# ATOMS AND MOLCULES

## 1. INTRODUCTION :

The structure of matter of been a subject of speculation from very early times. According to greek philosope Democritus, suggested that if we go on dividing matter into smaller parts, a stage would be reached when particles obtained cannot divided further. He called particle 'atoms' meaning indivisible.

**Conclusion :**

All matter is made up of small particles called atoms. Different kinds of atoms and molecules have different properties due to which different kind of matter also show different properties.

Laws of chemical combination :

By studying the result of quantitative measurement of many reactions it was observed that whenever Substance react, they follow certain laws. These laws are called the law chemical combination.

(a)Law of conservation of mass.
(b) Law of constant proportions.
(c) Law of multiple proportions

**(a) Law of conservation of mass :**

This law was given by the French chemist A Lavoisier in 1774. This law is every chemical reaction, the tota mass before and after the reaction remains constant.

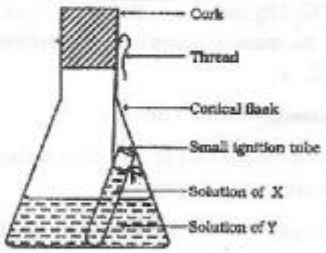
"That is mass can neither be created nor destroyed in a chemical reaction". Lavoisier showed that when mercurio oxide was heated, it produced free mercury oxygen. The sum of masses of mercury and oxygen was founc to be equal to mass of mercuric oxide.

| **Mercuric oxide →** | **Mercury** | **+ Oxygen** |
|---|---|---|
| 100g | 92.69 g | 7.49 g |

**Activity :** Demonstration of law of conservation of mass.

- Prepare separately a 5% solution of barium chloride and 5% solution of sodium sulphate.
- Take about 20 ml of barium chloride solution in a conical flask.
- Take sodium sulphate solution in a smallest tube. Hang the test tube in mouth of the flask with the help of thread. Close the mouth of the flask with cork.
- Weight the flask along with its constents.
- Now tilt the flask so that the two solution get mixed.
- Weight the flask again along with its contents. What do you observe ? It is observed that on mixing the two solution a chemical reaction takes place which is indicated by the formation of a white precipitate

  Barium chloride + Sodium sulphate → Barium sulphate (white ppt) + Sodium Chloride
- The mass of the flask and its contents remains constant. Thus, during a chemical reaction mass is neither crated nor destroyed.



*Ignition tube containing solution of X, dipped in a conical flask containing solution of Y.*

This activity can also be carried out with the following pairs :

(a) silver nitrate and sodium chloride
(b) Copper sulphate and sodium carbonate

**Q.** In a reaction 5.3 of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide. 0.9 g water and 8.2 g of sodium ethanoate. Show that these observation are in agreement with the law of conservation of mass. [NCERT]
Sodium carbonate + ethanoic acid → sodium ethanoate + carbon dioxide + water.

**Q.** Hydrogen and oxygen combine in the ratio of 1 : 8 by mass of form water. What mass of oxygen gas would been required to reach completely with 3 g of hydrogen gas ? [NCERT]

**Q.** Which postulate of Dalton's atomic theory is the result of the law conservation of mass? [NCERT]

**(b) Law of constant proportions :**

This law was given by the french chemist **A. Levoisiver and Joseph proust**. This law deals with the compotion of chemical compounds.

This law is : A pure chemical compound always contains same elements combined in same proposition by mass

**For example :** Pure water obtained from different sources with such as river, well etc. always contains hydrogen and oxygen combined together in the ratio 1 : 8 by mass similarly carbon dioxide can be obtained by different methods such as by burning of carbon, by heating lime stone. It show that samples of carbon dixoxde obtained proportion of hydrogen can oxygen or carbon and oxygen always remains constant.

**(C) Law of multiple proportions :**

It was given by Dalton in 1808. According to it. when one element combines with the other element to form or more different compounds, the mass of one element, which combines with a constant mass of the other, be a simple ratio to one another. Example. Carbon and oxygen when combine, can from two oxides that CO (carbon monoxide).

In CO, 12g carbon combine with 16 g of oxygen. In $CO_2$ 12 g carbon combine with 32g of oxygen. Thus, we can see the mass of oxygen which combine with a constant mass of carbon (12g) bear ratio of 16 : 32 on 1 : 2

**Dalton's Atomic Theory**

On the basis of laws of chemical combination John dalton proposed atomic theory in 1808. The main points of dalton's atomic theory are :

- All matter is made up of vary 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 element of have different masses and chemical properties.
- Atoms combine in the ratio of small whole numbers to from compounds.
- The relative number and kinds of atoms are constant in a given compound.

Dalton's atomic theory we based on the laws of chemical compound.

For example : The postulates of Delton's atomic theory that "atoms can neither be created nor destroyed", was the result of law of conservation of mass and the postulates of Delton's atomic theory " the element consist of atoms having fixed mass" and that the number and kind of atom in a given compound of fixed came from the low of constant proportion.

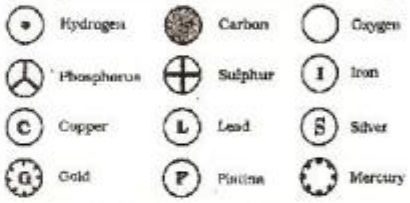
Q. Which postulate of Dalton's atomic theory can explain the law of proportion ? **[NCERT]**

**Drawbacks of Dalton's Atomic Theory :**
Some of the drawbacks of the Delton's theory of matter are given below :

- According t Dalton's atomic theory, atoms were thought to be indivisible. Bu it is now known that atoms can be further divided into still smaller particle called electrons, protons and neutrons.
- Delton's atomic theory said that all the atoms of an element have exactly the same mass. But it is now know the atoms of the same element can have slightly different masses, as in cases of isotopes.
- Delton's atomic theory said that atoms of different elements have different masses. But it now known that even atoms of different elements can have the same mass as in case of isobars.

**Atoms :**
All the matter is made up of atoms. An atoms is the smallest particle of an element that can take part in a chemical reaction. Atoms of most of the elements are vary reactive and do not exist in the free state (as single atom). They exist in combination with the atoms of the same elements or another element. Atoms are vary small in size. The size of an atom is indicated by its radius which is called atomic radius (radius of an atom). Atomic radius atom of all, having an atomic radius of 0.037nm. Atoms are so small that we cannot see the under the most powerful optical microscope.

**Symbol of elements :**
Symbol may be defined as the abbreviation use for the name of an element. The symbol of an element. The symbol of an element element are generally either the first letter or the first tow letter or the first and the third letters of the name of the element.For example, the symbol of the following elements are the first letter of the same of that element.



Symbols for some elements as proposed by Dalton

| S.NO. | Element | Symbol |
|---|---|---|
| 1 | Hydrogen | H |
| 2 | Carbon | C |
| 3 | Nitrogen | N |
| 4 | Oxygen | O |
| 5 | Fluorine | F |

- Some symbols derived from the first two letters of the names of the element.

| S.NO. | Element | Symbol |
|---|---|---|
| 1 | Alumininm | Al |
| 2 | Barium | Ba |
| 3 | Lithium | Li |
| 4 | Neon | Na |
| 5 | Calcium | Ca |

- Some symbol derived from the fist and the third letter of the names of the elements.

| S.NO. | Element | Symbol |
|---|---|---|
| 1 | Arsenic | As |
| 2 | Magnesium | Mg |
| 3 | Chlorine | Cl |
| 4 | Zinc | Zn |
| 5 | Chormium | Cr |

- There are certain symbol which seen to here no relationship to their names. They symbol of these element are derived from their latin names.

| Element | Latin Name | Symbol |
|---|---|---|
| Iron | Ferrum | Fe |
| Gold | Aurum | Au |
| Copper | Cuprum | Cu |
| Potassium | Kalium | Na |
| Sodium | Natrium | Hg |
| Mercury | Hydrogen | Hg |
| Lead | Plumbum | Pd |

**Atomic Mass :** Atomic mass of element may be defined as the average relative mass of an atom of the element as compared with mass of an atom of carbon (C – 12 isotope) taken as 12 amu.

$$\text{Atomic mass : } \frac{\text{Mass of 1 atom of element}}{1/12 \text{ of the mass of an atoms of C} - 12}$$

**How do Atoms occur :**
The atoms of only a few element called noble gases (such as helium, neon, argon and krypton etc.) which are chemically uncreative and exist in the free state (as single atom). Atoms of the element are chemically vary
Atoms usually exist in two ways :
(a) In the form of molecules and (b) In the form of ions.

| | | |
|---|---|---|
| **Q.** | Define the atomic mass unit | **[NCERT]** |
| **Q.** | Why is not possible to see atom with naked eyes ? | **[NCERT]** |

**Molecule :**
A molecule is the smallest particle of an element or compound that has independent existence. A molecule contain one or more than one atoms.
The molecules of element contain atoms of only on kind.
The number of atoms in molecule of an element is known as atomicit of the element. For example The atomicity of the noble gases is 1, that of hydrogen, nitrogen, oxygen etc is 2 each and of ozone is 3. Thus, noble gases hydrogen and ozone are respectively monoatomic, diatomic and triatomic molecules.

**Molecules of elements :**

The molecules of and element contain two similar atom chemically bonded together, for example of ozone gas has 3 oxygen atom combined together, so ozone exists in the form of $O_3$ A recently discovered form of carbon, called buckminsterfullerene has molecule formula $C_{60}$

**Molecule of compounds :**

The molecule of compound contains two or more different types of atoms chemically bonded together. For example: the molecule sulphur dioxide ($SO_2$) contain one atom of sulphur chemically bonded with two atom of oxygen.

**Molecular mass of formula mass :**

The molecular mass of a substance (an element or a compound) may be defined as the average relative mass of a molecule of the substance as compared with mass carbon of atom of carbon (C. 12 isotope) taken 12 amu.

$$\text{Molecular mass} = \frac{\text{Mass of 1 molecule of the substacne}}{1/12 \text{ of mass of an atoms of } C-12}$$

The molecular mass of compound can be obtained by adding atomic masses of all the atoms present n the molecular of the compound. Fox example, molecular mass of $CO_2$ is

$$+ 16 \times 2 = 44 \text{ u}$$

**Gram Molecular Mass :**

Gram molecular of a substance is defined as that much quantity of the substance whose mass expressed it gram is numerically equal to its molecular mass.,

**For example :** The molecular mass of $CO_2$ is 44 u , its gram molecular mass is 44 g. Gram molecule mass of substance is also know as gram-molecular mass of the substance.

**Formula Mass :**

Formula mass of an ionic compound is obtained by adding atomic mass of all the atoms in a formula unit to the compound.

**For example :** Formula mass of potassium chloride (KCI)

= Atomic mass of potassium + atomic mass of chlorine

39 + 35.5 = 75.5

**Q.** Calculate the molecular masses of $H_2$, $O_2$, $CI_2$ $CO_2$, $CH_4$, $C_2H_6$, $C_2H_4$, $NH_3$, $CH_3OH$ **[NCERT]**

**Q.** Calculate the formula unit masses of $ZnO$, $Na_2O$, $K_2CO_3$, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u and O = 16 U **[NCERT]**

**Q.** Calculate the molar mass of the following substances. **[NCERT]**

(a) Ethyne, $C_2H_2$ (b) Sulphur molecule, $S_8$

(c) Phosphorous molecule, $P_4$ (Atomic mass of phosphorus = 31)

(d) Hydrochloric acid, HCl

(e) Nitric acid, $HNO_3$

**Chemical formula :**

The chemical formula of a compound describe the composition of molecules of the compound in terms of the symbols of element and the number of atoms of each element present in one molecules of the compound.

- In the chemical formula of compound, the elements present are denoted by their symbols and the number of atoms of each element are denoted by writing their number as subscript of the symbols of the respective element.

**Example :** Water is compound whose one molecular is made up of two atoms of hydrogen by and hence its chemical formula is $H_2O$

- While writing the formula of an ionic compound the metal is written on the left hand side while the non – mater written on the right hand side. The name of the mater remains as such but that of the non-metal is changed have the ending ide.

  **Example :** MgO is named as magnesium oxide, KCl is named potassium chloride etc.

- Molecular compounds, formed by the combination between two different non-metals, are written in such a way that the less electronegative element is written on the left hand side with he more electronegative element is written on right hand side. In naming molecular compound, the name of the less negative non-metal is written as such but the name of the more electronegative element is changed to have the ending ide

  **Example :** $H_2S$ named as hydrogen sulphide.

- When there are more then one atoms of on element are present in the formula of the compound. then the number of atoms are indicate by the use of appropriate prefixes (Mono for : 1, id for 2,tri for 3 terta for 4)

  **Example :** $CO_2$ is named as carbon di oxide $CCl_4$ is named carbon tertra chloride.
  The preflxes are needed in naming those binary compounds in which the two non-metals form more then one compounds (by having different number of atoms)

  **Example :** Two non-metal, nitrogen and oxygen, combine to form different compound like nitrogen monoxide (NO), nitrogen di – oxide ($NO_2$). Nitrogen tri oxide ($N_2O_3$) etc.

- But, if two non-metals form only one compound, then prefixes are not used in naming such compounds

  **Example :**
  Hydrogen and sulphur combine to form only one compound $H_2S$, So, $H_2S$ is named as hydrogen sulphid and not hydrogen monosulphide.

**IONS :** An ion is positively or negative charged atom (or group of atoms)
These are two type of ions :

(1) cations (2) anions

**(1) Cations :** A positively charged is known as cation. For example : Sodium ion : $Na^+$ Magnesium ion : $Mg^{2+}$ A cation is formed by the loss of one or more electrons by an atom

**For example :** sodium atom, loses one electron to form a sodium in $Na^+$

$Na \xrightarrow{-1e^-} Na^+$ sodium ion
Sodium atom (A cation)

**(2) Anions :** A negatively charged ion is know as anion. $Cl^-$ (chloride ion) $O^{-2}$ (oxide ion) etc.
An anion is formed by the gain on or more electrons by an atom. For example a chlorine atom gains one electron to form a chloride ion $Cl^-$

- $Cl \xrightarrow{-1e^-} Cl^-$
  Chorine atom  Chloride ion (An anion)
  **Valency of ions :** The valecncy of an ion is same as the charge present on the ion.
  Monovalent cation (Valeny of cation + 1)
  **Example :** Sodium ion ($Na^+$). Potassium ($K^+$), Hydrogen ion ($H^+$)
  Divalent cations (valeny of cations + 2)
  **Example :** Magnesium ion ($Mg^{+2}$) Ferrous ion ($Fe^{+2}$)
  Trivalent cation (valency of cation + 3)
  **Example :** Aluminium ion ($Al^{+3}$) Ferric ion ($Fe^{+3}$)
  Monovalent anion (anion of valency - 1)
  **Example :** Chloride ion ($Cl^-$) Bromide ion ($Br^-$)
  Divalent anions (anions of valecny - 3)
  **Example :** oxide ion ($O^{-2}$) Peroxide ion (Br)
  Trivalent anoin ($O^{-2}$), Peroxide ion ($O_2^{-2}$) etc.
  Trivalent anion (anions of valency -3)
  **Example :** Nitride ion ($N^{-3}$) Phosphate ion ($PO^{-3}_4$) etc.
  **Writing fo formula of Molecular compound :**
  **Steps :** The steps to be followed for writing the formula of molecular compound are-

- First, below each symbol of the elements contributing the compound

- Then, below each symbol writ is elements contributing the compound.

- Finally, we exchange the valencis of the combining atoms that is with first atom, we write the valecy of the second atom and with second atom, we write the valency of the first atom, the valencies to be written at substance to the symbols.

- If the valencies have any common factor, then the formula is divided by the common factor. This given the required formula of the compound
  **Example :** To work out the formula of hydrogen sulphide
  (1) Hydrogen sulphide compound is made up of hydrogen and sulphur  elements. So first we write down the symbol of hydrogen and sulphur .

  (2) The vealcny of hydrogen is 1 and the valency of sulphur is 2. so below the symbol H  we write 1 and below the symbol S we write 2.

| Symbol | H | S |
|---|---|---|
| Valencies | 1 | 2 |


8 • We now cross-over the valencie of  H and atoms. With H atom we writhe the valecny of S (Which is 2) so that is becomes $H_2$ with a atom we write the valency of  (Which is) so that it becomes $S_1$. Now, joining together $H_2$ and $S_1$ the formula of hydrogen sulphide becomes $H_2S_1$ or $H_2S$ (This is becomes we don't write the subscript with an atom in a formula)

| | | |
|---|---|---|
| **Q.** | What is meant by the term chemical formula ? | **[NCERT]** |
| **Q.** | How many atoms are present in a | **[NCERT]** |
| **Q.** | (i) $H_2S$ molecule and (ii) $PO_4^{3-}$ ion | |
| **Q.** | What are polyatomic ions ? Give examples | **[NCERT]** |
| **Q.** | Give the name of th elements present in the following compounds. | **[NCERT]** |
| | (a) Quick line (b) Hydrogen bromide (c) Baking powder (d)Potassium sulphate | |

**Writing the formula of Ionic compound :**
**Steps :**

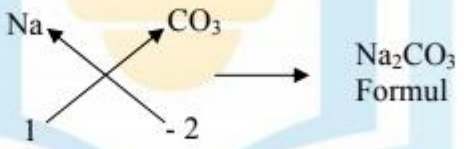
- First, write the symbols of the ions from with the ionic compound is made. As a convention. the cation is written on the left while the anion is written on the right side.
- The, the valencies of the respective cation and anion are written below their symbols.
- The valencies of cation and anion are exchanged. The number of cation and anion in the formula of the compound are adjusted in such a way that total positive charge of cation become equal to total negative charge of the anion making the ionic compound electrically neuter.
- The final formula of the ionic compound is then written but the charges present on the cation and the anion are not shown.

**Example :** To write the formula for sodium carbonate :

(1) First, write the symbol of sodium ion and carbonate ion and writhe their valance below their symbol are shown.

| | | |
|---|---|---|
| Symbols | Na | $CO_3$ |
| Valencies (or charges) | +1 | -2 |

(2) Now, are exchange the valencies of sodium ion and carbonate ion,




(3) So- 2 gets associated with Na and +1 gets associated with $CO_3$ in this way we get $Na_2$ and $CO_3$ and final formula of sodium carbonate is $Na_2CO_3$

**Q.** Write down the formula of **[NCERT]**
(i) sodium oxide (ii) aluminium chloride (iii) sodium sulphide (iv) magnesium hydroxide

**Q.** Write down the name of compounds represented by the following formulae. **[NCERT]**
(i) $Al_2(SO_4)_3$ (ii) $CaCl_2$ (iii) $K_2SO_4$
(iv) $KNO_3$ (v) $CaCO_3$

**Q.** Write the chemical formula of the following **[NCERT]**
(a) Magnesium chloride (b) Calcium oxide (c) Copper nitrate
(d) Aluminium chloride (e) Calcium carbonate

| Name of the compound | Positive ion (cation) | | | Negative ion (anion) | | | Chemical Formula |
|---|---|---|---|---|---|---|---|
| | Name | Formula | Valency number | Name | Formula | Valency number | |
| Hydorgen chloride | Hydrogen | H | 1 | Chloride | Cl | 1 | HCl |
| Hydrogen sulphide | Hydrogen | H | 1 | Sulphide | S | 2 | $H_2C$ |
| Sulphuric acid (hydrogen suplhate) | Hydrogen | H | 1 | Sulphate | $SO_4$ | 2 | $H_2(SO_4)$, $H_2(SO_4)$ |
| Sodium nitrate | Sodium | Na | 1 | Nitrate | $NO_3$ | 1 | $Na_1(NO_3)_1$. $NaNO_3$ |
| Aluminium Phosphate | Aluminium | Al | 3 | Phosphate | $PO_4$ | 3 | $Al_3(PO_4)_3$. $AlPO_4$ |
| Aluminium sulphate | Aluminium | Al | 3 | Sulphate | $SO_4$ | 2 | $Al_2(SO_4)_2$ |
| Ferrous sulphate | Ferrous | Fe | 2 | Sulphate | $SO_4$ | 2 | $Fe_2(SO_4)_2$. $FeSO_4$ |
| Ferric sulphate | Ferric | Fe | 3 | Sulphate | $SO_4$ | 2 | $Fe_2(SO_4)_3$ |
| Potassium dichromate | Potassium | | 1 | Dichromate | $Cr_2O_7$ | 2 | $K_2(Cr_2O_7)_1$ $K_2Cr_2O_7$ |
| Magnesium nitrate | Magnesium | Mg | 2 | Nitrate | $NO_3$ | 1 | $Mg(NO_3)_2$ |
| Silver chromate | Silver | Ag | 1 | Chromate | $Cr_2O_4$ | 2 | $Ag_2CrO_4$ |
| Barium carbonate | Barium | Ba | 2 | Carbonate | $CO_3$ | 2 | $Ba_2(CO_3)_2$. $BaCO_3$ |
| Potassium permanganate | Potassium | K | 1 | Permanganate | $MnO_4$ | 1 | $KMnO_4$ |
| Calcium hydroxide | Calcium | Ca | 2 | Hydroxide | OH | 1 | $Ca(OH)_2$ |
| Aluminium oxide | Aluminium | Al | 3 | Oxide | O | 2 | $Al_2O_3$ |
| Magnesium phosphate | Magnesium | Mg | 2 | Phosphate | $PO_4$ | 3 | $Mg_3(PO_4)_3$ |
| Ammonium sulphate | Ammonium | $NH_4$ | 1 | Sulphite | $SO_3$ | 2 | $(NH_4)_2SO_3$ |
| Zinc phosphate | | | | | | | |

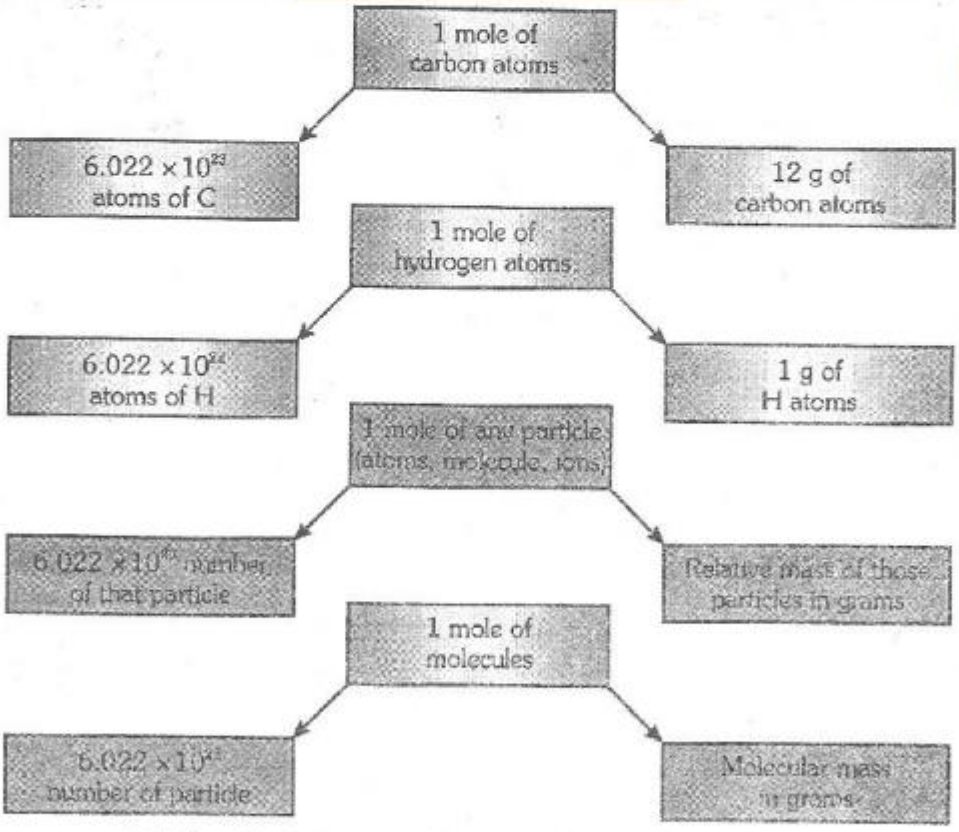
**Mole Concept :**
**Mole :** Mole is link between the mass of atoms (or molecules) and the number of atoms (or molecule.). A group of $6.022 \times 10^{23}$ particles (atom, molecules or ions) or a substance is called a mole of that substance.

Thus, 1 mole of atoms = $6.022 \times 10^{23}$ atoms.
1 mole of molecules = $6.022 \times 10^{23}$ molecules.

**For example :** oxygen atom in O and oxygen molecules is $O_2$
1 mole of oxygen atoms (O) = $6.022 \times 10^{23}$ oxygen atom
1 mole of oxygen molecules = $6.022 \times 10^{23}$ oxygen molecules.
Number of $6.022 \times 10^{23}$, which represents a mole is known an ***Avogadro number.***

**Moles of Atoms :** One mole of atoms of an element has a mass equal to the gram atomic mass of the element 1 mole of atoms of an element = Gram atomic mass of the element.

**For example :** The atomic mass of oxygen (O) is 16 u so gram atomic mass of oxygen will be gram.
1 mole of oxygen atoms = Gram atomic mass of oxygen = 165 gram
**Mole of molecules :**
1 mole of molecules of an substance has mass equal to gram molecular mass of the substance.
1 mole of molecules of a substance = Gram molecular mass of the substance.
**For example :** The molecular mass of oxygen ($O_2$) is 32, u So the gram molecule mass of oxygen molecule is 32 gram.
1 mole of oxygen molecules = Gram molecular mass of oxygen = 32 gram.




**Relationship between mole, Avogardro number and mass**

**Q.** If one mole of carbon atoms weighs 12 gram, what is the mass (in grams) of 1 atom of carbon ?
**Q.** Which has more number of atoms, 100 grams of sodium or 100 gram of iron (given, atomic mass of

N = 23u, Fe = 56 u) **[NCERT]**

**Q.** A 0.24 g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g o oxygen. Calculate the percentage composition o the compound by weight. **[NCERT]**

**Q.** When 3.0g of carbon is burnt in 8.00 oxygen, 11. 00 g of carbon dioxide is produced. Whet mass of carbon dioxide will be formed when 3.0 g of carbon is burnt in 50.00 of oxygen ? Which law of chemical combination will govern your answer ? **[NCERT]**

**Mass percentage of an element from molecular formula :**

The molecular formula of a compound many be defined as the formula which specifies the number or atoms of various element in the molecular of the compound.

**For example :** The molecular formula of glucose is $C_6H_{12}O_6$. This shows the a molecule of glucose six atoms of carbon, twelve atoms of hydrogen and six atoms of oxygen. With the help of molecule formula of a compound we can calculate its percentage composition y mass. First we calculate the molecular mass of the compound. From this we can find out mass of one mole the compound, which is equal to its gram molecular mass, The we calculate mass of element in one of the compound. The percentage of each element is the calculate by the following formula.

$$\text{Mass percentage of element X} = \frac{\text{Mass of X in one mole that is gram molecular mass}}{\text{Mass of one mole of the compound}} \times 100$$

**Determination of Molecular formula:**

To find out the molecular formula of a compound, the first is to determine its empirical formula from the percentage composition. The empirical formula of a compound may be defined as the formula which gives the simplest whole number ratio of atoms of the various elements present in the molecule of the compound.

**For example:** The empirical formula of the compound glucose($C_6H_{12}O_6$) is $CH_2O$ which shows that C,H and O are present in the simplest ratio of 1:2:1.

Molecular formula is whole number multiple of empirical formula thus,

Molecular formula = Empirical formula × n

$$n = \frac{Molecular\ formula}{Empirical\ formula}$$

Where n = 1,2,3.....

$$= \frac{Molecular\ Mass}{Empirical\ formula\ mass}$$

**Q.** What is the mass of – **[NCERT]**
(a) 1 mole of nitrogen stoms?
(b) 4 moles of aluminium atoms (Atomic mass of aluminium = 27)?
(c) 10 moles of sodium sulphite ($Na_2SO_3$)?

**Q.** Convert into mole. **[NCERT]**
(a) 12 g of oxygen gas (b) 20 g of water (c) 22 g of carbon dioxide

**Q.** What is the mass of . **[NCERT]**
(a) 0.2 mole of oxygen stoms? (b) 0.5 mole of water molecules?

**Q.** Calculate the number of molecules of sulphur ($S_8$) present in 16 g of solid sulphur. **[NCERT]**

**Q.** Calculate the number of aluminium ions present in 0.054 g of aluminium oxide. **[NCERT]**
(Hint.:The mass of an ion is the same as that of an atom of the same element. Atomic mass of Al =27 u)

**Steps for writing the empirical formula :**

The percentage of the element in the compound is determined by suitable methods and from the data collected, the empirical formula is determined by the following steps-

- Divide the percentage of each. element by its stomic mass. This gives the relative number of moles of various element present in the compound.
- Divide the quotients obtained in the above step by the smallest of them so as to get a simple ratio of moles of various elements.
- Multiply the gigures, so obtained by a suitable integer, if necessary, in order to obtain whole number ratio.
- Finally write down the symbols of the various elements side by side and put the above number as the subscripts to the lower right hand corner of each symbol. This will represent the empirical formula of the compound .

**Steps for writing the empirical formula :**

- Calculate the empirical formula as describe above.
- Find out the empirical formula mass by adding the atomic masses of all the atoms present in the empirical formula of the compound.
- Divide the molecular mass (determined experimentally by some suitable method) by the empirical formula mass and find out the value of "n"
- Multiply the empirical formula of the compound with n so as to find out the molecular formula of the compound.

**(A) OBJECTIVE TYPE QUESTIONS :**

**1.** The element s present in baking soda are
(A) Sodium, carbon and oxygen
(B) Sodium, carbon hydrogen
(C) Sodium, carbon, hydrogen and oxygen
(D) Potassium, carbon and oxygen

2. The first scientist to use of the symbols of elements was
(A) Dalton (B) Berzillius (C) Kanad (D) Proust

3. The overall charge on an ionic compound equal to
(A) Charge of the cation present
(B) zero
(C) Charge of the anion preset
(D) sun of charges of the cation & anion

4. The chemical formula of the copper nitrate.
(A) $Cu(NO_3)_2$ (B) $CuNO_3$ (C) $Cu_2(NO_3)_3$ (D) $Cu_2NO_3$

5. The number of carbon atoms in 1g of $CaCO_3$ is
(A) $6.022 \times 10^{23}$ (B) $6.022 \times 10^{21}$ (C) $3.0125 \times 10^{22}$ (D) $1.204 \times 10^{23}$g

6. The mass of a single atom of carbon is
(A) 12 g (B) 1/12 g (C) $1.99 \times 10^{-23}$ g (D) $1.99 \times 10^{23}$g

7. The mass of 1 u is
(A) $\frac{1}{2} \times \frac{12}{6.022 \times 10^{23}}$g (B) $\frac{1}{6.022 \times 10^{23}}$g
(C) $\frac{12}{6.022 \times 10^{23}}$g (D) $6.022 \times 10^{23}$ g

8. How many molecules are present in 9g of water
(A) $3.01 \times 10^{23}$ (B) $6.022 \times 10^{23}$ (C) $6.08 \times 10^{23}$ (D) $3.82 \times 10^{23}$

9. $Mg + O_2 \xrightarrow{\text{Burning}}$ 'X', 'X' is
(A) MgO (B) $Mg_2O$ (C) $MgO_2$ (D) $Mg_2O_3$

10. The formula of sulphuric acid is
(A) $H_2SO_3$ (B) $H_2SO_4$ (C) $H_2SO_5$ (D) $H_2S_2O_7$

11. What is true about potassium chlorate
(A) It given oxygen gas on strong heating
(B) Its molecular mass is 122.5 kg/mol
(C) 122.5g of contain oxygen atoms three the Avogadro number
(D) Its molecular formula is $KClO_4$

12. Mass of one Avogadro's number of O atoms is equal to
(A) 16 amu (B) 16 g (C) 32 g (D) 6 kg

13. Hydrogen reacts with oxygen to form water ($H_2O$). The ratio between masses of Hydrogen and oxygen is
(A) 1 : 8 (B) 63.5 : 8 (C) 2 : 1 (D) 63.5 : 16

14. The correct formula of aluminum sulphate is
(A) $AlSO_4$ (B) $Al_2SO_4$ (C) $Al_3(SO_4)_2$ (D) $Al_2(SO_4)_3$

15. Which of the following has highest intermolecular force of attraction
(A) Liquid water (B) Liquid ethyl alcohol (C) Gaseous $CO_2$ (D) Solid $CO_2$

16. Which of the following is not correct regarding gases
(A) Gases exert pressure (B) Gases have same intermolecular space
(C) Gases have tendency of diffuse (D) Gases have high intermolecular force of attraction

17. The Boiling not point water at normal atmospheric pressure is
(A) 273 K (B) 373 K (C) 100 K (D) $0^o$ C

18. Avogadro's number represents the number of atoms in
(A)12 g of $C^{12}$ (B) 320 of sulphur (C) 32 g of oxygen (D) 12.7 g of iodine

19. Molecular mass of ozone is
(A) 16 u (B) 32 u (C) 48 u (D) 64 u

20. Which of the following is not correct according to Dalton's atomic theory ?
(A) Matter is made up of atoms

(B) Atoms of all substance are identical in all respects

(C) Atoms combine in a simple whole number ratio

(D) Atoms of two element can combine to form more then one compound.

**(B) FILL IN THE BLANKS :**

**21**. The temperature at which a liquid change into gas is called…….
**22**. Intermolecular space in solid is…….. then that of liquid
**23**. Change of liquid state to solid sate is called…….
**24**. Small of cooked food reaches us in second due to the process know as…….
**25**. One mole atoms of oxygen contains…….. atom of oxygen
**26**. The number of atoms in a molecule of element substance called is…….
**27**. In water, the proportion of hydrogen and oxygen is……by mass.
**28**. Latin name of mercury is……..
**29**. Avogadro number is…….
**30**. One mole of sodium sulphate contains…….atoms of sodium……..atoms of sulphur and ……atom of oxygen
**31**. Intermolecular forces are maximum in…….
**32**. Water has boiling not equal to…….
**33**. Fusion is change of……to state.

**(C) MATHC OF COLUMN:**

**34.** Match the following elements & compounds given in column-A with column- B

| | **Column – A** | **Column - B** |
|---|---|---|
| (1) | Argon | (a) 8 |
| (2) | Suphur | (b) 4 |
| (3) | Oxygen | (c) 2 |
| (4) | Phosphorous | (d) 1 |
| (5) | Ozone | (e) 3 |
| (6) | Bromine | (f) 5 |
| (7) | Carbon monoxide | (g) 6 |
| (8) | Hydrogen peroxide | (h) 7 |
| (9) | Lime water | |
| (10) | Ammonia | |
| (11) | Quick Lime | |
| (12) | Baking powder | |
| (13) | Lime stone | |
| (14) | Common salt | |
| (15) | Sodium Suphate | |

**(D) VARY SHORT ANSWER TYPE QUESTION :**

**35.** Name of the building block of all matter ?

**36.** What are the symbols of copper and cobalt ?

**37.** What is 1 u ?

**38.** Give symbols for the following elements : Aluminum, Tin, Bromine, Neon.

**39.** What is ratio between masses of (i) hydrogen and oxygen in $H_2O$ (ii) nitrogen and hydrogen in $NH_3$ ?

**40.** What is meant by formula unit mass ?

**41.** What is meat by valecny of en element ?

**42.** 10 g silver nitrate solution are added to 10 g of sodium solution ? What change in mass of you expect after the reaction ?

**43.** Why is copper represented by the symbol "Cu' while there is not letter 'u' in the name ?

**44.** What do you understand by the 'atomicity' of the substance ?

**45.** Give two examples each of bivalent cations and bivalent anions.

**46.** How are mass, molar mass and number of mole related to each other ?

**(D) SHORTE ANSWRE TYPE QUESTION :**

**47.** What is the first law of chemical combination ?

**48.** What is the conclusion of the Daltion's atomic theory ?

**49.** Define a molecule. How many molecules are present in
(i) 9g of water (ii) 17 g of ammonia

**50.** What is meat by the term chemical formula ?

**51.** What are poly atomic ions ? Give example .

**52.** Calculate the number of molecules of Sulphur ($S_8$) present in 16 g of solid sulphur.

**53.** Give the name of the elements present in the following compounds.

**54.** Define the term mole ?

**55.** Write the molecular formula of the following and give the ratio by mass of atoms present ?

**56.** A hydrogen is found to contain 14.3% hydrogen and 85.7 % carbon. If molecular mass of the hydrocarbon i 28, find out is molecular formula (17 g).

**57.** Write down the names of the compound represented by the following formula ?
(i) $Al_2(SO_4)_3$ (ii) $CaCl_2$ (iii) $K_2SO_4$ (iv) $KNO_3$

**58.** What is meant by the term chemical formula ?

**59.** Calculate the mass of $CO_2$ which will contain the same number of molecule in 1 g of methane (S = 32 u, O = 16 u, C = 12 u, H = 1 u)

**60.** If 1 g of $SO_2$ contains x molecules, what will be the number of molecule in 1 g of methane? (S = 32 u,O = 16 u, C = 12 u, H = 1 u )

**61.** What is molar volume ? What is its value ?

**62.** Define the "law of constant proportions" How does Dalton's atomic theory explain the truth of the law ?

**63.** What is the difference between the actor mass of a molecule and gram molecular mass ?

**64.** What is formula unit mass ? For what type of compounds is it use and why ?

**65.** What is the unit of atomic mass or molecular mass ? Define it. What is the mass of this unit in kilograms ?

**(E) LONG ANSWER TYPE QUESTION:**

**66.** State and explain Law of Conservation Mass. How does Dalton's atomic theory explain this law ?

**67.** State and explain the following
(i) Atom (ii) Molecule (iii) Atomic mass (iv) Molecular mass

**68.** Arrange the following in roder of increasing masses (i) 0.1 g atom of silver (ii) 0.1 mole of $H_2SO_4$ (iii) $10^{23}$ molecule of $CO_2$ gas (iv) 1 gram of carbon (v) atoms of calcium.

**69.** How is the molecular formula of a compound related to its empsricial formula ?

**70.** Valencies or the charge numbers of some ions are given below :

| | | | | | |
|---|---|---|---|---|---|
| Aluminium ion | $3^+$ | Magnesium ion | $2^+$ | Potassium ion | $1^+$ |
| Nitride ion | $3^-$ | Sulphate ion | $2^-$ | Fluoride ion | $1^-$ |

Using the above information, write down the chemical formulae of the following
(i) Aluminium ion (ii) Magnesium nitride (iii) Aluminium sulphate
(vi) Potassium fluoride (v) Magnesium fluoride (vi) Potassium nitride

**71.** The molecular formula of a compound is $CH_3$ OH Calculate its molecular mass in atomic mass unit. Also write down its molar mass (atomic masses are : H= 1 u, C = 12 u, O = 16 u )

**72.** Find the number of atoms of each type present 3.42 grams of canesugar ($C_{12}$ $H_{22}$ $O_{11}$)

**73.** What are the postulates sand limitations of Dalton's atomic theory ?

## ANSWER KEY

- ***Objective type questions***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.**C | **2.**A | **3.**B | **4.**A | **5.** B | **6.**C | **7.**B | **8.**A | **9.**A | **10.**B |
| **11.**C | **12.**B | **13.**A | **14.**D | **15.** D | **16.** D | **17.** B | **18.**A | **19.** C | **20.** B |

- ***Fil in the blanks***

**21.** boiling point **22.** less **23.** solidification **24.** diffusion
**25.** Contain $6.022 \times 10^{23}$ **26.**Atomicity **27.** 1 : 8
**28.** Hydragyrum **29.** $6.022 \times 10^{23}$ **30.** $12.044 \times 10^{23}$, $6.022 \times 10^{23}$ $24.088 \times 10^{23}$
**31.** Solid **32.** 100°C **33.** Solid, liquid

- ***Math the column***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1.** d | **2.** a | **3.** c | **4.** d | **5.** e | **6.** c | **7.** c | **8.** b | **9.** f | **10.** b |
| **11.** c | **12**. g | **13.** f | **14.** c | **15.**h | | | | | |

- ***very short answer types question***

**35.** atoms **36.** Cu & Co

**37.** 1 u stands for one twelth (1/12) in the mass of carbon (carbon - 12) atom.

**38.** Al, Sn, Br, Na, **39.** (i) 1 : 8 (ii) 14 : 3 **42.** no change

**43** Symbol Cu has been taken from the latin word 'cuprum' which means copper

**44.** The number of atoms present in one molecule of the substance is called atomicity

**45.** Cations = $Zn^{2+}$, $Mg^{2+}$, anions = $SO_4^{2-}$, $CO_4^{2-}$

**46.** Number of moles (n) = $\frac{\text{Given mass(m)}}{\text{Molar mass(M)}}$ or $m = n \times m$