CHEMICAL REACTIONS AND EQUATIONS

Gist of the Lesson:

1. Chemical Reactions:

Chemical changes or chemical reactions are the changes in which one or more new substances are formed.

2. Chemical Equations:

Representation of a chemical reaction in terms of symbols and formulae of the reactants and products is known as chemical equation.

3) Balanced Chemical Equations:

The chemical equation in which the number of atoms of different elements is same on both sides of the arrow is called balanced chemical equation.

4) The chemical reactions can be classified into different types such as—

a) Combination Reaction:

The reactions in which two or more substances combine to form a new substance are called combination reaction.

For Example: $2Mg(s)+O_2(g)\rightarrow 2MgO(s)$

b) Decomposition Reaction:

The reaction in which a single compound breaks up into two or more simpler substances is called Decomposition Reactions.

For Example:

$$2Pb(NO_3)_2(s)\rightarrow 2PbO(s)+4NO_2(g)+O_2(g)$$

The decomposition of a substance by passing electric current through it is known as electrolysis. The decomposition of a substance on heating is known as thermal decomposition. The decomposition of a

substance by absorbing light energy is called photochemical decomposition.

c) Displacement Reactions:

The chemical reactions in which a more reactive element displaces a less reactive element from a compound are known as displacement reactions.

For Example,

i) $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

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

d) Double Displacement Reactions:

The chemical reactions in which compounds react to form two different compounds by mutual exchange of ions are called Double Displacement Reactions.

These reactions take place in solution; two common types of this reaction are precipitation reactions and neutralization reactions

i) Precipitation Reaction:

In this reaction, aqueous solutions of two salts are mixed whereby. Some salts precipitate due to mutual exchange of ions between the two salts.

For Example:

$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3$

ii) Neutralization Reaction:

In this type of reaction an acid reacts with a base to form salt and water by exchange of ions.

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O$

e) Redox Reaction:

Chemical reaction which shows both oxidation and reduction reaction.

Oxidation:

Reaction that involves the gain of oxygen or loss of hydrogen.

Reduction:

Reaction that shows the loss of oxygen or gain of hydrogen. Both oxidation and reduction take place simultaneously and hence called Redox Reaction.

$$ZnO + C \rightarrow Zn + CO$$

ZnO reduce to Zn ---- reduction C

Oxidize to CO ..... oxidation

f) Exothermic reaction and endothermic reaction:

On the basis of energy changes during chemical reaction, they can be classified as

i) Exothermic Reaction:

A chemical reaction in which heat energy is produced.

$$C + O_2 \rightarrow CO_2(g) + heat$$

ii) Endothermic Reaction:

A chemical reaction in which heat energy is absorbed.

$$CaCO_3 + Heat \rightarrow CaO + CO_2$$

5. Corrosion:

The process of slow conversion of metals into their undesirable compounds due to their reaction with oxygen, water, acids, gases etc. present in the atmosphere is called corrosion. Rusting - Iron when reacts with oxygen and moisture forms red substance called rust.

6. Rancidity:

The taste and odour of food materials containing fat and oil changes when they are left exposed to air for long time. This is called rancidity. It is caused due to oxidation of fat and oil present in food material. It can be prevented by using various methods such as by adding antioxidants to the food materials, Storing food in air tight container and by flushing out air with nitrogen.

One Mark Questions (One word or one sentence)

1. How do you show that respiration is a chemical change?

A. During respirations energy is released.

2. Calcium carbonate on heating forms calcium oxide and carbon-dioxide. Write the equation for the reaction and indicate the evolution of gas?

A. $CaCO_3 \longrightarrow CaO + CO_2 \uparrow$

3. Write balanced chemical equations to represent the following statements?

(i)Carbon (coke) burns in air to form carbon dioxide gas.

(ii)A piece of sodium metal on putting in water forms caustic soda and hydrogen gas.

A. (i) $C(s) + O_2 \uparrow \longrightarrow CO_2 \uparrow$

(ii) $2Na(s) + 2H_2O \longrightarrow 2NaOH(aq) + H_2 \uparrow$

4. The internal energy of the system increases when the following reaction is called out. State whether the reaction is exothermic or endothermic?

A. Endothermic.

5. Rewrite the following equation in a balanced form and indicate in the equation that the reaction is exothermic?

A. $C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$

$2C_6H_6 + 15O_2 \longrightarrow 12CO_2 + 6H_2O + heat$

6. The equation for the oxidation of methane is Make the equation as much informative as possible?

A. CH_4, O_2 and CO_2 are gases. We know that this reaction is highly exothermic and so H_2O is also obtained as steam.

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g) + heat$

7. What are Isomers?

A. Compounds having same molecular formulae (containing same number and kind of atoms) but different chemical properties are called Isomers. In isomers, arrangement of atoms is different.

8. State two ways of increasing the rate of reaction between marble chops and hydrochloric acid?

A. (i) By increasing temperature.

(ii)By using marble chips in powdered form, i.e., by increasing the surface area of reactants.

9. What is corrosion? What are its effects?

A. Due to the effect of moisture and acids, metals get corroded. This effect is called corrosion.

Corrosion causes damage to metal articles like car bodies, bridges, iron railings, ships and other substances of daily use.

10. Give two differences between rusting and burning?

A. (a) Rusting is a slow process while burning is a fast process.

(b) Rusting takes place in the presence of oxygen and moisture while burning requires only oxygen.

11. Give four similarities between rusting and burning?

A. (a) Both require oxygen; (b) Both produce oxides,

(c) Both produce heat energy and (d) Both are chemical changes.

12. When Iron is heated with sulphur, iron sulphide is formed?

$(Fe + S \longrightarrow FeS)$. What is this reaction called?

A. Combination reaction.

13. Name the reaction involved in the digestion of food in our body?

A. Decomposition reaction.

14. In the Redox Reaction:

$$ZnO + C \longrightarrow Zn + CO$$

Name the oxidising agent.

A. ZnO is oxidising agent.

15. Name the following reaction:

$$AB + CD \longrightarrow AD + CB$$

A. Double displacement reaction.

16. When hydrogen is passed over heated CuO, brown copper is deposited. Which substance is reduced?

A. Copper oxide.

17. Name the substance being reduced in the reaction?

$$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$$

A. MnO_2 is reduced.

18. The taste and smell of food changes when kept for long time in open. What is it called?

A. Rancidity.

19. What is the name given to a symbolic representation of an actual chemical change?

A. Chemical equation.

20. Give two necessary conditions for rusting?

A. (a) Presence of air or oxygen.

(b) Presence of moisture.

21. On what principle the balancing of chemical equation is based?

A. Law of conservation of mass.

22. How can rancidity be prevented?

A. By adding antioxidants to food.

Two Marks Questions (30 words)

1. How will you know whether a chemical reaction has taken place?

A. When a chemical reaction occurs, one or more of the following Changes take place:

(i) Change in state

(ii) Change in colour

(iii) Evolution of a gas

(iv) Change in temperature.

2. How would you justify that a chemical reaction has taken place in the following cases?

(i) Burning of magnesium ribbon in air.

(ii) Addition of lead nitrate solution to potassium iodide solution.

(iii) Addition of dilute hydrochloric acid to zinc granules.

A. (i) Burning of magnesium ribbon in air gives a powder (of MgO). So there is a change of state.

(ii) Addition of colourless lead nitrate solution to potassium iodide solution gives yellow coloured precipitate (lead iodide). So there is a change of colour.

(iii) Addition of dilute hydrochloric acid to zinc granules gives a gas (H_2) with effervescence.

3. What do you understand by skeleton and balanced chemical equation?

A. If the number of atoms of any element in a chemical equation is not equal on both sides, then it is a skeleton equation.

For Example: $Mg + HCl \longrightarrow MgCl_2 + H_2$

Here, the number of chlorine and hydrogen atoms are not equal on both sides.

In a balanced equation, the number of atoms of different elements on both sides of a chemical equation is equal. For example,

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$

4. What are the essentials of a chemical equation?

A. (i) It must refer to an actual chemical reaction.

(ii) It should be molecular. For example, H, 0, N should be written as H_2, O_2, N_2.

(iii) It should be balanced and conform to the law of conservation of matter.

5. What is a thermo chemical equation? Give two examples?

A. Most chemical reactions are accompanied by either evolution or absorption of heat. These reactions are known as exothermic and endothermic reactions respectively. Such an equation in which information about heat change is included is called a thermo chemical equation. It is very important in such a case to indicate the physical state of the various species involved.

Examples:

i) $C(s)+O_2(g)\longrightarrow CO_2(g);\Delta H = 393.5\ \text{kJ}$

(Exothermic .reaction)

(ii) $C(graphite)+2H_2(g)\longrightarrow CH_4(g)\Delta H = +74.25\,\text{kJ}$

(Endothermic reaction)

6. What are the resulting species when 11.2 litres of oxygen at S.T.P. is passed through 1 mole of HCl solution in water?

$4HCl+O_2\longrightarrow 2H_2O+2Cl_2$

A. 11.2 Ans. 11.2 litres of oxygen at S.T.P. $\frac{11.2}{22.4}=0.5=$ mole

From equation, it is seen that 1 mole of oxygen when passed into 4 moles HCl will produce 2 moles of chlorine. Thus, 0.5 mole oxygen will require 2 moles of HCl for complete reaction. Since, only 1 mole of HCl is present, only half of oxygen (0.25 mole) will be utilized.

$$\therefore \underset{1mole}{4HCl} + \underset{0.25mole}{O_2} \longrightarrow 2H_2O + \underset{0.5mole}{2Cl_2}$$

Thus, after the reaction is over, species present would be O_2 = 0.5 - 0.25 = 0.25 mole and Cl_2 = 0.5 mole.

7. State the electronic concept of oxidation and reduction?

A. (i) **Oxidation:** An oxidation reaction is one in which electrons are released or lost. Magnesium atom is oxidised to magnesium ion by loss of electrons.

$$\underset{Magnesium\ atom}{Mg} \longrightarrow \underset{Magnesium\ ion}{Mg^{2+}} + \underset{Electrons}{2e}$$

(ii) **Reduction:** A reaction in which electrons are accepted is called a reduction. Oxygen atom is reduced to oxide ion by accepting two electrons.

$$\underset{Oxygen\ atom}{O} + \underset{Electrons}{2e} \longrightarrow \underset{Oxide\ ion}{O^{2-}}$$

8. State some reactions of oxidation that you observe in your everyday life?

A. Some examples of oxidation reactions are:-

(a) Shiny iron articles on exposure to air get coated with a brownish layer.

(b) Copper articles on exposure to air get coated with a greenish layer.

(c) Silver articles on exposure become black.

(d) Fats and oils in food left for long time get oxidised.

9. What is Rancidity? How is it prevented?

A. Fats and oils in food kept for long time get oxidised and become rancid and taste of food changes and causes infection on eating. This is called rancidity.

To prevent rancidity antioxidants (which prevent oxidation) are added to foods containing fats and oils. Rancidity can also be prevented by flushing out oxygen with an insert gas like nitrogen. For example, packets of food items like chips are flushed with nitrogen so that these can be used even after long duration. Keeping food in air tight containers also help to slow oxidation and to preserve food for a longer time.

Three Marks Questions (50 words)

1. How is a chemical equation written? Illustrate with an example?

A. Reaction writing should be done in a systematic manner, using the conventions followed. These are illustrated with the help of an example. Let it be required to write a chemical equation that describes the reaction between magnesium and sulphuric acid to produce magnesium sulphate and hydrogen.

i) Write the symbols of all the substances involved in the reaction - first reactants and then the products - one after the other On the Same Line

Reactants Products

Mg H_2SO_4 $MgSO_4$ H_2

(ii)Separate the reacting substances from the products by a symbol meaning 'produce'. The sign (an arrow) or sometimes sign (equal) = is used for this purpose.

$$Mg \quad H_2SO_4 \longrightarrow MgSO_4 \quad H_2$$

(iii) Then put + sign between the reactants indicating that these 'react' and a (plus) + sign between the products which signifies 'and',

$$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$$

2. What does a balanced chemical equation convey to a chemist?

A. The following information are conveyed:

(i) Formulae of substances taking part in chemical reaction i.e., reactants.

(ii) Formulae of substances produced in the reaction i.e., products.

(iii) The relative number of molecules of reactants and products.

(iv) The relative masses of reactants and products.

(v) The relative volumes of gaseous substances involved in the reaction.

3. Explain the terms: (i) Thermal decomposition and

(ii) Electrolytic decomposition with suitable examples.

A. **(i) Thermal decomposition:** A reaction in which a compound is decomposed into two or more substances by heat is called thermal decomposition.

For Example: when calcium carbonate is heated, it decomposes to give calcium oxide and carbon dioxide.

$$\underset{\text{Calcium Carbonate}}{CaCO_3(s)} \xrightarrow[\text{Decomposition}]{\text{heat}} \underset{\text{Calcium Oxide}}{CaO(s)} + \underset{\text{Carbon Dioxide}}{CO_2(s)}$$

The single compound calcium carbonate gives two compounds, CaO and CO_2 and so, this reaction is a decomposition reaction.

(ii) Electrolytic Decomposition: In the presence of electricity, water breaks up into hydrogen and oxygen.

$$\underset{\text{water}}{2H_2O(l)} \xrightarrow[\text{decomposition}]{\text{Electricity}} \underset{\text{Hydrogen}}{2H_2(g)} + \underset{\text{Oxygen}}{O_2(g)}$$

This is an example of electrolytic decomposition, since a compound is decomposed by passing electricity through it.

4. What is the difference between the displacement and double displacement reactions? Write equations for these reactions?

A. In a displacement reaction, one element takes the place of another element in a compound, e.g., in the given reaction:

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

Chlorine is displacing bromine from potassium bromide to form potassium chloride and bromine is set free.

In a double displacement reaction, two different atoms or groups of atoms are displaced by other atoms/groups of atoms, e.g., in the reaction:

$$BaCl_2(aq) + Na_2SO_4(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$$

SO_4^{2-} ions displace Cl^- ions and Cl^- ions displace SO_4^{2-} ions. As these involve two groups of atoms (Cl^- and SO_4^{2-} - from two different compounds), these are called double displacement reactions. These reactions occur usually in ionic compounds.

Five Marks Questions (70 words)

1. Enlist the limitations of chemical equation?

A. Limitations or defects of a chemical equation:

A chemical equation does not indicate about:

(a) The physical states of the reactants and products.

(b) The concentrations of the reactants and products.

(c) The heat evolved (exothermic reaction) or absorbed (endothermic reaction) during the chemical reaction.

(d) The condition of temperature, pressure, catalyst etc. which are needed for a reaction.

(e) The rate of reaction, whether slow or fast.

(f) The reversibility of a reaction.

(g) Whether any precipitate is formed or gas is evolved in the reaction.

(h) The extent up to which reaction takes place.

(i) Time taken by the reaction for completion.

(j) Mechanism of the reaction.

2. What are the types of combination reactions? Give examples of each type?

A. Combination reactions are of three types. These are discussed as follows:

1. Combination between Two Elements:

In these reactions, two elements combine under suitable conditions to form a compound. A few samples of this type of combination reactions are:

(a) Carbon element burns in oxygen to form carbon dioxide

$$\underset{\text{Carbon}}{C} + \underset{\text{Oxygen}}{O_2} \xrightarrow{\text{combustion}} \underset{\text{Carbon dioxide}}{CO_2}$$

(b) Iron and sulphur elements when heated form iron sulphide

$$\underset{\text{Iron}}{Fe} + \underset{\text{Sulphur}}{S} \xrightarrow{heat} \underset{\text{Iron sulphide}}{FeS}$$

2. Combination between an element and a compound:

In these reactions, one of the combining substances is an element whereas the other is a compound. A few example of this type of combination reactions are:

(a) Carbon monoxide combines with oxygen to form carbon dioxide

$$\underset{\text{Carbon monoxide}}{2CO} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Carbon dioxide}}{2CO_2}$$

(b) Sulphur dioxide combines with oxygen upon heating to form sulphur trioxide.

$$\underset{\text{Sulphur dioxide}}{2SO_2} + \underset{\text{Oxygen}}{O_2} \xrightarrow{heat} \underset{\text{Sulphur dioxide}}{2SO_3}$$

3. Combination between two compounds:

In these combination reactions, two compounds take part to form a new compound.

For Example:

(a) Ammonia reacts with hydrogen chloride to form ammonium chloride.

$$\underset{\text{Ammonia}}{NH_3} + \underset{\text{Hydrogen chloride}}{HCl} \longrightarrow \underset{\text{Ammonium chloride}}{NH_4Cl}$$

(b) Carbon dioxide combines with calcium oxide (quick-lime) to form calcium carbonate.

$$\underset{\text{Calcium oxide (Quick-lime)}}{CaO} + CO_2 \longrightarrow \underset{\text{Calcium carbonate}}{CaCO_3}$$

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