Read the following Notes thoroughly and do the questions given at the end.

Notes for the Chapter 1, The Language of chemistry

Chemistry has its own language such as symbol, equation, ion, valency, atom, element, molecule, reaction and so on. A *chemical symbol* denotes in short, a particular element or an atom of that element. Chemical reactions are easy to write with chemical symbols than having to write the lengthy chemical names. Many scientists have devised several methods to symbolic representation.
Valency is the combining capability of an element. In other words, the number of electrons which an atom can gain or share or lose when a chemical reaction takes place defines its valency. The classification of elements into monovalent, divalent and so on is made based on their valency. Molecules are formed to satisfy the valency of an atom.
In this topic, you will learn about c*hemical symbols* and *valency*.

Symbols of some common elements

- A chemical symbol is a notation of one or two letters representing an atom of a chemical element.
- A symbol plays a significant role in the study of elements. For e.g. the symbol Cl represents:
  - The element chlorine
  - One atom of chlorine
  - The atomic mass of chlorine i.e.,17 a.m.u

Valency

- Valency indicates the combining capacity of an atom or radical. It is defined as the number of hydrogen atoms that will combine with or displace one atom of that element or radical.
- Metals are electropositive in nature and lose electrons to attain octet configuration. Metals in Group 1 (alkali metals) have one valence electron and are univalent.
- Metals in group 2 (alkaline earth metals) have 2 valence electrons and are divalent.
- Metals in group 3 have 3 valence electrons and are trivalent.

    - $Na - e^- \Rightarrow Na^+$ (univalent).
    - $Ca - 2e^- \Rightarrow Ca^{2+}$ (divalent).
    - $Al - 3e^- \Rightarrow Al^{3+}$ (trivalent).
- Non-metals are electronegative in nature and gain electrons to attain octet configuration.
    - $Cl + e^- \Rightarrow Cl^-$ (univalent).
    - $O + 2e^- \Rightarrow O^{2-}$ (divalent).
    - $N + 3e^- \Rightarrow N^{3-}$(trivalent).
- Carbon, silicon and other group four elements have four valence electrons. They are called tetravalent elements. Under normal conditions, these elements share electrons with one or more other elements to gain octet configuration.
- However, Sn^{4+} and Pb^{4+} also exist.

Variable Valency

When an element loses electrons from the valence shell and from the penultimate shell, it is said to have variable valency.

Radicals

An atom or a group of atoms that behave like a single unit and contain a positive or negative ion is called a radical. Radicals are very reactive and have a unique valency.

Chemical Formula

A *chemical reaction* involves the transformation of one set of chemical substances to another set. It leads to change in the chemical and physical properties of a substance. It also leads to the change in physical state and composition of that substance. Substances with more than two elements chemically bonded are known as compounds. *Chemical Formula* represents the elements that a compound is made of.

Chemical formula plays an important role in understanding the formation of a substance and proportions of elements in a specific chemical reaction. It is vital to know the symbol of elements of a compound, the valency of elements and formula for radicals to write a chemical formula.

Molecular Formulae and Equations

A molecular formula, also known as a chemical formula, is a combination of elemental symbols and subscript numbers which is used to show the composition of a compound. Examples: Silica is represented as SiO2 . Marble is represented as $CaCO_3$.

Writing the molecular formula

- Write the symbol of the positive ion/radical to the left and the negative ion/radical to the right along with their valency number. Interchange the valence number of the radicals and shift them to the lower side.
- Example: ammonium phosphate.

  NH_4^{+1} PO_4^{3-}

  $(NH_4)_3PO_4$
- Write the valencies of the constituents below each and crossover the valencies of the combining atoms
- Example: Hydrogen sulphide.

  H S

  2 1

  H_2S

Chemical Equations

1. One reactant and two or three products (decomposition reaction).

- 2HgO (s) → 2Hg (l) + O2 (g)
- $NH_4OH(aq) \rightarrow NH_3(g) + H_2O(l)$

2. Two reactants and one product (combination reaction).

- $2Na + Cl_2 \rightarrow 2NaCl$
- $S + O_2 \rightarrow SO_2$

3. Two reactants and two products (double displacement reaction).

- $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
- $NaOH + HCl \rightarrow NaCl + H_2O$

4. Two reactants and two or more products.

- $Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$
- $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$

The symbolic depiction of a chemical reaction in the form of symbols and formulae constitutes a chemical reaction. It basically consists of reactants (the starting substances) on the left-hand side and products (the substance formed as a result of chemical reaction) on the right-hand side of the equation, Both reactants and products of a chemical equation are represented by their chemical formulae. The individual reactants are separated by a plus (+) sign. The reactants and products are separated by an arrow symbol.

According to the law of conservation of mass, the quantity of each element does not change in a chemical reaction, meaning each side of the chemical equation should amount to the same quantity of any particular element. In a chemical reaction, the charge is conserved too. Thus, both sides of the balanced equation must depict the same charge. Balanced equations can be written using smallest whole-number coefficients. The coefficient 1 is implicit when there is no coefficient before a chemical formula,

In this topic, you will learn about various methods to balance chemical equations.

Balancing chemical equations Hit and trial method

- Start by balancing an element that appears in only one reactant and product.
- Once one element is balanced, proceed to balance another, and another, until all elements are balanced.
- Balance chemical formulas by placing coefficients in front of them.
- If two elements have the same number, balance the metal first.
  Example: Iron + Sulphuric acid → Iron(III) sulphate + Hydrogen.

Step 1

Write out the unbalanced reaction.

$Fe + H_2SO_4 \rightarrow Fe_2 (SO_4)_3 + H_2$.

Step 2

Write the elements which occur on the LHS and RHS of the chemical equation and indicate the total number of each element on the respective side.

LHS	RHS
Fe-1	Fe-2
H-2	H-2
S-1	S-3
O-4	O – (4 x 3) = 12

- $2Fe + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + H_2$.
- Now Fe is balanced, H has the same number on both sides, so we balance sulphur.
- $2Fe + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + H_2$.
- This makes hydrogen unbalanced, while the rest are balanced, so we add 3 in front of hydrogen on the RHS.
- $2Fe + + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3H_2$.
- The equation is balanced.

Chemical Formula Writing Worksheet

Write chemical formulas for the compounds in each box. The names are found by finding the intersection between the cations and anions. Example: The first box is the intersection between the "zinc" cation and the "chloride" anion, so you should write "$ZnCl_2$", as shown.

	zinc	*iron (II)*	*iron (III)*	*gallium*	*silver*	*lead (IV)*
chloride	$ZnCl_2$					
acetate						
nitrate						
oxide						
nitride						
sulfate						

Write the formulas for the following compounds:

1) copper (II) chloride _____

2) lithium acetate _____

3) vanadium (III) selenide _____

4) manganese (IV) nitride _____

5) beryllium oxide _____

6) sodium sulfate _____

7) aluminum arsenide _____

8) potassium permanganate _____

9) chromium (VI) cyanide _____

10) tin (II) sulfite _____

11) vanadium (V) fluoride _____

12) ammonium nitrate _____

Balancing Chemical Equations

Balance the equations below:

1) ____ N_2 + ____ H_2 → ____ NH_3

2) ____ $KClO_3$ → ____ KCl + ____ O_2

3) ____ NaCl + ____ F_2 → ____ NaF + ____ Cl_2

4) ____ H_2 + ____ O_2 → ____ H_2O

5) ____ $Pb(OH)_2$ + ____ HCl → ____ H_2O + ____ $PbCl_2$

6) ____ $AlBr_3$ + ____ K_2SO_4 → ____ KBr + ____ $Al_2(SO_4)_3$

7) ____ CH_4 + ____ O_2 → ____ CO_2 + ____ H_2O

8) ____ C_3H_8 + ____ O_2 → ____ CO_2 + ____ H_2O

9) ____ C_8H_{18} + ____ O_2 → ____ CO_2 + ____ H_2O

10) ____ $FeCl_3$ + ____ NaOH → ____ $Fe(OH)_3$ + ____NaCl

11) ____ P + ____O_2 → ____P_2O_5

12) ____ Na + ____ H_2O → ____ NaOH + ____H_2

13) ____ Ag_2O → ____ Ag + ____O_2

14) ____ S_8 + ____O_2 → ____ SO_3

15) ____ CO_2 + ____ H_2O → ____ $C_6H_{12}O_6$ + ____O_2

16) ____ K + ____ MgBr → ____ KBr + ____ Mg

17) ____ HCl + ____ $CaCO_3$ → ____ $CaCl_2$ + ____H_2O + ____ CO_2

18) ____ HNO_3 + ____ $NaHCO_3$ → ____ $NaNO_3$ + ____ H_2O + ____ CO_2

19) ____ H_2O + ____ O_2 → ____ H_2O_2

20) ____ NaBr + ____ CaF_2 → ____ NaF + ____ $CaBr_2$

21) ____ H_2SO_4 + ____ $NaNO_2$ → ____ HNO_2 + ____ Na_2SO_4

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