Language of Chemistry

Points to Remember:

- The valency of an element is the number of electrons donated or accepted by its 'atom' during chemical combination.
- There are some elements with more than one valency e.g., iron, copper, tin, lead.
- Two or more different non-metals that collectively accept or donate one or more electrons and become negatively or positively charged in the process are called **radicals.**
- A chemical reaction involves the transformation of original substance into an altogether new substance(s).
- A chemical reaction can be represented with the help of the symbols or the formulae of the elements and the compounds taking part in that reaction. This gives a chemical equation.
- Certain necessary conditions for a chemical reaction to happen are — close contact, solution form, heat, light and catalyst.
- Characteristics of chemical reactions are — change of colour, evolution of a gas, formation of a precipitate, change of state, change of smell and evolution/absorption of heat.
- A complete chemical equation symbolically represents the reactants, products and their physical states.
- The substances that react with each other are called reactants and they are represented on the left hand side of the equation. The substances that are formed as a result of the reaction are called products. They are represented on the right hand side of the equation.
- A chemical equation needs to be balanced to make it follow the law of the conservation of mass.
- The law of conservation of mass states that mass can be neither created nor destroyed, it can only be transformed from one form to another.
- A chemical equation gives both qualitative and quantitative information about the reactants and products.

ACTIVITY 1

Write the names and symbols of the first twenty elements that you have studied in class VI & VII.

Answer:

Name of the elements	Symbol	Valency
1. Hydrogen	H	1
2. Helium	He	0
3. Lithium	Li	1
4. Beryllium	Be	2
5. Boron	B	3
6. Carbon	C	4
7. Nitrogen	N	3
8. Oxygen	O	2
9. Fluorine	F	1
10. Neon	Ne	0
11. Sodium	Na	1
12. Magnesium	Mg	2
13. Aluminium	Al	3
14. Silicon	Si	4
15. Phosphorus	P	3
16. Sulphur	S	2
17. Chlorine	Cl	1
18. Argon	Ar	0
19. Potassium	K	1
20. Calcium	Ca	2

ACTIVITY 2

Write the molecular formulae of:

1. Copper oxide
2. Iron (III) chloride
3. Sodium hydroxide
4. Iron (II) sulphide
5. Lead (II) oxide
6. Hydrogen nitrate (nitric acid)
7. Hydrogen sulphate (sulphuric acid)
8. Calcium hydroxide
9. Magnesium carbonate
10. Ammonium carbonate

Answer:

1. Copper oxide – CuO
2. Iron (III) chloride – $FeCl_3$
3. Sodium hydroxide – $NaOH$
4. Iron (II) sulphide – FeS
5. Lead (II) oxide – PbO
6. Hydrogen nitrate (nitric acid) – HNO_3
7. Hydrogen sulphate (sulphuric acid) – H_2SO_4
8. Calcium hydroxide – $Ca(OH)_2$
9. Magnesium carbonate – $MgCO_3$
10. Ammonium carbonate – $(NH_4)_2CO_3$

ACTIVITY 3

Write the molecular formula for each of the following compounds:

1. Sulphur trioxide
2. Iron (II) sulphide and
3. Ammonia

Find the number and names of elements present in them and calculate their molecular masses.

Answer:

1. Sulphur trioxide

1. A molecule of sulphur trioxide is represented by the formula SO_3.
2. The elements present in it are sulphur dioxide and oxygen.

3. One molecule of sulphur trioxide has one atom of sulphur and three atoms of oxygen.
4. Molecular mass of sulphur trioxide (SO_3)
   = 32 + 3 x 16
   = 32 + 48 = 80 amu.

2. Iron (II) sulphide

1. A molecule of iron (II) sulphide is represented by the formula FeS.
2. The elements present in it are iron and sulphur.
3. One molecule of iron (II) sulphide has one atom of iron and one atom of sulphur.
4. Molecular mass of iron (II) sulphide (FeS)
   = 55.5 + 32
   = 87.5 amu.

3. Ammonia

1. A molecule of ammonia is represented by the formula NH_3.
2. The elements present in it are nitrogen and hydrogen.
3. One molecule of ammonia has one atom of nitrogen and three atoms of hydrogen.
4. Molecular mass of ammonia (NH_3)
   = 14 + 3 x 1
   = 14 + 3
   = 17 amu.

Exercise

Question 1.
Define:
(a) Radical
(b) Valency
(c) Molecular formula
Answer:
(a) Radical: A radical is an atom of an element or a group of atoms of different elements that behaves as a single unit with a positive or negative charge on it.
(b) Valency: It is the number of electrons donated or accepted by the valence shell of an atom during chemical combination.
(c) Molecular formula: It is a symbolic representation of a molecule. It shows the number of atoms of each element present in it. These atoms combine in whole number to form the molecule.

Question 2.
Give the symbols and valencies of following radicals:
(a) Hydroxide (b) Chloride
(c) Carbonate (d) ammonium

(e) Nitrate

Answer:

Element	Symbol	Valencies
(*a*) Hydroxide	OH^-	1
(*b*) Chloride	Cl^-	1
(*c*) Carbonate	CO_3^{2-}	2
(*d*) Ammonium	NH_4^+	1
(*c*) Carbonate	CO_3^{2-}	2
(*e*) Nitrate	NO_3^-	1

Question 3.

Write the molecular formula for the oxide and sulphide of following elements.
(a) Sodium (b) Calcium
(c) Hydrogen

Answer:

(a) Sodium oxide Na_2O
Sodium sulphide Na_2S
(b) Calcium oxide CaO
Calcium sulphide CaS
(c) Hydrogen oxide H_2O
Hydrogen sulphide H_2S

Question 4.

Write the molecular formulae for the following compounds and name the elements present.
(a) Baking soda (b) Common salt
(c) Sulphuric acid (d) Nitric acid

Answer:

(a) Baking soda — $NaHCO_3$
Elements present in Baking soda are sodium, hydrogen, oxygen and carbon.
(b) Common salt — NaCl
Element present are: Sodium and chlorine.
(c) Sulphuric acid — H_2SO_4
Element present are: Hydrogen, sulphur and oxygen.
(d) Nitric acid — HNO_3
Elements present are: Hydrogen, nitrogen and oxygen.

Question 5.

The valency of aluminium is 3. Write the valency of other radicals present in the following compounds.
(a) Aluminium chloride

(b) Aluminium oxide
(c) Aluminium nitride
(d) Aluminium sulphate

Answer:

(a) Aluminium chloride — ($AlCl_3$) here valency of Al is 3.
Other radical – Chloride (Cl^-)
Valency of chloride = 1
(b) Aluminium oxide — (Al_2O_3)
Here valency of Al is 3
Other radical present = oxide (O^{2-})
Valency of O^{2-} = 2
(c) Aluminium nitride — (Al N)
Here valency of aluminium = 3
Another radical = Nitride (N^{3-})
Valency of nitride (N^{3-}) = 3
(d) Aluminium sulphate — $Al_2(SO_4)_3$
Here valency of aluminium is 3
Another radical = Sulphate (SO_4^{2-})
Valency of ($SO_4$2-) = 2

Question 6.

What is variable valency ? Give two examples of elements showing variable valency.

Answer:

Certain elements exhibit more than one valency, that means they show variable valency.
Ferrous is written as Iron (II) and Ferric is written as Iron (III).

Metal	Radicals	Valency
Iron	Ferrous [Iron (II)] Ferric [Iron (III)]	2 3
Copper	Cuprous [Copper (I)] Cupric [Copper (II)]	1 2

Question 7.
(a) What is a chemical equation ?
(b) Why it is necessary to balance a chemical equation ?
(c) What are the limitations of a chemical equation ?
Answer:
(a) Chemical Equation— A chemical equation is the symbolic representation of a chemical reaction using the symbols and the formulae of the substances involved in the reaction.
(b) A chemical equation needs to be balanced so as to make the number of the atoms of the reactants equal to the number of the atoms of the products.
(c)

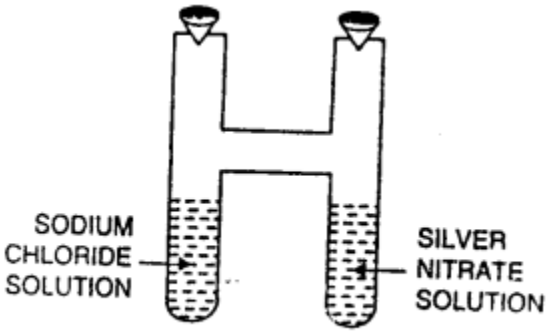
1. It does not inform about the physical states of the reactants and the product i.e. whether they are solids, liquids and gases.
2. It does not inform about the concentration of reactants and products.
3. It does not inform about the time taken for the completion of the reaction.
4. It does not inform about the rate at which a reaction proceeds.
5. It does not inform about the heat changes during the reaction i. e. whether the heat is given out or absorbed.
6. It does not inform about the conditions such as temperature, pressure, catalyst etc. which affect the reaction.
7. It does not inform about the nature of the reaction i.e. whether it is reversible or irreversible.

Question 8.
What are the ways by which a chemical equation can be made more informative ?
Answer:
A chemical equation can give more informations in the following ways:

1. The physical state of the reactants and products can be indicated by putting (s) for solid, (l) for liquid, (g) for gas and (aq) for aqueous state.
2. Evolution or absorption of heat during the reaction can be denoted by adding or subtracting a heat term on the product side.
3. Temperature, pressure and catalyst can be indicated above the arrow (→ or =) separating the reactants and products.
4. Concentration of reactants and products are indicated by adding word (dil) for dilute and (cone) for concentrated before their formulae.
5. By the sign → or ⇌ information about irreversible and reversible reactions can be obtained.

Question 9.
State the law of conservation of mass.
Answer:
Law of conservation of mass: It states that mass can neither be created nor

destroyed in a chemical reaction. During any change (physical or chemical), matter is neither created nor destroyed. However it may change from one form to another.



Landolt's Tube

Experimental Verification of Law of Conservation of Mass

Requirements: H-shaped tube called Landolt's tube, Sodium chloride solution, silver nitrate solution, etc.
Procedure: A specially designed H-shaped tube is taken. Sodium chloride solution is taken in one limb of the tube and silver nitrate solution in the other limb as shown in figure.
Both the limbs are now sealed and weighed. Now the tubes is averted so that the solutions can mix up together and react chemically. The reaction takes place and a white precipitate of silver chloride is obtained.

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

(silver nitrate) (sodium chloride) (silver chloride) (sodium nitrate)

The tube is weighed again. The mass of the tube is found to be exactly the same as the mass obtained before inverting the tube.
Thus, this experiment clearly verifies the law of conservation of mass.

Question 10.
Differentiate between:
(a) Reactants and products
(b) A balanced and an unbalanced chemical equation
Answer:
(a) Reactants and products

Reactants

1. The substances that react with one another are called reactants.
2. Reactants are written on the left hand side of equation.

Products

1. The new substances formed are called products.
2. Products are written on the right hand side of equation.

(b) A balanced and an unbalanced chemical equation

Balanced chemical

1. A balanced chemical reaction is the one in which the number of atoms of each element on the reactant side is equal to the number of atoms of that element on the product side.
2. Ex- $H_2 + Cl_2 \rightarrow HCl$

Unbalanced chemical

1. Number of elements on reactant side are not equal to the number of elements on product side.
2. Ex- $H_2 + Cl_2 \rightarrow 2HCl$

Question 11.

Balance the following equations:

(a) $N_2 + H_2 \rightarrow NH_3$

(b) $H_2 + O_2 \rightarrow H_2O$

(c) $Na_2O + H_2O \longrightarrow NaOH$

(d) $CO + O_2 \longrightarrow CO_2$

(e) $Zn + HCl \longrightarrow ZnCl_2 + H_2$

Answer:

(a) $N_2 + 3H_2 \rightarrow 2NH_3$

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

(c) $Na_2O + H_2O \longrightarrow 2NaOH$

(d) $2CO + O_2 \longrightarrow 2CO_2$

(e) $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

Question 12.

12. Write balanced chemical equations for the following word equations:
(a) Iron + Chlorine → Iron (III) chloride
(b) Magnesium + dil sulphuric acid → Magnesium sulphate + water
(c) Magnesium + oxygen → Magnesium oxide
(d) Calcium oxide + water → Calcium hydroxide

(e) Sodium + chlorine → Sodium chloride

Answer:

(a) Iron + Chlorine → Iron (III) chloride

$4Fe + 3Cl_2 \rightarrow 2F_2Cl_3$

(b) Magnesium + dil sulphuric acid → Magnesium sulphate + water

$2Mg + 2H_2SO_4 \rightarrow 2MgSO_4 + 2H_2$

(c) Magnesium + oxygen → Magnesium oxide

$2Mg + O_2 \rightarrow 2MgO$

(d) Calcium oxide + water → Calcium hydroxide

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

(e) Sodium + chlorine → Sodium chloride

$2Na + Cl_2 \rightarrow 2NaCl$

Question 13.

What information do you get from the following chemical equation:

$Zn(s) + 2HCl\ (dil) \rightarrow ZnCl_2\ (aq) + H_2(g)$

Answer:

This gives zinc chloride and hydrogen. The word equation is:

Zinc + Hydrochloric acid → Zinc chloride + Hydrogen

Formulae for the products are $ZnCl_2$ and H_2

ADDITIONAL QUESTIONS

Question 1.

(a) Define chemical reaction.

(b) What is a chemical equation?

(c) Why do we need to balance chemical equations?

Answer:

(a) Chemical reaction: Any chemical change in matter which involves its transformation into one or more new substances is called a chemical reaction.

(b) Chemical equation: A chemical equation is the symbolic representation of a chemical reaction using the symbols and the formula of the substances involved in the reaction.

(c) A chemical equation needs to be balanced so as to make the number of the atoms of the reactants equal to the number of the atoms of the products.

Question 2.

State four conditions necessary for a chemical reaction to take place.

Answer:

1. **Close contact—** For a chemical reaction to take place the reactants should be brought in close contact i.e., they should be mixed,
2. **Solution form—** Some substances react with each other only when they are mixed in the solution form,

e.g.,

$$\underset{\text{(aq.)}}{\text{Silve nitrate}} + \underset{\text{(aq.)}}{\text{Sodium chloride}} \longrightarrow \underset{\text{(ppt.)}}{\text{Silver nitrate}} + \underset{\text{(aq.)}}{\text{Sodium nitrate}}$$

3. **Heat—** Some reactants need to be heated to undergo a chemical change, e.g.,

$$\text{Potassium chlorate} \xrightarrow{\text{heat}} \text{Potassium chloride} + \text{Oxygen}$$

4. **Light—** Some reactions take place in the present of light.

$$\text{Carbon dioxide} + \text{Water} \xrightarrow[\text{sun light}]{\text{chlrophyll}} \text{Glucose} + \text{Oxygen}$$

Question 3.

Write balanced chemical equations for the reactions represented by word equations in the conditions for a chemical reaction.

Answer:

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

(*ii*) $AgNO_3 + NaCl \longrightarrow AgCl + NaNO_3$

(*iii*) $2KClO_3 \longrightarrow 2KCl + 3O_2$

(*iv*) $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

Question 4.

Balance the following equations:

(*i*) $Fe + O_2 \rightarrow Fe_3O_4$

(*ii*) $Fe + H_2O \rightarrow Fe_3O_4 + H_2$

(*iii*) $N_2 + O_2 \rightarrow NO$

(*iv*) $Pb_3O_4 \rightarrow PbO + O_2$

Ans. (*i*) $3Fe + 2O_2 \rightarrow Fe_3O_4$

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

(*iii*) $N_2 + O_2 \rightarrow 2NO$

(*iv*) $2Pb_3O_4 \rightarrow 6PbO + O_2$

Question 5.

Balance the following equations. Also name the products formed. The first one is done for you.

Answer:

1.	**$NaNO_3 \rightarrow NaNO_2 + O_2$**	**Name of product (s)**	
Ans.	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$	Sodium nitrite, oxygen	
2.	**$K + Cl_2 \rightarrow KCl$**		
Ans.	$2K + Cl_2 \rightarrow 2KCl$	Potassium chloride	
3.	**$Ag + S \rightarrow Ag_2S$**		
Ans.	$2Ag + S \rightarrow Ag_2S$	Silver sulphide	
4.	**$Mg + O_2 \rightarrow MgO$**		
Ans.	$2Mg + O_2 \rightarrow 2MgO$	Magnesium oxide	
5.	**$KClO_3 \rightarrow KCl + O_2$**		
Ans.	$2KClO_3 \rightarrow 2KCl + 3O_2$	Potassium chloride, oxygen	
6.	**$H_2O_2 \rightarrow H_2O + O_2$**		
Ans.	$2H_2O_2 \rightarrow 2H_2O + O_2$	Water, oxygen	
7.	**$H_2 + Cl_2 \rightarrow HCl$**		
Ans.	$H_2 + Cl_2 \rightarrow 2HCl$	Hydrogen chloride	
8.	**$Na + H_2O \rightarrow NaOH + H_2$**		
Ans.	$2Na + 2H_2O \rightarrow 2NaOH + H_2$	Sodium hydroxide, Hydrogen	
9.	**$CO + O_2 \rightarrow CO_2$**		
Ans.	$2CO + O_2 \rightarrow 2CO_2$	Carbon dioxide	
10.	**$Zn + HCl \rightarrow ZnCl_2 + H_2$**		
Ans.	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$	Zinc chloride, Hydrogen	
11.	**$K_2O + H_2O \rightarrow KOH$**		
Ans.	$2K_2O + 2H_2O \rightarrow 4KOH$	Potassium hydroxide	
12.	**$CO_2 + C \rightarrow CO$**		
Ans.	$CO_2 + C \rightarrow 2CO$	Carbon monoxide	
13.	**$N_2 + H_2 \rightarrow NH_3$**		
Ans.	$N_2 + 3H_2 \rightarrow 2NH_3$	Ammonia	
14.	**$PbCO_3 \rightarrow PbO + CO_2$**		
Ans.	$PbCO_3 \rightarrow PbO + CO_2$	Lead (*ii*) oxide, Carbon dioxide	
15.	**$FeCl_2 + Cl_2 \rightarrow FeCl_3$**		
Ans.	$2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$	Ferric chloride	

Question 6.
State what you would observe when the following substances are heated in a glass test tube:
(i) Red lead
(ii) Copper (II) carbonate
Answer:
(i) $2Pb_3O_4 \rightarrow 6PbO + O_2 \uparrow$
The dark red lead as red powder changes to yellow colour. The yellow colour residue on further heating sticks to the tube and give reddish colour to glass. A colourless and odourless gas is evolved.
(ii) $CuCO_3 \rightarrow CuO + CO_2 \uparrow$
The blue-green powder turns black and a colourless gas is evolved which extinguishes a burning flame.

Question 7.
Explain the following reaction with one suitable example for each.
(a) Combination reactions
(b) Decomposition reaction
(c) Displacement reaction
(d) Double decomposition reaction
Answer:
(a) Combination reactions: In this reaction two or more substances combine to form a new substance, e.g. Burning of hydrogen in air.
(b) Decomposition reaction: In this reaction a substance breaks up on heating to form two or more simpler substances, e.g. Electrolysis of water.
(c) Displacement reaction: In this reaction a more reactive element displaces a less reactive element from its compound, e.g. Reaction of iron with copper sulphate.
(d) Double decomposition reaction: In this reaction two compounds in solution state react with each other to form two new substances by exchanging their radicals, e.g. Reaction of sodium hydroxide with dilute hydrochloric acid.

Question 8.
Name the type of chemical reaction shown by the following equations:

(a) $\mathbf{CaCO_3 \rightarrow CaO + CO_2}$
(b) $\mathbf{2Mg + O_2 \rightarrow 2MgO}$
(c) $\mathbf{Fe + CuSO_4 \rightarrow FeSO_4 + Cu}$
(d) $\mathbf{NaOH + HCl \rightarrow NaCl + H_2O}$
(e) $\mathbf{Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe}$

Ans. (a) $CaCO_3 \rightarrow CaO + CO_2 \Rightarrow$ Decomposition reaction
(b) $2Mg + O_2 \rightarrow 2MgO \Rightarrow$ Combination reaction
(c) $Fe + CuSO_4 \rightarrow FeSO_4 + Cu \Rightarrow$ Displacement reaction
(d) $NaOH + HCl \rightarrow NaCl + H_2O \Rightarrow$ Double decomposition reaction
(e) $Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe \Rightarrow$ Displacement reaction

Question 9.

Write your observations and name the products when
(a) Zinc reacts with dilute hydrochloric acid.
(b) Iron nails are added to an aqueous solution of copper sulphate.
(c) An aqueous solution of barium chloride is added to dilute sulphuric acid.

Answer:

(a) When zinc pieces are added to hydrochloric acid, zinc displaces hydrogen. As a result, zinc chloride and hydrogen gas are produced.
(b) When iron pieces are added to an aqueous solution of copper sulphate iron being more reactive displaces copper from copper sulphate solution to produce ferrous sulphate.
(c) An aqueous solution of barium chloride when mixed with dilute sulphuric acid produces a white insoluble solid barium sulphate and hydrochloric acid.

Question 10.

A solution of a substance 'X' is used for white washing.
(a) Name the substance 'X' and write its formula.
(b) Write the reaction of the substance 'X' named in (a) above with water.

Answer:

(a) Calcium oxide CaO

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

quick lime — slaked lime