in a china dish.
- What is its colour?
- Place this china dish in sunlight for some time (Fig. 1.7).
- Observe the colour of the silver chloride after some time.

Observation:

- **Initial Color:** Silver chloride in the china dish is white.

After Sunlight Exposure:

- **Color Change:** Silver chloride gradually changes to a grayish color upon exposure to sunlight.

Explanation:

- **Chemical Reaction:**

$2AgCl \xrightarrow{\text{Sunlight}} 2Ag + Cl_2$

Sunlight causes the photodecomposition of silver chloride into silver and chlorine.

This color change is evidence of the photochemical decomposition of silver chloride in the presence of sunlight.

Displacement Reaction:

Definition: A displacement reaction is a chemical reaction in which a more reactive element displaces a less reactive element from its compound.

Types:

1. Single Displacement:

$$A + BC \rightarrow AC + B$$

Example: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

2. Double Displacement:

$$AB + CD \rightarrow AD + BC$$

Example: $NaOH + HCl \rightarrow NaCl + H_2O$

In both types, the more reactive element displaces the less reactive one, leading to the formation of new compounds.

Activity 1.9

- Take three iron nails and clean them by rubbing with sand paper.
- Take two test tubes marked as (A) and (B). In each test tube, take about 10 mL copper sulphate solution.
- Tie two iron nails with a thread and immerse them carefully in the copper sulphate solution in test tube B for about 20 minutes [Fig. 1.8 (a)]. Keep one iron nail aside for comparison.
- After 20 minutes, take out the iron nails from the copper sulphate solution.
- Compare the intensity of the blue colour of copper sulphate solutions in test tubes (A) and (B), [Fig. 1.8 (b)].
- Also, compare the colour of the iron nails dipped in the copper sulphate solution with the one kept aside [Fig. 1.8 (b)].

Explanation:

Experiment Summary:

1. **Prepare Nails:**
   - Clean three iron nails.
2. **Setup Test Tubes:**
   - Fill two test tubes (A and B) with blue copper sulfate solution.
3. **Immerse Nails:**
   - Dip two nails in test tube B; keep one aside.
4. **After 20 Min:**
   - Remove nails from test tube B.
5. **Compare:**
   - Check color change in test tubes and nails.

Explanation:

- Illustrates iron displacing copper in copper sulfate, causing color changes.

Activity 1.10

- Take about 3 mL of sodium sulphate solution in a test tube.
- In another test tube, take about 3 mL of barium chloride solution.
- Mix the two solutions (Fig. 1.9).
- What do you observe?

Explanation:

Observation:

Upon mixing sodium sulfate solution with barium chloride solution, a white precipitate forms.

Explanation:

Chemical Reaction:

$$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 \downarrow + 2NaCl$$

Outcome:

- Formation of barium sulfate ($BaSO_4$), a white insoluble precipitate.

Conclusion:

The observed white precipitate indicates the occurrence of a double displacement reaction, leading to the formation of the insoluble compound barium sulfate.

#Secret Questions:

1. Write the balanced chemical equation for the reactions that take place during respiration. Identify the type of combination reaction that takes place during this process and justify the name. Give one more example of this type of reaction. **[CBSE 2012]**

Solution:

(i) The carbohydrates that we take in our food are oxidized to carbon dioxide and water.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

The carbon of carbohydrates and oxygen combine to form CO_2.

(ii) It is an exothermic combination reaction.

(iii) Decomposition of vegetable matter into compost is another example of this type of reaction.

2. Translate a balanced chemical equation with state symbols for the following reactions:

i) Solutions of Barium chloride and Sodium sulfate in water react to give insoluble Barium sulfate and a solution of Sodium chloride.

ii) Sodium hydroxide solution in water interacts with hydrochloric acid to produce Sodium chloride solution and water.

iii) Hydrogen gas combines with nitrogen to form ammonia.

iv) potassium metal reacts with water to give potassium hydroxide and hydrogen gas.

Solution: i) BaCl2 + Na2SO4 → BaSO4 + 2NaCl

ii) NaOH + HCl → NaCl + H2O

iii) 3H2 + N2 2NH3

iv) 2K + 2H2O 2KOH + H2

Oxidation: E.M.A

Definition: Oxidation is a chemical process in which a substance loses electrons, increases its oxidation state, or undergoes an increase in the number of oxygen atoms.

Key Points:

Electron Loss: In oxidation, a substance loses electrons.

Oxidation State: The oxidation state of the substance increases.

Combination with Oxygen: Oxidation can involve the addition of oxygen to a substance.

Example:

$$2Fe + 3O_2 \rightarrow 2Fe_2O_3$$

Iron undergoes oxidation by combining with oxygen to form iron(III) oxide.

Importance: Oxidation is a fundamental process in various chemical reactions, including combustion and corrosion.

Activity 1.11

- Heat a china dish containing about 1 g copper powder (Fig. 1.10).
- What do you observe?

Explanation

Observation:

- Upon heating the china dish containing copper powder, the color of the copper powder changes.

Explanation:

- **Chemical Reaction:**

  $2Cu + O_2 \rightarrow 2CuO$

  Copper reacts with oxygen in the air to form copper oxide (CuO).
- **Outcome:**
  - The color change indicates the formation of copper oxide.
  - Initially, copper powder is red-brown, and after heating, it turns black due to t presence of copper oxide.

Reduction: E.M.A

Definition: Reduction is a chemical process in which a substance gains electrons, decreases its oxidation state, or undergoes a decrease in the number of oxygen atoms.

Key Points:

Electron Gain: In reduction, a substance gains electrons.

Oxidation State: The oxidation state of the substance decreases.

Removal of Oxygen: Reduction can involve the removal of oxygen from a substance.

Example:

$CuO + H_2 \rightarrow Cu + H_2O$

Copper oxide undergoes reduction by gaining hydrogen to form copper and water.

Redox Reaction: E.M.A

Definition: A redox (reduction-oxidation) reaction is a chemical process in which one substance undergoes reduction (gains electrons) while another undergoes oxidation (loses electrons).

Key Points:

Oxidation: Loss of electrons or an increase in oxidation state.

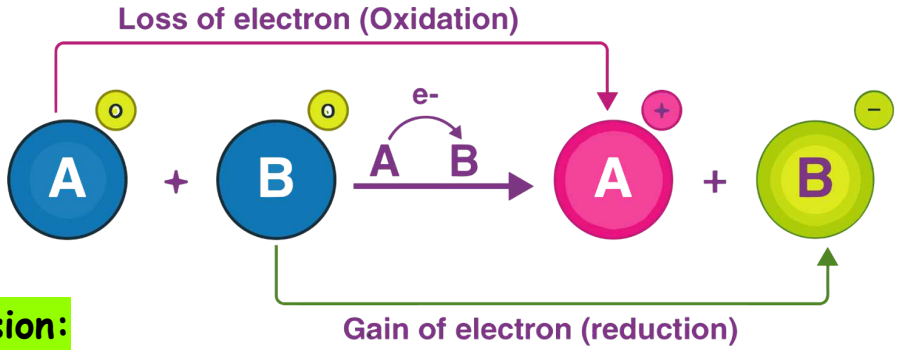
Reduction: Gain of electrons or a decrease in oxidation state.

Electron Transfer: Involves the transfer of electrons between reactants.

Example:

$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

Zinc undergoes oxidation, and copper ions undergo reduction.



1. **Corrosion:**

Definition: Corrosion is the gradual degradation of metals due to their reaction with atmospheric oxygen, moisture, or other chemicals.

Effect of Oxidation: Oxidation of metals, particularly iron, leads to the formation of metal oxides, commonly known as rust.

Impact: Corrosion weakens the metal structure, affecting its strength and durability.

Prevention: Coating metals with protective layers (e.g., paint or galvanization) helps prevent direct exposure to oxygen and moisture, reducing the risk of corrosion.

2. **Rancidity:**

Definition: Rancidity is the development of undesirable odors and flavors in fats and oils due to their exposure to oxygen.

Effect of Oxidation: Oxidation of the unsaturated fatty acids in fats and oils leads to the formation of rancid compounds.

Impact: Rancidity imparts unpleasant tastes and smells to food products, making them unpalatable and reducing their shelf life.

Prevention: Adding antioxidants, storing foods in airtight containers, and refrigerating can help slow down or prevent the oxidation process and, consequently, rancidity.

#Top Seven Questions:

1. Why is respiration considered an exothermic reaction? Explain.

Solution: Respiration is the process of burning food in the living body to produce energy. Respiration is considered an exothermic chemical reaction because glucose oxidation occurs in the respiration process, which creates a large amount of heat energy consumed in the form of ATP. During respiration, we inhale oxygen from the atmosphere, which reacts with glucose in our body cells to produce carbon dioxide and water. It is explained in the following chemical equation.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O + \text{energy (ATP)}$$

2. Explain the following in terms of the gain of oxygen with two examples each.

(a) Oxidation

(b) Reduction

Solution: (a) In a chemical reaction when oxygen is added to the element to form its respective oxide, it is the element being oxidized. For Example:

$4Na(s) + O2(g) \rightarrow 2Na2O(s)$

$H2S + O2 \rightarrow H2O + SO2$

(b) In a chemical reaction, it is said to be reduced when oxygen is removed from the compound. For Ex.,:

so $CuO(s) + H2(g) \rightarrow Cu(s) + H2O(l)$

$2HgO \rightarrow 2Hg + O2(g)$

3. A shiny brown-colored element 'X' on heating in the air becomes black. Name the element 'X' & the black-coloured compound formed.

Solution: The shiny brown-colored element is Copper metal (Cu). If the metal is heated in air, it interacts with atmospheric oxygen to form copper oxide. Therefore, the black-colored compound is copper oxide.

$2Cu(s) + O2(g) \rightarrow 2CuO(s)$

4. Why do we store silver chloride in dark-colored bottles?

Solution: Silver chloride is the best example of a light-sensitive chemical compound, and the reaction is an example of a photolytic decomposition reaction. It reacts with light very fast and loses its property by forming chlorine gas and silver. So avoid this silver chloride in dark-colored bottles.

5. Write one equation each for decomposition reactions in which energy is supplied in the form of heat, light, or electricity.

Solution: **(a) Thermal decomposition reaction (Thermolysis)**

Decomposition of potassium chlorate: If heated strongly, potassium chlorate decomposes into potassium chloride and oxygen molecules.

This reaction is commonly used for the synthesis of oxygen molecules.

$$2KClO3 + heat \rightarrow 2KCl + 3O2$$

(b) Electrolytic decomposition reaction (Electrolysis)-

Decomposition of sodium chloride NaCl: On passing electricity through molten sodium chloride NaCl, it decomposes into sodium and chlorine.

$$2NaCl—- 2Na + Cl2 \quad \text{(in Electrolysis)}$$

(c) Photodecomposition reaction (Photolysis)

Decomposition of Hydrogen peroxide- In the presence of light, hydrogen peroxide decomposes into water and oxygen molecules.

$$2H2O2 + light\ H2O + O2$$

6. What is the difference between displacement and double displacement reactions? Write relevant equations for the above.

Solution: A displacement reaction occurs when a more reactive substance replaces a less reactive substance from its salt solutions. A double displacement reaction occurs when a mutual exchange of metal ions happens between 2 compounds.

In this displacement reaction, only a single displacement occurs, whereas in the double displacement reaction, as the name suggests, two displacements occur between the molecules.

Example: Displacement reaction

$$Mg + 2HCl \rightarrow MgCl2 + H2$$

Double displacement reaction

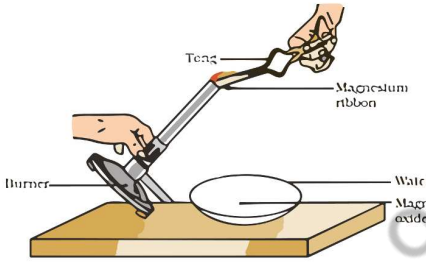
$$2KBr + BaI2 \rightarrow 2KI + BaBr2$$

7. Zinc liberates hydrogen gas when reacted with dilute hydrochloric acid, whereas copper does not. Explain why?

Solution: Zinc is more reactive than copper as Zinc is placed above hydrogen, and copper is placed below hydrogen in the activity series of metals. Thus, zinc liberates hydrogen gas when reacted with dilute hydrochloric acid, whereas copper does not.

Competency-Based Question:

1) Clean a magnesium ribbon about 2 cm long by rubbing it with sandpaper. Hold it with a pair of tongs. Burn it using a spirit lamp or burner and collect the ash so formed in a watch-glass



1. Magnesium ribbon needs to be rubbed before burning because it has a coating on its surface.

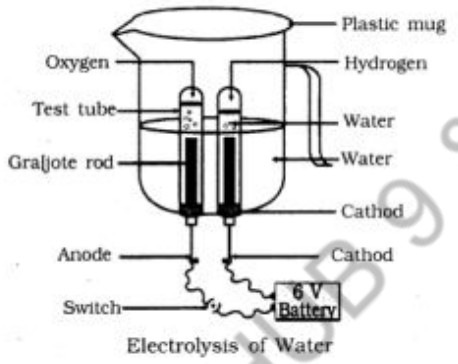
✔A. basic magnesium carbonate
B. basic magnesium oxide
C. basic magnesium sulphide
D. basic magnesium chloride

2. What is the colour of magnesium ribbon?
A. White
B. Black
✔C. Grey
D. Yellow

3. What is the chemical name of the powder obtained in the activity?
A. magnesium carbonate
✔B. magnesium oxide
C. magnesium sulphide
D. magnesium chloride

4. Which compound is formed when the powder obtained reacts with water?
A. Magnesium sulphate
B. Magnesium oxide
C. Magnesium carbonate
D. Magnesium hydroxide

2. Take a plastic mug, drill two holes at its base and insert carbon electrodes. Connect these electrodes to a 6 volt battery. Fill the mug with water such that the electrodes are immersed. Add a few drops of dilute sulphuric acid to the water. Take two test tubes filled with water and invert them over the two carbon electrodes. Switch on the current and leave the apparatus undisturbed for some time.



Electrolysis of Water

1. What is the ratio in which hydrogen and oxygen are present in water by
volume?
A. 1:2 B. 1:1 C. 2:1 D. 1:8

2. Which electrodes are used in this activity?
A. Graphite B. Diamond C. Copper D. Coke

3. Where is hydrogen gas collected?
A. Anode B. Cathode C. At both electrodes D. Hydrogen gas is not evolved in this activity

4. Which of the following is an endothermic process?
A. Dilution of sulphuric acid B. Condensation of water vapours
C. Respiration in human beings D. Electrolysis