1 LANGUAGE OF CHEMISTRY-II

1. SYMBOLS AND FORMULAE

	♦	SYMBOLS
	♦	RADICALS
	♦	CHEMICAL FORMULAE
	♦	NAMING OF COMPOUNDS

SYMBOLS OF ELEMENTS

In order to represent the elements, instead of using full lengthy names, scientists use abbreviated names. These abbreviated names of the elements are known as symbols. Thus, **symbol** may be defined as the shorthand representation of an element.

The abbreviation used for the name of an element is more precisely known as chemical symbol of that element.

The symbols of elements are generally either the first or the first two letters or the first and the third letters of the name of the element. For example, the symbols of the following elements are the first letter of the name of that element.

Element	Symbol	Element	Symbol
Hydrogen	H	Carbon	C
Nitrogen	N	Oxygen	O
Fluorine	F	Phosphorus	P
Sulphur	S	Iodine	I

Some symbols derived from the first two letters of the names of the elements.

Element	Symbol	Element	Symbol
Aluminium	Al	Barium	Ba
Lithium	Li	Beryllium	Be
Neon	Ne	Silicon	Si
Argon	Ar	Calcium	Ca
Nickel	Ni		

Some symbols derived from the first and the third letters of the names of the elements.

Element	Symbol	Element	Symbol
Arsenic	As	Magnesium	Mg
Chlorine	Cl	Chromium	Cr
Manganese	Mn	Zinc	Zn
Rubidium	Rb		

However, there are certain symbols which seem to have no relationship to their names. The symbols of these elements are, in fact, derived from their Latin names.

Some symbols derived from the Latin names of the elements are given below:

Element	Latin name	Symbol
Iron	Ferrum	Fe
Gold	Aurum	Au
Copper	Cuprum	Cu
Potassium	Kalium	K
Sodium	Natrium	Na
Silver	Argentum	Ag
Mercury	Hydrargyrum	Hg
Tin	Stannum	Sn
Lead	Plumbum	Pb
Antimony	Stibium	Sb

It is important to note that the first letter of every chemical symbol is capital letter but, if the symbol consists of two letters, the second letter is not capital letter, thus:

Symbol for aluminium is Al and not AL

Symbol for lead is Pb and not PB

Carelessness in writing symbols can lead to utter confusion.

Ex: Co is cobalt whereas CO is carbon monoxide. Therefore, if a person uses symbol CO for cobalt, the reader of the symbol will take it as carbon monoxide which is a compound of carbon and oxygen.

RADICALS

Most of the inorganic compounds contain oppositely charged parts called radicals. The positively charged part is called electropositive radical or basic radical whereas negatively charged part is called electronegative radical or

acidic radical. For example, sodium chloride is made up of Na^+ ions and Cl^- ions. Similarly, nickel sulphate is made up of Ni^{2+} ions and SO_4^{2-} ions. A radical behaves as single unit in reactions. Thus a **radical** is an atom or group of atoms, carrying positive or negative charge, that behaves as a single unit in reactions.

A radical containing only one atom is known as **simple radical** whereas a radical containing two or more than two atoms is known as **compound radical**. Thus, Na^+ is a simple radical whereas SO_4^{2-} is a compound radical.

The charge on the radical is known as valency of the radical. Knowing the formulae of the radicals present in a compound, the formula of the compound can be derived.

Formulae of some common electropositive and electronegative radicals are given in table.

FORMULAE AND VALENCIES OF COMMON RADICALS :

Electropositive Radicals							
Monovalent		**Bivalent**		**Trivalent**		**Tetravalent**	
Name	**Formula**	**Name**	**Formula**	**Name**	**Formula**	**Name**	**Formula**
Potassium	K^+	Barium	Ba^{2+}	Aluminium	Al^{3+}	Manganese [IV]	Mn^{4+}
Sodium	Na^+	Calcium	Ca^{2+}	Chromium	Cr^{3+}		
Copper [I]	Cu^+	Magnesium	Mg^{2+}	Iron [III]	Fe^{3+}	Tin [IV]	Sn^{4+}
Mercury [I]	Hg^+ or Hg_2^{2+}	Manganese	Mn^{2+}	Gold	Au^{3+}	Lead [IV]	Pb^{4+}
		Zinc	Zn^{2+}			Platinum	Pt^{4+}
Silver	Ag^+	Iron [II]	Fe^{2+}				
Ammonium	NH_4^+	Nickel	Ni^{2+}				
Hydrogen	H^+	Cobalt	Co^{2+}				
		Tin [II]	Sn^{2+}				
		Cadmium	Cd^{2+}				
		Lead [II]	Pb^{2+}				
		Copper [II]	Cu^{2+}				
		Mercury [II]	Hg^{2+}				
		Strontium	Sr^{2+}				

SOME COMMON POLYATOMIC IONS :

–1 Charge	Formula	–2 Charge	Formula	–3 Charge	Formula
Name of ion		**Name of ion**		**Name of ion**	
Hydrogen carbonate or bicarbonate ion	HCO_3^-	Carbonate ion	CO_3^{2-}	Phosphate ion	PO_4^{3-}
Hydrogen sulphate	HSO_4^-	Manganate ion	MnO_4^{2-}	Arsenate ion	AsO_4^{3-}
or (bisulphate ion)		Thiosulphate ion	$S_2O_3^{2-}$	Arsenite ion	AsO_3^{3-}
Hydroxide ion	OH^-	Silicate ion	SiO_3^{2-}	Phosphite ion	PO_3^{3-}

Nitrate ion	NO_3^-	Sulphate ion	SO_4^{2-}	Borate ion	BO_3^{3-}
Chlorate ion	ClO_3^-	Chromate ion	CrO_4^{2-}	Ferricyanide ion	$[Fe(CN)_6]^{3-}$
Nitrite ion	NO_2^-	Dichromate ion	$Cr_2O_7^{2-}$	**– 4 Charge**	**Formula**
Permanganate ion	MnO_4^-	Hydrogen Phosphate ion	HPO_4^{2-}	**Name of ion**	
Acetate ion	CH_3COO^-			Carbide ion	C^{4-}
Cyanide ion	CN^-	Oxalate ion	$C_2O_4^{2-}$	Ferrocyanide ion	$[Fe(CN)_6]^{4-}$
Hypophosphite ion	$H_2PO_2^-$			**+ 1 Charge**	**Formula**
Meta alumina ion	AlO_2^-			**Name of ion**	
				Ammonium ion	NH_4^+

There are certain elements that exhibit more than one valencies in their radicals (or compounds). For example, iron can exist as Fe^{2+} or Fe^{3+} in its compounds. In such cases, the name of the radical with lower valency ends with a suffix **'ous'** while that with higher valency ends with a suffix **'ic'**.

Names and formulae of some common basic radicals exhibiting variable valency are listed in table.

Name of Radical	Formula
Cuprous or Copper (I)	Cu^+
Cupric or Copper (II)	Cu^{2+}
Mercurous or Mercury (I)	Hg^+
Mercuric or Mercury (II)	Hg^{2+}
Ferrous or Iron (II)	Fe^{2+}
Ferric or Iron (III)	Fe^{3+}
Manganous or Manganese (II)	Mn^{2+}
Manganic orManganese (IV)	Mn^{4+}
Plumbous or Lead (II)	Pb^{2+}
Plumbic or Lead (IV)	Pb^{4+}
Stannous or Tin (II)	Sn^{2+}
Stannic or Tin (IV)	Sn^{4+}
Aurous or Gold (I)	Au^+
Auric or Gold (III)	Au^{3+}

CHEMICAL FORMULAE

As already discussed, the elements are represented in the abbreviated form by their symbols. Similarly, a compound is represented in the abbreviated form by its chemical formula.

The expression of the composition of a substance by chemical symbols and numerical subscripts is called the **chemical formula** of the substance.

The formula of a simple substance is obtained by writing the symbol of the element and indicating the number of atoms in a molecule of the substance by a subscript. For example, a molecule of hydrogen contains two atoms and hence hydrogen is represented by the formula H_2. A molecule of ozone contains three atoms of oxygen. Hence, ozone is represented by the formula O_3.

In order to represent the chemical formula of a compound, one must know what are the elements present in the compound and what is the number of atoms of one element that combine with a definite number of atoms of the other element. For example, a molecule of water contains two hydrogen atoms and one oxygen atom. It is represented by the formula H_2O.

The formula of a compound is, thus, expressed by the symbols of chemical elements contained in the compound and by the numerical subscripts (to the lower right of each symbol).

WRITING THE FORMULA OF A BINARY MOLECULAR COMPOUND

In binary molecular compounds, the atoms of the two elements are held by covalent bonds. A covalent bond, as you know, is formed by sharing of electrons between the two atoms. The number of electrons in an atom of the element contributes for sharing is known as valency of the element. Knowing the valencies of the two elements involved in the formation of a binary molecular compound, the formula of the compound can be derived.

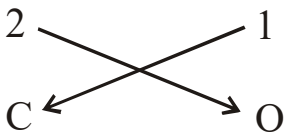
Step.1 Write the constituent elements and their valencies as shown below :

Valency	4	2
Element	C	O

Step.2 Reduce the valency numerals to simplest whole numbers by dividing by some common factor, if any.

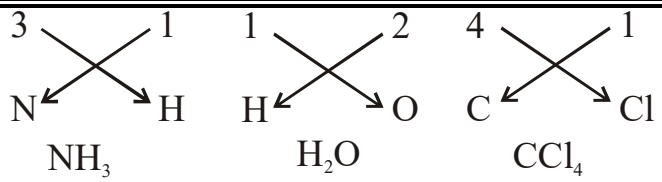
2	**1**
C	O

Step.3 Criss cross the reduced valency numerals and write them as subscripts at bottom right hand side of the symbols.



The subscript 1 is not written. Thus, the formula of the compound is CO_2.

Formulae of some more compounds are given below :



WRITING THE FORMULA OR ANIONIC COMPOUND

The formula of an ionic compound represents the simplest whole number ratio of ions in it. The total positive charge on cations is equal to the total negative charge on anions. Knowing the formulae of the radicals present in the compound, the formula of the compound can be written by the following steps:

Step.1 Write the formulae of the radicals of the compound side by side with basic radical on the left-hand side and acid radical on the right-hand side.

Step.2 Enclose the compound radical (if any) in a bracket.

Step.3 Reduce the valency numerals to a simple ratio by dividing with a common factor, if any.

Step.4 Criss-cross the valencies, i.e., shift the valency numerals crosswise to the lower right-hand corner of the radicals. The is done to achieve electrical neutrality.

Let us apply the above steps to write formula of **calcium phosphate.**

Step.1 Writing the formulae of the radicals.

Ca^{2+} PO_4^{3-}

Step.2 Enclose the compound radical phosphate in bracket.

Ca^{2+} $[PO_4]^{3-}$

Step.3 Not applicable, because ratio is already simple.

Step.4 Criss-cross the valencies.

Thus, the formula of calcium phosphate is **$Ca_3(PO_4)_2$**

On the basis of above steps the formula of some substances are given below in table:

Writing Formula of an Ionic Compound:

Compound	Positive Radical	Negative Radical	Formula
Potassium chlorate	K^1	$[ClO_3]^1$	$KClO_3$
Ammonium phosphate	$[NH_4]^1$	$[PO_4]^3$	$[NH_4]_3PO_4$
Lithium nitride	Li^1	N^3	Li_3N

Sodium oxalate	Na^1	$[C_2O_4]^2$	$Na_2C_2O_4$
Silver chromate	Ag^1	$[CrO_4]^2$	Ag_2CrO_4
Iron (II) sulphate	Fe^2	$[SO_4]^2$	$FeSO_4$
Sodium thiosulphate	Na^1	$[S_2O_3]^2$	$Na_2S_2O_3$
Ferric ferrocyanide	Fe^3	$[Fe(CN)_6]^4$	$Fe_4[Fe(CN)_6]_3$
Magnesium nitride	Mg^2	N^3	Mg_3N_2
Calcium cyanide	Ca^2	$(CN)^1$	$Ca(CN)_2$
Calcium phosphate	Ca^{2+}	PO_4^{3-}	$Ca_3(PO_4)_2$
Sodium zincate	Na^1	$[ZnO_2]^2$	Na_2ZnO_2
Potassium manganate	K^1	$[MnO_4]^2$	K_2MnO_4
Ammonium dichromate	$[NH_4]^1$	$[Cr_2O_7]^2$	$[NH_4]_2Cr_2O_7$
Mercurous chloride	$[Hg_2]^2$	Cl^1	Hg_2Cl_2

NAMES AND FORMULAE OF SIMPLE COMPOUNDS

The simplest compounds are binary compounds. A binary compound is a compound that contains atoms of only two different elements. For example, NaCl is a binary compound of sodium and chlorine. CaF_2 is a binary compound of calcium and fluorine. It may be noted that a binary compound may contain more than two atoms.

While writing the formula of a binary compound the symbol of the more electronegative element is written on right hand side while that of less electronegative element is written on left hand side. The number of atoms of each element are indicated by subscripts on the right hand side bottom of the symbol. For example, for a compound formed by combination of a metal with a non-metal, the symbol of the metal element is written first (left hand side) and the symbols of the non-metal element is written on right hand side.

While naming the binary compounds, the first element (less electronegative element) is named as such while the name of the second element (more electronegative element) is written with an '–**ide**' ending.

For example,

KI is named as potassium iodide.

MgO is named as magnesium oxide

NaH is named as sodium hydride

$CaCl_2$ is named as calcium chloride.

The names of some non-metallic elements with '–**ide**'endings are given as follows:

Hydrogen – Hydride

Fluorine – Fluoride

Chlorine – Chloride

Nitrogen – Nitride

Carbon – Carbide

Boron – Boride

Bromine – Bromide Iodine – Iodide
Oxygen – Oxide Sulphur – Sulphide
Phosphorus – Phosphide

While naming binary compounds of metals and non-metal, the subscript numericals are ignored. For example, $BaCl_2$ is named barium chloride and not barium dichloride.

On the other hand while naming the binary compounds of two non-metals, the subscript numericals have to be taken into consideration and are indicated as a part of the name. The reason for using prefixes is that the same two non-metallic elements may combine to form many compounds. For example, phosphorus and chlorine combine to form two compounds PCl_3 and PCl_5. A subscript 2 is indicated by the prefix **di**; subscript 3 by **tri** subscript 4 by **tetra** and so on. There should be no gap between the prefix and the name of the element. Some examples are given in table.

NAME OF SOME BINARY COMPOUNDS OF TWO NON-METALS :

Formula	Name	Formula	Name
CO	Carbon monoxide	CCl_4	Carbon tetrachloride
CO_2	Carbon dioxide	PCl_5	Phosphorus pentachloride
NO_2	Nitrogen dioxide	SF_6	Sulphur hexafluoride
SO_2	Sulphur dioxide	N_2O_4	Dinitrogentetroxide
SO_3	Sulphur trioxide	N_2O	Dinitrogen oxide
PCl_3	Phosphorus trichloride	N_2O_5	Dinitrogen pentoxide

It may be noted that:

- '–o' or '–a' at the end of the prefix is often dropped before another vowel. For example, tetroxide, pentoxide, etc. However, in case of iodides '–o' or '–a' at the end of the prefix is not dropped. For example, PI_5 is named phosphorus pentaiodide and not phosphorus pentaiodide.
- The prefix mono is generally not used for the first element in the formula.
- When hydrogen is the first element in the formula, no prefix is added before hydrogen irrespective of the number of hydrogen atoms in the formula. For example, H_2S is named hydrogen sulphide and not dihydrogen sulphide. Similarly, H_2Se is named hydrogen selenide.
- A few compounds of hydrogen with non-metals are named by their trivial or common names. For example, H_2O is called water and NH_3 is called ammonia.

1. SYMBOLS AND FORMULAE

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

SYMBOLS

1. The abbreviation used for the name of an element is called:
   1) Symbol 2) Radical 3) Formula 4) Trivalent
2. Symbol 'S' stands for the element:
   1) Strontium 2) Silicon 3) Sulphur 4) Selenium
3. The symbol for the element aluminium is:
   1) As 2) At 3) Al 4) An
4. The symbol for arsenic is:
   1) At 2) Am 3) *Al* 4) As
5. Latin name of tungsten is:
   1) Wolfram 2) Stibium 3) Aurum 4) Natrium

RADICALS

6. Most of the inorganic compounds contain oppositely charged parts called:
   1) Symbol 2) Radical 3) Formula 4) Trivalent
7. When element exhibits more than one valency it is said to be:
   1) Single valency 2) Double valency 3) Triple valency 4) Variable valency
8. Ferrous ion is:
   1) Monovalent 2) Bivalent 3) Trivalent 4) Both 2 and 3
9. Valency of copper is:
   1) 1 or 2 2) 2 or 3 3) 3 or 4 4) None
10. An atom (or) a group of atoms which can exist independently with charge(s) is called:
    1) Radical 2) Molecule 3) Compound 4) Substance
11. The valency of Mg is:
    1) 4 2) 3 3) 2 4) 1
12. Name the cation which is having the valency 4?
    1) Platinum 2) Arsenic 3) Gold 4) Cobalt
13. Cyanide ion is represented as:
    1) CN^- 2) SNC^- 3) SN^- 4) None
14. The charge of phosphate is:
    1) –1 2) –2 3) –3 4) 0

CHEMICAL FORMULAE

15. The symbolic representation of actual number of atoms in molecule is called:
    1) Valency 2) Formula 3) Ion 4) Both 1 & 2

16. A formula represents:
1) An atom of an element 2) One gram atom of an element
3) A molecule of a compound 4) Name of the atom

17. Chemical formula for calcium sulphate is $CaSO_4$. The formula for ferrous sulphate will be:
1) $Fe_2(P_2O_7)_3$ 2) $Fe_4P_3O_{14}$ 3) $FeSO_4$ 4) Fe_3PO_4

18. The chemical formula of Sodium phosphate is:
1) $Na_2P_2O_7$ 2) Na_3PO_4 3) $Na_4P_2O_7$ 4) Na_3PO_3

19. A metal M forms a compound M_2HPO_4. What will be the formula of the metal sulphate?
1) M_2SO_4 2) $M_2(SO_4)_3$ 3) MSO_4 4) $M(SO_4)_3$

NAMING OF COMPOUNDS

20. In a binary compound, the non-metallic part is given a suffix as:
1) –ate 2) –ite 3) –ide 4) All of these

21. In a binary compound, the metal ion is:
1)Named second 2) cannot be named
3) Named first with the non-metal name
4) Both 1 and 2

22. If oxygen present in a compound ending with-ate, contains more oxygen, then its prefix is:
1) Hypo 2) Hyper 3) Per 4) None

23. Formulae of potassium chlorate is:
1) $KClO_3$ 2) $KClO_2$ 3) $KClO$ 4) KCl

24. Formulae of calcium sulphate is:
1) $CaSO_3$ 2) $CaSO_4$ 3) Cas 4) $CaCO_3$

LEVEL–II

SYMBOLS

25. Symbol ‘Sr’ stands for the element:
1) Strontium 2) Silicon 3) Sulphur 4) Selenium

26. The symbol of an element is Hg. Identify the name of the element.
1) Gold 2) Mercury 3) Hafnium 4) Holmium

27. ‘O’ stands for the symbol of:
1) Osmium 2) Oxygen 3) Aluminium 4) Aurum

28. The element nobelium named after the name of the scientist is:
1) Madam curie 2) Mendeleev
3) Alfred Nobel 4) Enrico Fermi

RADICALS

29. The valency of lead are:
1) +2 2) +4 3) +3 4) Both 1 and 2

30. Lower valency of tin is:
1) +1 2) +2 3) +3 4) +4

31. Which of the following is bivalent electropositive ion?
1) Zn 2) Ca 3) Cd 4) All of these

32. The charge of manganite is:
1) -1 2)-2 3) -3 4) 2

33. Carbonate and bicarbonate ions are respectively:
1) CO_3^{-2}, HCO_3^{-2} 2) CO_3^{-}, HCO_3^{-2} 3) CO_3^{-2}, HCO_3^{-} 4) CO_2^{-2}, HCO_3^{-2}

CHEMICAL FORMULAE

34. The chemical formula of water:
1) H_2O_2 2) H_2O 3) O_2 4) H_2

35. Chemical formula for calcium sulphate is $CaSO_4$. The formula for ferric sulphate will be:
1) $Fe_2(P_2O_7)_3$ 2) $Fe_4P_3O_{14}$ 3) $Fe_2(SO_4)_3$ 4) Fe_3PO_4

36. The metal 'M' forms a chloride MCl_2 then what will be the formula of metal sulphate?
1) M_2SO_4 2) MSO_4 3) $M(SO_4)_3$ 4) $M_3(SO_4)_2$

37. The formula of sulphuric acid is:
1) H_2SO_4 2) H_2S 3) HCl 4) H_2SO_3

NAMING OF COMPOUNDS

38. Formulae of aluminium hydroxide is:
1) Al_2O_3 2) $AlOH$ 3) $Al(OH)_3$ 4) None

39. Formulae of phosphorus pentoxide is:
1) PCl_5 2) P_2O_5 3) P_4O_{10} 4) Both 2 & 3

40. Formulae of sodium bi carbonate is:
1) Na_2CO_3 2) $NaHCO_3$ 3) Na_2SO_4 4) $NaHSO_4$

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

41. The valency of an inert gas is:
1) Zero 2) One 3) Three 4) Two

42. Name the cation which is having the valency 5?
1) Platinum 2) Arsenic 3) Lead 4) Cobalt

43. Sulphate,bisulphate ions are respectively:
1) SO_4^{-2}, HSO_4^{-2} 2) SO_4^{-2}, HSO_4^{-} 3) SO_4^{-2}, SO_4^{-3} 4) SO_4^{-2}, HSO_4^{-2}

44. Formula of Aluminiumsulphate is:
1) $Al(SO_4)_3$ 2) $Al_2(SO_4)_3$ 3) $Al_3(SO_4)_3$ 4) Al_3SO_4

45. What is the name of $NaNO_3$ tertiary compound?
1) Sodium nitrite 2) Sodium nitride 3) Sodium nitrate 4) None

46. The chemical formula of hydrogen peroxide is:
1) H_2O 2) H_2O_2 3) HO_2 4) H_2O_3

LEVEL–IV

STATEMENT TYPE QUESTIONS

47. Statement I: The higher valency of a tin is 4.
Statement II: The higher valency of gold is 3.
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false
4) Statement I is false, statement II is true

48. Statement I: PCl_5 stands for phosphorous pentachloride.
Statement II: SO_3 stands for sulphur trioxide.
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

49. Which of the following is trivalent electronegative ions?
1) Nitride 2) Phosphide 3) Phosphite 4) Phosphate

50. Which of the following is / are correct formula?
1) Calcium carbonate - $CaCO_3$ 2) Calcium oxide – CaO
3) Nitric acid - HNO_2 4) Ammonium chloride - NH_4Cl

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE-1:

When an element exhibits more than one valency, it is said to exhibit variable valency

51. Lowervalency of arsenic is:

1) +3 2) +4 3) +5 4) +2

52. Lower valency of antimony is:
1) +2 2) +3 3) +4 4) +5

53. The valency of boronis:
1) +1 2) +2 3) +3 4) +4

PASSAGE-2:

The representation of a molecule of a substance in terms of symbols and subscripts numbers is known as formulae. The representation of a molecule of a substance (element or compound) in terms of symbols and subscript numbers is known as the formula.

54. A metal M forms a compound MPO_4. What will be the formula for the metal nitrate?
1) MN_2 2) $M(NO_3)_3$ 3) M_2N_3 4) $M(NO_2)_3$

55. Chemical formula for sodium sulphate is Na_2SO_4. The formula for bivalent metal sulphate will be:
1) $M_2(SO_4)_3$ 2) MSO_4 3) M_3SO_4 4)M_3PO_4

56. The phosphate of a metal has the formula MPO_4. What will be the formula of its carbonate?
1) $M_2(CO_3)_3$ 2) MCO_3 3) M_2CO_3 4) None

MATRIX MATCH TYPE QUESTIONS

57.

COLUMN - I	COLUMN - II
a) Potassium	p) Trivalent &Pentavalent
b) Arsenic	q) Bivalent & Tetravalent
c) Lead	r) Trivalent
d) Aluminium	s) Monovalent
	t) Hexavalent

58.

COLUMN-I	COLUMN-II
a) Hg_2Cl_2	p) Manganese sulphate
b) $Ca(OH)_2$	q) Sodium dichromate
c) $MnSO_4$	r) Calcium hydroxide
d) $Na_2Cr_2O_7$	s) Mercurous chloride
	t) Nickel bisulphate

2. CHEMICAL EQUATION

♦ CHEMICAL EQUATION

CHEMICAL EQUATION

The chemical equation is a statement that describes a chemical change in terms of symbols and formulae.

Before we start interpreting the meaning of chemical equation, let us know a few terms used in writing a chemical equation.

REACTANTS: The substances which take part in a chemical reaction are called reactants. The reactants are always written on the left side of a chemical equation.

Ex: In the equation $Zn + HCl \rightarrow ZnCl_2 + H_2$, Zn and HC$l$ are the reactants.

PRODUCTS: The substances formed, as a result of chemical change, are called products. The products are always written on the right-hand side of a chemical equation.

Ex: In the above equation, $ZnCl_2$ and H_2 are the products.

A chemical equation consists of formulae of reactants, connected by plus sign (+) and arrow $(\rightarrow)$ followed by the formulae of products, connected by plus sign (+).

The sign arrow $(\rightarrow)$ represents 'to yield' or 'givesrise to'.

CHARACTERISTICS OF CHEMICAL REACTION :

- In a chemical reaction, the substances known as reactants are converted into new substances called products.
- The conversion of reactants into products in a chemical reaction is often accompanied by some features which can be observed easily.
- The easily observable features (or changes) which take place as a result of chemical reactions are known as characteristics of chemical reactions.
- For example, when we mix two substances, if a gas is evolved, then we can say that a chemical reaction has taken place.
- The important characteristics of chemical reactions are:

  i) Evolution of a gas ii) Change in colour

  iii) Formation of a precipitate iv) Change in state

  v) Change in temperature and pressure

EVOLUTION OF A GAS:Some chemical reactions are characterized by theevolution of a gas.

Ex: i)The chemical reaction between zinc and dilute hydrochloric acid is characterized by the evolution of hydrogen gas.

$$Zn + dil\ HCl \rightarrow ZnCl_2 + H_2 \uparrow$$

ii) The chemical reaction between sodium carbonate and dilute hydrochloric acid is characterized by the evolution of carbon dioxide gas.

$$Na_2CO_3 + dil\ \ HCl \rightarrow 2NaCl + H_2O + CO_2 \uparrow$$

CHANGE OF COLOUR: Certain chemical reactions are characterized by the change in colour of the reacting substances.

Ex: i) When red lead oxide is heated strongly, it forms yellow coloured lead monoxide and gives off oxygen gas.

$$\underset{\text{Red lead oxide (red colour)}}{2Pb_3O_4} \xrightarrow[\Delta]{heat} \underset{\text{Lead monixide (yellow colour)}}{6PbO} + \underset{Oxygen}{O_2}$$

ii)When copper carbonate (green in colour) is heated strongly, it leaves behind a black residue of copper oxide and gives off carbon dioxide gas.

$$\underset{\text{Copper carbonate (green)}}{CuCO_3} \xrightarrow[\Delta]{heat} \underset{\text{Copper oxide (black)}}{CuO} + \underset{\text{Carbon dioxide}}{CO_2}$$

FORMATION OF A PRECIPITATE: Aprecipitate is a 'solid product' which separates out form the solution during a chemical reaction. Aprecipitate can be formed by mixing aqueous solutions (water solutions) of reactants when one of the products is insoluble in water. A precipitate can also be formed bypassing a gas into an aqueous solution of a substance (like passing carbon dioxide gas into lime water)

Some chemical reactions are characterized by the formation of a precipitate.

Ex: A white precipitate of silver chloride is formed when a colourless solution of silver nitrate is mixed with a colourless solution of sodium chloride.

$$AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$$

CHANGE IN STATE: In some chemical reactions we can observe change in state between reactants and products

Ex: On strong heating calcium carbonate gives carbon dioxide gas and a solid calcium oxide.

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$

2. CHEMICAL EQUATION

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

CHEMICAL EQUATION

1. The chemical equation is a statement that describes a chemical change interms of ____ and____.
   1) Symbols 2) Formula 3) Equation 4) Both 1 & 2
2. The substances which take part in a chemical reaction are called:
   1) Reactants 2) Products 3) Catalysts 4) All the above
3. The substances formed during a chemical reaction are called:
   1) Reactants 2) Products 3) Catalysts 4) All the above
4. The sign of an arrow means$(\rightarrow)$ ___or _____.
   1) To yield 2) To form 3) Gives rise 4) All of these
5. In a chemical reaction the atoms are neither _____ nor _____.
   1) Created 2) Destroyed 3) Both 1 & 2 4) Formation
6. The chemical substances which are shown with upward arrow mark in the chemical reaction are_____.
   1) Gases 2) PPT 3) Solution 4) None
7. The chemical substances which are shown with downward arrow mark in the chemical reaction are _____.
   1) Aqueous 2) Gases 3) PPT 4) All of these
8. $Zn+2HCl \rightarrow A+H_2$. Identify A.
   1) $ZnCl_2$ 2) ZnH_2 3) Zn_2Cl_2 4) ZnH

LEVEL–II

CHEMICAL EQUATION

9. _____decomposes on heating to form potassium nitrite and oxygen.
   1) KNO_3 2) K_2SO_4 3) KOH 4) None
10. When calcium oxide reacts with water to form?
    1) CaO 2) $Ca(OH)_2$ 3) $CaCO_3$ 4) None
11. $CH_4+O_2 \rightarrow A+B$. Identify A & B.
    1) A–CO_2, B–H_2O 2) A–H_2O, B–CO
    3) A–C, B–H_2O 4) A–CH_3OH, B–H_2O

12. Mg+dil.$H_2SO_4 \rightarrow MgSO_4$+A. Identify A.

1) N_2 2) O_2 3) CO_2 4) H_2

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

13. $CaSO_4 + KOH \rightarrow A + K_2SO_4$. Identify 'A'.

1) CaO 2) $Ca(OH)_2$ 3) CaS 4) $CaCO_3$

14. $Fe_2O_3 + C \rightarrow Fe + CO + A$. Identify 'A'.

1) FeO 2) C 3) CO_2 4) None

15. $Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$. In this equation precipitate is:

1) PbI_2 2) KNO_3 3) KI 4) $PbNO_3$

16. $Pb(NO_3)_2 \rightarrow PbO + O_2 + NO_2$. In this reaction colour of NO_2 is:

1) Blue 2) Yellow 3) Green 4) Reddish brown

17. $NH_3 + HCl \rightarrow A$. Identify 'A'.

1) NCl_3 2) NH_4Cl 3) Cl_2 4) None of these

LEVEL–IV

STATEMENT TYPE QUESTIONS

18. Statement I: The substance which take part in a chemical reaction is called reactants.

Statement II: $N_2 + H_2 \rightarrow NH_3$. In this equation NH_3 is reactant.

1) Both statements are true 2) Both statements are false

3) Statement I is true, statement II is false.

4) Statement I is false, statement II is true.

19. Statement I: $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2$

Statement II:In above equation colour of PbO is yellow.

1) Both statements are true 2) Both statements are false

3) Statement I is true, statement II is false.

4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

20. When $Mg(HCO_3)_2$ decomposed to give?

1) $MgCO_3$ 2) H_2O 3) CO_2 4) MgO

21. Which of the following is / are elementary gases:
1) Hydrogen 2) Oxygen 3) Nitrogen 4) Carbon dioxide

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

Chemical equation is a statement that describes a chemical change in terms of symbols and formula.

22. When zinc granules react with diluted hydrochloric acid to give _____ gas.
1) Oxygen 2) Hydrogen 3) Nitrogen 4) Carbon dioxide

23. $2H_2 + O_2 \rightarrow 'A'$. Identify 'A'.
1) H_2O 2) H_2O_2 3) $2H_2O$ 4) None of these

24. When is carbon dioxide passed through the lime water to give?
1) $Ca(OH)_2$ 2) CaO 3) CO 4) $CaCO_3$

MATRIX MATCH TYPE QUESTIONS

25.

COLUMN-I	COLUMN-II
a) $Mg+2HCl$	p) $MgO + C$
b) $2Mg+CO_2$	q) $CaCl_2+H_2O$
c) $Ca(OH)_2+2HCl$	r) $CaCl_2+H_2O+CO_2$
d) $CaCO_3+2HCl$	s) $MgCl_2+H_2$

3. BALANCED CHEMICAL EQUATIONS

♦ BALANCED CHEMICAL EQUATION

BALANCED CHEMICAL EQUATION:

The chemical equation in which number of atoms of all the elements on the both the sides of the equation is equal is known as **balanced chemical equation or stoichiometric equation.**

The equation which is not balanced is known as unbalanced equation (or) stoichiometric equation.

PRE-KNOWLEDGE TO BALANCE A CHEMICAL EQUATION:

Following knowledge is necessary before one starts writing a balanced equation:

- Whether or not the reaction takes place between two or more reactants.
- One must know all the products formed during the chemical reaction.
- One must know the correct symbols and formulae of the reactants and products.

BALANCING OF CHEMICAL EQUATION : A chemical equation can be balanced by using different methods like hit and trial method, frequency number method etc.

BALANCING OF A CHEMICAL EQUATION BY HIT AND TRIAL METHOD:

Following steps may be helpful in balancing a chemical equation by this method:

- Select the biggest formula and balance the same kinds of atoms in it on both sides of the arrow.
- If the above step fails, then select the element which occurs at the minimum number of places and this element is balanced first. The element which occurs at the maximum number of places is balanced last of all.
- In case the elementary gases like hydrogen, oxygen etc., the equation is balanced by keeping these gases in the atomic state.
- Atoms of the elementary gas are balanced last of all.
- The balanced equation in the atomic state is changed in the molecular form.
-

BALANCING EQUATION BY FREQUENCY NUMBER METHOD:

Frequency number: The number of times an element appearing in the chemical equation is called its frequency number (irrespective of coefficient and base numbers).

In frequency number method, for balancing order we follow certain rules.

- The element with lowest frequency number is balanced first.
- If two or more elements have same frequency number, metallic element is balanced first.
- If two or more metal or non-metals have same frequency number, the metal or non-metal with greater atomic number is balanced first.

Ex: Aluminum carbonate reacts with dilute nitric acid to form aluminium nitrate, water and carbon dioxide. This reaction can be written in equation form as under.

$$Al_2(CO_3)_3 + HNO_3 \rightarrow Al(NO_3)_3 + CO_2 + H_2O$$

Writing numbers and order of balancing each element.

Elements	*Al*	C	O	H	N
Frequency number	2	2	5	2	2
Order of balancing each element	1^{st}	3^{rd}	5^{th}	4^{th}	2^{nd}

REASONS FOR CHOOSING ORDER OF BALANCING OF EACH ELEMENT:

Aluminium, carbon, hydrogen and nitrogen have some frequency number. However,aluminium being a metal gets 1st place in balancing. Amongst the non-metals with frequency number 2, nitrogen has the highest atomic number followed by carbon and hydrogen. Thus, order of balancing nitrogen is 2nd, carbon is 3rd and hydrogen is 4th. The last element oxygen, which has frequency number 5 gets 5th place in order of balancing.

BALANCING ALUMINIUM: The atoms of aluminium towards the reactants side are 2 in $Al_2(CO_3)_3$ but in the products side it is one in $Al(NO_3)_3$ Thus, in order to balance aluminium we multiply $Al(NO_3)_3$ by 2 as shown in the equation (a)

$$Al_2(CO_3)_3 + HNO_3 \rightarrow 2Al(NO_3)_3 + CO_2 + H_2O.....(a)$$

BALANCING NITROGEN: In equation (a) number of nitrogen atoms in HNO_3 towards the recants side is 1. The number of nitrogen atoms in $2Al(NO_3)_3$ toward the products side is 6. Thus, in order to balance nitrogen we multiply HNO_3 by 6 as shown in equation (b)

$$Al_2(CO_3)_3 + 6HNO_3 \rightarrow 2Al(NO_3)_3 + CO_2 + H_2O.....(b)$$

BALANCING CARBON: In equation (b) number of carbon atoms in $Al_2(CO_3)_3$,towards the reactants side is 3. The number of carbon atoms in CO_2 towards the products side are 1.Thus, in order to balance carbon we multiply CO_2 by 3 as shown in equation..... (c)

$$Al_2(CO_3)_3 + 6HNO_3 \rightarrow 2Al(NO_3)_3 + 3CO_2 + H_2O.....(c)$$

BALANCING HYDROGEN: In equation (c) number of hydrogen atoms in HNO_3 towards the recants side are 6. The number of hydrogen atoms in H_2O towards the products side 2. Thus, in order to balance hydrogen, we multiply H_2O by 3 as shown in equation (d)

$$Al_2(CO_3)_3 + 6HNO_3 \rightarrow 2Al(NO_3)_3 + 3CO_2 + 3H_2O.....(d)$$

BALANCING OXYGEN: In equation(d) total number of oxygen atoms on the side of reactants is 27. Similarly, total number on the side of products are 27. Thus, equation is fully balanced.Thus, the balanced equation is

$$Al_2(CO_3)_3 + 6HNO_3 \rightarrow 2Al(NO_3)_3 + 3CO_2 + 3H_2O$$

3. BALANCED CHEMICAL EQUATION

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

BALANCED CHEMICAL EQUATION

1. A chemical equation in which number of atoms of each element is same on the side of reactants and products is called:
   1) Balanced equation 2) Unbalanced equation
   3) Both 4) Neither 1 nor 2
2. A Chemical equation in which number of atoms of each element is not same on the side of reactants and products is called:
   1) Unbalanced equation 2) Skeleton equation
   3) Balanced equation 4) Both 1 & 2
3. The number of places at which an element appears in a chemical equation is called:
   1) Repetition 2) Periodicity 3) Frequency 4) Regularity
4. When a metal and a non-metal have same frequency, then the element to be balanced first is:
   1) Metal 2) Non-metal
   3) Metal if its atomic number is more
   4) Non-metal if its atomic number is more
5. Which element is to be balanced first in the given equation?
   $Mg + CO_2 \rightarrow MgO + C$
   1) MgO 2) C 3) O 4) Mg
6. Identify the correct set of f - numbers of different elements in the given equation.
   $2KNO_3 \rightarrow 2KNO_2 + O_2$

	K	N	O
1)	2	2	3
2)	3	2	2
3)	2	3	2
4)	3	3	2

7. Identify the correct balanced equation from the following:
   1) $2KNO_3 \rightarrow 2KNO_2 + O_2$ 2) $Mg + HCl \rightarrow MgCl_2 + H_2$
   3) $Ca(OH)_2 + 2HCl \rightarrow 2CaCl_2 + 2H_2O$ 4) $2KClO_2 \rightarrow 3KCl + 2O_2$

LEVEL–II

BALANCED CHEMICAL EQUATION

8. The frequency number of nitrogen from the given equation is:
   $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

1) 1 2)2 3) 4 4) 6

9. Balanced the chemical equation $P_4 + O_2 \rightarrow P_4O_{10}$.

1) $2P_4 + 5O_2 \rightarrow P_4O_{10}$ 2) $P_4 + 5O_2 \rightarrow P_4O_{10}$

3) $P_4 + O_{10} \rightarrow P_4O_{10}$ 4) $5P_4 + O_2 \rightarrow 5P_2O_5$

10. Chemical equation for the formation of hydrogen sulphide is: $ZnS + XHCl \rightarrow ZnCl_2 + YH_2S\uparrow$. What is the value of x and y in the equation respectively?

1) 1 & 2 2) 3 & 1 3) 2 & 1 4) 2 & 2

11. What is the number of nitrogen atoms on the reactant side of the equation $3H_{2(g)} + N_{2(g)} \rightarrow NH_{3(g)}$ after balancing?

1) 1 2) 2 3) 3 4) 4

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

12. In the balanced equation a, b, c and d respectively are:
$aFe_2O_3 + bH_2 \rightarrow cFe + dH_2O$

1) 1,1,2,3 2) 1,1,1,1 3) 1,3,2,3 4) 1,2,2,3

13. In the following equations: $Na_2CO_3 + xHCl \rightarrow 2NaCl + CO_2 + H_2O$, the value of x is:

1) 1 2) 2 3) 3 4) 4

14. $aMg_3N_2 + bH_2O \rightarrow cMg(OH)_2 + dNH_3$. When the equation is balanced, the coefficient a,b,c,d respectively are:

1) 1,3,3,2 2) 1,6,3,2 3) 1,2,3,2 4) 2,3,6,2

15. In the balanced equation $Cu + xHNO_3 \rightarrow Cu(NO_3)_2 + yNO_2 + 2H_2O$ The values of x and y are:

1) 3 and 5 2) 8 and 6 3) 4 and 2 4) 7 and 1

16. Which of the following chemical equation is an unbalanced one:

1) $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$ 2) $2C_4H_{10} + 12O_2 \rightarrow 8CO_2 + 10H_2O$

3) $2Al + 6H_2O \rightarrow 2Al(OH)_3 + 3H_2$ 4) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

17. The stoichiometric coefficient of H_2 in the balanced chemical equation is $N_2 + H_2 \rightarrow NH_3$.

1) 1 2) 2 3) 3 4) 4

LEVEL–IV

STATEMENT TYPE QUESTIONS

18. Statement I: The element having highest frequency should be balanced first.
Statement II: When two non-metals have same f-number then element with higher atomic number is balanced first.

1) Both statements are true. 2) Both statements are false.

3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

19. Statement I: $Mg+2HCl \rightarrow MgCl_2+H_2$ is a balanced equation
Statement II: The number of atoms in the reactants is equal to the number of atoms in the products
1) Both statements are true. 2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

20. Identify the balanced equation from the following.
1) $H_2+Cl_2 \rightarrow 2HCl$ 2) $2Mg+O_2 \rightarrow 2MgO$
3) $2CO+O_2 \rightarrow 2CO_2$ 4) $Fe + S \rightarrow FeS$

21. Which of the following is correct statement in given equation?
$Al_2(SO_4)_3 + HNO_3 \rightarrow 2Al(NO_3)_3 + 3SO_2 + H_2O$
1) The f – number of Al is 2 2) The f – number of N is 2
3) The f – number of S is 2 4) The f – number of O is 4

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:
If an atom of an element is present at one place towards the reactant side, it must be present at one place towards the product side is called f – number.

22. $As + 6NaOH \rightarrow Na_3AsO_3 + A$. Identify A.
1) O_2 2) H_2 3) Na_2O 4) H_2O

23. Which element is to be balanced first in the given equation $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$.
1) H 2) O 3) C 4) Ca

24. Frequency number of 'O' in given equation $2Mg + CO_2 \rightarrow 2MgO + C$ is:
1) 2 2) 4 3) 6 4) 1

MATRIX MATCH TYPE QUESTIONS

25.

COLUMN – I	COLUMN – II
a) $2Mg+O_2 \rightarrow$	p) $ZnCl_2 + H_2S$
b) $H_2SO_4+2NaOH \rightarrow$	q) $PbSO_4+2NaNO_3$
c) $ZnS + 2HCl \rightarrow$	r) $2MgO$
d) $Pb(NO_3)_2+Na_2SO_4 \rightarrow$	s) $Na_2SO_4+2H_2O$

4. CHEMICAL COMBINATION & DECOMPOSITION REACTIONS

	♦	CHEMICAL COMBINATION REACTION
	♦	CHEMICAL DECOMPOSITON REACTION

TYPES OF CHEMICAL REACTIONS

We have studied that the chemical reactions generally involve simply the exchange of atoms in the reactants to form products. Neither the atoms disappear from the reaction mixture nor new atoms appear in the same. In fact, in chemical reactions, bonds present in the reacting species break and new bonds in the product species are formed. The exchange of partners in chemical reactions can take place in a number of ways leading to different types of reactions.

Chemical reactions can be grouped into various types on the basis of their nature. Some common type of chemical reactions are

- Chemical combination reactions
- Chemical decomposition reactions
- Chemical displacement reactions
- Chemical double displacement reactions
- Precipitation reactions
- Catalytic reactions
- Reversible and irreversible reactions
- Exothermic and endothermic reactions
- Oxidation
- Reduction

CHEMICAL COMBINATION REACTIONS

Combination reactions may be define as:

The reactions in which two or more substances combine to form a single substance under suitable conditions.

The combination reactions following three cases are observed:

(a) Combination of two elements to form a compound.

(b) Combination of an element and a compound to form a new compound.

(c) Combination of two compounds to form a new compound.

It is represented by $A + B \rightarrow AB$

COMBINATION OF TWO ELEMENTS TO FORM A COMPOUND: Two elements combine to form a new compound. Some examples are:

COMBUSTION OF COAL : Coal (C) burns in air to form carbon dioxide gas.

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$

COMBUSTION OF HYDROGEN: Hydrogen burns in oxygen to form water which is initially in the gaseous state i.e. steam. Upon cooling, it becomes liquid.

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$

COMBINATION BETWEEN HYDROGEN AND CHLORINE: Hydrogen and chlorine gases combine in the presence of sun light to form hydrogen chloride gas.

$$H_{2(g)} + Cl_{2(g)} \xrightarrow{Sun\ light} 2HCl_{(g)}$$

Hydrogen chloride gas is highly soluble in water and forms hydrochloric acid.

FORMATION OF IRON SULPHIDE: Iron sulphide is formed when fine pieces of iron are heated with sulphur powder (yellow in colour). It is in the form of a black mass.

$$Fe_{(s)} + S_{(s)} \xrightarrow{Heat} FeS_{(s)}$$

COMBINATION OF AN ELEMENT AND A COMPOUND TO FORM A NEW COMPOUND: An element may also combine with a compound to form a new compound. Some examples are given below:

COMBINATION BETWEEN NITRIC OXIDE AND OXYGEN: Both nitric oxide and oxygen are colourless gases. When these are allowed to react product formed is nitrogen dioxide which is a reddish-brown gas.

$$\underset{Nitric\ oxide}{2NO_{(g)}} + O_{2(g)} \rightarrow \underset{\substack{Nitrogen\ dioxide \\ (Brown\ gas)}}{2NO_{2(g)}}$$

FORMATION OF SULPHURTRIOXIDE: Sulphur dioxide combines with oxygen to form sulphur trioxide.

$$\underset{Sulphur\ dioxide}{2SO_{2(g)}} + O_{2(g)} \rightarrow \underset{Sulphur\ trioxide}{2SO_{3(g)}}$$

COMBINATION OF TWO COMPOUNDS TO FORM A NEW COMPOUND: Two compounds may combine to form a new compound. The common examples are given below

COMBINATION BETWEEN AMMONIA AND HYDROGEN CHLORIDE GAS: When vapours of ammonia and hydrogen chloride gas are mixed, a white solid mass of ammonium chloride is formed.

$$NH_{3(g)} + HCl_{(g)} \rightarrow \underset{Ammonium\ chloride}{NH_4Cl_{(s)}}$$

FORMATION OF CALCIUM SULPHATE: Calcium oxide reacts with sulphur trioxide to form calcium sulphate.

$$CaO + SO_3 \rightarrow \underset{Calcium\ sulphate}{CaSO_4}$$

CHEMICAL DECOMPOSITION REACTIONS

Decomposition reactions may be defined as: "**The reactions in which a single substance splits into two or more simple substances under suitable conditions.**"

It is represented by $AB \rightarrow A + B$.

The decomposition reaction takes place only when the energy in the form of heat, electricity or light is supplied. Thus, there are three types of decomposition reactions.

THERMAL DECOMPOSITION REACTION

When a decomposition reaction is carried out by heating, it is called thermal decomposition reaction. (Thermal means relating to heat)

Ex. $\underset{\text{Ferrous sulphate crystals}}{FeSO_4.7H_2O} \xrightarrow{Heat} \underset{\text{Anhydrous ferrous sulphate}}{FeSO_{4(s)}} + 7H_2O_{(s)}$

$\underset{\substack{\text{Ferrous sulphate} \\ \text{(Green) (Reddish brown)}}}{2FeSO_{4(s)}} \xrightarrow{Heat} \underset{\text{Ferric oxide}}{Fe_2O_{3(s)}} + \underset{\text{Sulphur dioxide}}{SO_{2(g)}}\uparrow + \underset{\text{Sulphur trioxide}}{SO_{3(g)}}\uparrow$

ELECTROLYTIC DECOMPOSITION REACTIONS

When a substance is decomposed by passing electric current, the process is called electrolysis (electro = electric ;lysis = break down). For instance, when an electric is passed through water (mixed with few drops of acid), it is decomposed into hydrogen and oxygen gases.

$$2H_2O_{(l)} \xrightarrow{\text{electric current}} 2H_{2(g)} + O_{2(g)}$$

PHOTODECOMPOSITION REACTIONS

When a chemical compound decomposes on absorbing light energy, so as to form two or more substances, (elements or compounds), then the reaction which takes place is called **photodecomposition reaction.**

Ex. $2\ AgCl \xrightarrow{sunlight} 2\ Ag + Cl_2$

DECOMPOSITION OF POTASSIUM CHLORATE: When potassium chlorate is heated strongly, it decomposes into potassium chloride and oxygen. The reaction is used for the preparation of oxygen.

$$2KClO_{3(s)} \xrightarrow{Heat} 2KCl_{(s)} + 3O_{2(g)}$$

If the decomposition is carried in the presence of manganese dioxide (MnO_2), it takes place at a lower temperature. In this case, manganese dioxide acts as a catalyst.

$$2KClO_3 \xrightarrow{Mno_2} 2KCl + 3O_2$$

DECOMPOSITION OF LIMESTONE: Lime stone is chemically calcium carbonate $(CaCO_3)$. When heated strongly, it decomposes into calcium oxide and carbon dioxide. Calcium oxide is also called **quick lime.** It is a major constituent of cement.

$$CaCO_{3(s)} \xrightarrow{Heat} CaO_{(s)} + CO_{2(g)}$$

DECOMPOSITION OF AMMONIUM DICHROMATE: It is yellowcoloured solid. When heated strongly, it decomposes into a mixture of chromium oxide, nitrogen gas and water in the gaseous state (steam). Chromium oxide is a grey solid.

$\underset{\text{Amm.dichromate}}{(NH_4)_2 Cr_2O_{7(s)}} \xrightarrow{Heat} \underset{\text{Chromium oxide}}{Cr_2O_{3(s)}} + N_{2_{(g)}} + 4H_2O_{(g)}$

4. CHEMICAL COMBINATION AND DECOMPOSITION REACTION

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

CHEMICAL COMBIINATION REACTION

1. A reaction in which when two or more substances combine to form a single substance is called:
   1) Chemical combination reaction 2) Chemical decomposition reaction
   3) Chemical displacement reaction
   4) Chemical double displacement reaction
2. Chemical combination involves:
   1) Combination of two atoms
   2) Combination of only same type of elements
   3) Combination of only same type of compounds.
   4) Combination of any two or more elements or compounds.
3. Which of the following reactions involves the combination of two elements?
   1) $CaO + CO_2 \rightarrow CaCO_3$ 2) $4Na + O_2 \rightarrow 2Na_2O$
   3) $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$ 4) $NH_3 + HC1 \rightarrow NH_4C1$
4. Formation of nitrous oxide from the reaction of reactants like nitrogen and oxygen is the example of what type of reaction?
   1) Decomposition reaction
   2) Chemical combination of one element and one compound.
   3) Chemical combination of two compounds.
   4) Chemical combination of two elements.
5. When carbon dioxide gas is passed through lime water:
   1) Calcium hydroxide is formed
   2) White precipitate of CaO is formed
   3) White precipitate of $CaCO_3$ is formed
   4) Colour of lime water disappears

CHEMICAL DECOMPOSITION REACTION

6. The reactions in which a single substance splits into two or more simple substances is called:
   1) Chemical combination reaction 2) Chemical decomposition reaction
   3) Chemical displacement reaction
   4) Chemical double displacement reaction
7. A decomposition reaction is carried out by heating is called:
   1) Thermal decomposition 2) Electrolytic decomposition
   3) Photo decomposition 4) None of these

8. A decomposition reaction is carried out by light energy is called:
   1) Thermal decomposition 2) Electrolytic decomposition
   3) Photo decomposition 4) None of these
9. A decomposition reaction is carried out by electric current is called:
   1) Thermal decomposition 2) Electrolytic decomposition
   3) Photo decomposition 4) None of these
10. Which of the following is a decomposition reaction?
   1) $ZnCO_3 \rightarrow ZnO + CO_2$ 2) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$
   3) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ 4) $3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3$

LEVEL–II

CHEMICAL COMBIINATION REACTION

11. Nitric oxide reacts with oxygen to form reddish brown nitrogen dioxide gas. Choose the correct equation for the above reaction.
   1) $2NO+O_2 \rightarrow 2NO_2$ 2) $N_2O+O_2 \rightarrow NO_2+NO$
   3) $NaNO_3 \xrightarrow{heat} 2NaNO_2 + O_2$ 4) $2NO_3+O_2 \rightarrow 2NO_2+2O_2$
12. $6PbO + O_2 \xrightarrow{heat} 2Pb_3O_4$.
   What type of chemical combination reaction is the above reaction?
   1) Combination of two elements to form one new compound.
   2) Combination of an element with a compound to form one new product.
   3) Combination of two compounds to form a new compound.
   4) Combination of atoms to form a compound.
13. Choose the incorrect statement:
   1) Combination of two different elements is not possible.
   2) Decomposition of single compound is possible.
   3) Decomposition of a chemical compound into two new compounds is possible.
   4) Combination of an element with a compound to form a new product is possible

CHEMICAL DECOMPOSITION REACTION

14. What type of chemical decomposition reaction is the following?
   $Cu(OH)_2 \xrightarrow{heat} CuO + H_2O$
   1) Decomposition of one element into one compound and one element.
   2) Decomposition of a compound into two new compounds.
   3) Decomposition of one compound into two elements.

4) Decomposition of one compound into one compound and one element.

15. Which of the following reactions is characterized by the change of colour?

1) $2NaNO_3 \xrightarrow{heat} 2NaNO_2 + O_2$ 2) $CuS + 2HCl \longrightarrow CuCl_2 + H_2s$

3) $CuCO_3 \xrightarrow{heat} CuO + CO_2$

4) $Zn + H_2SO_4(dil.) \longrightarrow ZnSO_4 + H_2$

16. Identify 'A' in the equation.

$CaCO_3 \longrightarrow CaO + A$

1) CO 2) CO_2 3) O_2 4) None of these

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

17. Which of the following reactions involves the combination of two elements?

1) $CaO + CO_2 \rightarrow CaCO_3$ 2) $N_2 + 3H_2 \rightarrow 2NH_3$

3) $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$ 4) $NH_3 + HCl \rightarrow NH_4Cl$

18. Ferrous sulphate on heating produces:

1) Ferric oxide 2) Ferrous oxide 3) Oxygen 4) Water

19. Copper on exposure to air reacts with moisture and CO_2 to develop a greenlayer which is chemically:

1) Copper sulphate 2) Copper carbonate
3) Copper nitrate 4) Basic copper carbonate

20. The following reaction is used for the preparation of oxygen gas in the laboratory.

$2KClO_{3(s)} \xrightarrow{Heat} 2KCl + 3O_{2(g)}$

Which of the following about the reaction is correct?

1) It is a combination reaction
2) It is a decomposition reaction and accompanied by release of heat
3) It is a decomposition reaction and endothermic in nature
4) It is a photo chemical decomposition reaction and exothermic in nature

21. What happens if hydrochloric acid is poured over sodium carbonate?

1) H_2 gas is evolved 2) O_2 gas is evolved
3) CO gas is evolved 4) CO_2 gas is evolved

22. White silver chloride in sunlight turns to:

1) Grey 2) Yellow 3) Remain white 4) Red

LEVEL–IV

STATEMENT TYPE QUESTIONS

23. Statement I: Heating of limestone is the decomposition reaction.
Statement II: Reaction between the lead monoxide and oxygen is the example of chemical combination reaction.
1) Both statements are true.
2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

24. Statement I: Carbon monoxide gas burns in oxygen to form carbon dioxide is a decomposition reaction.
Statement II:Carbon monoxide is a compound, and oxygen is an element combined together forms carbon dioxide which is a compound.
1) Both statements are true.
2) Both statements are false.
3) Statement I is true, statement II is false.
4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

25. Identify the correct combination reaction of two compounds to form a new product.
1) $H_2+Cl_2 \rightarrow 2HCl$ 2) $2CO+O_2 \rightarrow 2CO_2$
3) $CaO+H_2O \rightarrow Ca(OH)_2$ 4) $NH_3+HCl \rightarrow NH_4Cl$

26. $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + O_2 + 4NO_2$. What type of reaction it represents?
1) De-combination reaction 2) Combination reaction
3) Chemical composition 4) Decomposition reaction

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

In a chemical reaction one substance decompose into two or more elements or compounds or both are formed is called decomposition reaction.

27. $A \xrightarrow{\Delta} Al_2O_{3(s)} + C$. Identify A & C.

1) $A \to Al(OH)_3, C \to H_2O$ 2) $A \to 2Al(OH)_3, C \to 3H_2O$

3) $A \to 2Al(OH)_4, C \to 2H_2O$ 4) $A \to Al(OH)_3, C \to 4H_2O$

28. $A_{(s)} \underset{Cool}{\overset{Heat}{\rightleftharpoons}} NH_{3(g)} + C_{(g)}$. Identify A and C.

1) $A \to PCl_5, C \to NH_4Cl$ 2) $A, C \to HCl$

3) $A \to PCl_3, C \to Cl_2$ 4) $A \to NH_4Cl, C \to HCl$

29. Two gases 'z' having suffocating odour are obtained when a green solid 'x' is heated along with a residue 'Y'. These gases are major air pollutants. When the vapours of the gases are collected and dissolved in water, the solution turns blue litmus red. The colour of the residue becomes red. What would be x, y and z?

1) $x \to Pb(NO_3)_2, Y \to PbO_2, Z \to NO_2, N_2O_4$

2) $x \to Fe(OH)_3, Y \to FeO, Z \to H_2O, H_2O_2$

3) $x \to FeSO_4, Y \to Fe_2O_3, Z \to SO_2, SO_3$

4) $x \to PbSO_4, Y \to Pb_2O_3, Z \to SO_2, SO_3$

MATRIX MATCH TYPE QUESTIONS

30.

COLUMN-I	COLUMN-II
a) $H_2+Cl_2 \to 2HCl$	p)Decomposition of a compound into two elements.
b) $CaO+H_2O \to Ca(OH)_2$	q)Combination of two elements into a newproduct.
c) $2HgO \xrightarrow{Heat} 2Hg + O_2$	r)Decomposition of a compound into acompound and anelement
d) $2KClO_3 \xrightarrow{heat} 2KCl + 3O_2$	s)Combination of two compounds into a new product.

5. CHEMICAL DISPLACEMENT & DOUBLE DISPLACEMENT REACTIONS

CHEMICAL DISPLACEMENT REACTIONS

Displacement reactions may be defined as: **The chemical reactions in which one element takes the position or place of another element present in a compound.**

(or)

When more reactive metal displaces less reactive metal from its aqueous salt solution, the chemical reaction is called chemical displacement.

The general representation of a displacement reaction is:

$AB + C \rightarrow AC + B$

Following is the list of metals in the order of their decreasing chemical reactivities:

$$K > Na > Ca > Mg > Al > Zn > Fe > Pb > [H] > Cu > Hg > Ag$$

In these reactions, an atom or group of atoms in a molecule is replaced by another atom or a group of atoms.

These reactions are very common in inorganic chemistry. These reactions occur mostly in solution form and a more active metal displaces or removes another less active element from a compound. Some examples of displacements reactions

- When metallic zinc reacts with dilute sulphuric acid, zinc sulphate is formed and hydrogen gas is evolved.

$$\underset{\text{Zinc}}{Zn_{(s)}} + \underset{\text{dil.sulphuric acid}}{H_2SO_{4(aq)}} \rightarrow \underset{\text{Zinc sulphate}}{ZnSO_{4(aq)}} + \underset{\text{Hydrogen gas}}{H_{2(g)}}$$

In this case, H^+ ions (in H_2SO_4) are replaced by Zn^{2+} ions (in $ZnSO_4$).

Zinc displaces copper from coppersulphate solution.

$$\underset{\text{Zinc}}{Zn_{(s)}} + \underset{\text{Copper sulphate}}{CuSO_{4(aq)}} \rightarrow \underset{\text{Zinc sulphate}}{ZnSO_{4(aq)}} + Cu_{(s)}$$

Magnesium displaces copper from copper sulphate solution:

$$\underset{\text{Magnesium}}{Mg_{(s)}} + \underset{\text{Copper sulphate}}{CuSO_{4(aq)}} \rightarrow \underset{\text{Magnesium sulphate}}{MgSO_{4(aq)}} + Cu_{(s)}$$

CHEMICAL DOUBLE DISPLACEMENT REACTIONS

Double displacement reactions may be defined as: The **chemical reactions in which one component each of both the reacting molecules get exchanged to form the products.**

(or)

A chemical reaction, in which two compounds in their aqueous solution react by exchanging their radicals, is called chemical double-decomposition or chemical double-displacement.

It is represented by

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

These reactions are also classified as partner exchange reactions. Some more reactions involving double displacement of ions are:

(i) $\underset{\text{Silver nitratre}}{AgNO_{3(aq)}} + \underset{\text{Sodium chloride}}{NaCl_{(aq)}} \rightarrow \underset{\text{Silver chloride (precipitate)}}{AgCl_{(s)}} + \underset{\text{Sodium nitrate}}{NaNO_{3(aq)}}$

(ii) $\underset{\text{Barium chloride}}{BaCl_{2(aq)}} + \underset{\text{Sulphuric acid}}{H_2SO_{4(aq)}} \rightarrow \underset{\text{Barium sulphate (precipitate)}}{BaSO_{4(s)}} + \underset{\text{Hydrochloric acid}}{2HCl}$

(iii) $\underset{\text{Copper sulphate}}{CuSO_{4(aq)}} + \underset{\text{Hydrogen sulphide}}{H_2S_{(aq)}} \rightarrow \underset{\text{Copper sulphide (Precipitate)}}{CuS_{(s)}} + \underset{\text{Sulphuric acid}}{H_2SO_{4(aq)}}$

Double displacement reactions are two types they are

1) Precipitation reaction

2) Neutralization reaction

PRECIPITATION REACTIONS

When the aqueous solution of two ionic compounds reacts by exchanging their ions/radicals, to form two or more new compounds, such that one of the products formed in an insoluble salt, and hence, forms precipitate, the double displacement reaction is said to be **precipitation reaction.**

(or)

In a double displacement reaction one of the products is insoluble is called precipitation reaction.

For example: When lead nitrate solution is mixed with potassium iodide solution a yellow precipitate is formed. This reaction is a precipitation reaction and can be expressed as follows:

$$\underset{\text{Lead nitrate solution (colourless)}}{Pb(NO_3)_{2(aq)}} + \underset{\text{Potassium iodide solution (colourless)}}{2KI_{(aq)}} \rightarrow \underset{\text{Lead iodide (yellow ppt)}}{PbI_2(\downarrow)} + \underset{\text{Potassium nitrate solution}}{2KNO_{3(aq)}}$$

In the above reaction, the lead nitrate solution and potassium iodide solution exchange their ions to form a precipitate of lead iodide and potassium nitrate solution.

NEUTRALIZATION REACTIONS

When an aqueous solution of an acid reacts with a base (alkali) by exchanging their ions/ radicals to form salt and water as the products, the reaction which takes place is called **neutralization reactions.**

(or)

In a double displacement reaction one of the products is soluble in aqueous solution is called neutralization reaction.

Examples: Acid + Base/Alkali $\rightarrow$ Salt + Water

$$\underset{\text{Sulphuric acid}}{H_2SO_{4(aq)}} + 2\underset{\text{Sodium hydroxide}}{NaOH_{(aq)}} \rightarrow \underset{\text{Sodium sulphate}}{Na_2SO_{4(aq)}} + 2\underset{\text{water}}{H_2O_{(l)}}$$

$$\underset{\text{Hydrochloric acid}}{2HCl_{(aq)}} + \underset{\text{Magnesium hydroxide}}{Mg(OH)_{2(aq)}} \rightarrow \underset{\text{Magnesium chloride}}{MgCl_{2(aq)}} + \underset{\text{Water}}{2H_2O_{(l)}}$$

5. CHEMICAL DISPLACEMENT & DOUBLE DISPLACEMENT REACTION

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

CHEMICAL DISPLACEMENT REACTION

1. When more reactive metal displaces less reactive metal from its aqueous salt solution, the chemical reaction is called:
   1) Chemical combination reaction 2) Chemical decomposition reaction
   3) Chemical displacement reaction
   4) Chemical double displacement reaction
2. Which of the following is a displacement reaction?
   1) $CaO + H_2O \rightarrow Ca(OH)_2$ 2) $MgCO_3 \rightarrow MgO + CO_2$
   3) $2Na + 2H_2O \rightarrow 2NaOH + H_2$ 4) $H_2 + C1_2 \rightarrow 2HC1$
3. Which of the following is not an example single displacement reaction?
   1) $CuO + H_2 \rightarrow H_2O + Cu$ 2) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
   3) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ 4) $Zn + 2HC1 \rightarrow H_2 + ZnC1_2$
4. Copper displaces which of the following metals from its salt solution?
   1) $ZnSO_4$ 2) $FeSO_4$ 3) $AgNO_3$ 4) $NiSO_4$

CHEMICAL DOUBLE DISPLACEMENT REACTION

5. The reaction in which two compound exchange their ions to form two new compounds is called:
   1) Displacement reaction 2) Combination reaction
   3) Double displacement reaction 4) Redox reaction
6. $A^+B^- + C^+D^- \rightarrow A^+D^- + C^+B^-$
   Identify the above generalized type of reaction.
   1) Chemical replacement reaction.
   2) Chemical double decomposition reaction.
   3) Chemical displacement reaction.
   4) Chemical combination reaction.
7. The reason between an acid and a base is known as
   1) Condensation reaction 2) Addition reaction
   3) Neutralization reaction 4) Elimination reaction
8. When lead nitrate reacts with potassium iodide, yellow precipitate of
   1) PbI_2 is formed 2) KNO_3 is formed
   3) $Pb(NO_3)_2$ is formed 4) $PbIO_3$ is formed

9. Which of the following is not a double displacement reaction?
1) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$ 2) $CuSO_4 + H_2S \rightarrow CuS + H_2SO_4$
3) $NaOH + HCl \rightarrow NaCl + H_2O$ 4) $ZnO + C \rightarrow Zn + CO$

LEVEL–II

CHEMICAL DISPLACEMENT REACTION

10. Which of the following is a displacement reaction?
1) $CaO + H_2O \rightarrow Ca(OH)_2$ 2) $MgCO_3 \rightarrow MgO + CO_2$
3) $2Na + 2H_2O \rightarrow 2NaOH + H_2$ 4) $H_2 + Cl_2 \rightarrow 2HCl$

11. When dilute hydrochloric acid is added to zinc pieces taken in a test tube:
1) No change takes place
2) The colour of the solution becomes yellow
3) A pungent smelling gas gets liberated
4) Small bubbles of hydrogen gas appear on the surface of zinc pieces.

12. The correct order of metal reactivity is:
1) Copper > Mercury > Calcium > Magnesium
2) Potassium > Sodium > Calcium > Magnesium
3) Sodium > Tin > Zinc > Magnesium
4) Potassium > Calcium >Aluminium> Iron

CHEMICAL DOUBLE DISPLACEMENT REACTION

13. Barium chloride on reacting with ammonium sulphate forms barium sulphateand ammonium chloride. Which of the following correctly represents the type of the reaction involved?
(i) Displacement reaction (ii) Precipitation reaction
(iii) Combination reaction (iv) Double displacement reaction.
1) (i) Only 2) (ii) Only 3) (iv) only 4) (ii) and (iv)

14. When ferrous hydroxide reacts with hydrochloric acid, ……and H_2O are produced.
1) $FeCl_3$ 2) $FeCl_2$ 3) $FeCl_4$ 4) $FeCl$

15. When hydrogen sulphide gas is passed through a blue solution of copper sulphate, a black precipitate of copper sulphide is obtained and the sulphuric acid so formed remains in the solution. The reaction is an example of:
1) A combination reaction
2) A displacement reaction
3) A decomposition reaction
4) A double displacement reaction

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

16. Which of the following is a displacement reaction?

1) $CaO + H_2O \rightarrow Ca(OH)_2$ 2) $MgCO_3 \rightarrow MgO + CO_2$

3) $Mg + FeSO_4 \rightarrow MgSO_4 + Fe$ 4) $H_2 + C1_2 \rightarrow 2HC1$

17. Iron nails were dipped in solution kept in a test tube. After half an hour, it was observed that the colour of the solution has changed. The solution present in the test tube was that of:

1) Zinc sulphate 2) Copper sulphate

3) Iron sulphate 4) Aluminiumsulphate

18. $Zn + H_2SO_{4(dill.)} \rightarrow ZnSO_4 + H_2 \uparrow$.

1) Decomposition reaction 2) Single displacement reaction

3) Combination reaction 4) Synthesis reaction

19. When lead nitrate reacts with potassium iodide, yellow precipitate of:

1) PbI_2 is formed 2) KNO_3 is formed

3) $Pb(NO_3)_2$ is formed 4) $PbIO_3$ is formed

20. Sodium hydroxide reacts with hydrochloric acid to produce salt and water. This represents:

1) Chemical replacement reaction.

2) Chemical double decomposition reaction.

3) Chemical displacement reaction. 4) Chemical combination reaction.

LEVEL–IV

STATEMENT TYPE QUESTIONS

21. Statement I: Chemical reactions are characterized by the evolution of a gas.

Statement II: The chemical reaction between zinc and dilute sulphuric acid is characterized by the evolution of hydrogen gas.

1) Both statements are true. 2) Both statements are false.

3) Statement I is true, statement II is false.

4) Statement I is false, statement II is true.

22. Statement I: When a zinc rod is dipped in a solution of copper sulphate, zinc rod dissolves partially and its surface is coated with copper metal.

Statement II: This reaction is due to the presence of sulphate ions.

1) Both statements are true. 2) Both statements are false.

3) Statement I is true, statement II is false.

4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

23. Which of the following is / are double displacement reactions?

1) $HCl + NaOH \rightarrow NaCl + H_2O$ 2) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

3) $2H_2O \rightarrow 2H_2 + O_2$ 4) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

24. When iron nails are kept in the solution of copper sulphate, what would be the observations?

1) The blue colour of the solution fades 2) Iron nails turn brown

3) The solution turns green 4) Weight of iron nails decreases

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

In a double displacement reaction between aqueous potassium iodide and aqueous lead nitrate, a yellow precipitate of lead iodide is formed.

25. While performing the activity if lead nitrate is not available, which of the following can be used in place of lead nitrate?

1) Lead sulphate (insoluble) 2) Lead acetate

3) Ammonium nitrate 4) Potassium sulphate

26. Which of the following statements is true regarding precipitates?

1) Product formation after saturation point

2) Product formation before saturation point

3) Precipitation does not related to saturation point of a solution

4) Product with higher concentration in a reaction is precipitate

27. Which of the following is a double displacement reaction?

1) $2KI + Cl_2 \rightarrow 2KCl + I_2$ 2) $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$

3) $ZnS + 2HCl \rightarrow ZnCl_2 + H_2S\uparrow$ 4) $Mg + CuSO_4 \rightarrow MgSO_4 + Cu$

MATRIX MATCH TYPE QUESTIONS

28.

COLUMN-I	COLUMN-II
a) $2Na+Cl_2 \rightarrow 2NaCl$	p) Displacement reaction
b) $2NaOH+H_2SO_4 \rightarrow Na_2SO_4+2H_2O$	q) Neutralization reaction
c) $Na_2SO_4+BaCl_2 \rightarrow 2NaCl+BaSO_4$	r) Combination reactions
d) $Zn+H_2SO_4 \rightarrow ZnSO_4+H_2$	s) Precipitation reaction
	t) Double displacement reaction

6. DIFFERENT TYPES OF REACTIONS

	♦	CATALYTIC REACTIONS
	♦	REVERSIBLE AND IRREVERSIBLE REACTIONS
	♦	EXOTHERMIC AND ENDO THERMIC REACTIONS
	♦	REDOX REACTIONS

CATALYTIC REACTIONS

A chemical reaction in which the rate of reaction is altered in the presence of a catalyst is called catalytic reaction. "A substance which does not take part in a chemical reaction, but changes rate of reaction is called catalyst."

Ex. Potassium chlorate upon strong heating decomposes to potassium chloride and oxygen.

$$2KClO_3 \xrightarrow[MnO_2]{700^\circ C} 2KCl + 3O_2$$

The rate of release of oxygen is very slow. But on heating it with manganese dioxide, decomposition begins at a much lower temperature, i.e., at 300°C, but manganese dioxide remains unaffected. So, in this reaction, manganese dioxide acts as a catalyst.

CATALYSTS ARE TWO TYPES:

POSITIVE CATALYST: When a catalyst accelerates a reaction, it is known as a Positive catalyst.

Ex. The rate of decomposition of hydrogen peroxide is increased in thepresence of manganese dioxide.

$$2H_2O_{2(l)} \xrightarrow[Catalyst]{MnO_2} 2H_2O_{(l)} + O_{2(g)}$$

NEGATIVE CATALYST: A catalyst which retards a reaction is known as a negative catalyst.

Ex. Addition of little alcohol retards the rate of decomposition of hydrogen peroxide into water and oxygen. Rate of oxidation of chloroform decreases in the presence of alcohol.

$$2H_2O_{2(l)} \xrightarrow[H_3PO_3]{Alcohol} 2H_2O_{(l)} + O_{2(g)}$$

PROMOTERS: Substances that influence the rate of a chemical reaction by improving the efficiency of the catalyst, are called promoters.

Ex. Molybdenum is added to iron, the catalyst in Haber's process to prepareammonia.

$$N_{2(g)} + 3H_{2(g)} \underset{}{\overset{Fe-Mo}{\rightleftharpoons}} 2NH_{3(g)} + Heat$$

REVERSIBLE AND IRREVERSIBLE REACTIONS

REVERSIBLE REACTIONS: Reaction in which both the forward reaction (formation of products) and the backward reaction (formation of reactants from the products) occur at the same time and a state is reached when overall composition of mixture is constant is called reversible reaction. Such reactions are generally shown by using bidirectional $(\rightleftharpoons)$

$$N_{2(g)} + 3H_{2(g)} \underset{450^oC-400atm}{\overset{Fe-Mo}{\rightleftharpoons}} 2NH_{3(g)}$$

$$3Fe_{(s)} + 4H_2O_{(g)} \overset{Red-hot}{\rightleftharpoons} Fe_3O_{4(s)} + 4H_{2(g)}$$

Note: It must be remembered that reversible reaction can take place only in the closed vessels, such that none of the products is removed from the chemical system. However, if one or more products are removed, then the reaction takes place in the forward direction.

IRREVERSIBLE REACTIONS: A chemical reaction in which products do not react amongst themselves to form the original reactants is known as an irreversible reaction.

Here, the reactants are completely changed into products, but the products cannot be changed into reactants. Such reactions are generally, shown by using a unidirectional [one sidedarrow$(\rightarrow)$].

Ex. (i)When magnesium reacts with oxygen it forms magnesium oxide.

$2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

(ii)When silver nitrate solution is added to aqueous sodium chloride solution, a white precipitate is formed due to the formation of silver chloride.

$AgNO_{3(aq.)} + NaCl_{(aq.)} \rightarrow AgCl_{(s)} + NaNO_{3(aq.)}$

(iii)When sodium sulphate is added to barium chloride, a precipitate of barium sulphate is formed.

$Na_2SO_{4(aq.)} + BaCl_{2(aq.)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq.)}$

In the above reactions, the reactants react completely, and the reactions proceed only in the forward direction. Backward reactions in these cases are not possible. So, we can say thatall irreversible reactions can be carried to completion. They proceed in one direction i.e., they are unidirectional.

Note: i)Generally, all ionic reactions, explosion reactions, combustion reactions, precipitation reactions are irreversible.

ii)Reactions in which gaseous products are formed are also irreversible when carried out in open vessels.

EXOTHERMIC AND ENDOTHERMIC REACTIONS

EXOTHERMIC REACTIONS: The chemical reactions which proceed with the evolution of heat energy are known as exothermic reactions.

Ex: $C_{(s)} + O_{2(g)} \rightarrow CO_{2(l)} + 94.00$ kcal.

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)} + 136.00$ kcal.

ENDOTHERMIC REACTIONS: The chemical reactions which proceed with the absorption of heat energy are known as endothermic reactions.

Ex: $C_{(s)} + 2S_{(s)} \rightarrow CS_{2(l)} - 22$ kcal

$H_2O_{(g)} + C_{(s)} \xrightarrow{1100^\circ C} H_{2(g)} + CO_{(g)} - 31.4\,kcal$

REDOX REACTIONS

OXIDATION-REDUCTION REACTIONS (REDOX REACTIONS)

OXIDATION: When a substance gains oxygen or loses hydrogen, the oxidation of substance takes place.

OXIDISING AGENT: The substance which loses oxygen or gains hydrogen is called oxidising agent.

REDUCTION: When a substance gains hydrogen or loses oxygen, the reduction of substance takes place.

REDUCING AGENT: A substance which loses hydrogen or gains oxygen is called reducing agent.

Ex: $\underset{\left(\begin{smallmatrix}\text{Reduced}\\ \text{oxidising agent}\end{smallmatrix}\right)}{CuO_{(s)}} + \underset{\left(\begin{smallmatrix}\text{oxidised}\\ \text{reducing agent}\end{smallmatrix}\right)}{H_{2(g)}} \xrightarrow{Heat} Cu_{(s)} + H_2O_{(g)}$

(i)As the hydrogen gains oxygen from copper oxide, therefore, hydrogen is oxidised.

(ii)As the hydrogen gains oxygen from copper oxide, therefore, hydrogen is reducing agent.

(iii)As the copper oxide loses oxygen, therefore, reduction of copper oxide takes place the copper oxide loses oxygen, therefore, copper oxide is oxidising agent. If the oxidation of one reactant takes place, at the same time the reduction of other reactant takes place. In other words, the oxidation-reduction reactions takes place simultaneously and, hence, are called redox reactions.

SOME OTHER EXAMPLES OF REDOX REACTIONS ARE:

- $ZnO + C \rightarrow Zn + CO$

In this reaction carbon is oxidized to CO and ZnO is reduced to Zn.

- $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

In this reaction HCl is oxidized to $Cl_2$where asMnO_2 is reduced to $MnCl_2$.

6. DIFFERENT TYPES OF REACTIONS

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

CATALYTIC REACTIONS

1. A chemical reaction in which the rate of reaction is altered in the presence of a catalyst is called:
   1) Catalytic reaction 2) Oxidation reaction
   3) Reversible reaction 4) Exothermic reaction
2. When a catalyst accelerates a reaction, it is known as:
   1) Positive catalyst 2) Negative catalyst
   3) Promoters 4) None of these
3. A catalyst which retards a reaction is known as:
   1) Positive catalyst 2) Negative catalyst
   3) Promoters 4) None of these
4. Substances that influence the rate of a chemical reaction by improving the efficiency of the catalyst, are called:
   1) Positive catalyst 2) Negative catalyst
   3) Promoters 4) None of these
5. Which of the following speeds up the reaction?
   1) Negative catalyst 2) Enzyme
   3) Positive catalyst 4) None
6. "If potassium chlorate is heated in presence of manganese dioxide, it decomposes topotassium chloride and oxygen gas". Here, manganese dioxide is a:
   1) Positive catalyst 2) Negative catalyst
   3) Promoter 4) Inhibitor
7. Which of the following catalyst is used for converting vegetable oils into vanaspati ghee?
   1) Asbestos 2) MnO_2 3) Nickel 4) Platinum

REVERSIBLE AND IRREVERSIBLE REACTIONS

8. Reaction in which both the forward reaction and the backward reaction occur at the same time is called:
   1) Catalytic reaction 2) Oxidation reaction
   3) Reversible reaction 4) Exothermic reaction
9. A chemical reaction in which products do not react amongst themselves to form the original reactants is known as:
   1) Catalytic reaction 2) Irreversible reaction

3) Reversible reaction 4) Exothermic reaction

10. Identify irreversible change:
1) Heating zinc oxide 2) Magnetizing iron
3) Decomposition of mercuric oxide 4) Sugar solution

11. Amongst the following chemical reactions the irreversible reaction is:
1) $H_2 + I_2 \rightarrow 2HI$ 2) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
3) $CaCO_3 \rightarrow CaO + CO_2$ 4) $O_2 + 2SO_2 \rightarrow 2SO_3$

EXOTHERMIC AND ENDOTHERMIC REACTION

12. The chemical reactions which proceed with the evolution of heat energy are known as:
1) 1) Catalytic reaction 2) Irreversible reaction
3) Reversible reaction 4) Exothermic reaction

13. The chemical reactions which proceed with the absorption of heat energy are known as:
1) Endothermic reaction 2) Irreversible reaction
3) Reversible reaction 4) Exothermic reaction

14. Formation of carbon disulphide from carbon and sulphur takes place by:
1) Absorption of heat 2) Evolution of heat
3) No change in heat content 4) None of the above

15. Heat is evolved during:
1) Endothermic reaction 2) Displacement reaction
3) Combustion reaction 4) Combination reaction

REDOX REACTIONS

16. When a substance gains oxygen or loses hydrogen is called:
1) Oxidation 2) Reduction 3) Rancidity 4) None of these

17. When a substance gains hydrogen or loses oxygen is called:
1) Oxidation 2) Reduction 3) Rancidity 4) None of these

18. Combination of phosphorus and oxygen is an example of:
1) Oxidation 2) Reduction 3) Rancidity 4) None of these

LEVEL–II

CATALYTIC REACTIONS

19. The catalyst used in Haber's process:
1) Ni 2) Fe 3) V_2O_5 4) MnO_2

20. The catalyst used in decomposition of H_2O_2 is:
1) V_2O_5 2) MnO_2 3) H_3PO_4 4) None

REVERSIBLE AND IRREVERSIBLE REACTIONS

21. A chemical reaction in which the products are capable of undergoing a chemical change to give back reactants is called:
1) Neutralisation reaction 2) Reversible reaction

3) Redox reaction 4) Catalytic reaction

22. Reactions in which gaseous products are formed are also irreversible when carried out in:
1) Closed vessels 2) Open vessels 3) Both 1 and 2 4) None

EXOTHERMIC AND ENDOTHERMIC REACTION

23. In an endothermic reaction:
1) The energy content of products is less than heat content of reactants
2) The energy content of products is greater than that heat content of reactants
3) Heat is released
4) Heat is neither absorbed nor released

24. Which of the following reaction evolves heat?
1) $C + O_2 \rightarrow CO_2$ 2) $C_6H_{12}O_6 + CO_2 \rightarrow 6CO_2 + 6H_2O$
3) $CaO + H_2O \rightarrow Ca(OH)_2$ 4) All of these

REDOX REACTIONS

25. Oxidation involves:
1) Loss of electrons 2) Gain of electrons
3) Increase in the valence of negative part
4) Decrease in the valence of positive part

26. In the reaction $3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3$ the oxidizing agent is:
1) MnO_2 2) Al 3) Al_2O_3 4) Mn

27. In the reaction, $Br_2 + 2I^- \rightarrow 2Br^- + I_2$, the oxidizing agent is:
1) Br_2 2) I^- 3) Br^- 4) I_2

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

28. When magnesium is burnt in air (indicate which statement is not correct)?
1) It burns with a brilliant flame 2) A white residue is formed
3) An endothermic reaction takes place
4) A combination reaction takes place.

29. In the reaction $Cu + I_2 \rightarrow CuI_2$ the substance undergoing reduction is:
1) Cu 2) I_2 3) CuI_2 4) Both (1) & (2)

30. Which of the statement about the reaction below are incorrect?
$2PbO_{(s)} + C_{(s)} \rightarrow 2Pb_{(s)} + CO_{2(g)}$
i) Lead is getting reduced ii) CO_2 is getting oxidized
iii) carbon is getting oxidized iv) PbO is getting reduced

1) i & ii 2) i & iii 3) i, ii & iii 4) All of these

31. In the reaction $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$, Zn is:

1) Oxidising agent 2) Reducing agent 3) Neutral 4) Both (1) & (2)

32. Which of the following is a redox reaction?

1) $NaCl + KNO_3 \rightarrow NaNO_3 + KCl$ 2) $CaC_2O_4 + 2HCl \rightarrow CaCl_2 + H_2C_2O_4$

3) $Mg(OH)_2 + 2NH_4Cl \rightarrow MgCl_2 + 2NH_4OH$

4) $Zn + 2AgCN \rightarrow 2Ag + Zn(CN)_2$

LEVEL–IV

STATEMENT TYPE QUESTIONS

33. Statement I: Catalyst is a substance which takes part in a chemical reaction undergoes in chemical reaction and changes the rate of a reaction.

Statement II: Catalyst is a substance which does not take part in a chemical reaction but changes the rate of a reaction.

1) Both statements are true. 2) Both statements are false.

3) Statement I is true, statement II is false.

4) Statement I is false, statement II is true.

34. Statement I: Mutual exchange of elements or radicals by two substances is known as double decomposition reaction.

StatementII: Splitting of single substance into two or more substances is called combination reaction.

1) Both statements are true. 2) Both statements are false.

3) Statement I is true, statement II is false.

4) Statement I is false, statement II is true.

MULTI CORRECT ANSWER TYPE QUESTIONS

35. Which of the following are exothermic processes?

1) Dilution of an acid 2) Reaction of water with quick lime
3) Evaporation of water 4) Sublimation of camphor

36. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ is an example of:

1) Displacement reaction 2) Combination reaction
3) Redox reaction 4) Neutralisation reaction

LEVEL–V

COMPREHENSION TYPE QUESTIONS

PASSAGE:

Some chemical reactions need a catalyst to accelerate or decelerate their rates. Catalysts themselves do not take part in the reaction. For example, by itself, potassium chlorate reacts only at 700°C, and even then, the rate of release of oxygen is very slow. But on heating it with manganese dioxide, decomposition begins at a much lower temperature, i.e., at 300°C, but manganese dioxide remains unaffected. So, in this reaction, manganese dioxide acts as a catalyst.

$2KClO_3 \xrightarrow{MnO_2} 2KCl + 3O_2$

37. Which of the following speeds up the reaction?

1) Negative catalyst 2) Enzyme

3) Positive catalyst 4) None

38. "If potassium chlorate is heated in presence of manganese dioxide, it decomposes topotassium chloride and oxygen gas". Here, manganese dioxide is a:

1) Positive catalyst 2) Negative catalyst

3) Promoter 4) Inhibitor

39. Which of the following catalyst is used for converting vegetable oils into vanaspati ghee?

1) Asbestos 2) MnO_2 3) Nickel 4) Platinum

MATRIX MATCH TYPE QUESTIONS

40.

COLUMN-I	COLUMN-II
a) MnO_2	p) Promoter
b) Molybdenum	q) Catalyst
c) $N_2+3H_2 \rightarrow 2NH_3$	r) Irreversible reaction
d) $AgNO_3+NaCl \rightarrow AgCl+NaNO_3$	s) Reversible reaction