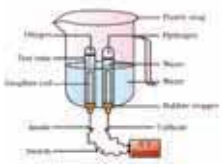


# Chapter - 1 Chemical Reactions And Equations

**CHEMICAL REACTIONS AND EQUATIONS**

- **Reaction**
  - Change in
    - Colour
    - State
    - Temperature
  - Form Equation
    - Simplest Way to Write Word Equation
      - Magnesium + Oxygen → Magnesium oxide
      - $Mg + O_2 \longrightarrow MgO$ — Unbalanced Equation
      - $2Mg + O_2 \longrightarrow 2MgO$ — Balanced Equation
        - Energy Absorbed – Endothermic
        - Energy Released – Exothermic
        - ❖ Follows law of conservation of mass.
        - ❖ No. of atoms remain same.
        - ❖ Reactants and Products both present
        - ❖ Phycical states of elements, written as solid(s) liquid(l), aqueous(aq) and gas(g)
- **Types of Chemical Reaction**
  - Combination Reaction – Exothermic Reaction
  - Decomposition Reaction – Endothermic Reaction
  - Displacement Reaction
  - Double Displacement Reaction / Precipitation
  - Oxidation – Reduction Reaction – Effects of Oxidation – Corrosion and rancidity

**Note:** Skeletal equations are usually unbalanced equation but there are few which need not to be balanced as they are already balanced e.g.

| Skeleton Equation | Balanced Equation |
|---|---|
| $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ | $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ |
| $Zn_{(s)} + H_2SO_{4(l)} \longrightarrow ZnSO_4 + H_{2(g)}$ | $Zn_{(s)} + H_2SO_{4(l)} \longrightarrow ZnSO_4 + H_{2(g)}$ |
| $S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$ | $S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$ |
| $NaCl_{(aq)} + AgNO_{3(aq)} \longrightarrow NaNO_{3(aq)} + AgCl_{(aq)}$ | $NaCl_{(aq)} + AgNo_{3(aq)} \longrightarrow NaNo_{3(aq)} + AgCl_{(aq)}$ |

The process in which new substances with new properties are formed is called **Chemical Reaction.**

* The substances which take part in chemical reaction are called **Reactants.**
* The substances which are formed in a chemical reaction are called **Products.**

*Examples :*

(i) Digestion of food

(ii) Respiration

(iii) Rusting of iron

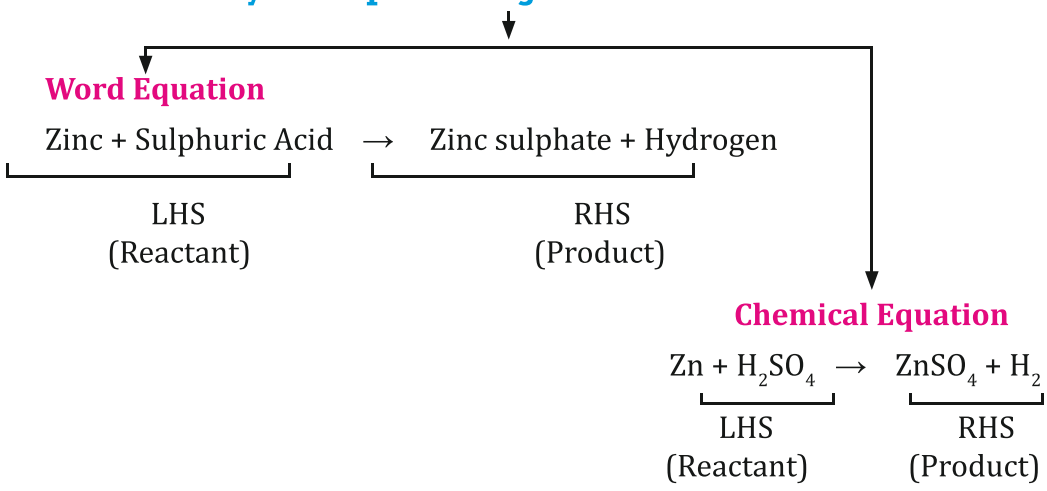
(iv) Burning of Magnesium ribbon

(v) Formation of curd

**Chemical reaction involves :**

- Change in state
- Change in colour
- Change in temperature
- Evolution of gas

## Ways of Representing a Chemical Reaction




### Chemical Equation

* A chemical reaction can be represented by chemical equation. It involves uses of symbol of elements or chemical formula of reactant and product with mention of physical state.
* The necessary conditions such as temperature, pressure or any catalyst should be written on arrow between reactant and products.

*e.g.,* Magnesium is burnt in air to form Magnesium oxide.

$$2\,Mg + O_2 \rightarrow 2\,MgO$$

### Balancing Chemical Equation

* Law of conservation of Mass : Matter can neither be created nor be destroyed in a chemical reaction.
* So number of atoms of the elements involved in chemical reaction should remain same at reactant and product side.

### STEPWISE BALANCING (Hit and Trial)

**Step 1.** Write a chemical equation and draw boxes around each formula.

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

* Do not change anything inside the box.

**Step 2.** Count the number of atoms of each element on both the sides of chemical equation.

| Element | | No. of atoms at reactant side | No. of atoms at product side |
|---|---|---|---|
| 1. | Fe | 1 | 3 |
| 2. | H | 2 | 2 |
| 3. | O | 1 | 4 |

**Step 3.** Equalise the number of atoms of element which has maximum number by putting in front of them.

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

**Step 4.** Try to equalize all the atoms of elements on reactant and product side by adding coefficient in front of them.

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

* Now all the atoms of elements are equal on both sides.

**Step 5.** Write the physical states of reactants and products.

$$3Fe\,(s) + 4H_2O\,(g) \rightarrow Fe_3O_4\,(s) + 4H_2\,(g)$$

Solid state = (s)

Liquid state = (*l*)

Gaseous state = (g)

Aqueous state = (aq)

**Step 6.** Write necessary conditions of temperature, pressure or catalyst on arrow above or below.

## TYPES OF CHEMICAL REACTIONS

**I. COMBINATION REACTION :** The reaction in which two or more reactants combine to form a single product. A+B→C

*e.g.* (i) Burning of coal

$C\,(s) + O_2\,(g) \rightarrow CO_2\,(g)$

(ii) Formation of water

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

(iii) $CaO\,(s) + H_2O\,(l) \rightarrow Ca(OH)_2\,(aq)$

Quick lime Slaked lime

**Exothermic Reactions :** Reaction in which heat is released along with formation of products.

*e.g.,* (i) Burning of natural gas

$CH_4(g) + O_2(g) \rightarrow CO_2(g) + 2H_2O(g) + Heat$

(ii) Respiration is also an exothermic reaction.

$C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) + energy$

**II. DECOMPOSITION REACTION :** The reaction in which a compound splits into two or more simple substances is called decomposition reaction.

$$A \rightarrow B + C$$

- **Thermal decomposition :** When decomposition is carried out by heating.

*e.g.,* (i) $2FeSO_4(s) \xrightarrow{Heat} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

(Ferrous sulphate) (Ferric oxide)

Green colour Red-brown colour

(ii) $CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$

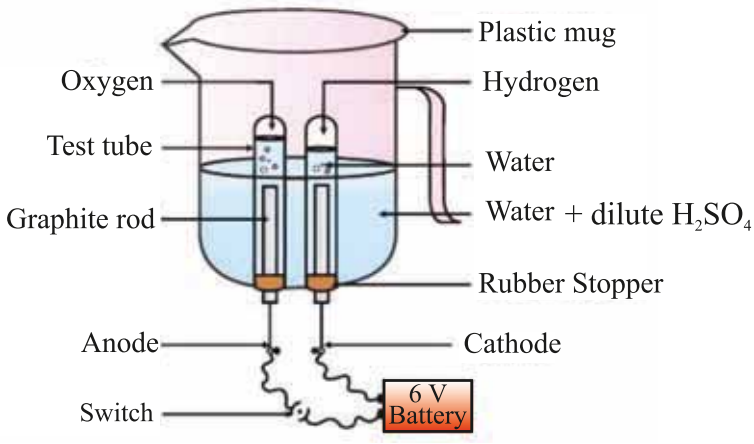
(Lime stone) (Quick lime)

(iii) $2Pb(NO_3)_2(s) \xrightarrow{Heat} 2PbO(s) + 4NO_2(g) + O_2$

(lead nitrate) (lead oxide) (Nitogen dioxide)

- **Electrolytic Decomposition :** When decomposition is carried out by passing electricity.

*e.g.,* $2H_2O(l) \xrightarrow[\text{current}]{\text{Electric}} 2H_2(g) + O_2(g)$




- **Photolytic Decomposition :** When decomposition is carried out in presence of sunlight.

The decomposition reactions are mostly endothermic in nature. Energy in the form of heat, light or electricity is generally absorbed in these reactions.

*e.g.,* $2AgCl\ (s) \xrightarrow{Sunlight} 2Ag\ (s) + Cl_2\ (g)$

$2AgBr\ (s) \xrightarrow{Sunlight} 2Ag\ (s) + Br_2\ (g)$

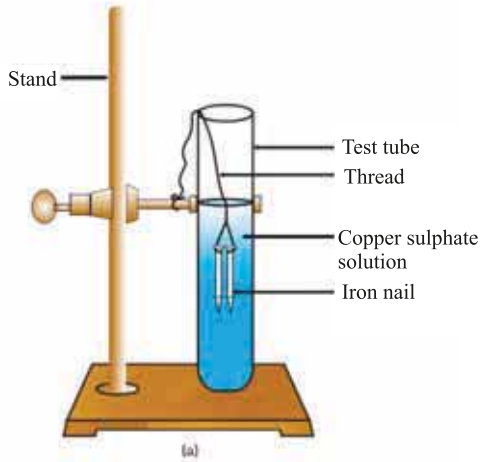
Silver chloride turns grey on exposure to sunlight

* Above reaction is used in black and white photography.

- **Endothermic Reactions :** The reactions which require energy in the form of heat, light or electricity to break reactants are called endothermic reactions.

**III. DISPLACEMENT REACTION :** The chemical reaction in which more reactive element displaces less reactive element from its salt solution.

(a) **$Fe\ (s) + CuSO_4\ (aq) \longrightarrow FeSO_4\ (aq) + Cu\ (s)$**




The iron nail becomes brownish in colour by deposition of Cu and blue colour of $CuSO_4$ changes to dirty green colour due to formation of $FeSO_4$.

(b) **$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$**

Zn is more reactive than copper.

**IV. DOUBLE DISPLACEMENT REACTION :** A reaction in which new compounds are formed by mutual exchange of ions between two compounds.

(i) **$Na_2SO_4\ (aq) + BaCl_2\ (aq) \rightarrow BaSO_4\ (s) + 2NaCl\ (aq)$**

| (Sodium sulphate) | (Barium chloride) | (Barium sulphate) | (Sodium chloride) |
|---|---|---|---|

white precipitate of $BaSO_4$ is formed, so it is also called precipitation reaction.

**Note:** All double displacement reactions are not precipitation reactions.

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

Potassium iodide — Lead nitrate — Lead iodide (Yellow ppt) — Potassium nitrate

(iii) $2KBr + BaI_2 \rightarrow 2KI + BaBr_2$

Potassium bromide — Barium iodide — Potassium iodide — Barium bromide

## V. OXIDATION AND REDUCTION :

**Oxidation :** (i) The addition of oxygen to reactant.

(ii) The removal of hydrogen from a reactant.

$$C + O_2 \rightarrow CO_2$$

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

$$CuO + H_2 \xrightarrow{Heat} Cu + H_2O$$

**Reduction :** (i) The addition of hydrogen to reactant.

(ii) The removal of oxygen from a reactant.

oxidation

$$CuO + H_2 \xrightarrow{Heat} Cu + H_2O$$

Reduction

In this reaction CuO is reduced to Cu and $H_2$ is oxidized to $H_2O$. So, oxidation and reduction taking place together is redox reaction.

### Effects of Oxidation in Daily Life

**1) Corrosion**

- When a metal is exposed to moisture, air, acid etc. for some time, a layer of hydrated oxide is formed which weakens the metal and hence metal is said to be corroded.
- Rusting of iron, black coating on silver and green coating on copper are examples of corrosion.
- Corrosion can be prevented by galvanization, electroplating or by **applying paints.**

**2) Rancidity :** The oxidation of fats and oils when exposed to air is known as rancidity. It leads to bad smell and bad taste of food.

**Methods to Prevent Rancidity**

(i) By adding antioxidants

(ii) Keeping food in air tight containers

(iii) Replacing air by nitrogen

(iv) Refrigeration

## QUESTIONS

## VERY SHORT QUESTIONS (1 Mark)

## MULTIPLE CHOICE QUESTIONS

Q. 1 The shiny finish of wall after white wash is because of.

a) Calcium oxide b) Calcium hydroxide

c) Calcium Carbonate d) Calcium phosphate

Q. 2 Electrolysis of water is decomposition reaction. The mole ratio of hydrogen and oxygen gases liberated during electrolysis of water is

a) 1:1 b) 2:1 c) 4:1 d) 1:2

Q. 3 Which the following statements about the given reaction are correct:

$3Fe(s) + 4H_2O(g) \longrightarrow Fe_2O_3(s) + 4H_2(g)$

i) Iron metal is getting oxidized

ii) Water is getting reduced

iii) Water is acting as reducing agent

iv) Water is acting as oxidizine agent

a) (i), (ii) and (iii) b) (iii) and (iv)

c) (i), (ii) and (iv) d) (ii) and (iv)

Q. 4 In order to prevent the spoilage of potato chips, they are packed in plastic bags containing the gas

a) $Cl_2$ b) $O_2$ c) $N_2$ d) $H_2$

Q. 5 The process of respiration is -

a) an oxidation reaction which is endo thermic

b) a reduction reaction which is exothermic

c) a combination reaction which is endo thermic

d) an oxidation reaction which is exothermic

Q. 6 Burning of Methane is an example of

I. Exothermic recation

II. Combustion reaction

III. Decompostition reaction

a. I only b. II only c. I and II d. I and III

Q. 7 A solution of substance X is used for white washing, the substance X is

a. Calcium oxide b. Calcium hydroxide

c. Calcium carbonate d. Calcium chloride

Q. 8 When iron nails are dipped into Copper Sulphate solution the colour of Copper Sulphate solution changes from

a. Green to blue b. Blue to green

c. Green to colourless d. Blue to colourless

Q. 9 The given Chemical reaction is an example of

$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$

a. Combination reaction b. Displacement reaction

c. Decomposition reaction d. Double displacement reaction

Q. 10 The balanced equation for the given chemical reaction is

Hydrogen + Chlorine $\longrightarrow$ Hydrogen Chloride

a. $H_2 + Cl_2 \rightarrow 2HCl$ b. $H + Cl \rightarrow HCl$

c. $H_2 + Cl_2 \longrightarrow HCl$ d. none of the above

Q. 11 When a magnesium ribbon is burnt in air, the ash formed is

(a) Black (b) White (c) Yellow (d) Pink.

Q.12 In reaction $Na_{(s)} + O_{2(g)} \rightarrow Na_2O_{(s)}$. No. of moles of Sodium needed to balance equation would be

(a) 1 (b) 2 (C) 3 (d) 4

(13.) The reaction in which two compounds exchange their ions to form two new compound is called: -

(a) displacement reaction (b) combination reaction

(c) Double displacement reaction (d) redox reaction.

Q.14 Which of the given products is formed when calcium oxide reacts with water ?

(a) Slaked line (b) Carbon dioxide

(c) calcium oxide (d) Oxygen gas

Q.15 Which of the statement is correct for the following example?

$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$ is a :-

(a) combination reaction. (b) double displacement reaction

(C) decomposition reaction. (d) dis placement reaction

Answers

1. (b) 2. (b) 3. (c) 4. (a) 5. (d)

Q. 16 Give an example of double displacement reaction? (CBSE 2010, 2011)

Q. 17 Name the reducing agent in given chemical reaction

$3\,MnO_2 + 4Al \longrightarrow 3\,Mn + 2Al_2O_3$ (CBSE-2016)

Q.18 Name the brown coloured gas evolved when lead nitrate crystals are heated in dry test-tube.

Q. 19 Give reasons-

a) Silver chloride is stored in dark coloured bottles.

b) Copper vessel loses shine when exposed to air

c) Iron displaces copper from copper sulphate solution.

Q. 20 Identify the following reactions as

i) combination ii) decomposition iii) displacement

iv) double displacement

i) $ZnCO_3(s) \longrightarrow ZnO(s) + CO_2(g)$

ii) $Pb(s) + CuCl_2(ag) \longrightarrow PbCl_2(aq) + Cu(s)$

iii) $H_2(g) + Cl_2(g) \longrightarrow 2HCl$

iv) $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

v) $NaCl(aq) + AgNO_3(a) \longrightarrow AgCl + NaNO_3$

vi) $3H_2(g) + N_2(g) \longrightarrow 2NH_3(g)$

vii) $Fe_2O_3 + Al \longrightarrow Al_2O_3 + 2Fe$

21. What changes do you observe in iron nails and colour of copper sulphate solution, if iron nails are dipped in $CuSO_4$ solution for sometime?

22. Identify the chemical change :

Melting of ice or conversion of milk into curd.

23. Why is respiration considered an exothermic reaction ?

24. Why do copper vessel lose shine when exposed to air ?

25. Potato chips manufacturers fill the packet of chips with nitrogen gas. Why ?

26. Why do we store silver chloride in dark coloured bottles in labs?

27. Write a chemical equation of double displacement reaction.

28. $N_2 + 3H_2 \rightarrow 2NH_3$, name the type of reaction.

29. What happens when milk is left open at room temperature during summers ?

30. What happens when quick lime is added to water ?

**Practical Based MCQ's**

1. When aqueous solution of sodium sulphate and barium chloride are mixed together, we observe-
   a) precipitate red b) white precipitate
   c) yellow precipitate d) colourless solution
2. The colour of ferrous sulphate crystals is-
   a) yellow b) light green c) red d) brown
3. A student took solid quick lime in a china dish and added a small amount of water to it. He would hear-
   a) pop sound b) a crackling sound
   c) hissing sound d) no sound at all

4. When an iron nail is placed in copper sulphate solution the observation are as follow-

a) The solution turns light green

b) A brown deposit is formed on the nail

c) Both 'a' and 'b'

d) None of the above

Answer

1. (b) 2.(b) 3.(c) 4.(c)

## Assertion and Reason type of questions

In the following questions a statement of Assertion is followed by a statement of Reason.

Mark the correct choice as two statements are given, one labeled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

(a) Both A and R are true, and R is correct explanation of the assertion.

(b) Both A and R true, but R is not the correct explanation of the assertion.

(c) A is true, but R is false.

(d) A is false, but R is true.

1. **Assertion (R):** Chemical reaction changes the physical and chemical state of substance.

   **Reason (R):** When electric current is passed through water (liquid), it decomposes to produce hydrogen and oxygen gases.

2. **Assertion (R):** In a balanced chemical equation, total mass of the each element towards reactant side is equal to the total mass of the same element towards product side.

   **Reason (R):** Mass can neither be created nor destroyed during a chemical change.

3. **Assertion (R):** When calcium carbonate is heated, it decomposes to give calcium oxide and carbon dioxide.

   **Reason (R):** The decomposition reaction takes place on application of heat, therefore its an endothermic reaction.

4. **Assertion (R):** Chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting oxidised.
   **Reason (R):** This increases the taste of the chips and helps in their digestion.
5. **Assertion (R):** Rusting of iron metal is the most common form of corrosion.
6. **Reason (R):** The effect of rusting of iron can be reversed if they are left open in sun light.

## SHORT ANSWER TYPE OF QUESTIONS (2 AND 3 MARKS)

1. Define combination reaction. Give two examples of combination reaction, which are exothermic in nature.
2. What is decomposition reaction ? Explain with the help of an example.
3. Name and state the law which is kept in mind when we balance a chemical equation.
4. Give one example of each :
   (a) Chemical reaction showing evolution of gas.
   (b) Change in colour of a substance during a chemical reaction.
   (c) Chemical reaction showing change in temperature.
5. What is rancidity ? Write two ways by which it can be prevented.
6. What are two conditions which promote corrosion ?
7. A small amount of Ferrous sulphate is heated in hard glass tube.
   (a) Write the chemical equation.
   (b) What type of reaction is taking place or Name the type of reaction.
8. What happens when Zn strip is dipped in $CuSO_4$ solution ?
   Give equation and identify the type of reaction.
9. What is redox reaction ? Write down a chemical reaction representing it.

10. In electrolysis of water :

(a) Name the gas collected at cathode and anode respectively.

(b) Why is volume of one gas collected at one electrode is double of another ?

(c) Why is it necessary to add few drops of dil. $H_2SO_4$ to water before electrolysis?

11. In the reaction

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

(a) Name the oxidized substance.

(b) Name the reduced substance.

(c) Name the oxidizing agent.

12. Give reasons :

(a) White Silver chloride turns grey in sunlight.

(b) Brown coloured copper powder on heating in air turns into black coloured substance.

13. Compound 'X' decomposes to form compound 'Y' and $CO_2$ gas. Compound Y is used in manufacturing of cement.

(a) Name the compounds 'X' and 'Y'.

(b) Write the chemical equation for this reaction.

14. A metal salt MX when exposed to light splits up to form metal M and gas $X_2$. Metal M is used to make ornaments whereas gas $X_2$ is used in making bleaching powder. The salt MX is used in black & white photography.

(a) Identify the metal M and gas $X_2$.

(b) Identify MX.

(c) Write down the chemical reaction when salt MX is exposed to sunlight.

15. A metal strip X is dipped in blue coloured salt solution $YSO_4$. After some time a layer of metal 'Y' is formed on metal strip X. Metal X is used in galvanization whereas metal Y is used for making electric wires.

(a) What could be metal 'X' and 'Y' ?

(b) Name the metal salt $YSO_4$.

(c) What type of chemical reaction takes place between X and $YSO_4$? Write the balanced chemical equation.

Q.16 When potassium Iodide solution is added to a solution of lead nitrate in test tube, a precipitate is formed.

i) State the colour of precipitate.

ii) Name the compound which is precipitated.

iii) Write balanced equation for chemical reaction (CBSE-2015 Comptt)

Q. 17 Decomposition reactions require energy either in the form of heat or light a electricity for breaking down of reactions. Write one equation for each type of decomposition reaction where heat, light or electricity is used as form of energy. (CBSE-2018)

Q. 18 2 gm of silver chloride is taken in china dish, and china dish is placed in sunlight for sometime. What will be your observation. Write the balanced chemical equation for above reaction and identify the type of reaction. (CBSE-2019)

Q.19 Identify the type of reactions taking place in each of following cases and write the balanced chemical equation for the reactions.

a) Zn reacts with silver nitrate to produce zinc nitrate and silver.

b) Potassium iodide reacts with lead nitrate to produce potassium nitrate and lead iodide (CBSE-2019)

**LONG ANSWER TYPE OF QUESTIONS (5 MARKS)**

1. White wash was being done at Mukesh's house. Mukesh saw that the painter added quick lime to drum having water. Mukesh touched outer surface of drum, it was unbelievably hot.

   (a) Write the chemical equation for above reaction.

   (b) What type of reaction is it ?

   (c) This reaction is exothermic or endothermic. Justify your answer.

2. Write down the balanced chemical equation for the following :

   (a) Silver chloride is decomposed in presence of sunlight to give silver and chlorine gas.

   (b) Calcium oxide reacts with water to give lime water.

   (c) Sodium hydroxide reacts with hydrochloric acid to give sodium chloride and water.

   (d) Dil. hydrochloric acid is added to copper oxide to give green coloured copper chloride and water.

   (e) Solution of barium chloride and sodium sulphate in water reacts to give insoluble Barium sulphate and solution of Sodium chloride.

## Case Study/Source Based Question

In most pollution control application lime is used as calcium hydroxide. To manufacture calcium hydroxide the limestone must be converted to calcium oxide then calcium oxide then converted to calcium hydroxide. The following is a brief chemical reaction of this process:

Limestone + Heat $\longrightarrow$ Calcium oxide + Carbon dioxide

However, calcium oxide is unstable in the presence of moisture and carbon dioxide. A more stable form of lime is calcium hydroxide.

Calcium oxide + Water $\longrightarrow$ Calcium hydroxide + Heat

The process of adding water to calcium oxide to produce calcium hydroxide is referred to as hydration process or lime slaking. The hydration of Calcium oxide; commercially referred to as quick lime, is an exothermic process releasing a great quantity of heat. The hydration takes place quickly, releasing a lot of heat energy. This heat will boil the water and genrate steam, which makes the particles burst, exposing the inner surfaces to water for further slaking. This process will continue until hydration is complete.

(i) Lime is used as calcium hydroxide. The formula of lime is calcium hydroxide that absorb $CO_2$ from air and become white, the compound formed is

(a) CaO (b) $Ca(HCO_3)_2$

(c) $CaCO_3$ (d) $CaO.2H_2O$

(ii) The chemical reaction of the given word equation:

(a) $2CaO + Heat \longrightarrow 2Ca + O_2$

(b) $CaCO_3 + Heat \longrightarrow CaO + CO_2$

(c) $Ca(OH)_2 + Heat \longrightarrow CaO + H_2O$

(d) $2CaCO_3 + Heat \longrightarrow 2CaO + CO_2$

(iii) The stable form of lime is

(a) Calcium hydroxide (b) Calcium oxide

(c) Calcium carbonate (d) Calcium oxide. Dehydrate

(iv) What is the chemical name and chemical formula of quick lime?

or

What happens when water is added to quick lime? Write its chemical reaction. Is it an exothermic or endothermic reaction?