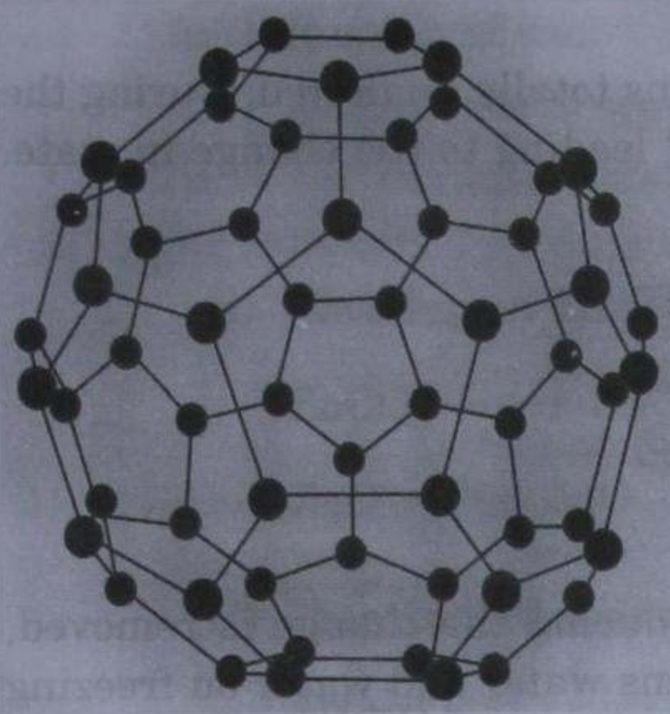


5

PHYSICAL AND CHEMICAL CHANGES

SCOPE OF SYLLABUS

(i) ***Definitions and distinction between Physical and Chemical changes.***
Simple experiments like dissolution of sugar in water, burning of paper should be shown to make the concepts of physical and chemical change clear. More examples of such type may be given.

(ii) ***Conditions for chemical change.***
Close contact, heat, light, electricity, pressure, catalysts with examples.

(iii) ***Types of chemical change.***
Direct combination; decomposition; displacement; double decomposition with examples.

(iv) ***Energy changes in a chemical change.***
Exothermic and endothermic reactions with examples – evolution/absorption of heat, light and electricity.

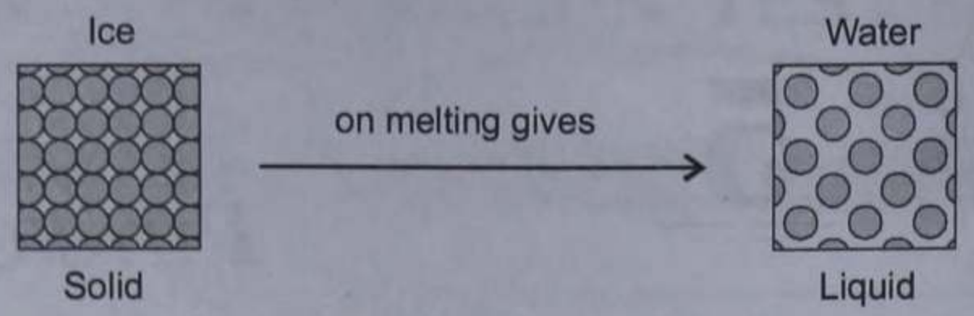
(v) ***Burning : Definition and conditions of burning.***
Definition; conditions for burning (combustible substance, supporter of combustion and ignition temperature); comparison of respiration and burning; burning of magnesium or candle to show that substances gain weight on burning; students to be made aware of how the balance of O_2 and CO_2 is maintained in nature.

IMPORTANT POINTS TO REMEMBER

1. The **changes** in **energy** are always **accompanied** by some kind of **change** (**chemically** or **physically**). During the **reaction** the **old bonds** in the **reactants break** and the **new bonds** in the **products** are **formed**. During this **breaking** and **making** of **bonds** there is **difference** in **energy**. If the **energy required** to **break** the bonds is **greater** than the **energy required** to **make** the **bonds**, then the **energy** is **given out** to the **surroundings**. Such **reactions** or **changes** are **exothermic**. But if the **energy required** to **break** the bonds is **less** than the **energy required** to **make** the bonds, then the **energy** is **absorbed** from the **surroundings**. Such **reactions** are said to be **endothermic reactions**.
2. Many **changes** occur in our **natural environment** like **evaporation** of **water**, **condensation** of **water vapours**, **rainfall**, etc. In the above mentioned changes only the **change** in **state** is **involved**. Such changes are referred to as **physical changes**.
3. The **physical change** may be defined as the **change** which occurs in **size**, **shape**, **colour**, **texture**, **state**, **magnetic** or **electrical condition** but the **molecular composition** remains totally **unaltered**, *i.e.*, **no new product** is formed as a result of **physical change**.

The characteristics of the physical change are as follows :

(*i*) **No new product is formed.** The molecular composition remains totally unaltered. During the physical change only the arrangement of molecules gets altered leading to the change in state. For example,



The molecular compositions of ice and water remain same.

(*ii*) **The change is temporary and reversible.** If the cause producing the change is removed, then the reaction gets reversed. For example, ice on melting forms water and water on freezing produces ice.

(*iii*) **No energy changes take place as a result of physical change.** The energy required to bring about a physical change is generally equal to the amount of energy required to reverse the change. Therefore there is no change in energy.

(*iv*) **The mass of the substance remains same during a physical change.** There is no involvement of mass during physical change but only energy is added or removed. So, no matter is added or removed during a physical change and hence the mass of the substance remains the same.

4. Examples of physical changes are

(*i*) Melting of wax
(*ii*) Boiling of water
(*iii*) Heating of zinc oxide
(*iv*) Freezing of water
(*v*) Heating of camphor
(*vi*) Melting of ice
(*vii*) Heating of ammonium chloride
(*viii*) Dissolution of sugar in water
(*ix*) Dissolution of sulphur in carbon disulphide
(*x*) Cutting of wood.

5. A **change** during which the **molecular composition** gets **totally altered**, *i.e.* a change in which always a **new product** is formed is called a **chemical change**.

The characteristics of the chemical change are as follows :

(*i*) **Chemical change results in the formation of a new product.** Entirely a new product is formed with a complete difference in the molecular composition.

(*ii*) **The change is permanent and irreversible.** It means that the chemical change cannot be reversed by altering or changing the experimental conditions.

(*iii*) **The mass of the substance gets altered during a chemical change.** During a chemical change either the mass is added or removed. It results in either the increase in weight or decrease in weight of the substance.

(*iv*) **Energy changes take place during a chemical change.** There is a difference in energy in the breaking of old bonds in reactants and making of new bonds in products. Either the energy is released or absorbed during a chemical change.

If the energy is **released** then the reaction is **exothermic** and if the energy is **absorbed** then the reaction is **endothermic**.

For example, when paper is burnt, it forms carbon dioxide and water vapours along with energy in the form of heat and light.

6. Examples of chemical changes are

(*i*) Burning of candle
(*ii*) Burning of wood or paper
(*iii*) Souring of milk
(*iv*) Rancidification of butter
(*v*) Burning of camphor
(*vi*) Digestion of food

(*vii*) Rusting of iron

(*viii*) Photosynthesis

(*ix*) Electrolysis of water

(*x*) Combustion of fuel.

7. There are **certain substances** which undergo **physical** and **chemical changes simultaneously**. For example,

(*i*) Heating of zinc carbonate

$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$ (Chemical change)

$\underset{\text{white}}{ZnO} \xrightarrow{\Delta} \underset{\text{yellow}}{ZnO}$ (Physical change)

(*ii*) Heating of sodium nitrate

$2NaNO_3(s) \xrightarrow{\Delta} 2NaNO_3(l)$ (Physical change)

$2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$ (Chemical change)

(*iii*) Heating of lead nitrate

$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$ (Chemical change)

$\underset{\text{light yellow}}{PbO} \xrightarrow{\Delta} \underset{\text{reddish}}{PbO}$ (Physical change)

8.

Physical change	*Chemical change*
(*i*) A change which alters only the physical properties but the molecular composition remains totally unaltered.	(*i*) A change which alters all the physical properties and the molecular composition is called the chemical change.
(*ii*) No new substance is formed as a result of physical change.	(*ii*) Always a new substance is formed as a result of chemical change.
(*iii*) The change is temporary.	(*iii*) The change is permanent.
(*iv*) The change is reversible.	(*iv*) The change is irreversible.
(*v*) No energy changes take place as a result of physical change.	(*v*) Energy changes take place as a result of chemical change.
(*vi*) Mass of the substance undergoing physical change remains totally unaltered.	(*vi*) Mass of the substance gets altered during a chemical change.

9. Energy change always **takes place** during the **chemical reaction**. The **energy** is either **released** or **absorbed** during **the chemical reaction**.

10. The **chemical reaction** which proceeds by the **liberation** of **heat energy** is termed as **exothermic reaction**. During this reaction the **heat** is **produced**.

The process of burning of fuels, respiration in human beings are the examples of exothermic reactions.

$$C + O_2 \longrightarrow CO_2 + \text{Heat}$$

11. The **chemical reaction** which proceeds by the **absorption** of **heat** is termed as **endothermic reaction**. During this reaction **heat** is **absorbed,** this type of reaction will only **continue** in the **presence** of **external source** of **heat**.

Thermal decomposition of metallic carbonate, metallic bicarbonate, metallic hydroxide, metallic nitrate are the examples of endothermic reactions.

$$CaCO_3 + \text{Heat} \longrightarrow CaO + CO_2$$

$$2NaHCO_3 + \text{Heat} \longrightarrow Na_2CO_3 + H_2O + CO_2$$

12. The **reaction** in which **elements** or **compounds** undergo a **chemical change** with either the **liberation** or **absorption** of **energy** leading to the **formation** of **one more product** is called a **chemical reaction**.

The **chemical reactions** are **classified** as the following main types :

(*i*) Synthesis and direct combination reaction

(*ii*) Decomposition reaction

(*iii*) Double decomposition reaction.

13. When **two** or **more elements combine** to give a **single product** then the reaction is called **synthesis reaction**.

e.g., $N_2 + 3H_2 \longrightarrow 2NH_3$

14. The different synthesis reactions are summarised as :

(*i*) Reaction of metals with oxygen :

Metal + Oxygen $\longrightarrow$ Metallic oxide

Silver and **gold do not react** with **oxygen** while metals from **potassium** to **copper react** with **oxygen** to form their respective **metallic oxides**. However the **reactivity decreases** from **potassium** to **copper**. **Metallic oxides** formed are usually **basic oxides** and **few** are **amphoteric oxides**.

$4K + O_2 \longrightarrow 2K_2O$

$4Na + O_2 \longrightarrow 2Na_2O$

$2Ca + O_2 \longrightarrow 2CaO$

$2Zn + O_2 \xrightarrow{\Delta} 2ZnO$

$2Cu + O_2 \longrightarrow 2CuO$

(*ii*) Reaction of non-metals with oxygen :

Non-metallic oxides are usually **acidic oxides** and very **few** are **neutral oxides**.

Non-metal + Oxygen $\longrightarrow$ Non-metallic oxide

$C + O_2 \longrightarrow CO_2$

$S + O_2 \longrightarrow SO_2$ (Sulphur burns with pale blue flame)

$2S + 3O_2 \longrightarrow 2SO_3$

$4P + 5O_2 \longrightarrow 2P_2O_5$

$2H_2 + O_2 \longrightarrow 2H_2O$

(*iii*) Reaction of metals with chlorine :

$2Na + Cl_2 \longrightarrow 2NaCl$

$2K + Cl_2 \longrightarrow 2KCl$

$\underset{\text{heated}}{2Fe} + \underset{\text{dry}}{3Cl_2} \longrightarrow \underset{\text{anhydrous}}{2FeCl_3}$

(*iv*) Reaction of non-metals with chlorine :

$2P + 3Cl_2 \longrightarrow 2PCl_3$

$2P + 5Cl_2 \longrightarrow 2PCl_5$

$H_2 + Cl_2 \xrightarrow{\text{sunlight}} 2HCl$

(*v*) Reaction of metals with sulphur :

$Zn + S \xrightarrow{\Delta} ZnS$

$Fe + S \xrightarrow{\Delta} FeS$

(*vi*) Reaction of non-metals with sulphur :

$$H_2 + \underset{\text{boiling}}{S} \longrightarrow H_2S$$

$$\underset{\text{boiling}}{2S} + Cl_2 \longrightarrow \underset{\text{sulphur monochloride}}{S_2Cl_2}$$

(*vii*) Reaction of metals with nitrogen :

Metals like **magnesium**, **calcium** and **aluminium** directly **combine** with **nitrogen** on heating to **form** respective **metallic nitrides**.

$$\underset{\text{burning}}{3Mg} + N_2 \longrightarrow Mg_3N_2$$

$$\underset{\text{burning}}{3Ca} + N_2 \longrightarrow Ca_3N_2$$

$$\underset{\text{burning}}{2Al} + N_2 \longrightarrow 2AlN$$

(*viii*) Reaction of non-metals with nitrogen :

$$N_2 + 3H_2 \underset{\substack{450°-500°C \\ 200-1000\ atm}}{\overset{Fe-Mo}{\rightleftharpoons}} 2NH_3 \quad \text{(Haber's process)}$$

$$N_2 + O_2 \xrightarrow[\text{Lightening}]{\text{Thunder and}} 2NO$$

15. When **two** or **more elements** or **compounds** combine **chemically** to give a **single product** then the reaction is called **direct combination reaction**. (In this, **two elements** never combine).

e.g., $2CO + O_2 \longrightarrow 2CO_2$

16. The direct combination reactions can be summarized as :

(*i*) Reaction of lower oxides with oxygen to form higher oxides :

Carbon monoxide burns with **pale blue flame**.

$$2CO + O_2 \longrightarrow 2CO_2$$

Nitric oxide on coming in **contact** with **oxygen** turns **reddish brown**.

$$2NO + O_2 \longrightarrow 2NO_2$$

Catalytic oxidation of **sulphur dioxide**.

$$2SO_2 + O_2 \xrightarrow[450°C]{V_2O_5} 2SO_3$$

(*ii*) Reaction of soluble basic oxide with water :

Soluble basic oxides react with **water** to form **alkalies** which turns **red litmus** to **blue**.

$$Na_2O + H_2O \longrightarrow 2NaOH$$

$$K_2O + H_2O \longrightarrow 2KOH$$

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

(*iii*) Reaction of acidic oxide with water : Acidic oxides react with **water** to form **acids** which turns **blue litmus** to **red**. Acidic oxides are also called as **acid anhydrides**.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

$$SO_2 + H_2O \longrightarrow H_2SO_3$$

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

$$P_2O_5 + 3H_2O \longrightarrow 2H_3PO_4$$

17. The **chemical reaction** in which a **compound breaks down** to give **two** or **more products** (may be elements or compounds) on **absorbing energy** is called **decombination** or **decomposition reaction**.

18. The examples of decomposition reactions are :

(*i*) Effect of Heat on Metallic and Non-Metallic Nitrates :

(*a*) Non-metallic nitrate : Ammonium nitrate

$$NH_4NO_3 \xrightarrow{\Delta} \underset{\substack{\text{Nitrous oxide}\\ \text{or}\\ \text{Laughing gas}}}{N_2O} + 2H_2O$$

(*b*) In metallic nitrates, **sodium** and **potassium nitrate** on heating give **oxygen** as the only gaseous product.

$$2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$$

$$2KNO_3 \xrightarrow{\Delta} 2KNO_2 + O_2$$

(*c*) From **calcium nitrate** to **copper nitrate** all metallic nitrates on heating decompose to give their respective **metallic oxides**, **oxygen** and **nitrogen dioxide**.

$$2Ca(NO_3)_2 \xrightarrow{\Delta} 2CaO + 4NO_2 + O_2$$

$$2Zn(NO_3)_2 \xrightarrow{\Delta} 2ZnO + 4NO_2 + O_2$$

$$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$$

$$2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + 4NO_2 + O_2$$

(*d*) **Silver nitrate** and **mercury nitrate** on heating give their respective **metals**, **nitrogen dioxide** and **oxygen**.

$$Hg(NO_3)_2 \xrightarrow{\Delta} Hg + 2NO_2 + O_2$$

$$2AgNO_3 \xrightarrow{\Delta} 2Ag + 2NO_2 + O_2$$

(*ii*) Effect of Heat on Metallic Carbonates :

(*a*) **Sodium carbonate** and **potassium carbonate do not decompose** on **heating**, *i.e.*, they are **stable** towards heat.

(*b*) From **calcium** to **copper** all metallic carbonates decompose to give their respective **metallic oxides** and **carbon dioxide**.

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

$$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$$

$$PbCO_3 \xrightarrow{\Delta} PbO + CO_2$$

$$CuCO_3 \xrightarrow{\Delta} CuO + CO_2$$

(*c*) **Silver carbonate** and **mercury carbonate** on heating give respective **metals**, **carbon dioxide** and **oxygen**.

$$2HgCO_3 \xrightarrow{\Delta} 2Hg + 2CO_2 + O_2$$

$$2Ag_2CO_3 \xrightarrow{\Delta} 4Ag + 2CO_2 + O_2$$

(*iii*) Effect of Heat on Metallic Hydroxides :

(*a*) **Sodium hydroxide** and **potassium hydroxide** do not decompose on heating, *i.e.*, they are stable towards heat.

(*b*) From **calcium** to **copper** all metallic hydroxide decompose to give their respective **metallic oxides** and **water**.

$$Ca(OH)_2 \xrightarrow{\Delta} CaO + H_2O$$

$$Mg(OH)_2 \xrightarrow{\Delta} MgO + H_2O$$

$$Zn(OH)_2 \xrightarrow{\Delta} ZnO + H_2O$$

$$Pb(OH)_2 \xrightarrow{\Delta} PbO + H_2O$$

$$Cu(OH)_2 \xrightarrow{\Delta} CuO + H_2O$$

(*c*) **Silver hydroxide** and **mercury hydroxide** on heating decompose to give their respective **metals**, **oxygen** and **water**.

$$2Hg(OH)_2 \xrightarrow{\Delta} 2Hg + 2H_2O + O_2$$

$$4AgOH \xrightarrow{\Delta} 4Ag + 2H_2O + O_2$$

19. A **reversible thermal decomposition** reaction is called **thermal dissociation reaction**.

$$NH_4Cl \underset{\text{cool}}{\overset{\Delta}{\rightleftharpoons}} NH_3 + HCl$$

20. Activity series : The series in which the metals are arranged in the decreasing order of their reactivity is called activity series.

K	Potassium	↑ Reactivity Increases	↓ Reactivity Decreases
Ca	Calcium		
Na	Sodium		
Mg	Magnesium		
Al	Aluminium		
Zn	Zinc		
Fe	Iron		
Pb	Lead		
[H]	Hydrogen		
Cu	Copper		
Hg	Mercury		
Ag	Silver		
Au	Gold		
Pt	Platinum		

21. The **element** lying **above** in the **metal activity series** displaces **element** lying **below** in the **metal activity series** from their **salt solutions**. Such reactions are called **simple displacement reactions**.

22. Metals lying **above hydrogen** in the **metal activity series** displace **hydrogen** from **water** and **dilute acids**. However, **metals** lying **below hydrogen** like **copper**, **silver**, **gold**, *etc.*, do not displace **hydrogen** on reaction with **dilute acids** and **water**.

(*i*) **Sodium**, **potassium** and **calcium** displace hydrogen from cold water.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

$$2K + 2H_2O \longrightarrow 2KOH + H_2$$

$$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$$

(*ii*) **Rest of the metals** react with **steam** to form their **respective oxides** with the liberation of **hydrogen**.

$$Mg + H_2O \longrightarrow MgO + H_2$$

$$Zn + H_2O \longrightarrow ZnO + H_2$$

$$3Fe + 4H_2O \underset{\text{heated}}{\rightleftharpoons} Fe_3O_4 + 4H_2$$

(*iii*) **Copper**, **silver**, **gold**, *etc.*, **do not react** with **water** under any condition.

23. Metals react with dilute acids as follows :

(*i*) **Sodium**, **potassium** and **calcium** react **explosively** with **dilute acids** to liberate **hydrogen**.

$$2K + 2HCl \longrightarrow 2KCl + H_2$$

$$2Na + 2HCl \longrightarrow 2NaCl + H_2$$

$$Ca + 2HCl \longrightarrow CaCl_2 + H_2$$

(*ii*) **Magnesium**, **aluminium** and **zinc** react with **dilute acids less vigorously** to liberate **hydrogen**.

$$Mg + \underset{\text{dil.}}{2HCl} \longrightarrow MgCl_2 + H_2$$

$$Zn + \underset{\text{dil.}}{2HCl} \longrightarrow ZnCl_2 + H_2$$

$$2Al + \underset{\text{dil.}}{6HCl} \longrightarrow 2AlCl_3 + 3H_2$$

(*iii*) **Iron** reacts **silently** and **slowly** with **dilute acids**.

$$Fe + \underset{\text{dil.}}{2HCl} \longrightarrow FeCl_2 + H_2$$

$$Fe + \underset{\text{dil.}}{H_2SO_4} \longrightarrow FeSO_4 + H_2$$

(*iv*) **Copper**, **silver** and **gold do not react** with **dilute acids** to liberate **hydrogen**.

24. The **more electropositive metals** displace **less electropositive metals** from their **salt solutions**.

$$CuSO_4 + Fe \longrightarrow FeSO_4 + Cu$$

$$CuSO_4 + Mg \longrightarrow MgSO_4 + Cu$$

25. The **more electronegative element** displaces **less electronegative element** from its **salt solution**. For example in case of halogens

F — Fluorine

Cl — Chlorine

Br — Bromine

I — Iodine

$$\underset{\text{colourless}}{2KI} + Cl_2 \longrightarrow 2KCl + \underset{\text{deep yellow}}{I_2}$$

$$2KBr + Cl_2 \longrightarrow 2KCl + \underset{\text{reddish brown}}{Br_2}$$

26. The reaction in which the **interchange of radicals** takes place in **their solution form** is called as **double decomposition reaction**.

27. The solubility chart is given as follows :

(*i*) All oxides are insoluble except sodium oxide, potassium oxide and calcium oxide which are sparingly soluble in water.

(*ii*) All sulphites are insoluble except sodium sulphite and potassium sulphite.

(*iii*) All hydroxides are insoluble except sodium hydroxide, potassium hydroxide, ammonium hydroxide, calcium hydroxide which are sparingly soluble.

(*iv*) All sulphates are soluble except calcium sulphate, lead sulphate and barium sulphate.

(*v*) All nitrates are soluble.

(*vi*) All chlorides are soluble except silver chloride, mercury chloride and lead chloride (soluble in hot water but insoluble in cold water).

(*vii*) All carbonates are insoluble except sodium carbonate, potassium carbonate and ammonium carbonate.

(*viii*) All salts of sodium, potassium and ammonium are soluble.

28. The double decomposition reactions are of two types :

(*i*) Neutralization (*ii*) Precipitation

29. Neutralization is a reaction in which **acids react with bases to form salt and water** as the only products. This reaction is employed for the **preparation** of **soluble salts**.

$$Acid + Base \longrightarrow Salt + Water$$

$$HCl + NaOH \longrightarrow NaCl + H_2O$$
$$HCl + NH_4OH \longrightarrow NH_4Cl + H_2O$$
$$H_2SO_4 + 2KOH \longrightarrow K_2SO_4 + 2H_2O$$
$$HNO_3 + KOH \longrightarrow KNO_3 + H_2O$$

30. During **double decomposition precipitation** reaction **two soluble salts combine** in their **solution forms** to give **one insoluble compound** in the form of **precipitate** and other **soluble compound**. This method is employed for the **preparation** of **insoluble salts**.

$$BC + DE \longrightarrow BE + DC.$$
$$AgNO_3 + NaCl \longrightarrow \underset{\text{white ppt.}}{AgCl\downarrow} + NaNO_3$$
$$BaCl_2 + Na_2SO_4 \longrightarrow \underset{\text{white ppt.}}{BaSO_4\downarrow} + 2NaCl$$
$$CuSO_4 + 2NaOH \longrightarrow \underset{\text{pale blue ppt.}}{Cu(OH)_2\downarrow} + Na_2SO_4$$
$$Pb(NO_3)_2 + Na_2SO_4 \longrightarrow \underset{\text{white ppt.}}{PbSO_4\downarrow} + 2NaNO_3$$
$$Pb(NO_3)_2 + 2KI \longrightarrow \underset{\text{yellow ppt.}}{PbI_2\downarrow} + 2KNO_3$$

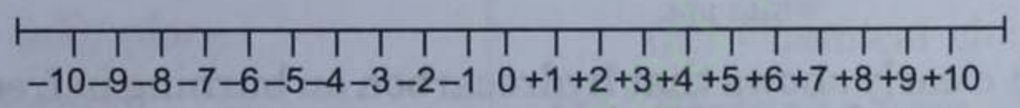
31. During the **chemical reaction** the **transference** of **electrons** takes place.

32. The process of **gain** of **electrons** is called **reduction**.

33. The process of **loss** of **electrons** is called **oxidation**.

34. The reactions in which **oxidation** and **reduction** take place **simultaneously** is called **redox reaction**.

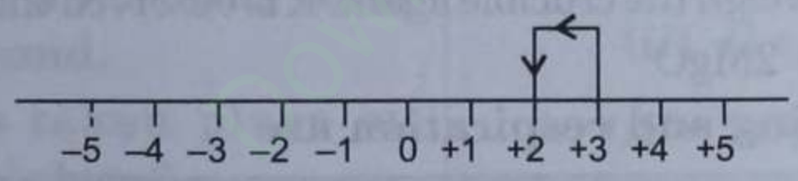
35. The process of **oxidation** and **reduction** can be easily explained on the basis of the following **number line.**



36. In the process of **reduction**, the number **decreases** according to the **number line**.

For example,

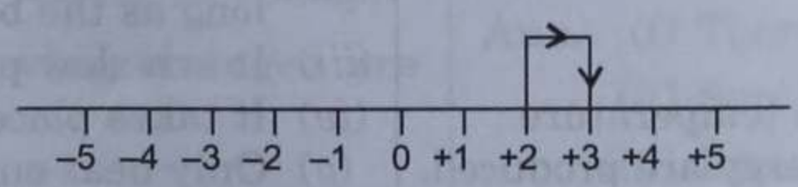
$$Fe^{3+} \longrightarrow Fe^{2+}$$ (Reduction, *i.e.*, gain of e^-)



$$Fe^{3+} + e^- \longrightarrow Fe^{2+}$$

37. In the process of **oxidation**, the number **increases** according to the **number line**

$$Fe^{2+} \longrightarrow Fe^{3+}$$ (Oxidation, *i.e.*, loss of e^-)



$$Fe^{2+} - e^- \longrightarrow Fe^{3+}$$

38. Reducing agents are the **electron donors**. **Metals** are **reducing agents**.

39. Oxidizing agents are **electron acceptors**. **Non-metals** are **oxidizing agents**.

40. Reducing agent in the reaction **gets oxidized** and the **oxidizing agent** in the reaction **gets reduced**.

41. Combustion is a **chemical process** in which **substances** combine with **oxygen** to form their respective **oxides** with the **liberation** of **energy** in the form of **heat** or **light**.

42. The necessary conditions for burning are

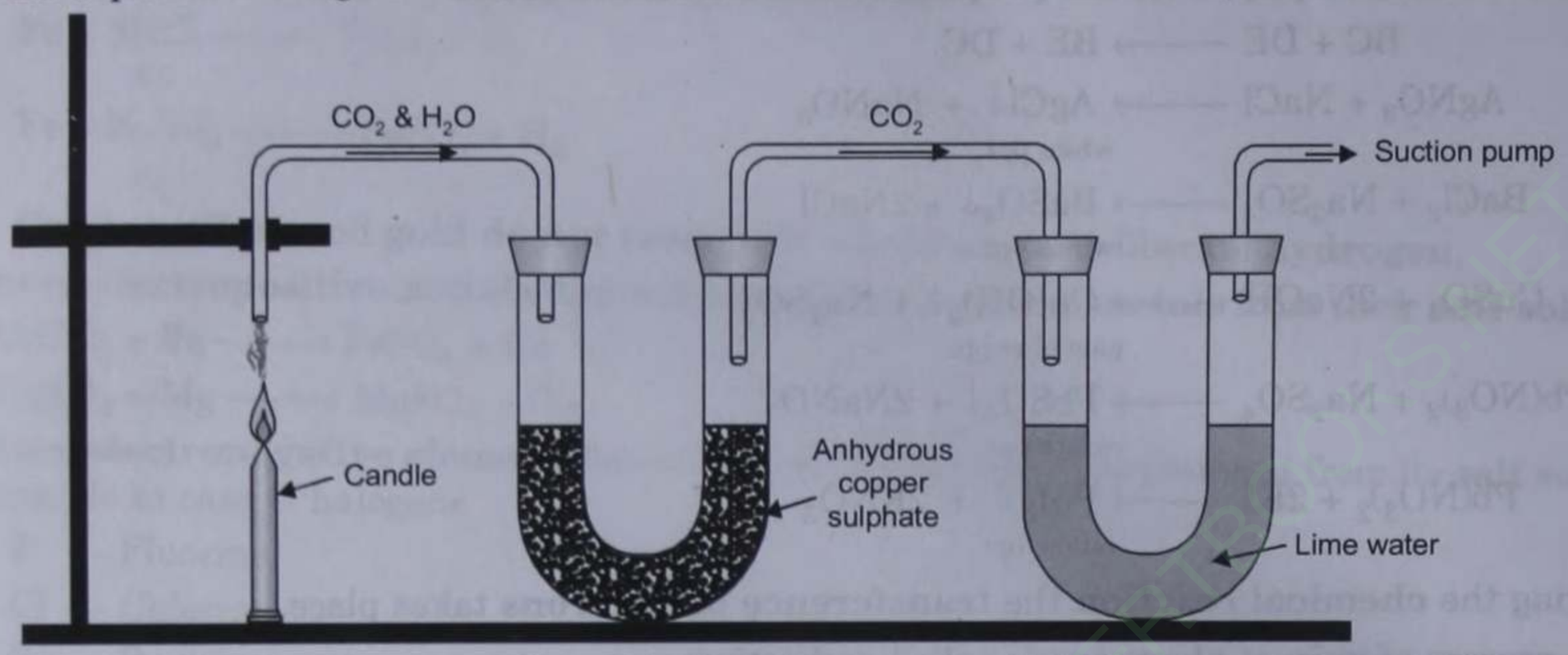
(*i*) The presence of supporter of combustion. The common example is oxygen.

(*ii*) The presence of combustible substance. For example, wood, fuel, paper etc.

(*iii*) The attainment of ignition temperature. It is the minimum temperature that a substance must attain before it catches fire.

43. Hydrocarbon (wax, methane) **burns** in **free supply** of **air** to form **carbon dioxide** and **water vapour** as the only products.

Set the experiment as given below :



As the reaction proceeds we see that **anhydrous copper sulphate** changes from **white** to **blue**

$$\underset{\text{white}}{CuSO_4} + 5H_2O \longrightarrow \underset{\text{blue}}{CuSO_4 \,.\, 5H_2O}$$

and **lime water** turns **milky**.

$$Ca(OH)_2 + CO_2 \longrightarrow \underset{\text{white ppt.}}{CaCO_3} + H_2O$$

The above experiment clearly shows that hydrocarbon on burning in free supply of air or oxygen produces carbon dioxide and water vapour.

44. Magnesium ribbon on **burning** in **air** or **oxygen** produces a **white powder** of **magnesium oxide**. Weigh magnesium piece in a crucible before burning and then ignite in a crucible. When the ignition is complete, cool the crucible and weigh the crucible again. It is observed that the weight increases after ignition.

$$2Mg + O_2 \longrightarrow 2MgO$$

45. Differences between burning and respiration are

Burning	*Respiration*
(*i*) It is an artificial process.	(*i*) It is a natural process.
(*ii*) It is not a continuous process. It is to be started.	(*ii*) It is a continuous process and takes place as long as the body lives.
(*iii*) It is a fast process.	(*iii*) It is a slow process.
(*iv*) It takes place at a high temperature.	(*iv*) It takes place at a body temperature.
(*v*) Both heat and light energy are produced.	(*v*) Only heat energy is produced.

46. Life on **earth** exists due to the sensitive **balance** between **oxygen** and **carbon dioxide**. Both of these gases are **essential** for the sustenance of **human life**. However, both of these gases are used up during

(*i*) Respiration – Oxygen (*ii*) Photosynthesis – Carbon dioxide.

The **balance** between the amount of these **gases** is **maintained** as discussed below.

47. Oxygen is **removed** from **air** by the following ways :

(*i*) Combustion of fuels.

(*ii*) Respiration.

(*iii*) Decomposition of waste materials etc.

Oxygen is mainly **present** in the **atmosphere** by the process of **photosynthesis**.

$$6CO_2 + 6H_2O \xrightarrow[\text{sunlight}]{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2$$

Thus, **balance** of **oxygen** is **maintained** by **Oxygen cycle**.

48. **Carbon dioxide** is mainly **used** from the atmosphere by **photosynthesis**. It is added to the atmosphere by the following ways :

(*i*) Burning of fuels – wood, paper, coke, coal, petrol, diesel etc.

(*ii*) Respiration – exhaled air contains CO_2.

(*iii*) By plants – At night plants also release CO_2.

(*iv*) Fermentation.

The level of **carbon dioxide** is also **maintained** between **sea water** and that is in **air**. If the amount of **carbon dioxide increases** in air, the **excess** of **carbon dioxide dissolves** in **sea water** and if the level of **carbon dioxide falls** in air the **sea** gives some of its **dissolved carbon dioxide** and thus **restoring** the level of **carbon dioxide** (Carbon cycle).

49. The **various processes** by which the **percentage proportion** of **carbon dioxide** and **oxygen** in the atmosphere is kept **constant**, constitutes **carbon** and **oxygen cycle** respectively.

IMPORTANT QUESTIONS

Q1. Choose the characteristics of a physical change from the following :

(*i*) Always a new product is formed.

(*ii*) No energy changes take place.

(*iii*) The change is permanent.

(*iv*) The change is temporary.

(*v*) The change is reversible.

Ans. (*ii*) No energy changes take place.

(*iv*) The change is temporary.

(*v*) The change is reversible.

Q2. Mixing and grinding of iron and sulphur gives a mixture whereas on heating them together forms a compound.

(*i*) What change has taken place on mixing iron and sulphur ?

(*ii*) What change has taken place on heating iron and sulphur together ?

Ans. (*i*) Physical change (*ii*) Chemical change.

Q3. State whether the following changes are physical or chemical.

(*i*) Heating of sugar

(*ii*) Cutting of wood

(*iii*) Stitching of shirt

(*iv*) Lighting of bulb

(*v*) Burning of paper

(*vi*) Production of gobar gas

(*vii*) Conversion of atmospheric nitrogen into soluble nitrogenous compound

(*viii*) Rusting of iron

(*ix*) Digestion of food

(*x*) Mastication of food.

Ans. (*i*) Chemical change (*ii*) Physical change

(*iii*) Physical change (*iv*) Physical change

(*v*) Chemical change (*vi*) Chemical change

(*vii*) Chemical change (*viii*) Chemical change

(*ix*) Chemical change (*x*) Physical change.

Q4. State the type of chemical reactions of the following :

(*i*) $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

(*ii*) $C + O_2 \xrightarrow{\Delta} CO_2$

(*iii*) $2CO + O_2 \xrightarrow{\Delta} 2CO_2$

(*iv*) $CuCO_3 \xrightarrow{\Delta} CuO + CO_2$

(*v*) $NH_4Cl \underset{\text{cool}}{\overset{\Delta}{\rightleftharpoons}} NH_3 + HCl.$

Ans. (*i*) Thermal decomposition reaction

(*ii*) Synthesis

(*iii*) Direct combination

(*iv*) Thermal decomposition

(*v*) Thermal dissociation

Q5. Complete and balance the following equations :

(*i*) $N_2 + O_2 \longrightarrow$

(*ii*) $NO + O_2 \longrightarrow$

(*iii*) $S + O_2 \longrightarrow$

(iv) $SO_3 + H_2O \longrightarrow$

(v) $KNO_3 \xrightarrow{\Delta}$

(vi) $NaNO_3 \xrightarrow{\Delta}$

(vii) $Ca(NO_3)_2 \xrightarrow{\Delta}$

(viii) $AgNO_3 \xrightarrow{\Delta}$

(ix) $Cu(OH)_2 \xrightarrow{\Delta}$

(x) $Pb_3O_4 \xrightarrow{\Delta}$

(xi) $PbO_2 \xrightarrow{\Delta}$

(xii) $HgO \xrightarrow{\Delta}$

(xiii) $Ag_2O \xrightarrow{\Delta}$

(xiv) $PCl_5 \underset{\text{cool}}{\overset{\Delta}{\rightleftharpoons}}$

(xv) $Pb(NO_3)_2 + NaCl \longrightarrow$

Ans. (i) $N_2 + O_2 \longrightarrow 2NO$

(ii) $2NO + O_2 \longrightarrow 2NO_2$

(iii) $S + O_2 \longrightarrow SO_2$

$2S + 3O_2 \longrightarrow 2SO_3$

(iv) $SO_3 + H_2O \longrightarrow H_2SO_4$

(v) $2KNO_3 \xrightarrow{\Delta} 2KNO_2 + O_2$

(vi) $2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

(vii) $2Ca(NO_3)_2 \xrightarrow{\Delta} 2CaO + 4NO_2 + O_2$

(viii) $2AgNO_3 \xrightarrow{\Delta} 2Ag + 2NO_2 + O_2$

(ix) $Cu(OH)_2 \xrightarrow{\Delta} CuO + H_2O$

(x) $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2$

(xi) $2PbO_2 \xrightarrow{\Delta} 2PbO + O_2$

(xii) $2HgO \xrightarrow{\Delta} 2Hg + O_2$

(xiii) $2Ag_2O \xrightarrow{\Delta} 4Ag + O_2$

(xiv) $PCl_5 \underset{\text{cool}}{\overset{\Delta}{\rightleftharpoons}} PCl_3 + Cl_2$

(xv) $Pb(NO_3)_2 + 2NaCl \longrightarrow PbCl_2 + 2NaNO_3$.

Q6. Complete the following equations :

(i) $Cu(NO_3)_2 + NaOH \longrightarrow$

(ii) $Pb(NO_3)_2 + KI \longrightarrow$

(iii) $Pb(NO_3)_2 + HCl \longrightarrow$

(iv) $Pb(NO_3)_2 + Na_2CO_3 \longrightarrow$

(v) $Pb(NO_3)_2 + Na_2SO_4 \longrightarrow$

(vi) $BaCl_2 + Na_2SO_4 \longrightarrow$

(vii) $MgSO_4 + NaOH \longrightarrow$

(viii) $FeCl_3 + NaOH \longrightarrow$

(ix) $FeCl_2 + NaOH \longrightarrow$

(x) $CuSO_4 + Fe \longrightarrow$

(xi) $KBr + Cl_2 \longrightarrow$

(xii) $Fe + HCl \longrightarrow$

(xiii) $Fe + H_2SO_4 \longrightarrow$

(xiv) $Fe + S \longrightarrow$

(xv) $Mg + H_2SO_4 \longrightarrow$

Ans. (i) $Cu(NO_3)_2 + 2NaOH \longrightarrow Cu(OH)_2 + 2NaNO_3$

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

(iii) $Pb(NO_3)_2 + 2HCl \longrightarrow PbCl_2 + 2HNO_3$

(iv) $Pb(NO_3)_2 + Na_2CO_3 \longrightarrow PbCO_3 + 2NaNO_3$

(v) $Pb(NO_3)_2 + Na_2SO_4 \longrightarrow PbSO_4 + 2NaNO_3$

(vi) $BaCl_2 + Na_2SO_4 \longrightarrow BaSO_4 + 2NaCl$

(vii) $MgSO_4 + 2NaOH \longrightarrow Mg(OH)_2 + Na_2SO_4$

(viii) $FeCl_3 + 3NaOH \longrightarrow Fe(OH)_3 + 3NaCl$

(ix) $FeCl_2 + 2NaOH \longrightarrow Fe(OH)_2 + 2NaCl$

(x) $CuSO_4 + Fe \longrightarrow FeSO_4 + Cu$

(xi) $2KBr + Cl_2 \longrightarrow 2KCl + Br_2$

(xii) $Fe + 2HCl \longrightarrow FeCl_2 + H_2$

(xiii) $Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$

(xiv) $Fe + S \xrightarrow{\Delta} FeS$

(xv) $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$.

Q7. State which of the following are oxidized or reduced.

(i) $S^{2-} \longrightarrow S$ **(ii)** $Cl^- \longrightarrow Cl$

(iii) $Mn^{5+} \longrightarrow Mn^{7+}$ **(iv)** $Cl_2 \longrightarrow Cl^-$

(v) $Cr^{7+} \longrightarrow Cr^{5+}$.

Ans. (i) $S^{2-} \longrightarrow S$

$S^{2-} - 2e^- \longrightarrow S$ (Oxidation)

(ii) $Cl^- \longrightarrow Cl$

$Cl^- - e^- \longrightarrow Cl$ (Oxidation)

(iii) $Mn^{5+} \longrightarrow Mn^{7+}$

$Mn^{5+} - 2e^- \longrightarrow Mn^{7+}$ (Oxidation)

(iv) $Cl_2 \longrightarrow Cl^-$

$Cl_2 + 2e^- \longrightarrow 2Cl^-$ (Reduction)

(v) $Cr^{7+} \longrightarrow Cr^{5+}$

$Cr^{7+} + 2e^- \longrightarrow Cr^{5+}$ (Reduction)

Q8. Fill in the blanks :

(i) Oxidation is the process of _____ of electrons.

(ii) Reduction is the process of _____ of electrons.

(iii) Reducing agents are electron _____.

(iv) Oxidizing agents are electron _____.

(v) Metals are _____ agents.

(vi) Non-metals are _____ agents.

Ans. (i) loss (ii) gain

(iii) donors (iv) acceptors

(v) reducing (vi) oxidising.

Q9. Name the reducing agent in the following reactions :

(i) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

(ii) $CuO + H_2 \longrightarrow Cu + H_2O$

(iii) $ZnO + C \longrightarrow Zn + CO$

(iv) $3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$

(v) $PbO + C \longrightarrow Pb + CO.$

Ans. (*i*) Carbon monoxide, CO

(*ii*) Hydrogen

(*iii*) Carbon

(*iv*) Ammonia

(*v*) Carbon.

Q10. Define

(*i*) exothermic reaction.

(*ii*) endothermic reaction.

Ans. (*i*) Exothermic reaction :

The reaction in which the energy is liberated is called exothermic reaction.

(*ii*) Endothermic reaction :

The reaction in which the energy is absorbed is called endothermic reaction.

Q11. Give four differences between physical change and chemical change.

Ans. Differences :

Physical change	*Chemical change*
(*i*) No new product is formed.	(*i*) Always a new product is formed.
(*ii*) The change is temporary.	(*ii*) The change is permanent.
(*iii*) The change is reversible.	(*iii*) The change is irreversible.
(*iv*) No energy changes take place.	(*iv*) Energy changes take place.

Q12. Give two examples in which physical and chemical changes occur simultaneously.

Ans. (*i*) Heating of sodium nitrate

$$2NaNO_3(s) \xrightarrow{\Delta} 2NaNO_3(l)$$

(Physical change)

$$2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$$

(Chemical change)

(*ii*) Heating of zinc carbonate

$$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$$

(Chemical change)

$$\underset{\text{white}}{ZnO} \longrightarrow \underset{\text{yellow}}{ZnO}$$

(Physical change)

Q13. What is the difference between precipitation and neutralization reactions? What type of salts are prepared by neutralization and precipitation ?

Ans. In neutralization the products formed are soluble whereas during precipitation the products formed are insoluble.

Soluble salts are prepared by neutralization.

Insoluble salts are prepared by precipitation.

Q14. What is a photochemical reaction ? Give one example.

Ans. The chemical reactions which proceed in the presence of light are called photochemical reactions. The example is the process of photosynthesis.

Q15. Give balanced chemical equation for the action of heat on the following :

(*i*) Red lead

(*ii*) Lead dioxide

(*iii*) Potassium dichromate

(*iv*) Silver oxide

(*v*) Mercuric oxide.

Ans. (*i*) $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2$

(*ii*) $2PbO_2 \xrightarrow{\Delta} 2PbO + O_2$

(*iii*) $4K_2Cr_2O_7 \xrightarrow{\Delta} 4K_2CrO_4 + 2Cr_2O_3 + 3O_2$

(*iv*) $2Ag_2O \xrightarrow{\Delta} 4Ag + O_2$

(*v*) $2HgO \xrightarrow{\Delta} 2Hg + O_2.$

Q16. Name the following :

(*i*) Two metallic oxides decompose on heating.

(*ii*) An oxidizing agent which does not contain oxygen.

(*iii*) A gas acting both as an oxidizing as well as reducing agent.

(*iv*) Two metals which do not react with water.

(*v*) A metallic carbonate which on heating forms respective metal.

Ans. (*i*) Mercuric oxide and silver oxide

(*ii*) Chlorine

(*iii*) Sulphur dioxide

(*iv*) Copper, silver

(*v*) Silver carbonate.

Q17. Name the natural process by which oxygen is removed and carbon dioxide is produced in the atmosphere.

Ans. Respiration.

Q18. Name the natural process by which oxygen is added and carbon dioxide is removed from the atmosphere.

Ans. Photosynthesis.

LET'S RECALL

Fill Your Answer in the Space Given for Each Question.

Q1. Match the following :

Column I	Column II
(*i*) Interchange of radicals	(*a*) Direct combination
(*ii*) Combination of only elements	(*b*) Neutralization
(*iii*) Combination of elements and compounds	(*c*) Double decomposition
(*iv*) Reaction for the formation of soluble salts	(*d*) Precipitation
(*v*) Reaction for the formation of insoluble salts	(*e*) Synthesis

Ans. (*i*) ☐ (*ii*) ☐ (*iii*) ☐ (*iv*) ☐ (*v*) ☐

Q2. Fill in the blanks.

(*i*) Heating of camphor is a _____ change whereas the burning of camphor is a _____ change.

(*ii*) A reversible thermal decomposition reaction is called thermal _____ reaction.

(*iii*) During exothermic reaction energy is _____.

(*iv*) _____ is the process of loss of electrons.

(*v*) _____ is the process of gain of electrons.

(*vi*) Reducing agents are electron _____.

(*vii*) Oxidizing agents are electron _____.

(*viii*) _____ are reducing agents.

(*ix*) _____ are oxidizing agents.

(*x*) Heating of zinc oxide is a _____ change.

Q3. State whether the following statements are True or False.

(*i*) During endothermic reaction heat is liberated. ☐

(*ii*) During physical change always a new product is formed. ☐

(*iii*) Rancidification of butter is a chemical change. ☐

(*iv*) Sodium nitrate is stable towards heat. ☐

(*v*) Neutralization is a type of double decomposition reaction. ☐

Q4. Each question has four options out of which only one option is correct. Dark the bubble for correct answer.

(*i*) A green coloured metallic carbonate is

(*a*) $CuCO_3$ (*b*) $ZnCO_3$ (*c*) Na_2CO_3 (*d*) $CaCO_3$

Ans. (a) (b) (c) (d)

(*ii*) A metallic carbonate stable towards heat is

(*a*) $CuCO_3$ (*b*) $ZnCO_3$ (*c*) Na_2CO_3 (*d*) $CaCO_3$

Ans. (a) (b) (c) (d)

(*iii*) Water, steam and ice are chemically

(*a*) HO_2 (*b*) H_2O (*c*) HO (*d*) H_2O_2

Ans. (a) (b) (c) (d)

(*iv*) Rusting of iron is a

(*a*) physical change (*b*) photochemical reaction

(*c*) chemical change (*d*) None of these

Ans. (a) (b) (c) (d)

(*v*) Formation of ammonia from its elements is a

(*a*) direct combination (*b*) neutralization

(*c*) synthesis (*d*) precipitation

Ans. (a) (b) (c) (d)

(*vi*) The only products of neutralization reaction are

(*a*) salt and oxygen (*b*) salt and hydrogen

(*c*) hydrogen and oxygen (*d*) salt and water

Ans. (a) (b) (c) (d)

(*vii*) Soluble salts are generally prepared by

(*a*) synthesis (*b*) neutralization

(*c*) precipitation (*d*) None of these

Ans. (a) (b) (c) (d)

(*viii*) Insoluble salts are generally prepared by

(*a*) synthesis (*b*) neutralization

(*c*) precipitation (*d*) None of these

Ans. (a) (b) (c) (d)

(*ix*) A metal which reacts reversibly with steam is

(*a*) copper (*b*) lead

(*c*) iron (*d*) zinc

Ans. (a) (b) (c) (d)

(*x*) A metallic nitrate on heating gives oxygen as the only gaseous product is

(*a*) zinc nitrate (*b*) copper nitrate

(*c*) silver nitrate (*d*) sodium nitrate

Ans. (a) (b) (c) (d)

Q5. Complete and balance the following equations.

(*i*) $Al + HCl \longrightarrow$ _____ + _____

(*ii*) $CuSO_4 + Fe \longrightarrow$ _____ + _____

(*iii*) $NH_4NO_3 \xrightarrow{\Delta}$ _____ + _____

(*iv*) $AgNO_3 \xrightarrow{\Delta}$ _____ + _____ + _____

(*v*) $Pb_3O_4 \xrightarrow{\Delta}$ _____ + _____

(*vi*) $N_2 + O_2 \longrightarrow$ _____

(*vii*) $CuCO_3 \xrightarrow{\Delta}$ _____ + _____

(*viii*) $NaNO_3 \xrightarrow{\Delta}$ _____ + _____

(*ix*) $CO + O_2 \longrightarrow$ _____

(*x*) $P_2O_5 + H_2O \longrightarrow$ _____

Answers

1. (*i*) *c* (*ii*) *e* (*iii*) *a* (*iv*) *b* (*v*) *d*

2. (*i*) physical,chemical (*ii*) dissociation (*iii*) released (*iv*) oxidation
(*v*) reduction (*vi*) donors (*vii*) acceptors (*viii*) metals (*ix*) non-metals
(*x*) physical

3. (*i*) False (*ii*) False (*iii*) True (*iv*) False (*v*) True

4. (*i*) *a* (*ii*) *c* (*iii*) *b* (*iv*) *c* (*v*) *c*
(*vi*) *d* (*vii*) *b* (*viii*) *c* (*ix*) *c* (*x*) *d*

5. (*i*) $2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$

(*ii*) $CuSO_4 + Fe \longrightarrow FeSO_4 + Cu$

(*iii*) $NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

(*iv*) $2AgNO_3 \xrightarrow{\Delta} 2Ag + 2NO_2 + O_2$

(*v*) $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2$

(*vi*) $N_2 + O_2 \longrightarrow 2NO$

(*vii*) $CuCO_3 \xrightarrow{\Delta} CuO + CO_2$

(*viii*) $2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

(*ix*) $2CO + O_2 \longrightarrow 2CO_2$

(*x*) $P_2O_5 + 3H_2O \longrightarrow 2H_3PO_4$

SELF EVALUATION TEST

Time : *30 minutes* ***Marks :*** *30*

Q1. Define **2**

(*i*) neutralization.

(*ii*) exothermic reaction.

Q2. What do you observe when **3**

(*i*) chlorine is passed through potassium iodide solution ?

(*ii*) chlorine is passed through potassium bromide solution ?

(*iii*) potassium iodide is added to lead nitrate solution ?

Q3. State the type of chemical reactions. **5**

(*i*) $2CO + O_2 \longrightarrow 2CO_2$

(*ii*) $C + O_2 \longrightarrow CO_2$

(*iii*) $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2$

(*iv*) $PCl_5 \underset{\text{cool}}{\overset{\Delta}{\rightleftharpoons}} PCl_3 + Cl_2$

(*v*) $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

Q4. State which of the following are oxidized or reduced. **5**

(*i*) $Fe^{2+} \longrightarrow Fe$

(*ii*) $Fe^{3+} \longrightarrow Fe^{2+}$

(*iii*) $O^{2-} \longrightarrow O$

(*iv*) $Cr^{7+} \longrightarrow Cr^{5+}$

(*v*) $Zn \longrightarrow Zn^{2+}$

Q5. Name the following. **5**

(*i*) Gas liberated when ammonium nitrate is heated.

(*ii*) Two stable metallic hydroxides.

(*iii*) Two metals which does not react with oxygen.

(*iv*) Two metals which directly combine with sulphur on heating.

(*v*) Two metals which directly combine with nitrogen on heating.

Q6. State whether the following changes are physical or chemical. **10**

(*i*) Heating of lead oxide

(*ii*) Whipping of cream

(*iii*) Digestion of food

(*iv*) Mastication of food

(*v*) Respiration

(*vi*) Breathing

(*vii*) Breaking of glass

(*viii*) Cooking of food

(*ix*) Ripening of fruit

(*x*) Dissolution of magnesium in dilute hydrochloric acid.