

Chapter notes

Class: IX

Chapter Name: Atoms and molecules

Top concepts

1. Laws of chemical combination

- Law of conservation of mass: Mass can neither be created nor destroyed in a chemical reaction
- Law of constant proportion or Law of definite proportion: In a chemical substance the elements are always present in definite proportions by mass

2. Postulates of Dalton's atomic theory

- All matter is made of very tiny particles called atoms
- Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction
- Atoms of a given element are identical in mass and chemical properties
- Atoms of different elements have different masses and chemical properties
- Atoms combine in the ratio of small whole numbers to form compounds
- The relative number and kinds of atoms are constant in a given compound

3. Some Limitations of Dalton's atomic theory

- According to Dalton's atomic theory atoms of a given element are identical in mass and chemical properties. Atoms of different elements have different masses and chemical properties. This is wrong because atoms of some elements vary in their mass and density. Such atoms of the same element having different masses are called isotopes. For example, chlorine has two isotopes having mass numbers 35 a.m.u and 37 a.m.u.
- According to Dalton's atomic theory atoms of different elements have different masses and chemical properties. This has been proved wrong in certain cases like argon and calcium atoms, which have the same atomic mass of 40. Such atoms of different elements that have the same atomic mass are called isobar.
- According to Dalton's atomic theory atoms combine in the ratio of small whole numbers to form compounds. This is not seen in complex

organic compounds like sugar $C_{12}H_{22}O_{11}$. Ratio of C, H and O is 12:22:11 which is not simple.

4. Atoms are building block of all matter
5. Atomic radius is measured in nanometres ($1 \text{ m} = 10^9 \text{ nm}$)
6. Individual atoms can be observed using Scanning Tunnelling Microscopes
7. Each element has a name and a unique symbol
8. Rules for assigning symbols for atoms of various elements
 - a. The abbreviation used to represent an element is generally the first letter in capital of the English name of element

English name of element	Symbol
Hydrogen	H
Boron	B
Oxygen	O
Nitrogen	N
Fluorine	F

- b. When the names of two or more elements begin with the same initial letter, the initial letter followed by the letter appearing later in the name is used to symbolize the element

Name of element	Symbol
Barium	Ba
Bismuth	Bi
Bromine	Br
Silicon	Si
Cadmium	Cd

- c. Symbols of some elements are derived from their Latin names

Name of element	Latin name	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
Copper	Cuprum	Cu
Iron	Ferrum	Fe

Gold	Aurum	Au
Silver	Argentum	Ag

9. One atomic mass unit is a mass unit equal to exactly one twelfth($1/12$ th) the mass of one atom of carbon-12
10. Relative atomic mass of the atom of an element is defined as the average mass of the atom, as compared to $1/12$ th the mass of one carbon-12 atom
11. Atoms of most elements are not able to exist independently. Atoms form molecules and ions
12. A molecule can be defined as the smallest particle of an element or a compound that is capable of an independent existence and shows all the properties of that substance
13. Molecules of element are formed by the atoms of the same type
14. Atoms of different elements join together in definite proportions to form molecules of compounds

Based upon atomicity we can classify molecules as follows.

- Monoatomic molecules: Noble gases like helium, neon, argon, etc., exist in atomic forms, i.e., they are monoatomic. For example, helium, neon and argon exist as He Ne and Ar respectively.
- Diatomic molecules: These molecules consist of two atoms. For example, hydrogen (H_2), oxygen (O_2), nitrogen (N_2), chlorine (Cl_2), carbon monoxide (CO), hydrogen chloride (HCl) and sodium chloride (NaCl).
- Triatomic molecules: These molecules consist of three atoms. For example, ozone (O_3) is a triatomic molecule. Similarly, carbon dioxide (CO_2), nitrogen dioxide (NO_2) and hydrogen sulphide (H_2S) are examples of triatomic molecules.

- Tetraatomic molecules: These molecules consist of four atoms. For example, P_4 is a tetraatomic molecule of phosphorus.
 - Polyatomic molecules: Any molecule containing more than four atoms is called a polyatomic molecule. For example, sulphur (S_8), methane (CH_4), nitric acid (HNO_3), ethanol (C_2H_5OH).
15. An ion is a charged particle and can be negatively or positively charged
 16. A negatively charged ion is called an 'anion'
 17. A positively charged ion is called 'cation'
 18. Ions may consist of a single charged atom or a group of atoms that have a net charge on them
 19. Ionic compounds contain charged species called ions as their smallest unit
 20. A group of atoms carrying a fixed charge on them are called polyatomic ions or radicals
 21. The chemical formula of a compound is a symbolic representation of its composition
 22. Valency is the combining capacity of an element
 23. Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound

24. Names and symbols of some ions

Valency	Name of ion	Symbol	Non-metallic element	Symbol	Polyatomic ions	Symbol
1.	Sodium	Na ⁺	Hydrogen	H ⁺	Ammonium	NH ₄ ⁺
	Potassium	K ⁺	Hydride	H ⁻	Hydroxide	OH ⁻
	Silver	Ag ⁺	Chloride	Cl ⁻	Nitrate	NO ₃ ⁻
	Copper (I)*	Cu ⁺	Bromide	Br ⁻	Hydrogen carbonate	HCO ₃ ⁻
			Iodide	I ⁻		
2.	Magnesium	Mg ²⁺	Oxide	O ²⁻	Carbonate	CO ₃ ²⁻
	Calcium	Ca ²⁺	Sulphide	S ²⁻	Sulphite	SO ₃ ²⁻
	Zinc	Zn ²⁺			Sulphate	SO ₄ ²⁻
	Iron (II)*	Fe ²⁺				
	Copper (II)*	Cu ²⁺				
3.	Aluminium	Al ³⁺	Nitride	N ³⁻	Phosphate	PO ₄ ³⁻
	Iron (III)*	Fe ³⁺				

25. Rules for writing formula of compound:

- Formula of compound is given by writing side by side the symbols of constituent elements
- Symbol of the more metallic element is written first in formula
- Number of atoms of each of the constituent element present in the molecule is indicated by subscript
- When either of the ions or both the ions are polyatomic and their valency is more than 1, we enclose the polyatomic ions in brackets. No brackets are necessary if the valency(ies) of polyatomic ion(s) is(are) 1
- While writing formula of compound if the valency numbers have a highest common factor (H.C.F), divide the valency numbers by H.C.F to get the simple ratio between the combining elements

26. The simplest compounds, which are made up of two different elements are called binary compounds

27. Formula of a binary compound is written by criss crossing the valencies of elements present in a molecule of the compound

28. A chemical compound is always electrically neutral, so the positive and negative valencies or charges of the ions in the compound must add up to zero

29. The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of the substance. It is therefore the relative mass of molecule expressed in *atomic mass units (u)*
30. The formula unit mass of a substance is a sum of the atomic masses of all atoms in a formula unit of a compound
31. 1mole of any substance = 6.022×10^{23} units
32. The mole is the amount of substance that contains the same number of particles (atoms/ ions/ molecules/ formula units etc.) as there are atoms in exactly 12 g of carbon-12
33. Mass of 1 mole of a substance is called its molar mass
34. Atoms of different elements are of different sizes and masses. A mole of one type of atoms will have a different mass from a mole of another type of atoms
35. Molar mass = Mass of one mole of any substance = Gram atomic mass or gram molecular mass or gram formula mass of the substance
36. Number of moles = Given number of particles/Avogadro's number
37. Molar mass is expressed in g/mol
38. Atomic mass of an element expressed in grams is called gram atomic mass
39. Molecular mass of a substance expressed in grams is called gram molecular mass
40. Mass of one mole of atoms of any element is equal to gram atomic mass of that element

