CLASS 10 NOTES

SCIENCE

Chemical Reactions & Equations

PRASHANT KIRAD

Chemical Reaction:

- The transformation of chemical substance into another chemical substance is known as Chemical Reaction. e.g.: Rusting of iron, the setting of milk into curd, digestion of food, respiration, etc.
- Chemical changes indicate that a chemical reaction has occurred.

Characteristics of chemical reactions:
Formation of new substances with different properties, Change in color, Evolution of gas, Evolution or absorption of heat, Formation of a precipitate, Irreversibility of many chemical reactions, Change in state of matter, Change in energy.

Chemical Equation:

- Representation of chemical reaction using symbols and formulae of the substances is called Chemical Equation.

Example: $A + B \rightarrow C + D$

Reactant Product

Magnesium + Oxygen → Magnesium oxide

$Mg + O_2 \rightarrow MgO$

Activity 1.1

CAUTION: This Activity needs the teacher's assistance. It would be better if students wear eye protection.

- 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 as shown in Fig. 1.1. Burn the magnesium ribbon keeping it as far as possible from your eyes.
- What do you observe?

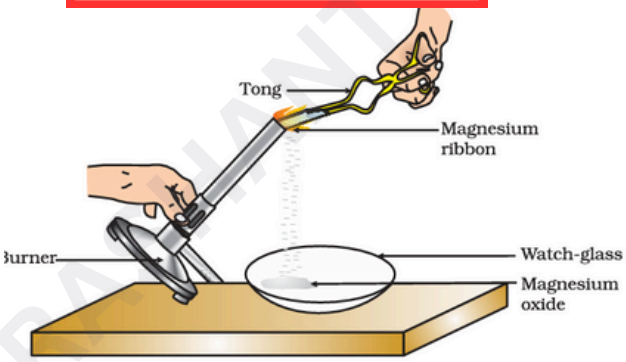


Figure 1.1
Burning of a magnesium ribbon in air and collection of magnesium oxide in a watch-glass

Magnesium ribbon burns with a **dazzling white flame** and changes into a **white powder**. This powder is **magnesium oxide**. It is formed due to the reaction between magnesium and oxygen present in the air

Magnesium is rubbed with sandpaper to remove the oxide layer, allowing it to burn more easily.

Balanced Chemical Equation:

- A balanced chemical equation has an equal number of atoms of each element in the reactant and product side.
- Law of Conservation of Mass: **Mass of reactants = Mass of products.**

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

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

number of atoms of each element in reactants = number of atoms of each element in products

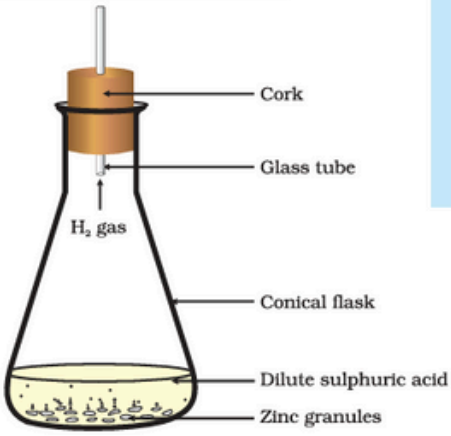
Activity 1.2

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

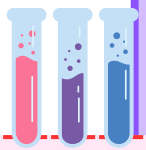
"Experiment ka funda":
Take some lead nitrate solution in a test tube or beaker and add potassium iodide solution. A **yellow precipitate** of lead iodide forms immediately, and the solution changes color from **colorless to yellow**.

Activity 1.3

- Take a few zinc granules in a conical flask or a test tube.
- Add dilute hydrochloric acid or sulphuric acid to this (Fig. 1.2).
  CAUTION: Handle the acid with care.
- Do you observe anything happening around the zinc granules?
- Touch the conical flask or test tube. Is there any change in its temperature?



Formation of hydrogen gas by the action of dilute sulphuric acid on zinc



"Experiment ka funda":
Take some zinc granules in a conical flask and add sulfuric acid. **Bubbles of hydrogen gas** will form around the zinc metal. We verify it's hydrogen gas because the bubbles burn with a **popping sound** when passed through a soap solution. Additionally, the flask becomes **hot** to the touch, indicating that the reaction releases heat along with the gas.

Balancing Chemical Reaction:

1. Identify the unbalanced equation:

$$Fe + H_2O \rightarrow Fe_3O_4 + H_2$$

2. List the number of atoms of different elements in the unbalanced equation:

Element	Number of atoms in reactants (LHS)	Number of atoms in products (RHS)
Fe	1	3
H	2	2
O	1	4

3. Start balancing the compound (reactant of product) that contains the maximum number of atoms. In that compound, balance the element with the maximum number of atoms

Atoms of oxygen	In reactants	In products
(i) Initial	1 (in H_2O)	4 (in Fe_3O_4)
(ii) To balance	1×4	4

⇢ $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

(Balanced)

"Balancing ki practice jyaada se jyaada karo"
- Prashant Bhaiya

More Questions to practice:

1. $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$.
2. $CH_4 + O_2 \rightarrow CO_2 + H_2O$
3. $Fe_2O_3 + C \rightarrow Fe + CO_2$
4. $N_2 + H_2 \rightarrow NH_3$

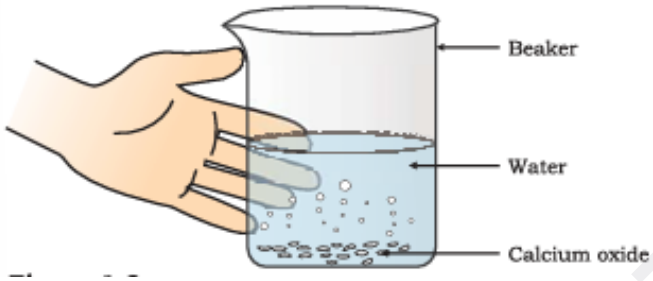
A solution of slaked lime $Ca(OH)_2$ is used for whitewashing walls. It reacts with carbon dioxide in the air to form calcium carbonate $CaCO_3$, which gives the walls a shiny finish after two to three days. Marble also has the formula $CaCO_3$. The reaction is:
$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$

TYPES OF CHEMICAL REACTIONS:

1. Combination Reactions: two or more reactants combine to form single products.

A + B → AB

1. Formation of Water : $2H_2 + O_2 \rightarrow 2H_2O$
2. Formation of Calcium Oxide : $CaO + H_2O \rightarrow Ca(OH)_2$ (slaked lime)



Activity 1.4

- Take a small amount of calcium oxide or quick lime in a beaker.
- Slowly add water to this.
- Touch the beaker as shown in Fig. 1.3.
- Do you feel any change in temperature?

"Experiment ka funda":
Take a small amount of calcium oxide (quick lime) in a beaker and slowly add water to it. Touch the outside of the beaker, and you will feel it getting **hot**. This is because calcium oxide reacts vigorously with water to produce slaked lime (calcium hydroxide), releasing a large amount of heat.

Reactions that release heat along with the formation of products are called **exothermic** chemical reactions, while those that absorb heat are known as **endothermic** reactions.

2. Decomposition Reactions: a single reactant decomposes to form two or more products.

AB → A + B

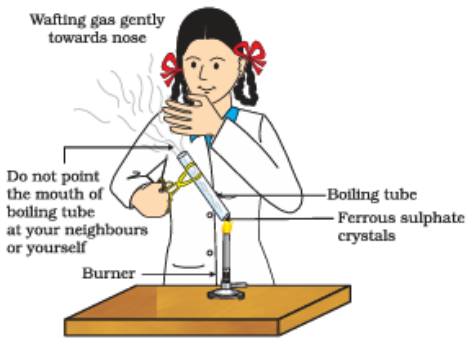
1. Decomposition of Calcium Carbonate : $CaCO_3(s) \rightarrow CaO(S) + CO_2$
2. Decomposition of Ferrous Sulphate :

$2FeSO_4 \rightarrow Fe_2O_3 + SO_2 + SO_3$

Saari activities acche se dekhna, important h! Direct questions aa jaate h

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.



"Experiment ka funda":
Take about 2 grams of Ferrous Sulphate Crystals in a DRY Boiling Tube. They are originally **green** in color. Heat the boiling tube over a burner, and you will observe the magic. The **green color** changes to **white** and then finally a **brown solid** is formed, which is ferric oxide. Along with the color change, the **smell of burning sulphur** is also noticeable

- **Thermal Decomposition Reactions: heat-induced breakdown.**

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.

$$2Pb(NO_3)_2(s) \xrightarrow{Heat} 2PbO(s) + 4NO_2(g) + O_2(g)$$
(Lead nitrate) (Lead oxide) (Nitrogen dioxide) (Oxygen)

"Experiment ka funda":
Take 2 grams of lead nitrate powder in a boiling tube. Heat it over a burner. **Brown fumes of nitrogen dioxide gas** are released, filling the tube. Holding a glowing splinter over the tube causes it to catch fire, indicating the presence of **oxygen gas**. After the reaction, **yellow** lead monoxide solid remains in the tube, which appears **reddish-brown** when hot and **yellow** when cold.

Electrolytic Decomposition - heat-induced breakdown.

Activity 1.7:

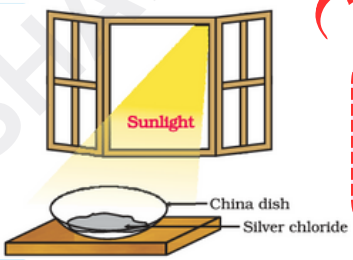
- Hydrogen (cathode) will produce a popping sound when a burning candle is brought close.
- Oxygen (anode) will make the flame of the candle burn brighter.

Photolytic Decomposition - light-induced decomposition.

$$2AgCl(s) \xrightarrow{Sunlight} 2Ag(s) + Cl_2(g)$$

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.



"Experiment ka funda":
White silver chloride turns **grey** in sunlight. This is due to the decomposition of silver chloride into silver and chlorine by light.

3. Displacement Reactions: chemical reaction in which a more reactive element displaces a less reactive element from its compound.

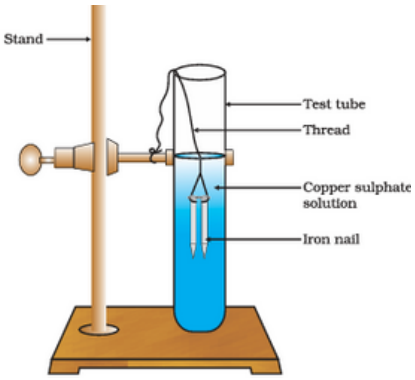
Single Displacement: $A+BC \rightarrow AC+B$

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

Reactivity series of metals

K	Potassium	Most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
Zn	Zinc	Reactivity decreases
Fe	Iron	
Pb	Lead	
H	Hydrogen	
Cu	Copper	
Hg	Mercury	
Ag	Silver	
Au	Gold	Least reactive

Trick to remember reactivity reactivity series:
Katrina ne car mangi alto zen ferari phir bhi haye cu mili silver audi



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)].

"Experiment ka funda":
In this reaction, the iron nail turns **brownish** and the **blue color** of the copper sulphate solution fades because iron displaces copper from copper sulphate ($CuSO_4$) in a displacement reaction. The original deep blue color of the solution fades to **light green**, and the iron nail becomes covered with a **red-brown layer of copper**.

$$Fe(s) + CuSO_4(aq) \rightarrow \underset{\text{(Copper sulphate)}}{} \quad \underset{\text{(Iron sulphate)}}{FeSO_4(aq)} + Cu(s)$$

4. Double Displacement Reaction:

Those reactions in which two ionic compounds in the solution react by exchange of their ions to form new compounds are called double displacement reactions.

Double Displacement: AB+CD→AD+BC

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

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?

"Experiment ka funda":
Take 3 mL of sodium sulphate solution in a test tube and 3 mL of barium chloride solution in another. Add the barium chloride solution to the sodium sulphate solution. **A white precipitate** will form in the test tube

$$\underset{\text{(Sodium sulphate)}}{Na_2SO_4(aq)} + \underset{\text{(Barium chloride)}}{BaCl_2(aq)} \rightarrow \underset{\text{(Barium sulphate)}}{BaSO_4(s)} + \underset{\text{(Sodium chloride)}}{2NaCl(aq)}$$

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 **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) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$
ii) $NaOH + HCl \rightarrow NaCl + H_2O$
iii) $3H_2 + N_2 \rightarrow 2NH_3$
iv) $2K + 2H_2O \rightarrow 2KOH + H_2$

5. Oxidation Reactions:

Oxidation: If a substance gains oxygen or loses hydrogen during a reaction, it is said to be oxidized.

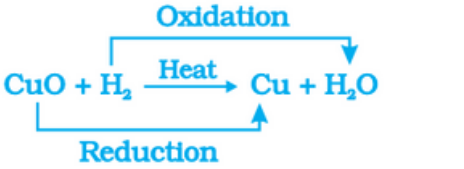
Reduction: If a substance loses oxygen or gains hydrogen during a reaction, it is said to be reduced.

Redox Reaction: In a reaction where one reactant gets oxidized while the other gets reduced, it is called an oxidation-reduction reaction or redox reaction.

Activity 1.11

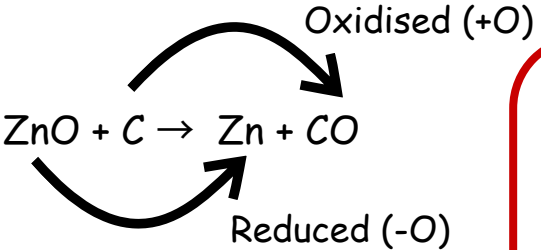
- Heat a china dish containing about 1 g copper powder (Fig. 1.10).
- What do you observe?

$$2Cu + O_2 \xrightarrow{\text{Heat}} 2CuO$$

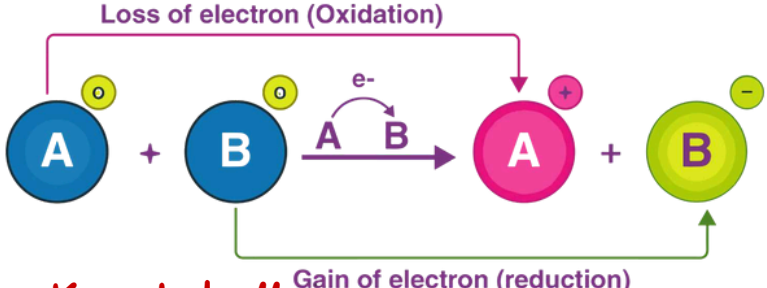


"Experiment ka funda":
When about 1 gram of red-brown copper powder is heated in a china dish, it forms a black substance, which is copper oxide (CuO). This black coating is a result of the oxidation of copper to copper oxide. To turn the black coating back to reddish-brown, hydrogen gas can be passed over the heated copper oxide, causing a reverse reaction that produces copper.

"Ox"idation: "Ox"ygen dost (gaining oxygen) or Hydrogen dushman (losing hydrogen).
"Re"duction: Oxygen dushman (losing oxygen) or "Hy"drogen dost (gaining hydrogen). { Hy re! }



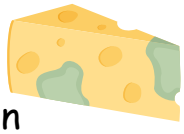
Extra Knowledge!!



EFFECTS OF OXIDATION REACTIONS IN EVERYDAY LIFE?

Corrosion: the process by which metals are gradually destroyed by chemical reactions with substances in their environment, such as moisture and acids. This often results in the formation of an oxide or other compound on the metal's surface.

- **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.
- **Examples:** Rusting of iron, Tarnishing of silver, Green coating on copper



Rancidity: the spoilage of fats and oils in food, leading to unpleasant taste and smell. This happens due to the oxidation of fats and oils when exposed to air.

- **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
- **Examples**: Spoiled butter, Old cooking oil, Stale chips

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

Answer: Respiration is the process of breaking down food in the living body to produce energy. Respiration is considered an exothermic chemical reaction because the oxidation of glucose occurs during the process, releasing a large amount of energy, which is captured 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, water, and energy. The reaction is represented by the following chemical equation:

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

2. Explain the following in terms of the gain of oxygen with two examples each.
(a) Oxidation (b) Reduction.

Answer: (a) Oxidation: In a chemical reaction, when oxygen is added to an element or compound to form its oxide, the element or compound is being oxidized. For example:

$4Na(s)+O_2(g)\rightarrow 2Na_2O(s)$

$H_2S(g)+O_2(g)\rightarrow H_2O(l)+SO_2(g)$

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

$CuO(s)+H_2(g)\rightarrow Cu(s)+H_2O(l)$

$2HgO(s)\rightarrow 2Hg(l)+O_2(g)$

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

Answer: 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.

$2Cu(s) + O_2(g) \rightarrow 2CuO(s)$.

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

Answer: Silver chloride is highly sensitive to light and undergoes photolytic decomposition upon exposure to light. This reaction occurs rapidly and causes the silver chloride to lose its properties, forming chlorine gas and elemental silver. Therefore, silver chloride is stored in dark-colored bottles to protect it from light and prevent its decomposition.

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

Answer: **(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.

$2KClO_3+heat\rightarrow 2KCl+3O_2$

(b) Electrolytic decomposition reaction (Electrolysis): Decomposition of sodium chloride (NaCl): On passing electricity through molten sodium chloride, it decomposes into sodium and chlorine.

$2NaCl(electrolysis)\rightarrow 2Na+Cl_2$

(c) Photodecomposition reaction (Photolysis):
Decomposition of hydrogen peroxide: In the presence of light, hydrogen peroxide decomposes into water and oxygen molecules.
$2H_2O_2 + light \rightarrow 2H_2O + O_2$

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

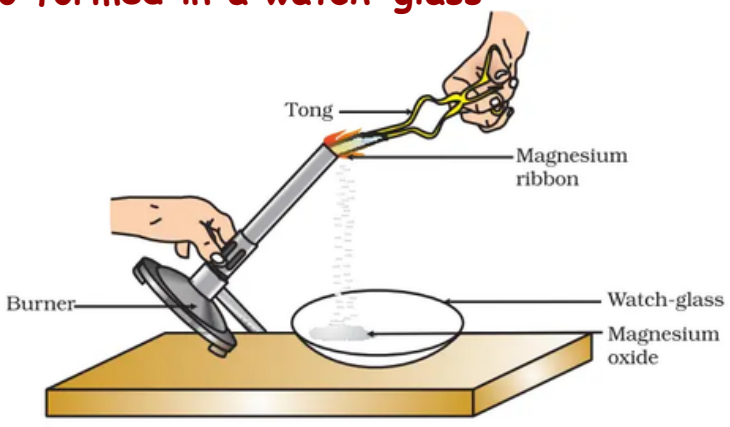
Answer: A displacement reaction occurs when a more reactive substance replaces a less reactive substance from its salt solutions. A double displacement reaction occurs when a mutual exchange of metal ions happens between two compounds.
In a displacement reaction, only a single displacement occurs, whereas in the double displacement reaction, as the name suggests, two displacements occur between the molecules.
Example of Displacement reaction:
$Mg + 2HCl \rightarrow MgCl_2 + H_2$
Example of Double displacement reaction:
$2KBr + BaI_2 \rightarrow 2KI + BaBr_2$

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

Answero 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.

Top 7 Questions

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



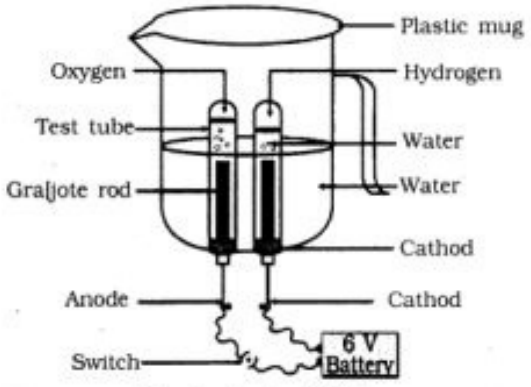
(i). Magnesium ribbon needs to be rubbed before burning because it has a coating on its surface.
A. basic magnesium carbonate
B. basic magnesium oxide
C. basic magnesium sulphide
D. basic magnesium chloride

(ii). What is the colour of magnesium ribbon?
A. White
B. Black
C. Grey
D. Yellow

(iii). What is the chemical name of the powder obtained in the
A. magnesium carbonate
B. magnesium oxide
C. magnesium sulphide
D. magnesium chloride

(iv). 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

(i). 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

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

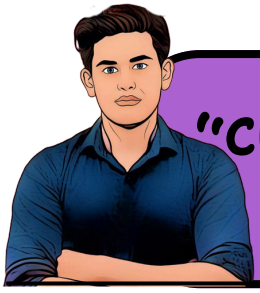
(iii). Where is hydrogen gas collected?
A. Anode
B. Cathode
C. At both electrodes
D. Hydrogen gas is not evolved in this activity

(iv). 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

Answers:

1.
(i) A
(ii) C
(iii) B
(iv) D

2.
(i) C
(ii) A
(iii) B
(iv) D



"Class 10th Phodenge"
- Prashant Bhaiya