INTRODUCTION

Every matter is made up of very tiny particles called atoms. Molecules are formed from atoms. Atoms and molecules are too small to be seen through naked eye. They can only be seen through a powerful microscope. Let us know about atoms and molecules in details.

AN ATOM

- The word atom comes from the word "atomos" meaning 'indivisible' coined by a Greek philosopher Democritus.
- John Dalton in the year 1808 suggested that an atom is the basic unit of matter.
- An atom is defined as the smallest particle of an element that may or may not exist independently but still shows all the properties of that element and takes part in every chemical reaction.
- For Example:

  On crushing a zinc piece, even the smallest piece of the Zinc metal shows the properties of the zinc.
- In other words, "An Atom is the smallest possible unit of an element"

CHARACTERISTICS OF ATOM AS SUGGESTED BY JOHN DALTON

- An atom is the smallest particle of matter which cannot be divided further into smaller particles.
- Atoms of the same element are identical but they differ from the atoms of the other elements.
- An atom of an element exhibits all the properties of that element.
- Atoms can neither be created nor destroyed.
- Atoms may or may not have independent existence but they can take part in chemical reaction.

A MOLECULE

A molecule is the smallest particle of an element or compound which exist independently and exhibits all the properties of that element or compound.

Molecule can also be defined as the group of two or more atoms that are chemically bonded together by attractive forces.

Molecules are of two types: -

- Molecule of an Element
- Molecule of a Compound

ATOMICITY

Atomicity is defined as the number of atoms of an element join together to form a molecule is known as the Atomicity of that molecule.

Depending on the Atomicity, the molecule of elements can be divided into: -

- Monoatomic Molecules
- Diatomic Molecules
- Triatomic Molecules
- Polyatomic Molecules

MONOATOMIC MOLECULE

- The molecule that contains only one atom are Monoatomic molecule.
- Examples of Monoatomic Molecules are: - Na, Zn, Mg, and Noble gases like He, Ne, Ar, and Xe etc.

DIATOMIC MOLECULE

- The molecule that contains two atoms are Diatomic molecule.
- Examples of Diatomic Molecules are: - H_2, N_2, O_2, Cl_2 etc.

TRIATOMIC MOLECULE

- The molecule that contains three atoms are Triatomic molecule.

- Examples of Triatomic Molecules are: - O_3 (ozone)

POLYATOMIC MOLECULE

- The molecule that contains more than three atoms are Polyatomic molecule.
- Examples of Monoatomic Molecules are: - P_4 (Phosphorus) and S_8 (Sulphur)

MOLECULAR FORMULA OF AN ELEMENT

- Molecular formula of an element is defined as the symbolic representation of its molecule.
- For Example, Cl_2 is the molecular formula of Chlorine gas consists of two atoms of Chlorine.
- For example, two atoms of Hydrogen and one atom of oxygen forms a molecule of Water.

NAME OF THE ELEMENT	SYMBOLS OF MOLECULES	ATOMICITY	STATE
Hydrogen	H_2	2	Gas
Nitrogen	N_2	2	Gas
Oxygen	O_2	2	Gas
Fluorine	F_2	2	Gas
Chlorine	Cl_2	2	Gas
Bromine	Br_2	2	Liquid
Iodine	I_2	2	Solid
Ozone	O_3	3	Gas
Phosphorous	P_4	4	Solid
Sulphur	S_8	8	Solid

MOLECULES OF COMPOUNDS

- When atoms of two or more elements join together in a fixed ratio by mass, a molecule of a compound is formed.
- For Example, two atoms of Hydrogen and one atom of oxygen combine to form a molecule of water.
- H + O + H----------→ H2O

  1atom + 1atom + 1atom----------→ 1 Molecule of Water
- The smallest unit of a compound is its molecule.
- Molecules of different compounds show different properties. For Example, Water molecule and Sugar molecules are different from each other

RADICALS

- A Radical is an atom of an element or a group of atoms of different elements that behaves like a single unit.
- Radicals are of two types: -
  - Basic Radical: - They have positive charge and are also called Cations.
  - Acid Radical: - They have negative charge and are also called Anions.

Some of the Positive Radicals are given below: -

Name of Radical	Representation	Valency
Hydrogen	H^+	1
Sodium	Na^+	1
Potassium	K^+	1
Silver	Ag^+	1
Ammonium	NH_4^+	2
Magnesium	Mg^{2+}	2
Calcium	Ca^{2+}	2
Zinc	Zn^{2+}	2
Iron(II)	Fe^{2+}	2
Gold	Au^{2+}	2
Copper(II)	Cu^{2+}	2
Iron(III)	Fe^{3+}	3
Aluminium	Al^{3+}	3
Tin(IV)	Sn^{4+}	4
Platinum(IV)	Pt^{4+}	4

Some of the Negative Radicals are given below: -

Name of Radical	Representation	Valency
Chloride	Cl^-	1
Bromide	Br^-	1
Hydroxide	OH^-	1
Acetate	CH_3COO^-	1
Nitrate	NO_3^-	1
Nitrite	NO_2^-	1
Bisulphate	HSO_4^-	1
Bisulphite	HSO_3^-	1
Bicarbonate	HCO_3^-	1
Oxide	O^{2-}	2
Carbonate	CO_3^{2-}	2
Sulphate	SO_4^{2-}	2
Sulphite	SO_3^{2-}	2
Dichromate	$Cr_2O_7^{2-}$	2
Nitrite	N^{3-}	3
Phosphate	PO_4^{3-}	3

Valency

Valence electrons are those electrons which are present in the outermost orbit of the atom.

- The capacity of an atom to lose, gain or share valence electrons in order to complete its octet determines the valency of the atom.
- Examples: - The valency of hydrogen is one
- In hydrogen chloride molecule (HCl) one atom of chlorine combines with one atom of hydrogen, hence valency of chlorine is 1

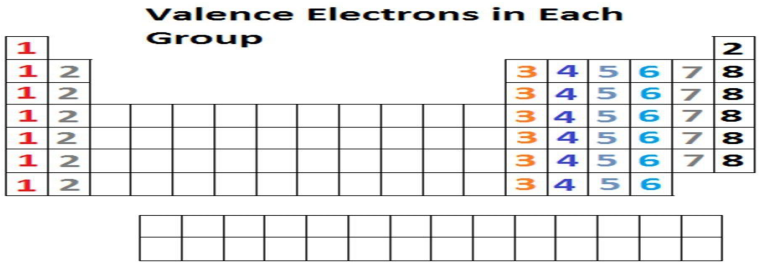
Variable Valency

- Some elements show more than one valency or simply variable valency.

- The suffix *ous* is used for the lower valency and the suffix *ic* is used for the higher valency
- For example, IRON (II) is known as Ferrous with valency 2 and IRON (III) is known as Ferric with valency 3.

RELATIONSHIP BETWEEN VALENCY OF ELEMENTS AND PERIODIC TABLE

- Periodic Table is a tabular arrangement of elements in vertical columns and horizontal rows indicating the regular trends in the properties of elements.
- The table consists of 118 elements known to us.
- These elements are arranged in 18 vertical columns called groups and 7 horizontal rows called periods according to the IUPAC system.



NAME OF THE ELEMENT	SYMBOL	VALENCY
Hydrogen	H	1
Helium	He	0
Lithium	Li	1
Beryllium	Be	2
Boron	B	3
Carbon	C	4
Nitrogen	N	3
Oxygen	O	2
Fluorine	F	1
Neon	Ne	0
Sodium	Na	1

Magnesium	Mg	2
Aluminium	Al	3
Silicon	Si	4
Phosphorous	P	3
Sulphur	S	2
Chlorine	Cl	1
Argon	Ar	0
Potassium	K	1
Calcium	Ca	2

SYMBOLS OF ELEMENTS

1 - Hydrogen H	21 - Scandium Sc	41 - Niobium Nb
2 - Helium He	22 - Titanium Ti	42 - Molybdenum Mo
3 - Lithium Li	23 - Vanadium V	43 - Technetium Tc
4 - Beryllium Be	24 - Chromium Cr	44 - Ruthenium Ru
5 - Boron B	25 - Manganese Mn	45 - Rhodium Rh
6 - Carbon C	26 - Iron (Ferrum) Fe	46 - Palladium Pd
7 - Nitrogen N	27 - Cobalt Co	47 - Silver (Argentum) Ag
8 - Oxygen O	28 - Nickel Ni	48 - Cadmium Cd
9 - Fluorine F	29 - Copper (Cuprum) Cu	49 - Indium In
10 - Neon Ne	30 - Zinc Zn	50 - Tin (Stannum) Sn
11 - Sodium (Natrium) Na	31 - Gallium Ga	51 - Antimony (Stibium) Sb
12 - Magnesium Mg	32 - Germanium Ge	52 - Tellurium Te
13 - Aluminium (Aluminum) Al	33 - Arsenic As	53 - Iodine I
14 - Silicon Si	34 - Selenium Se	54 - Xenon Xe
15 - Phosphorus P	35 - Bromine Br	55 - Caesium (Cesium) Cs
16 - Sulfur S	36 - Krypton Kr	56 - Barium Ba
17 - Chlorine Cl	37 - Rubidium Rb	57 - Lanthanum La
18 - Argon Ar	38 - Strontium Sr	58 - Cerium Ce
19 - Potassium (Kalium) K	39 - Yttrium Y	59 - Praseodymium Pr
20 - Calcium Ca	40 - Zirconium Zr	60 - Neodymium Nd

MOLECULAR FORMULA

- A Molecular formula of a compound is the symbolic representation of its (one) molecule.
- It shows the number of atoms of each element present in it. The atoms combine in whole numbers to form the molecules.
- For Example: - A molecule of Sulphur Dioxide gas is represented by SO_2. It indicates that one molecule of SO_2 is formed by an atom of sulphur and two atoms of Oxygen.

WRITING A CHEMICAL FORMULA OF A COMPOUND

To write the chemical formula, the following steps must be followed.

1. Write the Symbols
2. Interchange the valence number
3. Write the valency of the symbols.
4. Write the interchanged numbers at the base.
5. Write the formula of the compound

For example, the step wise method for writing the formula of CALCIUM OXIDE is given below

CALCIUM OXIDE

Step 1: Write the symbols and valencies.

Symbols	
Calcium	Oxide
Ca	O

Valencies	
Calcium	Oxide
2^+	2^-

Step 2: Ca^{2+} O^{2-}

Step 3: Ca^{2+} O^{2-}

Step 4: Ca_2O_2

Step 5: Reduce the valency numbers to the lowest ratio, if possible.

$\therefore$ the formula is CaO

Similarly, Formulas like Magnesium oxide, Calcium nitride, zinc hydroxide and Aluminium carbonate can be written by CRISS-CROSS method.

SIGNIFICANCE OF MOLECULAR FORMULA

- It represents one molecule of a compound.
- The number of each kind of atoms present, i.e., the ratio in which the atoms are present in one molecule.
- The mass of one molecule of the compound can be calculated.
- Molecular mass is the algebraic sum of the masses of all the atoms present in a given molecule.
- Molecular mass of H_2O (water) can be calculated

  (2 X Atomic Mass of Hydrogen) + (1 X Atomic Mass of Oxygen)

  (2X1) + (1X16) = 18 Units

- For example, in Sulphuric acid (H_2SO_4), the ratio of hydrogen, Sulphur and oxygen

is 2:1:4

NAME OF THE COMPOUNDS	FORMULA	STATE
1. Common Salt (Sodium Chloride)	NaCl	Solid
2. Sugar	$C_{12}H_{22}O_{11}$	Solid
3. Glucose	$C_6H_{12}O_6$	Solid
4. Baking Soda (Sodium bicarbonate)	$NaHCO_3$	Solid
5. Washing Soda (Sodium carbonate)	$Na_2CO_3.10H_2O$	Solid
6. Marble & Chalk (Calcium carbonate)	$CaCO_3$	Solid
7. Sand (Silica)	SiO_2	Solid
8. Calcium Hydroxide (slaked lime)	$Ca(OH)_2$	Solid
9. Sodium hydroxide (Caustic Soda)	NaOH	Solid
10. Copper Sulphate (Blue Vitriol)	$CuSO_4$	Solid
11. Water	H_2O	Liquid
12. Acetic Acid (Vinegar)	CH_3COOH	Liquid
13. Hydrochloric Acid	HCl	Liquid
14. Sulphuric Acid	H_2SO_4	Liquid
15. Nitric Acid	HNO_3	Liquid
16. Carbon Dioxide	CO_2	Gas
17. Carbon Monoxide	CO	Gas
18. Sulphur dioxide	SO_2	Gas
19. Sulphur trioxide	SO_3	Gas
20. Ammonia	NH_3	Gas
21. Hydrogen sulphide	H_2S	Gas
22. Nitrogen dioxide	NO_2	Gas
23. Nitric oxide (nitrogen monoxide)	NO	Gas

Molecular formulae, the common names and the state of some common compounds

24. Nitrous oxide (Laughing Gas)	N_2O	Gas
25. Phosphorous pentoxide	P_2O_5	Gas