Chemical Reaction & Equation

Assess Yourself

Q. 1. What happens when a chemical reaction occurs?

Answer: When a chemical reaction occurs:

i. New substances are formed by breaking and making of new bonds.

ii. Some gases may evolve during the reaction.

iii. Change in smell.

iv. Change in colour.

v. Change in state (liquid, solid or gaseous)

vi. Change in temperature.

Q. 2. What happens when hydrogen combines with oxygen in the presence of an electric current?

Answer: When hydrogen reacts with oxygen in the presence of an electric current, formation of water takes place which conducts electricity.

At the cathode, the electrons and the hydrogen ions combine with oxygen to make water.

The reaction takes place is given as:

$2H_2 + O_2 \rightarrow 2H_2O$

Q. 3. Give an example of a double displacement reaction.

Answer: The reaction in which there is an exchange of ions between the reactant takes place is called double displacement reaction.

A and C are Cations (Positive Ions)
B and D are Anions (Negative Ions)

Double Displacement Reaction

For example:

$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$

Sodium Barium Barium Sodium sulphate chloride sulphate chloride

In the above reaction, the exchange of ions (SO_4^{2-} and Ba^{2+}) takes place. The white precipitate of BaSO4 is formed by the reaction of SO_4^{2-} and Ba^{2+}. The other product formed NaCl remains in the solution.

Q. 4. "We need to balance a skeletal chemical equation." Give reason to justify this statement.

Answer: Balanced chemical equation: A chemical equation in which the number of atoms of reactants are equal to the number of atoms of products is called a balanced equation.

We need to balance a skeletal chemical equation because:

i. According to the law of conservation of mass, mass (or atoms) are neither created nor destroyed in chemical reactions.

ii. It means the total mass of the products formed in chemical reaction must be equal to the mass of reactants consumed.

Q. 5. Giving an example list two information which make a chemical equation more useful (informative).

Answer: Chemical equations can be made more informative by the following characteristics:

Physical state

There are three different states which are solid, liquid and gaseous. If the substance exists in solid state, it is represented by (s).

If the substance exists in aqueous state, it is represented by (aq).

If the substance exists in gaseous state, it is represented by (g).

For example:

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

Evolution of gas

If the gas is liberated in a reaction, it is indicated by an arrow upward and its physical state is shown by (g).

For example:

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)\uparrow$

Q. 6.A. Write a balanced chemical equation for process of photosynthesis.

Answer: Photosynthesis reaction: $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2 + H_2O$

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

Step 1: Write the unbalanced equation

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

Step 2: Compare the number of atoms of reactants with the number of atoms of products.

	Reactants (left side)	Products (right side)
Element	Number of atoms	Number of atoms
C	1	6
H	2	14
O	3	9

Step 3: Now, first we consider the element having unequal no. of atoms on both sides. Thus, first let us consider carbon atom. If we multiply 6 in the reactant (in CO_2), we will get the equal number of atoms as in product (in $C_6H_{12}O_6$)

No. of atoms of carbon	Reactant (in CO_2)	Product (in $C_6H_{12}O_6$)
Initially	1	6
To balance	$1 \times 6 = 6$	6

Step 4: Write the resulting equation:

6CO2 + H2O → C6H12O6 + O2 + H2O

Step 5: Now check whether the equation is balanced or not by comparing the atoms

	Reactants (left side)	Products (right side)
Element	Number of atoms	Number of atoms
C	6	6
H	2	14
O	13	9

We find that the equation is not balanced yet. As the number of

Hydrogen and oxygen atoms are unequal on the two sides.

First balance the hydrogen atom.

Step 6: If we multiply 12 in the reactant (in H_2O) and 6 in the product (in H_2O), we will get the equal number of hydrogen atoms both sides.

No. of atoms of hydrogen	Reactant (in H_2O)	Product (in $C_6H_{12}O_6 + H_2O$)
Initially	2	14
To balance	$2 \times 12 = 24$	$12 + 2 \times 6 = 24$

Step 7: Write the resulting equation:

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

Step 8: Now check whether the equation is balanced or not by comparing the atoms.

	Reactants (left side)	Products (right side)
Element	Number of atoms	Number of atoms
C	6	6
H	24	24
O	24	14

We find that the equation is not balanced yet. As the number of oxygen atoms are unequal on the two sides.

Step 9: Now, we consider oxygen atoms. If we multiply 6 in the product (in O_2), we will get the equal number of atoms as in reactants (in $6CO_2$ and $12H_2O$)

No. of atoms of oxygen	Reactant ($6CO_2$ and $12H_2O$)	Products ($C_6H_{12}O_6 + O_2 + 6H_2O$)
Initially	24	14
To balance	24	$6 + 2 \times 6 + 6 = 24$

Step 10: Write the resulting equation:

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

We find that the equation is balanced now.

Step 11: Write down the final balanced equation:

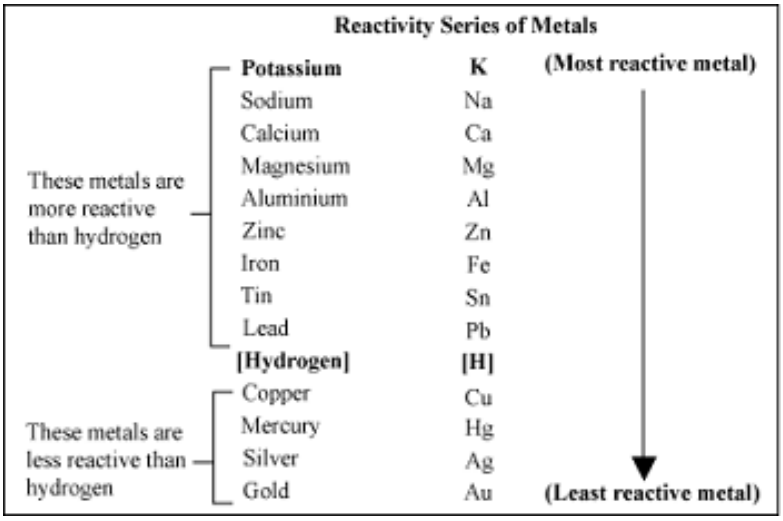
$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

Q. 6.B. When do desert plants take up carbon dioxide and perform photosynthesis?

Answer: In deserts, the weather is very hot and the amount of rainfall is very low. Hence, if desert plants take CO_2 during day, large amount of water can be lost. To avoid this water loss, some of the desert plants take CO_2 during night.

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

Answer:



As you can observe in the above series that zinc is more reactive than the hydrogen whereas copper is less reactive than hydrogen.

More reactive the metal is, more easily it will displace hydrogen atoms. Hence,

i. When zinc reacts with hydrochloric acid, it liberates hydrogen gas (hydrogen is displaced)

$Zn + HCl \rightarrow ZnCl_2 + H_2$

ii. On the other hand, when copper reacts with hydrochloric acid, it is unable to displace the hydrogen gas. As a result, no hydrogen gas is liberated.

$Cu + HCl \rightarrow$ No reaction

Q. 8. Identify the reducing agent in the following reactions:

(a) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

(b) $H_2O + F_2 \rightarrow HF + HOF$

(c) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(d) $2H_2 + O_2 \rightarrow 2H_2O$

Answer: Reducing agent: A reducing agent is an element that loses electrons.

The reducing agent means to loose electrons; it is said to have been oxidized.

The element which undergoes oxidation (gets oxidized) is called reducing agent.

a) NH3 is reducing agent

$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

In the given reaction, nitrogen is oxidized to NO by gaining oxygen atom. Thus, NH3 is reducing agent as it undergoes oxidation.

b) F_2 is reducing agent

$H_2O + F_2 \rightarrow HF + HOF$

In the given reaction, F_2 is oxidized to HOF by gaining hydrogen atom. Thus, F_2 is reducing agent as it undergoes oxidation.

(c) CO is reducing agent

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

In the given reaction, CO is oxidized to CO2 by gaining oxygen atom. Thus, CO is reducing agent as it undergoes oxidation.

(d) H_2 is reducing agent

$2H_2 + O_2 \rightarrow 2H_2O$

In the given reaction, $2H_2$ is oxidized to $2H_2O$ by gaining oxygen atom. Thus, $2H_2$ is reducing agent as it undergoes oxidation.

Q. 9. You might have noted that when copper powder is heated in a china dish, the surface of copper powder becomes coated with a black colour substance.

(a) How has this black coloured substance formed?
(b) What is that black substance?
(c) Write the chemical equation of the reaction that takes place.

Answer: (a) When copper powder is heated in the presence of air (oxygen), cooper reacts with oxygen to form copper oxide. The copper oxide formed is black in colour. The black colour is formed because the oxidation of copper takes place.

(b) The black substance formed is copper oxide.

(c) The chemical equation of the reaction that takes place is given below:

$2Cu + O_2 \rightarrow 2CuO$

Q. 10. Identify the oxidising agent (oxidant) in the following reactions:

(a) $Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + Cl_2 + 4H_2O$

(b) $2Mg + O_2 \rightarrow 2MgO$

(c) $CuSO_4 + Zn \rightarrow Cu + ZnSO_4$

(d) $V_2O_5 + 5Ca \rightarrow 2V + 5CaO$

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

(f) $CuO + H_2 \rightarrow Cu + H_2O$

Answer: Oxidizing agent: An oxidizing agent is an element that gains electrons. Since, the oxidizing agent means to gain electrons; it is said to have been reduced.

The element which undergoes reduction (gets reduced) is called oxidizing agent.

(a) Pb_3O_4 is reducing agent

$Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + Cl_2 + 4H_2O$

In the given reaction, Pb_3O_4 loses oxygen and reduces to $PbCl_2$.

Thus, Pb_3O_4 is an oxidizing agent as it undergoes reduction.

(b) O_2 is oxidizing agent

$2Mg + O_2 \rightarrow 2MgO$

In the given reaction, O2 is reduced by losing oxygen atoms. Thus, O_2 is an oxidizing agent as it undergoes reduction.

(c) $CuSO_4$ is oxidizing agent

$CuSO_4 + Zn \rightarrow Cu + ZnSO_4$

In the given reaction, CuSO4 is reduced to Cu by losing oxygen atoms. Thus, CuSO4 is an oxidizing agent as it undergoes reduction.

(d) V_2O_5 is oxidizing agent

$V_2O_5 + 5Ca \rightarrow 2V + 5CaO$

In the given reaction, V_2O_5 is reduced to V by losing oxygen atoms. Thus, V_2O_5 is an oxidizing agent as it undergoes reduction.

(e) H_2O is oxidizing agent

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

In the given reaction, H_2O is reduced to H_2 by losing oxygen atoms. Thus, H_2O is an oxidizing agent as it undergoes reduction.

(f) CuO is oxidizing agent

$CuO + H_2 \rightarrow Cu + H_2O$

In the given reaction, Cu is reduced to Cu by losing oxygen atom. Thus, CuO is an oxidizing agent as it undergoes reduction.

Q. 11. Write the balanced chemical equation for the following equations for the following reaction and identify the type of reaction in each case.

(a) Nitrogen gas is treated with hydrogen gas in the presence of a catalyst at 773K to form ammonia gas.

(b) Sodium hydroxide solution is treated with acetic acid to form sodium acetate and water.

(c) Ethanol is warmed with ethanoic acid to form ethyl acetate in presence of conc. H_2SO_4.

(d) Ethene is burnt in presence of oxygen to form carbon dioxide, water and releases heat and light.

Answer: (a) When nitrogen gas is treated with hydrogen gas in the presence of a catalyst at 773K to form ammonia gas. The following reaction takes place:

$$N_2(g) + 3H_2(g) \xrightarrow[773\ K]{\text{Catalyst}} 2NH_3(g)$$

The above reaction is a type of combination reaction.

Combination reaction is reaction in which two reactants combined together to form a product.

(b) When sodium hydroxide solution is treated with acetic acid to form sodium acetate and water. The following reaction takes place:

$NaOH + CH_3COOH \rightarrow CH_3COONa + H_2O$

The above reaction is a type of neutralization reaction/ double displacement reaction.

A neutralization reaction is a reaction in which base (NaOH) and acid (CH_3COOH) react together to form a salt (CH_3COONa) and water.

(c) When ethanol is warmed with ethanoic acid to form ethyl acetate in presence of conc. H_2SO_4. The following reaction takes place:

$$C_2H_5OH + CH_3COOH \xrightarrow{H_2SO_4\ \text{conc}} CH_3COOC_2H_5 + H_2O$$

The above reaction is a type of esterification reaction/double displacement reaction.

An esterification reaction is a reaction in which alcohol (C_2H_5OH) and Carboxylic acid (CH_3COOH) react together to form a sweet-smelling substance called ester ($CH_3COOC_2H_5$)

(d) When ethene is burnt in presence of oxygen to form carbon dioxide, water and releases heat and light. The following reaction takes place:

$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$ + heat + light

The above reaction is a type of combustion reaction.

Combustion reaction is a reaction which takes place in the presence of oxygen to form carbon dioxide.

Q. 12. Complete the missing components/variables given as x and y in the following reactions:

(a) $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(x) + 2KNO_3(y)$

(b) $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + x$

(c) $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(x) + H_2(y)$

(d) $CaCO_3(s) \xrightarrow{x} CaO(s) + CO_2(g)$

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

Hence, x is (s) and y is (aq) (s) means PbI_2 exists in solid state and (y) means that KNO3 exists in aqueous/liquid state.

(b) $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

Hence, x is Ag(s) In the above reaction, Ag gets replaced by Cu.

(c) $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

Hence, x is (aq) and y is (g) (aq) means copper sulphate formed exists in aqueous state. (g) Means hydrogen gas is liberating.

(d) $CaCO_3(s) \xrightarrow{heat} CaO(s) + CO_2(g)$

Hence x is heat

When $CaCO_3$ is heated in the presence of oxygen, it forms calcium oxide (CaO) and carbon dioxide.

Q. 13. Identify the type of chemical reaction taking place in each of the following:

(a) Barium chloride solution is mixed with a copper sulphate solution and a white precipitate is observed.

(b) On heating copper powder in the air in a china dish, the surface of copper powder turns black.

(c) On heating, green coloured ferrous sulphate crystals, reddish brown solid is left and a smell of a gas having an odour of burning sulphate is experienced.

(d) Iron nails when left dipped in blue copper sulphate solution become brownish in colour and the blue colour of copper sulphate fades away.

(e) Quick lime reacts vigorously with water releasing a large amount of heat.

Answer: (a) Double displacement and precipitation reaction

When barium chloride solution is mixed with copper sulphate solution and a white precipitate is observed.

In double displacement reaction, a precipitate is formed which settles down at the bottom. Any reaction that produces a precipitate is called a precipitation reaction.

$BaCl_2 + CuSO_4 \rightarrow BaSO_4 (\downarrow) + NaCl$ White ppt.

Note: A precipitate is a substance which is insoluble in water.

(b) Oxidation reaction

On heating copper powder in air in a china dish, the surface of copper powder turns black because copper undergoes oxidation in the presence of air.

$2Cu + O_2 \rightarrow 2CuO$ Black

(c) Thermal decomposition

On heating green coloured ferrous sulphate crystals, reddish brown solid is left and smell of a gas having odour of burning sulphate is experienced.

$$2FeSO_4(s) \xrightarrow{Heat} Fe_2O_3(s) + SO_2(g) + SO_3(g)$$

In the above reaction, ferrous sulphate ($FeSO_4$) decomposes to ferric oxide (Fe_2O_3)

(d) Displacement reaction

Iron nails when left dipped in blue copper sulphate solution become brownish in colour and the blue colour of copper sulphate fades away.

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

As we know that displacement reaction is a reaction in which one element displaces other element from its compound and takes its place there in.

In the above reaction Fe replaces Cu and form a new compound.

(e) Exothermic reaction

Quick lime reacts vigorously with water releasing a large amount of heat:

$CaO + H_2O \rightarrow Ca(OH)_2 + heat$

In the above reaction, the heat is released. Hence, it is an exothermic reaction.

Exothermic reaction is a reaction in which heat is released when reactants changes into products.

Q. 14. Seema likes sugar apple which is a multipurpose, an all-rounder fruit. It can be used by athletes as high calorie fruit for high energy. The powdered of its seeds is an effective pesticide in agriculture and horticulture and also used to remove head lice. Its leaves have anti-diabetic properties. The alcoholic extract of its leaves and stems can treat tumours. This extract is an antidepressant. Fruits are sweet and increase the haemoglobin, cooling and act as sedative. Seeds are insecticides. Its roots are powerful purgatives and used in dysentery.

(a) Why is sugar apple used by athletes?

(b) Why should we use it as a pesticides and insecticides instead of chemicals? Which value is associated with its use?

(c) Which metal is present in haemoglobin?

Name one more fruit which is rich in iron?

(d) Why should people take fruits rich in iron?

(e) What values are possessed by Seema who uses this multipurpose fruit instead of junk food?

Answer: (a) Sugar is used by athletes because:

i. It is a multipurpose, an all-rounder fruit.

ii. It can be used by athletes as high calorie fruit for high energy.

iii. It increases the flow of blood in the whole body.

iv. It increases haemoglobin too.

(b) We should use sugar apple as a pesticides and insecticides instead of chemicals because:

i. Chemicals can harm plants and can stop their growth.

ii. On the other hand, the powdered seeds of sugar apple do not cause any harm to plants as they are purely natural.

(c) Iron is present in our haemoglobin. Iron is an important element for the formation of blood in the body. The lack of iron in body can cause too many problems. The other fruits which is rich in iron is banana.

(d) People take fruits rich in iron because iron increases the production of blood in the body. It increases the haemoglobin which keeps us fit from top to bottom

(e) Seema is health-conscious, aware and knowledgeable too.