Chapter 5. Physical and chemical changes

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Solution 1:
A physical change is a temporary change in which no new substance is formed and the composition or identity of the substance is not altered although certain specific physical properties may be changed.

Solution 2:
A chemical change is a permanent change in which the original substance gives rise to one or more substances with different properties.

Solution 3:
The reactions in which heat is evolved are called exothermic reactions while the reactions in which heat is absorbed are called endothermic reactions.

Solution 4:

1. False
2. False
3. False
4. False
5. True

Solution 5:
When wood or paper is burnt in air, it gives carbon dioxide and water leaving behind a little ash.

$$[C_6(H_2O)_5]_n + 6nO_2 \rightarrow 6n\,CO_2 + 5n\,H_2O + \text{heat}$$

Wood — Oxygen — Carbon dioxide — Water

We call it as chemical change because-

(i) In above reaction new substances are formed. Impurities which are non-volatile, remain behind.

(ii) The change is permanent.

(iii) Heat and light energies are given out.

(iii) Mass of wood get changed but the total mass remains the same.

Solution 6:
Possible conditions for a chemical change are-

1. One or more new substance is formed during reaction.

2. The change occurring during the reaction is permanent.
3. The mass of the substance undergoing a chemical change is generally altered.
4. Chemical change involves making and breaking of bond.

Solution 7:

Reactions in which both the reactants exchange their radicals to give new compounds are called double displacement or double decomposition reaction.

The general reaction can be written as:-

$$A^+B^- + C^+D^- \rightarrow A^+D^- + C^+B^-$$

The two examples of double decomposition reaction are:-

(a) Precipitation reactions-Reactions involving the formation of a precipitate. Sodium chloride and silver nitrate react to form an insoluble white precipitate of silver chloride. For example:-

$$NaCl + AgNO_3 \rightarrow AgCl \downarrow + NaNO_3$$

White ppt

(b) Neutralisation reaction-Reactions in which acids and bases mix together, forming compounds i.e. salt and water.

For example:-

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

Base Acid Salt Water

Solution 8:

(a) **Redox reaction –** The reaction in which both oxidation and reduction takes place simultaneously is known as rtedox reaction. Oxidation is a reaction that involves the addition of oxygen or the removal of the hydrogen. Reduction is a reaction that involves the addition of hydrogen or the removal of oxygen.

$$2H_2 + O_2 \longrightarrow 2H_2O$$

(b) **Oxidation –** Oxidation is a reaction that involves the addition of oxygen or the removal of the hydrogen. In electronic concept, it is defined as the process in which an atom, molecule or ion loses one or more electrons. This results in increase in the positive charge or decrease in negative charge on the resulting species.

$$Cu \rightarrow Cu^{2+} + 2e^-$$

(c) **Reduction –** Reduction is a reaction that involves the addition of hydrogen or the removal of oxygen. In the electronic concept, it is defined as the process in which an atom, molecule or ion gains one or more electrons. This results in increase in the negative charge or decrease in positive charge on the resulting species.

$$H^+ + e^- \longrightarrow H$$

Solution 9:

1. Exothermic reaction
2. Endothermic reaction

Solution 10:

	Characteristics	Physical Change	Chemical Change
1.	Nature of change	Temporary	Permanent
2.	Reversibility	Reversible. It can be reversed by reversing the conditions.	Not easily reversible. It cannot be reversed by reversing the conditions.
3.	Chemical composition of the substance	The chemical composition of the substance remains unchanged.	Chemical composition of the substance is changed.
4.	Product of the change	No chemically new substance is formed. The substance obtained after the change has the same chemical compositions as that of the original substance.	At least one or more new substances with different chemical compositions are formed.
5.	Change in properties	Only physical properties of the substance change. The chemical properties remain the same.	The new substances formed have physical and chemical properties different from the original substance.

Solution 11:

The chemical reactions which occur with the absorption of light energy are called photochemical reactions.

Examples-

Decomposition of silver nitrate takes place in the presence of light.

$$2AgNO_3 \xrightarrow{\text{light}} 2Ag + 2NO_2 + O_2$$

Solution 12:

As the burning substance combines with oxygen ,the total mass of the products should be greater than that of the burning substance. For example,when,magnesium is burnt,a new substance magnesium oxide is formed,whose weight is greater than that of the original magnesium.

Experiment – A crucible is weighed containing about 0.5 gm of magnesium.Now crucible is heated.When magnesium begins to burn,the lid is put back on the crucible and the lid is occasionally raised to allow air to enter and burn the magnesium such that no product is lost.When,all the magnesium has been burnt up, the crucible is allowed to cool and then on weighing it we observe that there is gain in weight.

Solution 13:

S.N.	Respiration	Burning
1.	It involves a series of biochemical reactions which take place in presence of enzymes, it is a slow process.	It is a single step chemical reaction which is a rapid process.
2.	It takes place at body temperature (37°C).	This process takes place at high temperature.
3.	Less energy in the form of heat and chemical energy is liberated.	More energy in the form of heat and light is liberated.

Solution 14:

Three conditions necessary for burning are-

1. The substance to be burnt must be combustible.
2. A supporter of combustion such as air or oxygen must be present.
3. A combustible substance must be heated to its ignition temperature.

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Solution 15:

(a) A reaction which gives out heat is called an exothermic reaction. For example:- Burning of coal in air is an example of exothermic reaction.

$$C + O_2 \rightarrow CO_2 + heat$$

(b) A reaction which proceeds in both forward as well as backward directions. They are indicated by the sign `$\rightarrow$'.

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

(c) $2Mg + O_2 \longrightarrow {}_2MgO + light + heat$

(d) A reaction which takes place with the help of sunlight.

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

(e) $2H_2O \xrightarrow{\text{Electricity}} 2H_2 + O_2$

Solution 16:

1. $2AgNO_3 \xrightarrow{\text{Heat}} 2Ag + O_2 + 2NO_2$
2. $2Cu(NO_3)_2 \xrightarrow{\text{Heat}} 2CuO + 4NO_2 + O_2$
3. $2Al(OH)_3 \xrightarrow{\text{Heat}} Al_2O_3 + 3H_2O$
4. $2AgCO_3 \xrightarrow{\text{Heat}} Ag_2O + 2CO_2$
5. $2KNO_3 \xrightarrow{\text{Heat}} 2KNO_2 + O_2$

Solution 17:

When oxidation occurs there is a loss of electrons but simultaneously there is a gain of electrons by other species which is called reduction. These both process occur simultaneously so we can say that both oxidation and reduction go hand in hand and such reactions are known as redox reaction.

Solution 18:

1. Copper is oxidized to copper sulphate while sulphur in sulphuric acid is reduced to sulphur dioxide.
2. Silver in silver oxide is reduced to silver while oxygen in hydrogen peroxide is oxidised to molecular oxygen.

Solution 19:

Four types of chemical reactions are-

(i) Direct combination or Synthesis reactions

(ii) Decomposition reactions

(iii) Displacement reactions

(iv) Double decomposition reactions

(i) Direct combination or Synthesis reactions-When two or more elements combine to form a compound, the process is called synthesis. It may be brought about by the action of heat, electricity or pressure.
For Example:-
a. Where two elements combine to form a new compound.

H_2 + Cl_2 → 2HCl

(Hydrogen) (Chlorine) (Hydrogen chloride)

b. Where an element and a compound combine to form a new compound.

$CO + 2H_2 \xrightarrow[ZnO+Cr_2O_3]{430^\circ C, 200\ atm} CH_3OH$

(Carbon monoxide) (Hydrogen) (Methyl alcohol)

(ii) Decomposition reactions-When a single compound is broken down in a chemical reaction into two or more simpler substances (elements or compounds) the reaction is called a decomposition reaction. It can be brought about by the heat, light or electricity. They are reverse of combination reaction. For example:-
a. Decomposition by heat:

$MgCO_3 \xrightarrow{Heat} MgO + CO_2$

(Magnesium Carbonate) (Magnesium oxide) (carbon dioxide)

b. Decomposition by electricity:

$2H_2O \xrightarrow[current]{electric} 2H_2 + O_2$

(Acidified Water) (Hydrogen) (Oxygen)

(iii) Displacement reactions - A reaction in which one element displaces another element from its compound to form a new compound is called a displacement reaction. For example:-

$$\underset{\text{(Zinc)}}{Zn} + \underset{\text{(sulphuric Acid)}}{H_2SO_4} \rightarrow \underset{\text{(Zinc sulphate)}}{ZnSO_4} + \underset{\text{(hydrogen)}}{H_2}$$

(iv) Double decomposition reactions-Reactions in which both the reactants exchange their radicals to give new compounds is called a double displacement reaction.
A general reaction:-

$$A^+B^- + C^+D^- \rightarrow A^+D^- + C^+B^-$$

For example:-

a. Precipitation reaction

$$NaCl + AgNO_3 \rightarrow \underset{\text{White ppt}}{AgCl \downarrow} + NaNO_3$$

b. Neutralisation reaction

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

Solution 20:

(a) In activity series, Gold is placed almost at the end of the series since it is least reactive. So, it does not tend to react with other elements easily and thus found free in nature.

(b) For most of the ionic compounds the lattice enthalpy is very high therefore, they do not easily decompose on heating.

(c) On prolonged exposure to air silver react with oxygen present in air to form silver oxide which is black in colour.

$$Ag + O_2 \longrightarrow Ag_2O$$

Silver(grey) Silver oxide(black)

(d) The reaction between ammonium nitrate and water is endothermic. It takes away heat from the beaker. So, beaker becomes cold.

$$NH_4NO_3 + H_2O \xrightarrow{heat} NH_4NO_3\,(aq)$$

(e) The reaction between magnesium and hydrochloric acid is an exothermic reaction which gives heat to the beaker and thus beaker becomes hot.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2 + heat$$

Solution 21:

A candle is a stick of paraffin wax with cotton wick.As a candle burns wax melts and trickles down. It gets solidified shortly. This is physical change. Paraffin wax is a mixture of hydrocarbons. When wick catches fire, paraffin wax melts, evaporates and burns in air like any hydrocarbon to give carbon dioxide and water. This is a chemical change.

Solution 22:

1. physical
2. chemical
3. chemical
4. physical

Solution 23:

Two examples are:-

1. Burning of wood-carbon get oxidized and oxygen gets reduced.
2. Rusting-In it iron is oxidized.

Solution 24:

1. Chromium(VI) .
2. Hydrogen peroxide
3. Barium carbonate.
4. Silver nitrate.

5. Manganese dioxide.

Solution 25:

Ignition temperature – Ignition temperature is the lowest temperature up to which temperature of a substance must be raised so that it catches fire.
A combustible substance must be heated to its ignition temperature for burning.

Solution 26:

S.N.	Respiration	Burning
1.	It involves a series of biochemical reactions which take place in presence of enzymes, it is a slow process.	It is a single step chemical reaction which is a rapid process.
2.	It takes place at body temperature (37°C).	This process takes place at high temperature.
3.	Less energy in the form of heat and chemical energy is liberated.	More energy in the form of heat and light is liberated.

Solution 27:

On heating few crystals of iodine in a test tube, the grey crystals sublimes and dense violet fumes are seen. On cooling, the vapours again form the crystals. So, a physical change can be reversed.

Solution 28:

When hydrogen burns in air, formation of water occurs.

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

Two reasons are-

(i)Water is formed as a product which is different from hydrogen and oxygen. Mass of water is different from either hydrogen or oxygen but the total mass of the substance involved in the chemical reaction remains same.

(ii)The change is permanent and cannot be reversed by reversing the conditions that initially caused the change to occur.

Solution 29:

When water is freezed and evaporated, these both are physical changes because-

1. The change is temporary and reversible.

2. No new substance is formed and the chemical composition of the original substance remains the same.
3. Mass of the substance remains unchanged
4. The amount of energy required to bring about a physical change is generally equal to the amount of energy required to reverse the change. Hence,there is no net energy change involved.

Solution 30:

When two or more elements combine to form a compound, the process is called synthesis. It may be brought about by the action of heat, electricity or pressure. Reactions in which direct combination of chemical substances occur are called as synthesis.

Example-

(a) When two elements combine to form a new compound.

$$H_2 + Cl_2 \rightarrow 2HCl$$

Hydrogen Chlorine Hydrogen chloride

(b) Where an element and a compound combine to form a new compound.

$$2CO + O_2 \rightarrow 2CO_2$$

Carbon monoxide Oxygen Carbon dioxide

(c) Where two compounds combine to form new compounds.

$$NH_3 + HCl \rightarrow NH_4Cl$$

Solution 31:

Air is necessary for burning. Incorrect amount of air in fuel combustion accounts for the largest losses in combustion system. If the fuel does not get enough air for combustion it will generate smoke and a potentially unhealthy mixture of gas products.

Solution 32:

1. (a) Combustible substances -The substances that catch fire and burn easily. Ex- Wood, Charcoal, petrol, kerosene etc.
   Non-combustible substances-Substance which cannot burn in air or oxygen are called as non- combustible substances. Ex-Nitrogen gas, carbon dioxide etc.
2. (b) Two substances other than oxygen that support combustion are-
   1. Hydrogen
   2. Nitrogen

Solution 33:

1. (a)
   1. Burning of coal in air releases CO_2 in air.
   2. Respiration releases carbon dioxide and water vapours.

2. (b)
    1. Photosynthesis removes CO_2 from the atmosphere. Plants take carbon dioxide from the atmosphere in the presence of sunlight and use it to synthesise glucose with the liberation of oxygen.
    2. Some man made chemical activities such as setting of mortar also use atmospheric carbon dioxide and helps in removing carbon dioxide.

Solution 34:
Nitrogen is inert in nature and does not support combustion while oxygen supports combustion.If proportions of nitrogen and oxygen in the air were reversed then the rate of combustion of substances will increase.

Solution 35:
Heating of sulphur – If some powdered sulphur is heated gently in a glass test tube, it melts to a pale yellow liquid. Flame is removed to stop heating, it is quickly changed back to solid sulphur.

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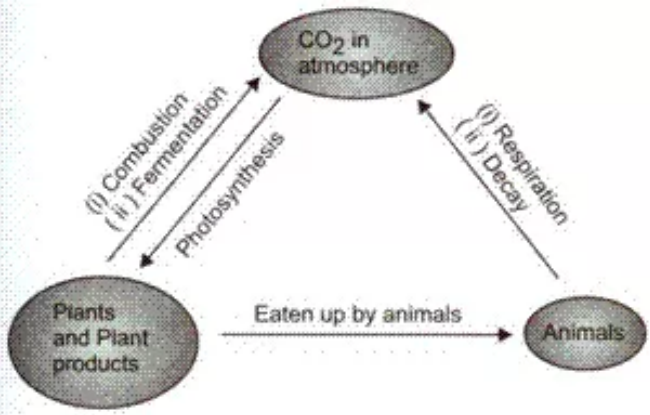
Solution 36:
Activity series – The arrangement of the metals in the decreasing order of their chemical reactivity is called the activity series.
In displacement reactions, a more reactive element (metal or non-metal) displaces a lesser reactive element from its compound. With the help of the activity series, it is possible to predict which metals will displace other metals from their solutions.

Solution 37:
Balance of oxygen and carbon dioxide is maintained in nature because there is a natural oxygen cycle and a natural carbon cycle operating all the time by which the desired proportions of the two gases in the air are maintained. This is also known as carbon dioxide-oxygen cycle.



Solution 38:

(a) $N_2 + O_2 \xrightarrow{3000^\circ C} 2\,NO$
Combination reaction

(b) $ZnCO_3 \longrightarrow ZnO + CO_2$
Decomposition reaction

(c) $Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$
Displacement reaction

(d) $Mg + 2HCl \longrightarrow MgCl_2 + H_2$
Displacement reaction

(e) $P_2O_5 + 3H_2O \longrightarrow 2H_3PO_4$
Combination reaction

(f) $2KI + Cl_2 \longrightarrow 2KCl + I_2$
Displacement reaction

(g) $2Cu(NO_3)_2 \longrightarrow 2CuO + 4NO_2 + O_2$
Decomposition reaction

(h) $ZnSO_4 + 2NaOH \longrightarrow Zn(OH)_2 + Na_2SO_4$
Double decomposition reaction

(i) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$
Displacement reaction

(j) $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$
Base Acid
Double decomposition reaction

(k) $Fe + S \longrightarrow FeS$
Combination reaction

(l) $Mg(HCO_3)_2 \longrightarrow MgCO_3 + H_2O + CO_2$
Decomposition reaction

(m) $CaO + H_2O \longrightarrow Ca(OH)_2$
Combination reaction

(n) $CaCl_2 + 2NH_4OH \longrightarrow Ca(OH)_2 + 2NH_4Cl$
Double decomposition reaction

(o) $3Mg + N_2 \longrightarrow Mg_3N_2$
Combination reaction

Solution 39:

Carbon dioxide from the atmosphere enters the plant through photosynthesis, where carbohydrates are produced. From green plants, the carbon in the form of carbohydrates, etc. enter the animal and human bodies. The atmospheric carbon dioxide gets dissolved in oceans by diffusion. Marine algae and photosynthetic bacteria obtain carbon dioxide from water.

Carbon dioxide returns to the atmosphere by respiration, combustion of fossil fuels like

coal, wood, petroleum etc., weathering of rocks, volcanic eruptions etc.

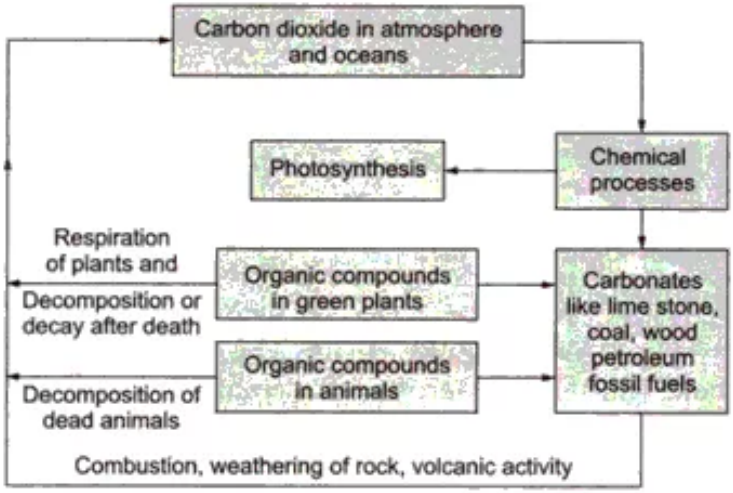


Fig-Carbon dioxide cycle

Solution 40:

The oxygen cycle is the biogeochemical cycle that describes the movement of oxygen within atmosphere, biosphere and lithosphere. The main source of atmospheric oxygen is photosynthesis, which produces sugars and oxygen from carbon dioxide and water.

$$6CO_2 + 6H_2O + \text{Energy} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

Oxygen also comes from photolysis.

Then oxygen is taken away from atmosphere by plants and animals. It is also consumed from atmosphere by chemical weathering i.e. oxidation of exposed minerals and rocks.

$$4FeO + O_2 \rightarrow 2Fe_2O_3$$

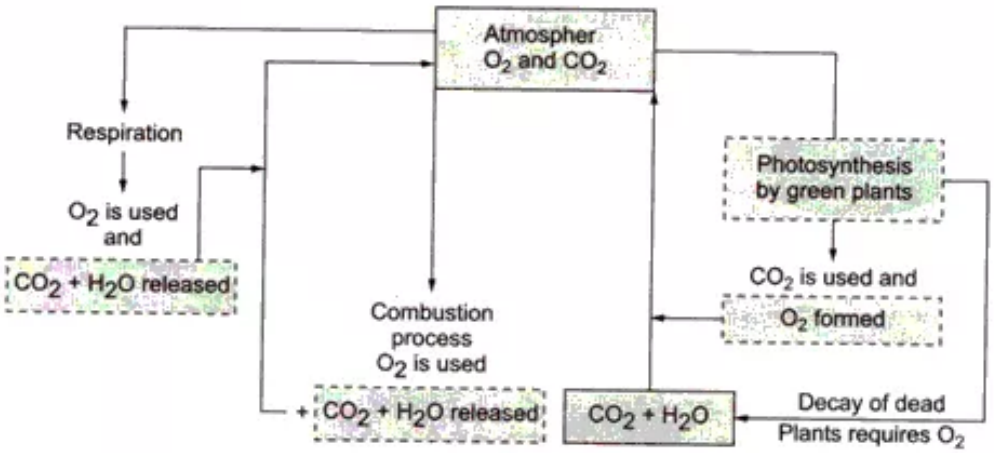


Fig-Oxygen cycle