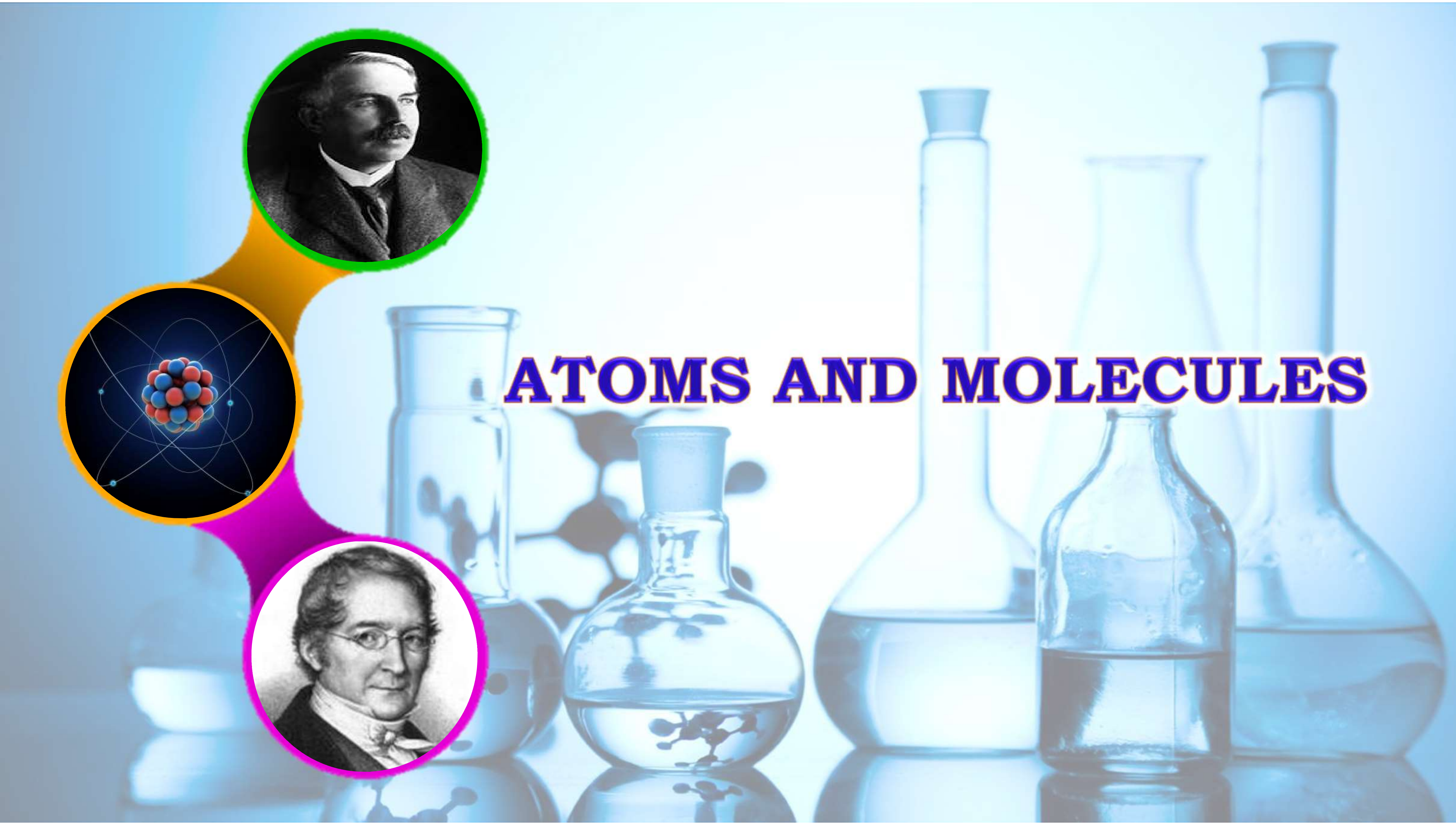
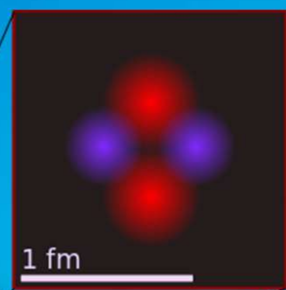
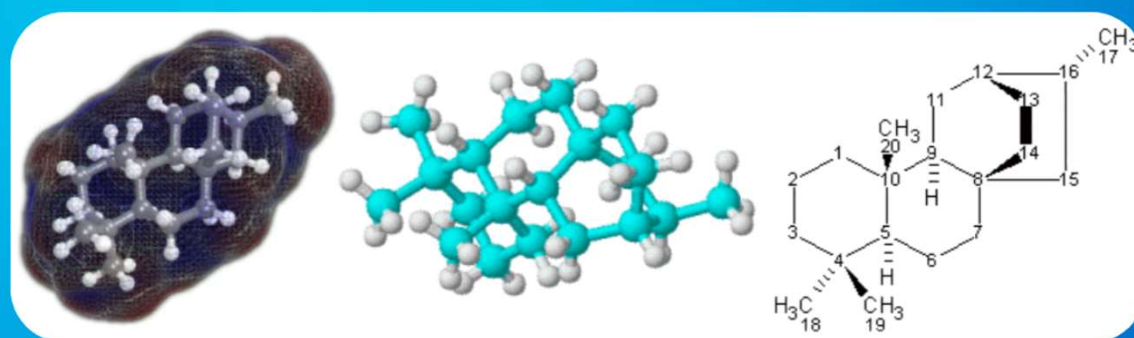

ATOMS AND MOLECULES

MODULE : 1

- **Introduction to matter**



ATOMS AND MOLECULES

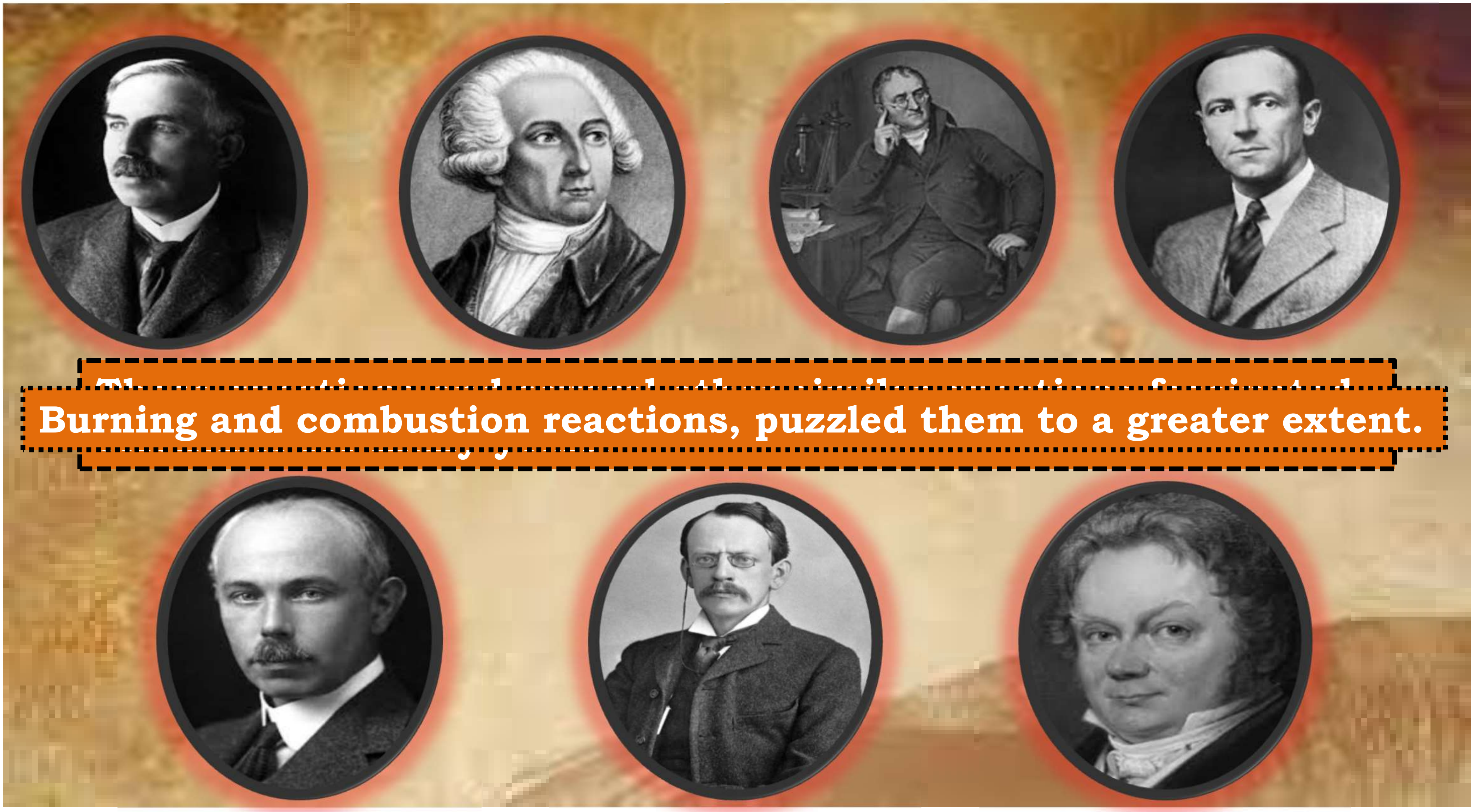


If some how we could go on dividing matter we will get smaller and particles. Ultimately we will get the smallest particle of matter which cannot be divided any further. This smallest particle of matter will be atom

All matter is made up of small particles called atoms and molecules.

Let us study Burning Reactions

On burning charcoal, it leaves ash at the end.



Burning and combustion reactions, puzzled them to a greater extent.

MODULE : 2

- **Law of chemical combination, Law of conservation of mass**

Lavoisier studied combustion reactions in detail.

Antoine Lavoisier
(1743 – 1794)

Was a French nobleman.

He was able to find the masses of reactants and Products accurately irrespective of their physical states.

He made many important contributions to chemistry and some call him the **Father of Modern Chemistry.**

Based on these observations he proposed the **law of conservation of mass.**

Aim:

To find out the change in the mass before and after a chemical reaction.

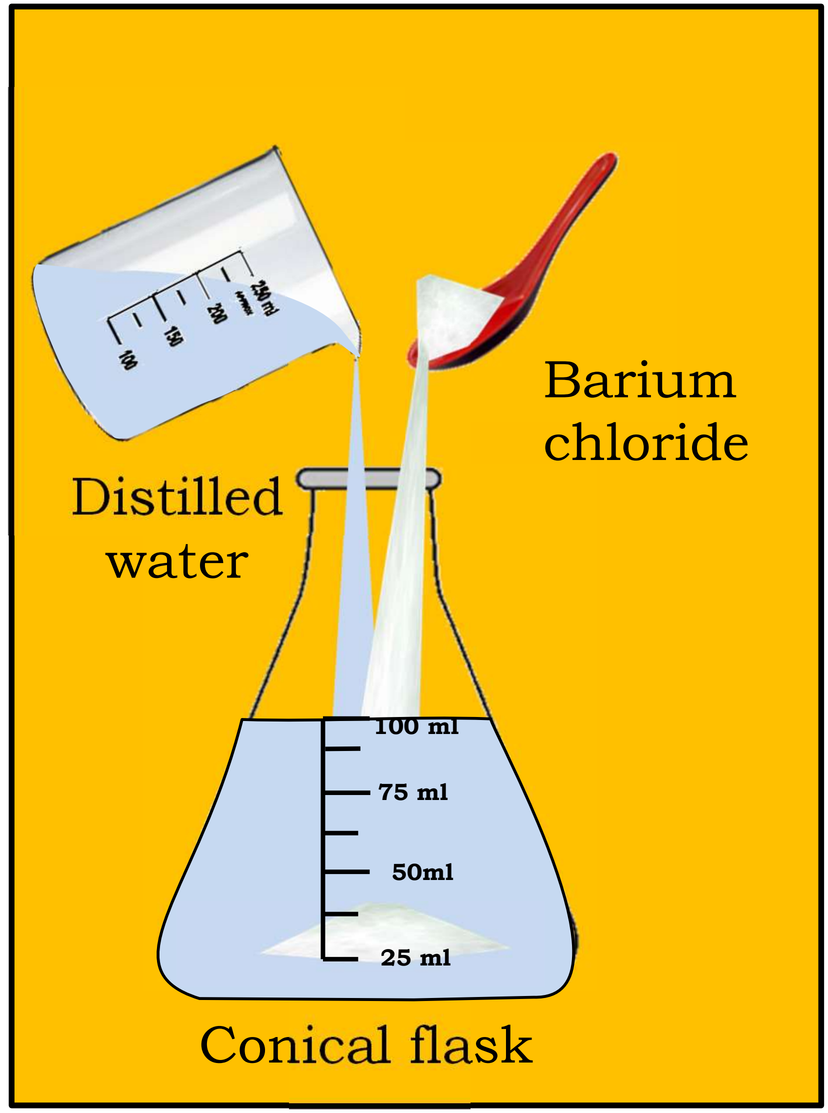
Materials required

- Barium chloride
- Sodium sulphate
- Distilled water
- Conical flask
- Small test tube
- Rubber cork
- Spring balance
- Retort stand
- Thread

Procedure :

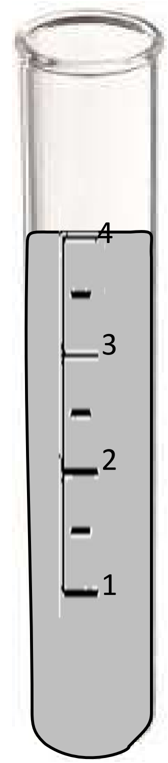
1. Prepare a solution of Barium chloride by dissolving barium chloride in distilled water in a 250 ml conical flask

Barium chloride



Procedure :

3. Take some solution of Barium chloride in a small test tube from the above prepared solution.

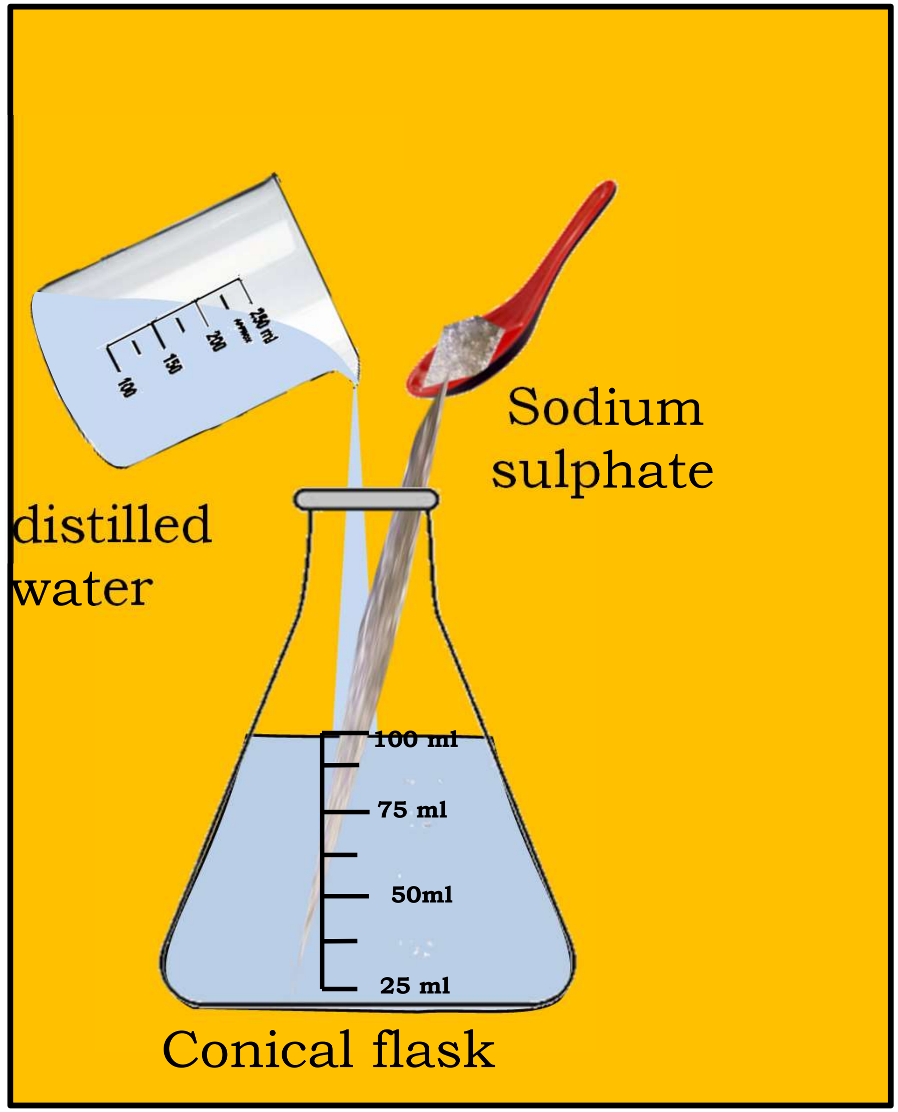


Barium chloride

Procedure :

Prepare the Sodium sulphate solution by dissolving sodium sulphate in water in another conical flask

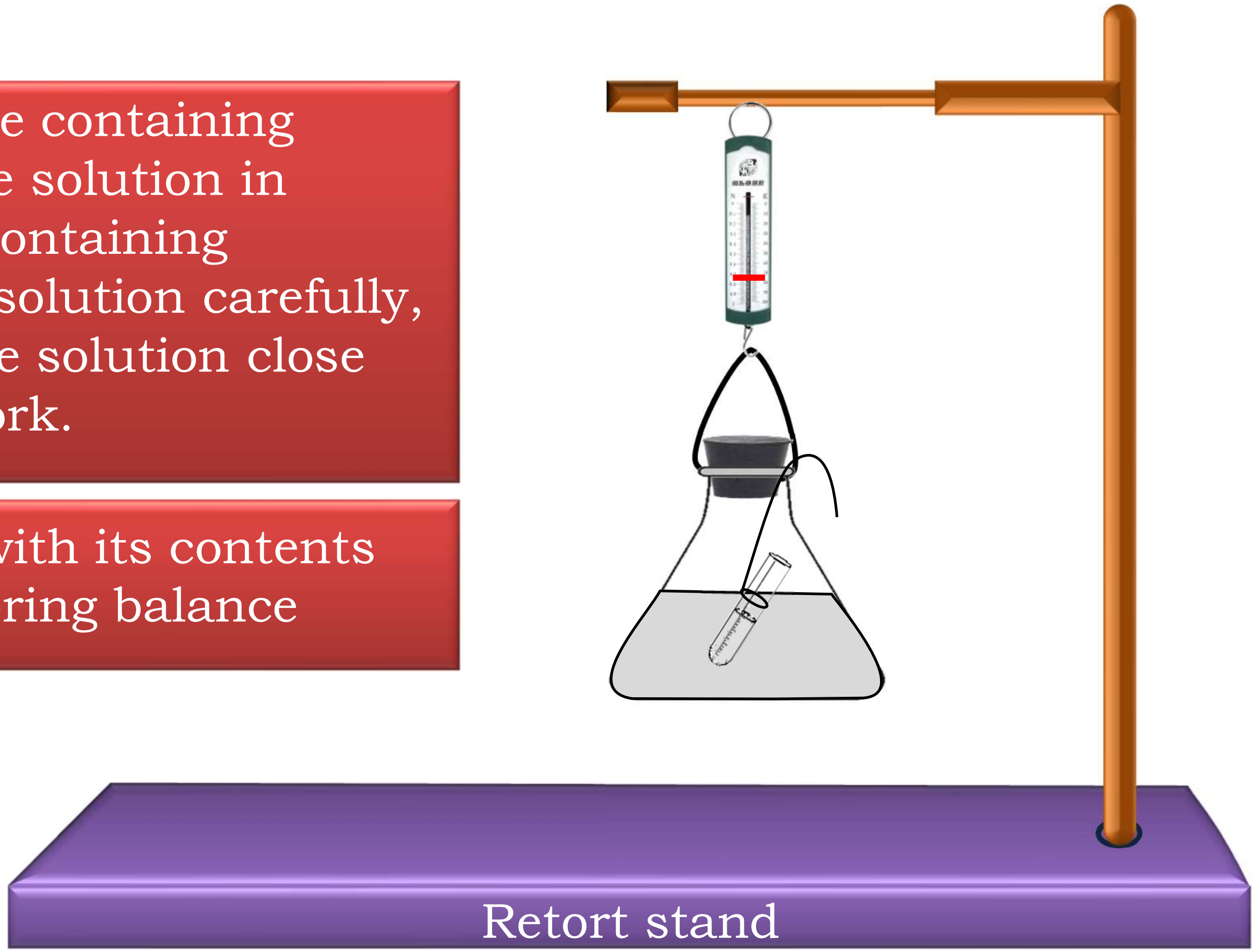
Sodium sulphate



Procedure :

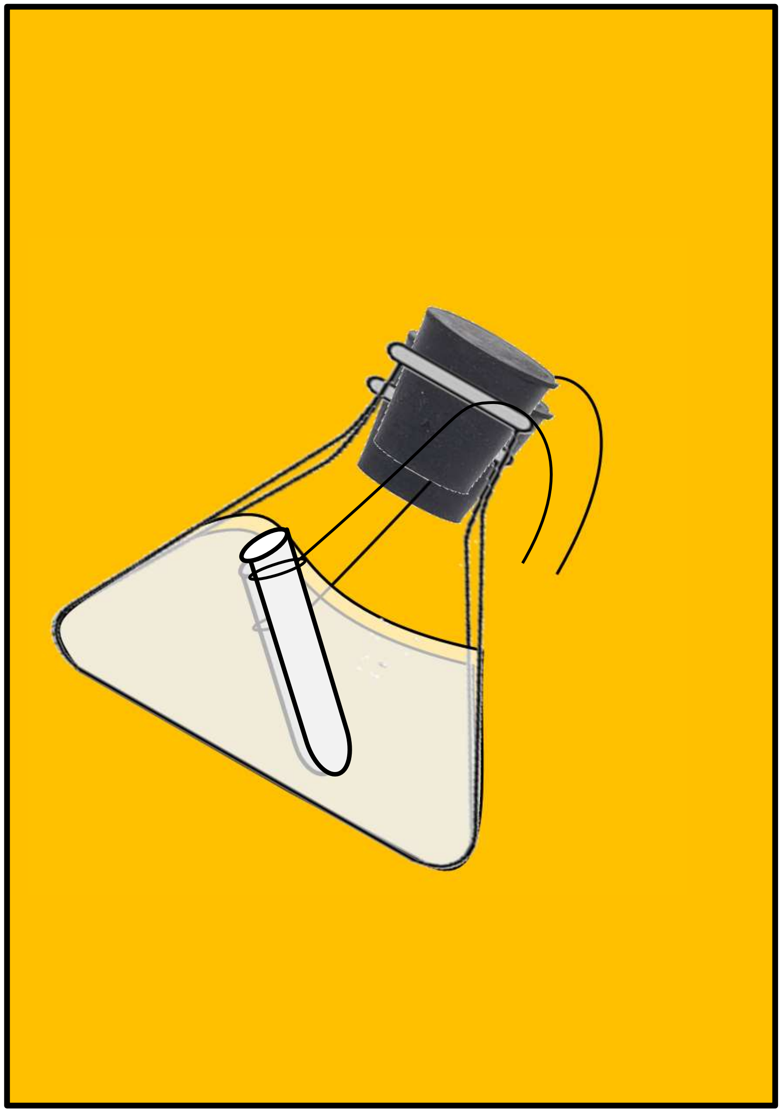
4. Hang the test tube containing of Barium chloride solution in the conical flask containing Sodium sulphate solution carefully, without mixing the solution close the flask with a cork.

5. Weight the flask with its contents carefully using spring balance



Procedure :

6. Now tilt and swirl the flask, so that the two solutions mix.

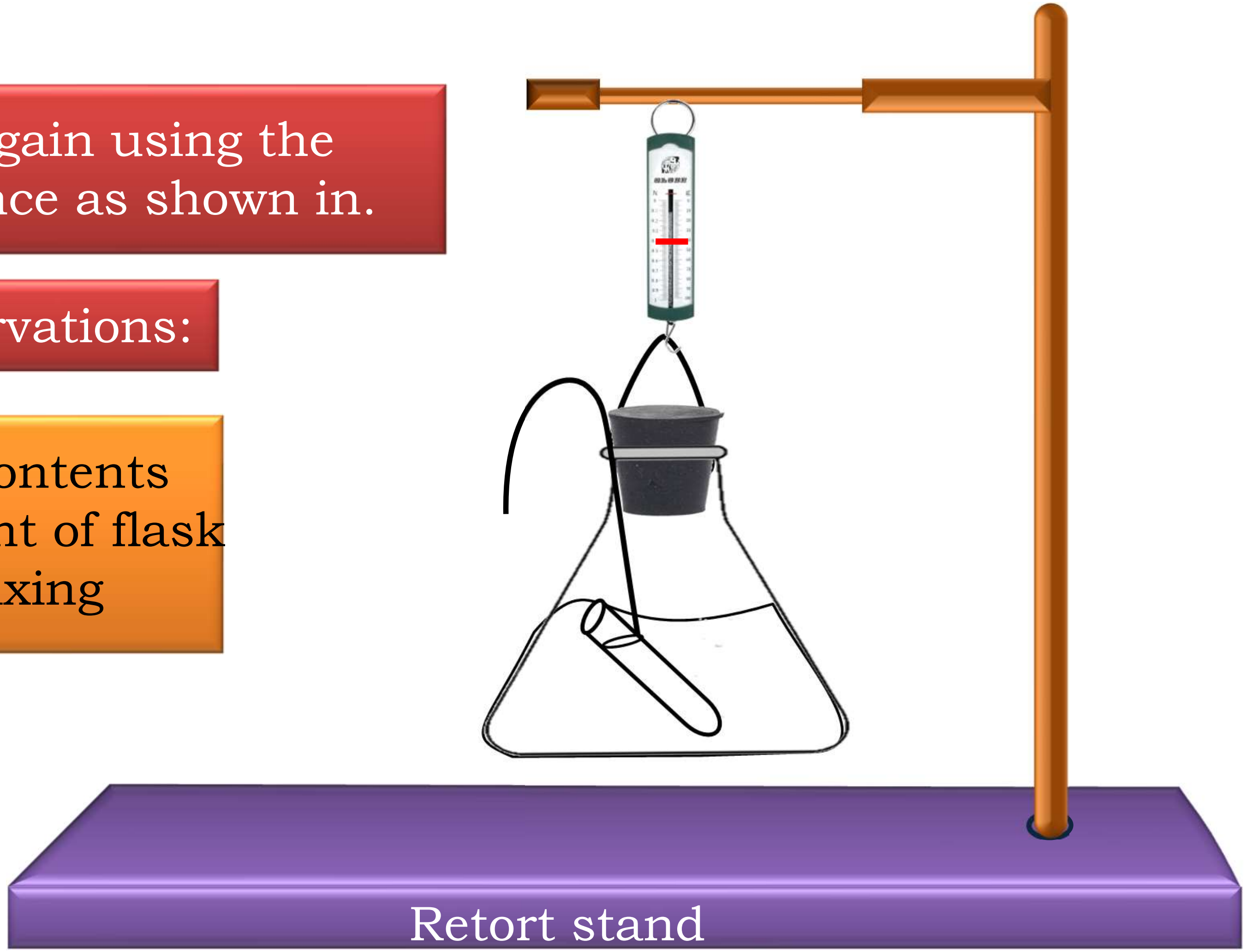


Procedure

7. Weight the flask again using the same spring balance as shown in.

8. Record your observations:

Weight of flask and contents before mixing = Weight of flask and contents after mixing



Barium chloride when reacts sodium sulphate, White precipitate of barium sulphate is formed along with sodium chloride.

$$BaCl_2 + Na_2SO_4 \longrightarrow \underset{\text{(White ppt)}}{BaSO_4 \downarrow} + 2NaCl$$

A chemical reaction takes place and the mass remains same before and after the chemical reaction. Therefore mass is neither created nor destroyed in the chemical reaction.

The chemical reaction taking place in the above experiment can be written as:

Barium chloride (Solution) + Sodium sulphate (Solution) → Barium sulphate (White solid) + Sodium chloride (Solution)

In an experiment to verify the law of conservation of mass, the following data was obtained:

i) Mass of barium chloride taken	=	20.8 g
ii) Mass of sodium sulphate taken	=	14.2 g
iii) Mass of barium sulphate formed	=	23.3 g
iv) Mass of sodium chloride formed	=	11.7 g

In this case, barium chloride and sodium sulphate are reactants.

Mass of reactants = 20.8 +14.2 g

= 35.0 g

Here, barium sulphate and sodium chloride are products.

Mass of products = 23.3 g + 11.7 g

= 35.0 g

Since the total mass of products (35 g) in this chemical reaction is equal to the total mass of reactants (35 g) therefore, the given data verifies the law of conservation of mass.

Law of Conservation Mass

- ❑ Lavoisier, carried out the burning of charcoal in a closed apparatus and found no change in mass.
- ❑ Antonie lavoisier on the basis of his experiment he proposed the law of conservation of mass

It states that **"Matter is neither created nor destroyed during a chemical reaction"**

More simply the mass of products is equal to the mass of the reactants in a chemical reaction.

MODULE : 3

- **Numericals based on the laws**

15.9g. Of copper sulphate and 10.6 g of sodium carbonate react together to give 14.2 g of sodium sulphate and 12.3 g of copper carbonate. Which law of chemical combination is obeyed?? How?

Solution:

$$CuSO_4 + Na_2CO_3 \longrightarrow Na_2SO_4 + CuCO_3$$

(15.9 + 10.6)gm **(14.2 + 12.3)gm**

= (26.5gm) **= (26.5gm)**

$\because$ **Total mass of products is equal to the total mass of the reactants**

Hence the above reaction obeys the law of conservation of mass

Carbon dioxide is added to 112g of calcium oxide. The product formed is 200 g of calcium carbonate. Calculate the mass of carbon dioxide used. Which law of chemical combination will govern your answer.

Solution: $CO_2 + CaO \longrightarrow CaCO_3$

Mass of CO_2 + Mass of CaO = Mass of $CaCO_3$

Mass of CO_2 + 112 = 200

$\therefore$ Mass of CO_2 = 200 - 112 = 88 gm

The law of conservation of mass governs the answer

MODULE : 4

- **Laws of constant proportion + Numericals**

Law of constant proportions

He analysed the chemical composition of a large number of compounds

and came to the conclusion that the proportion of each element in a compound is constant.

The law of constant proportions was given by proust in 1779.

A chemical compound always consists of the same elements combined together in the same proportion by mass.

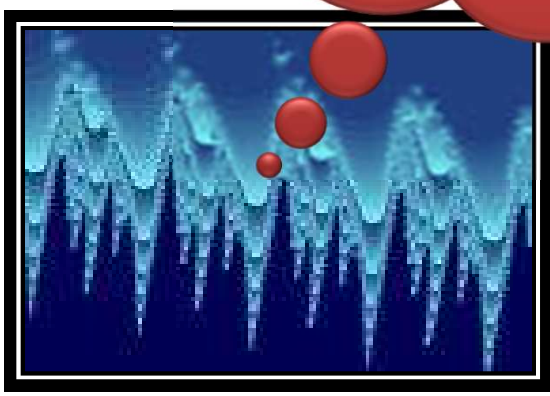
Law of constant proportions

According ... proportions.

A chem... sists of th...
combi... oporti...

Water is a compound which always consists of the same two elements, hydrogen and oxygen.

Combined together
In the same constant proportion of.
1:8by mass



Ice water

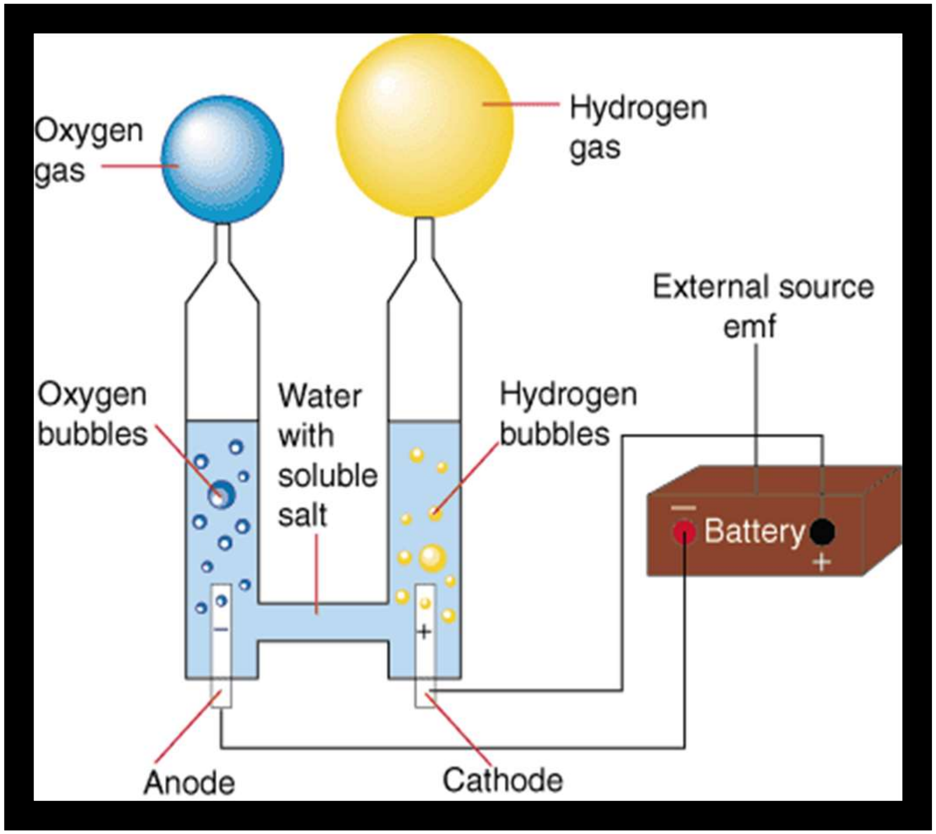
H_2O 1 : 8

River water

H_2O 1 : 8

Sea water

H_2O 1 : 8



If we decompose 100gm of pure water by passing electricity through it, then 11grams of hydrogen and 89 grams of oxygen are obtained.

Now, if we repeat this experiment by taking pure water from different sources(like river, sea, well, etc.)

The same masses of hydrogen and oxygen elements are obtained in every case.

This experiment shows that water always consists of the same two elements, hydrogen and oxygen, combined together in the same constant proportion of 11:89 or 1:8 by mass

Calcium carbonate decomposes, on heating, to form calcium oxide and carbon dioxide. When 10 g of calcium carbonate is decomposed completely, then 5.6 g of calcium oxide is formed. calculate the mass of carbon dioxide formed. Which law of chemical combination will you use in solving this problem??

Solution.

This problem is to be solved by using the law of conservation of mass in chemical reaction, calcium carbonate is the reactant whereas calcium oxide and carbon dioxide are products.

Now, from the law of conservation of mass we have:

Mass of products = mass of reactants

Mass of calcium + Mass of carbon = Mass of calcium
oxide **dioxide** **carbonate**

5.6 + Mass of carbon = 10
dioxide

Mass of carbon = 10 – 5.6

dioxide

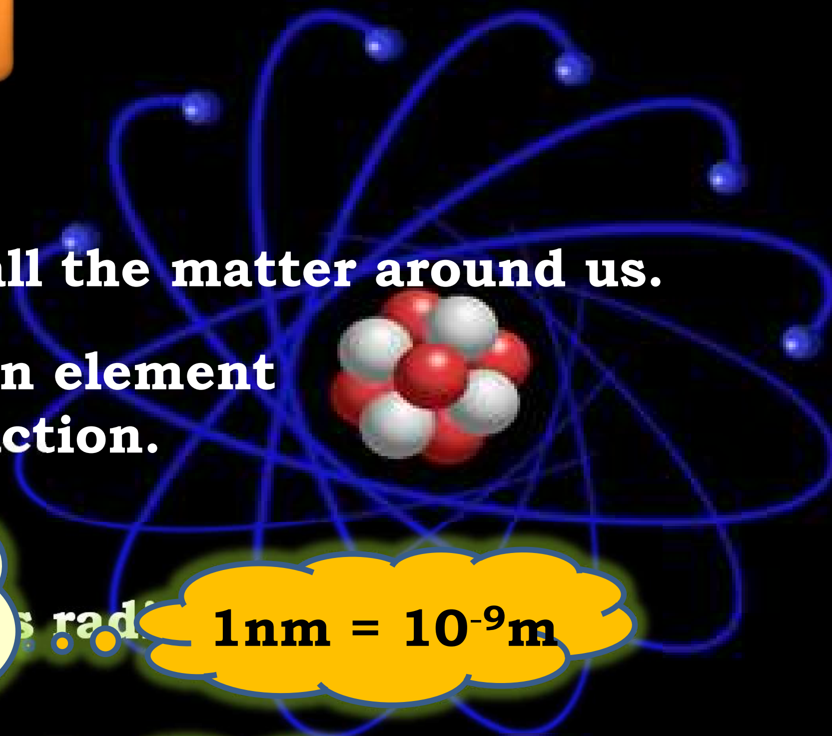
=4.4 g

Thus, the mass of carbon dioxide formed is 4.4 g.

MODULE : 5

- **Atoms, Daltons atomic theory and symbols**

Atoms



- All the matter is made up of atoms.
- These atoms are building blocks of all the matter around us.
- An atom is the smallest particle of an element than can take part in a chemical reaction.
- Atoms are very ver
- The size of an a   s radi
  radius”
- Atomic exist combination wit   ment or
  another element.

Atomic radius is measured in nanometer.

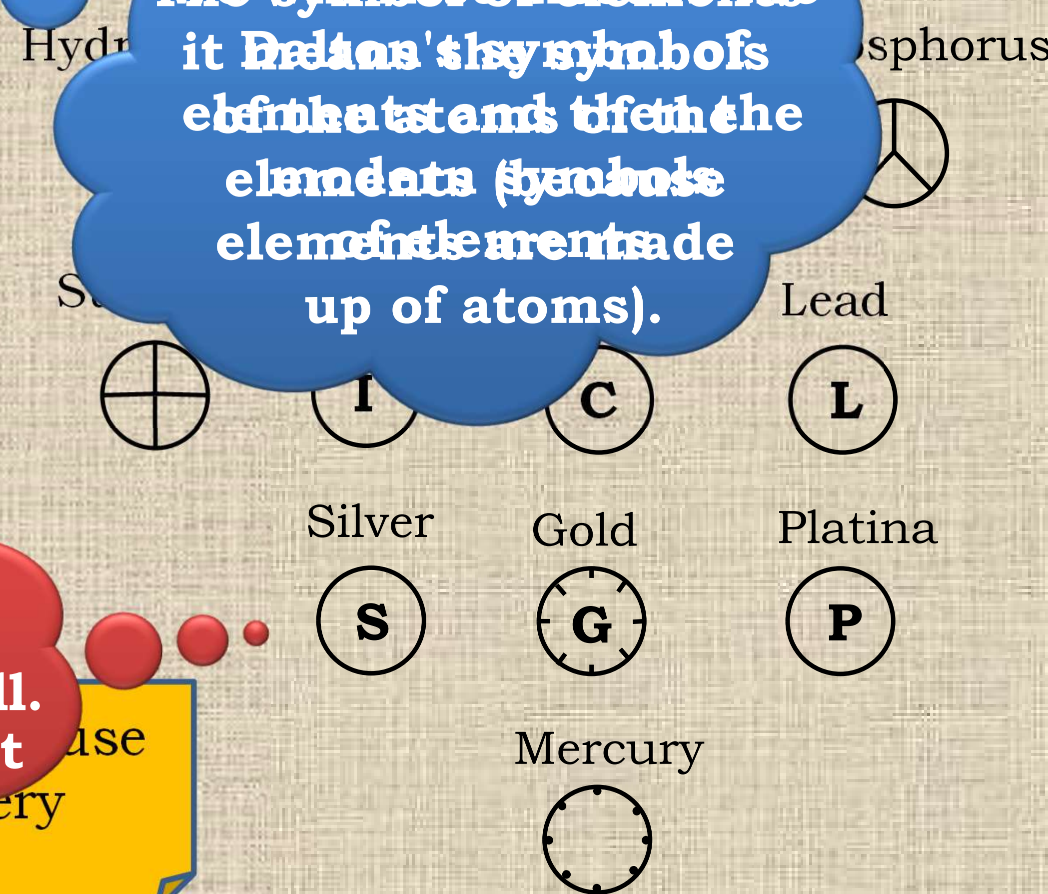
1nm = 10^{-9}m

Atoms of Hydrogen is smallest at all

Symbols for some elements

The symbols of elements it means the symbol of the atoms of the elements (because elements are made up of atoms).

We will first discuss the Dalton's symbols for elements and then the modern symbols of elements.



Dalton's symbols for elements were difficult to draw and inconvenient to use

They are not used at all.

So Dalton's symbols are only of historical importance.

Modern symbols of elements

The symbol of an element is the “first letter” or the “first letter and another letter” of the English name or Latin name of the element.

The symbol of Hydrogen is H **(First letters of name)**

The symbol of Oxygen is O **(First letters of name)**

There are, however some elements whose names begin with the same letter.

Carbon

Calcium

Chlorine

Copper

The symbol of Carbon is C

In such cases, one of the elements is given a "one letter" symbol

The symbol of Calcium is Ca

but all other elements are given "two letter" symbols.

(First and second

The symbol of Chlorine is Cl

please note that this "another letter" may or may not be the

The symbol of Copper is Cu

The "two letters" are the "first letter " and "another letter" of the English name or Latin name of the element.

(First and second letter of its Latin name Cuprum)

MODULE : 6

- **Elements and their Symbols**

It should be noted that in a ' two letter' symbol the first letter is the 'capital letter' but the second letter is the small letter'

English name of the Element	Symbol	English name of the Element	Symbol
Hydrogen	H	Fluorine	F
Helium	He	Neon	Ne
Lithium	Li	Magnesium	Mg
Boron	B	Aluminium	Al
Carbon	C	Silicon	Si
Nitrogen	N	Phosphorus	P
Oxygen	O	Sulphur	S

English name of the Element	Symbol	English name of the Element	Symbol
Chlorine	Cl	Bromine	Br
Argon	Ar	Krypton	Kr
Calcium	Ca	Iodine	I
Manganese	Mn	Barium	Ba
Nickel	Ni	Cobalt	Co
Zinc	Zn	Uranium	U

In our study of chemistry we use the English names of the elements so we are not familiar with the Latin names of the elements.

Most of the confusion therefore arises in the symbols derived from the Latin names of the elements.

English name of the Element	Symbol	Latin name	English name of the Element	Symbol	Latin name
Sodium	Na	Natrium	Gold	Au	Aurum
Potassium	K	Kalium	Mercury	Hg	Hydragyrum
Iron	Fe	Ferrum	Lead	Pb	Plumbum
Copper	Cu	Cuprum	Tin	Sn	Stannum
Silver	Ag	Argentum			

Latin name and Symbol of the element

Elements	Latin name	Symbol
Sodium	Natrium	Na
Silver	Argentum	Ag
Tungsten	Wolfram	W
Potassium	Kalium	K
Copper	Cuprum	Cu
Gold	Aurum	Au
Iron	Ferrum	Fe
Lead	Plumbum	Pb
Mercury	Hydragyrum	Hg

MODULE : 7

- **Atomicity**

Interesting fact about Elements

Sometimes elements are named based on their property.

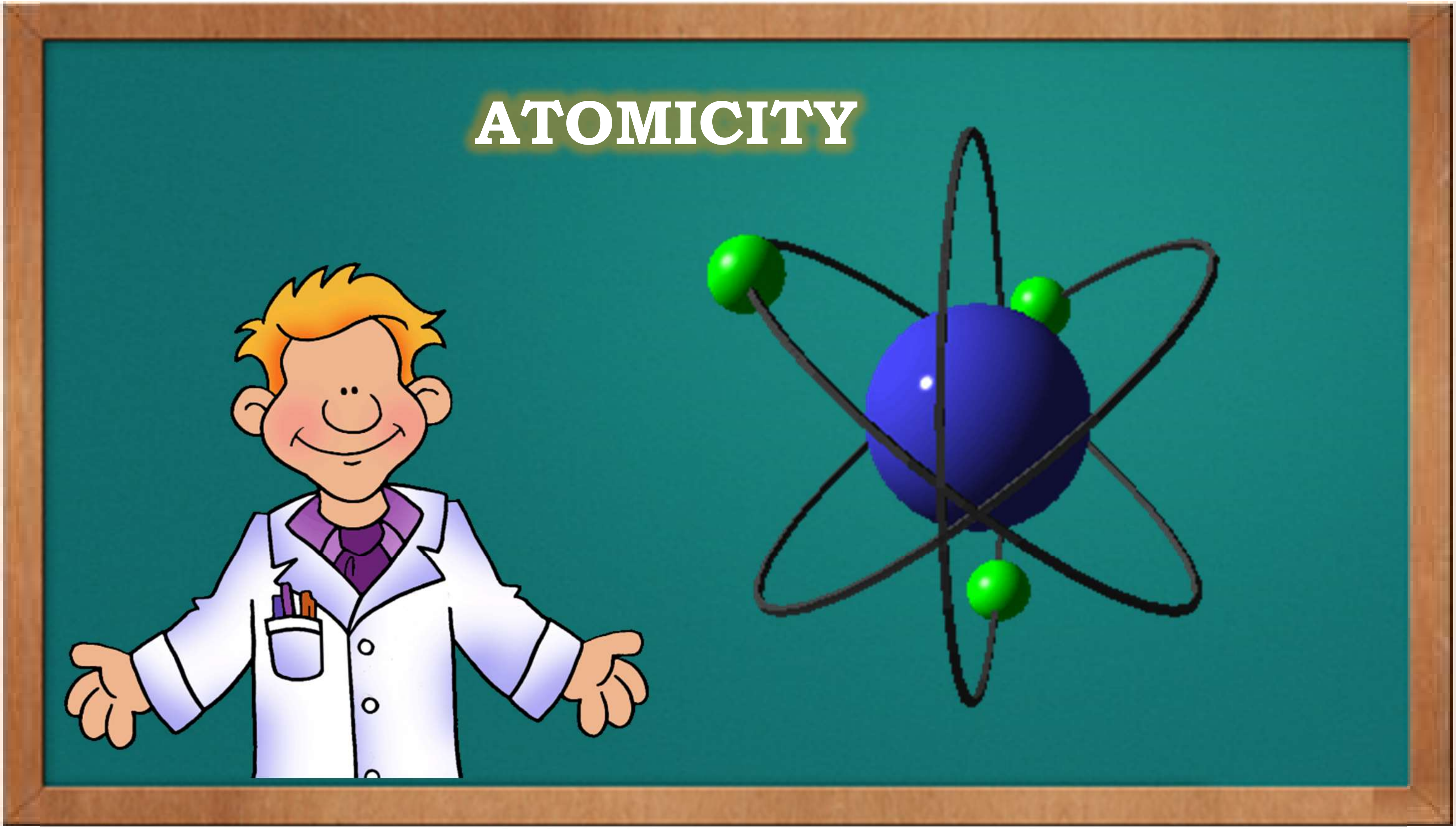
At one time people believed that any substance that contained oxygen would be acidic in nature.

Place of discovery of element can also play a role in its naming.

Sometimes elements were named to honour the scientists.

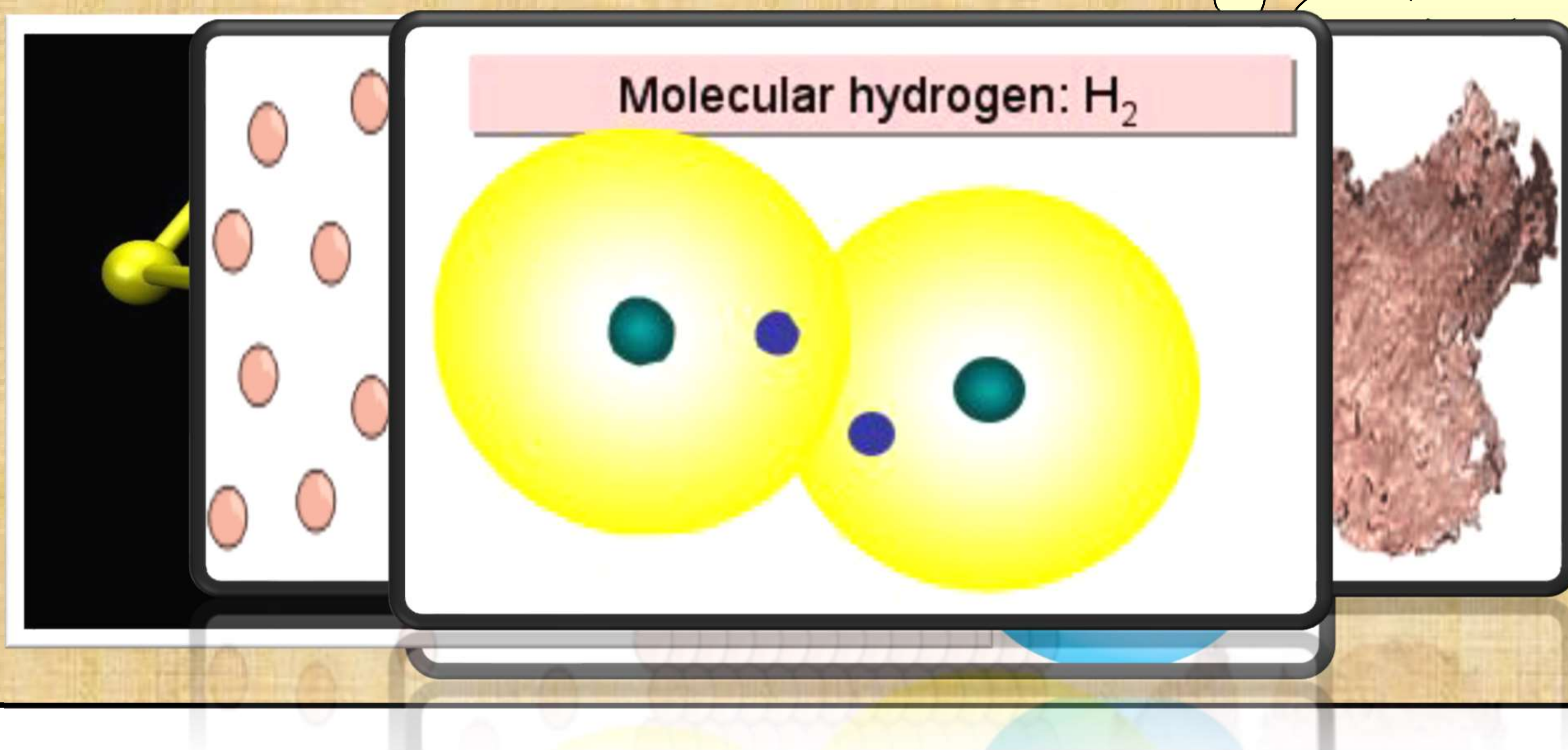
The Latin word for acid is **'oxy'**

Example: Einsteinium, Fermium, Rutherfordium And Mendelevium.


ATOMICITY

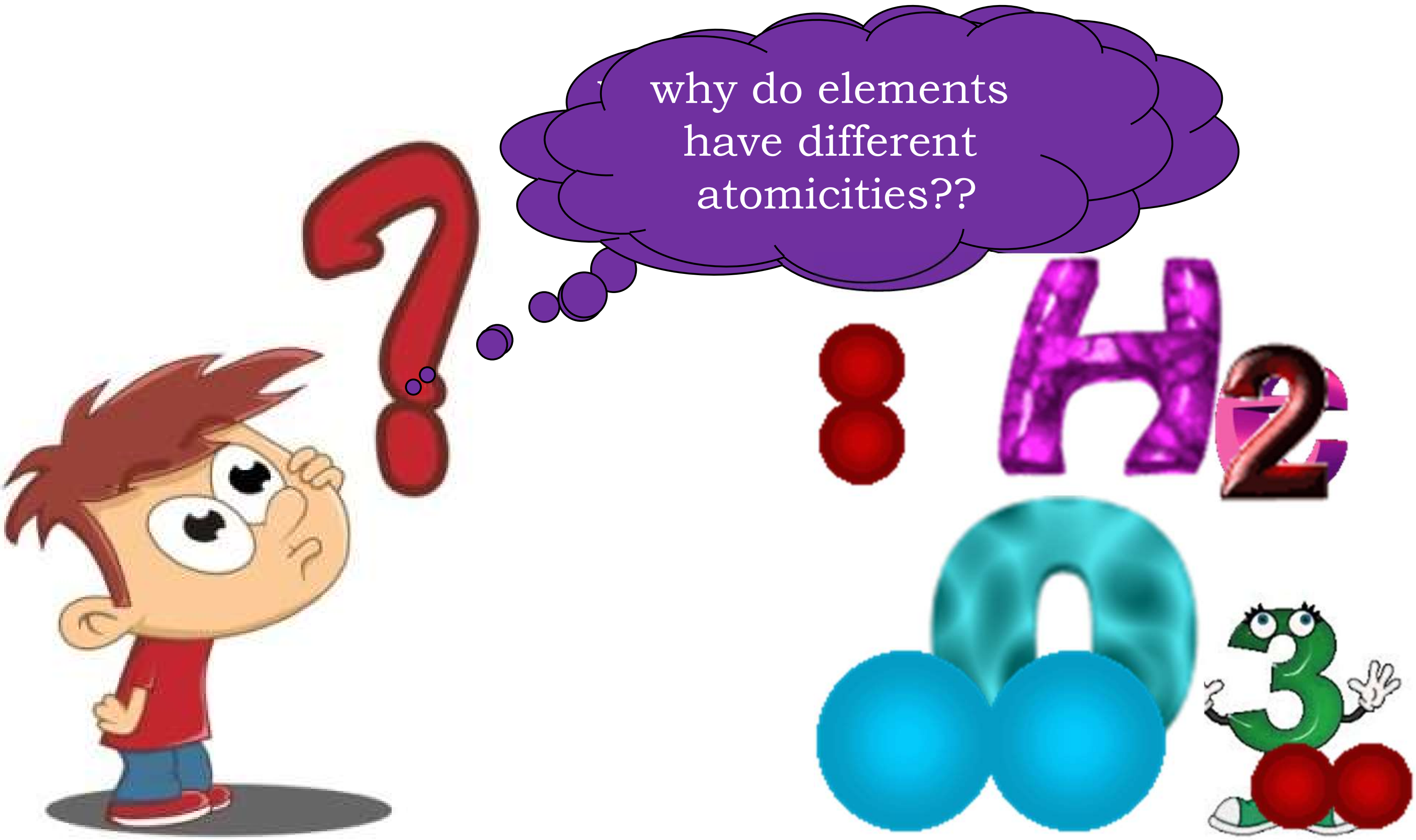
The number of atoms constituting a molecule is known as its **Atomicity.**

Molecule of Sulphur consists of eight atoms of Sulphur. Here the atomicity is eight; hence it is known as Octatomic molecule.



MODULE : 8

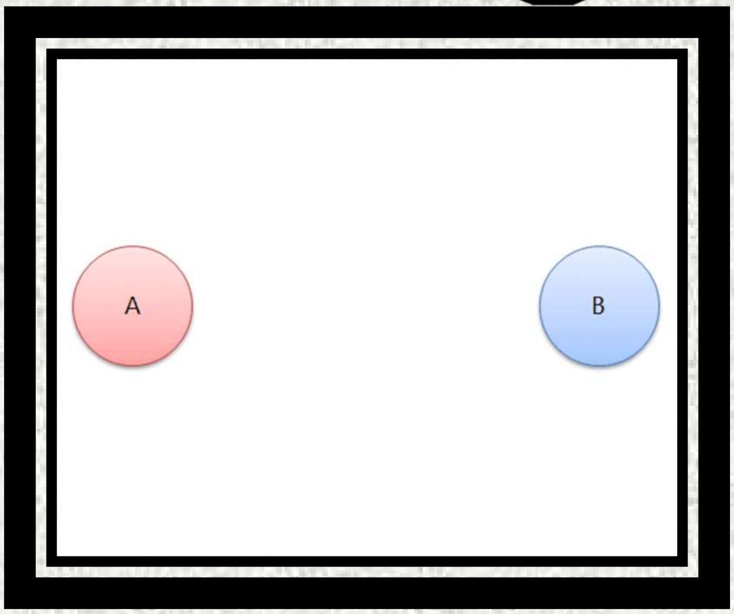
- **Valency**


why do elements
have different
atomicities??
H2
O3

What is valency??

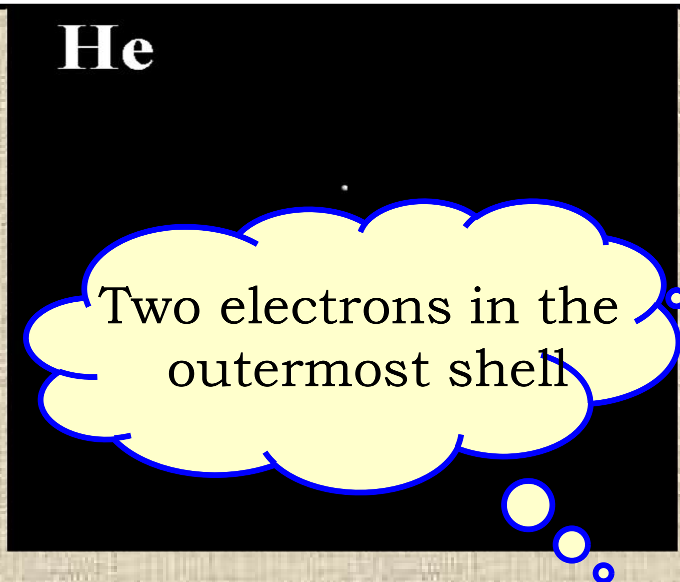
Every element has a definite combining capacity, that determines the atomicity of its molecules.

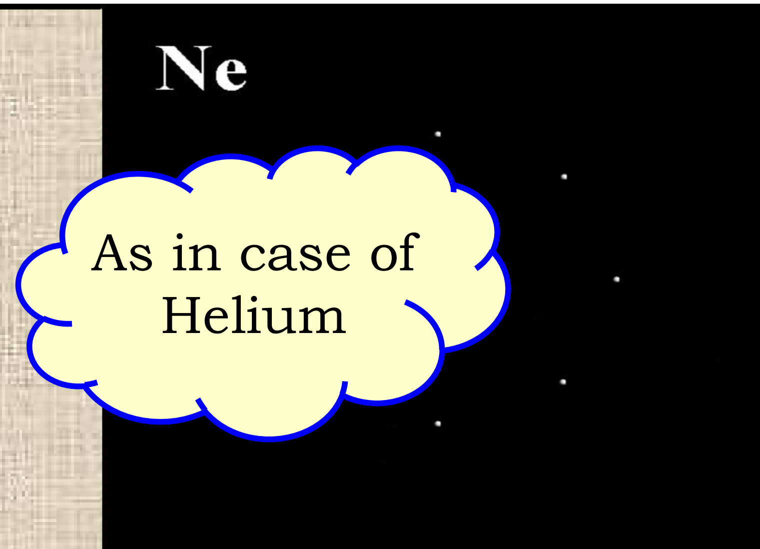
We call as its valency.



Every elements reacts with other elements according to its combining capacity.

Valency





All elements tend to complete the duplet or octet electrons in their outermost orbit. i.e. a stable state when there are 8 electrons in their outermost orbit.

This they do by donating, accepting or sharing of the outermost orbit with electrons of other elements.

In doing so they form chemical bonds with the other elements leading to formation of compounds.

Find out the valency for sodium

Steps:

Find out atomic number of sodium

Its 11

Write its electronic configuration

2,8,1

Find out weather sodium is stable or unstable

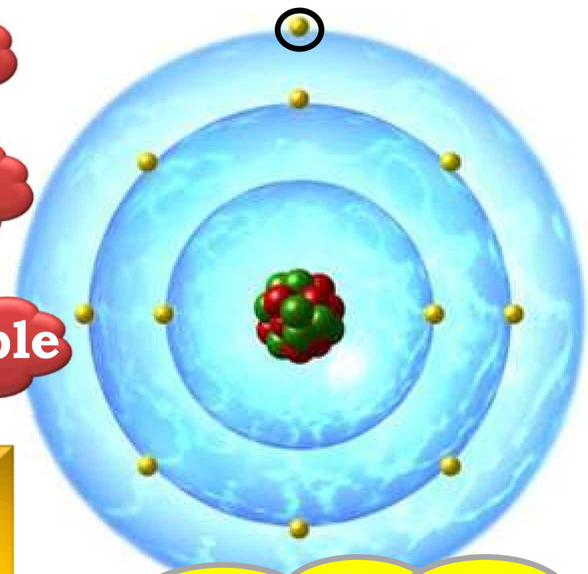
unstable

To become stable sodium can give 1 electron or take 7 electrons

For sodium the nearest inert gas is Neon

It is easy to give 1 electron.

∴Valency of sodium is 1



Valency of chlorine

The atomic number of chlorine is 17, so its electronic configuration is 2,8,7.

The chlorine atom has 7 electrons in its Outermost shell

It needs 1 more electron to achieve the 8 electron configuration

Since one chlorine atom gains 1 electron to achieve the inert gas electron configuration, so the electrovalency of chlorine is1

Valencies of Some Common Metal Elements

Element	Symbol	V[illegible]	[illegible]	[illegible]	[illegible]y
Lithium	Li	1	[illegible]gnesium	[illegible]	2
Sodium	Na	1	Calcium	Ca	2
Potassium	K	1	Zinc	[illegible]	[illegible]
Silver	[illegible]	[illegible]	[illegible]on	Fe	2 and 3
Copper	Cu	1 and 2	Aluminium	Al	3
Mercury	Hg	1 and 2			

Metals are electropositive

Metals tend to give away electrons

Ferrous

Ferric

Cupric

Mercurous

Mercuric

Valencies of Some Common Non - Metal Elements

Non-metals are electronegative

Non-metals tend accept or share electrons

Element	Symbol	[illegible]	[illegible]	[illegible]	ncy
Hydrogen	H	[illegible]	Sulphur	[illegible]	2
Fluorine	F	1	Nitrogen	N	3
Chlorine	Cl	1	Phosphorus	P	3
Bromine	Br	1	Carbon	C	4
Iodine	I	1			
Oxygen	O	2			

MODULE : 9

- **Ions and Polyatomic Ions**

What is an ion??

Compounds formed by metals and non metals contain charged species.

The charged species are known as ions.

A negatively charged ion is called anion and the positive charge ion is cation.

For example: Sodium ion is written as Na^+ and chloride ion as Cl^-

Valencies of some elements

Element	Valency
Helium	0
Hydrogen	1
Fluorine	1
Chlorine	1
Oxygen	2
Nitrogen	3
Carbon	4

What is an ion??

Compounds formed by metals and non metals contain charged species.

The charged species are known as ions.

A negatively charged ion is called anion and the positive charge ion is cation.

Some Common, Simple and poly atomic ions

Net charge	Cation	Symbol	Anion	Symbol
1 Unit	Hydrogen	H^+	Hydride	H^-
	Sodium	Na^+	Chloride	Cl^-
	Potassium	K^+	Bromide	Br^-
	Silver	Ag^+	Iodide	I^-
	Copper *	Cu^+	Hydroxide	OH^-
	Ammonium	NH_4^+	Nitrate	NO_3^-
2 Units	Magnesium	Mg^{+2}	Oxide	O^{-2}
	Calcium	Ca^{+2}	Sulphide	
	Zinc	Zn^{+2}	Sulphate	
	Copper*	Cu^{+2}	Carbonate	
	Iron*	Fe^{+2}	Dichromate	
3 Units	Aluminium	Al^{+3}	Nitride	
	Iron*	Fe^{+3}	Phosphate	PO_4^{-3}

Valency of oxide ion (O^{-2}) is 2.

MODULE : 10

- **Atomic Mass**

Atomic Mass

The mos
Dalton

Acc
a c

Since, a ... and
small
measu ... s.

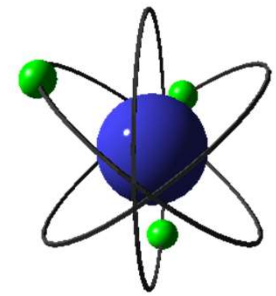
... e atom is
... dard atomic
... er element.

In 1961, it was universally accepted the mass of carbon- 12 atom would be used as a standard reference for measuring atomic masses of other elements.

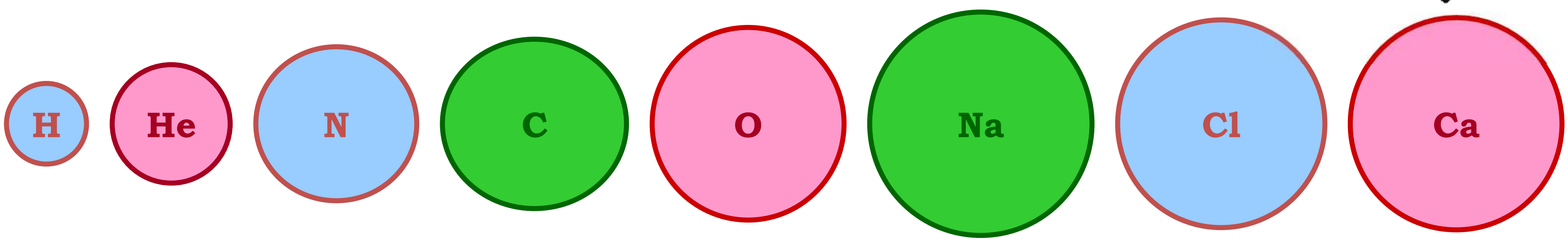
Earlier scientist used Hydrogen as a reference standard.

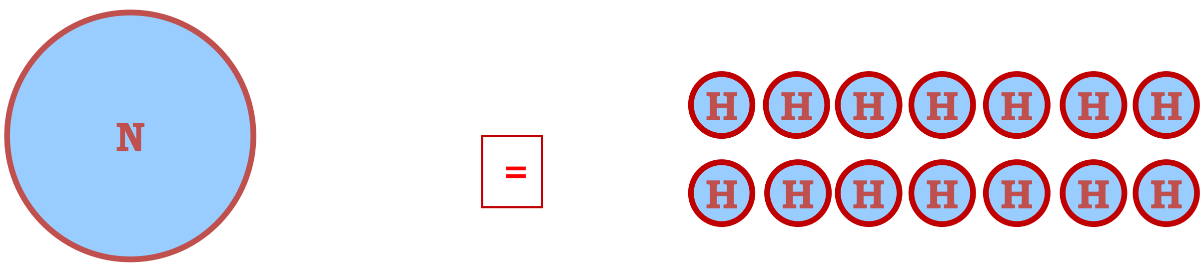
Since hydrogen has no neutrons.

Atomic Mass



Hydrogen being the smallest atom is taken as a standard particle for Comparing masses of other atoms

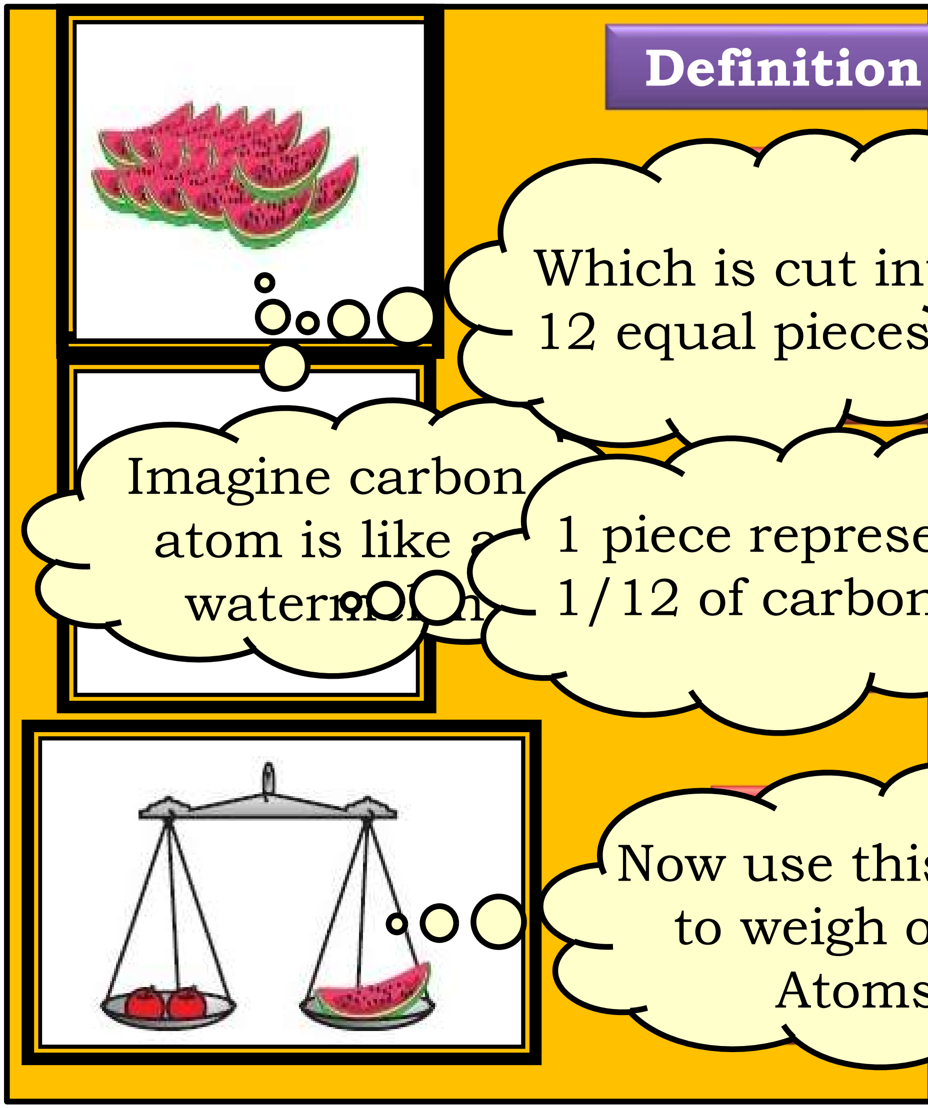




1 atom of nitrogen **14 atoms of hydrogen**

Therefore RELATIVE MASS OF NITROGEN ATOM IS 14

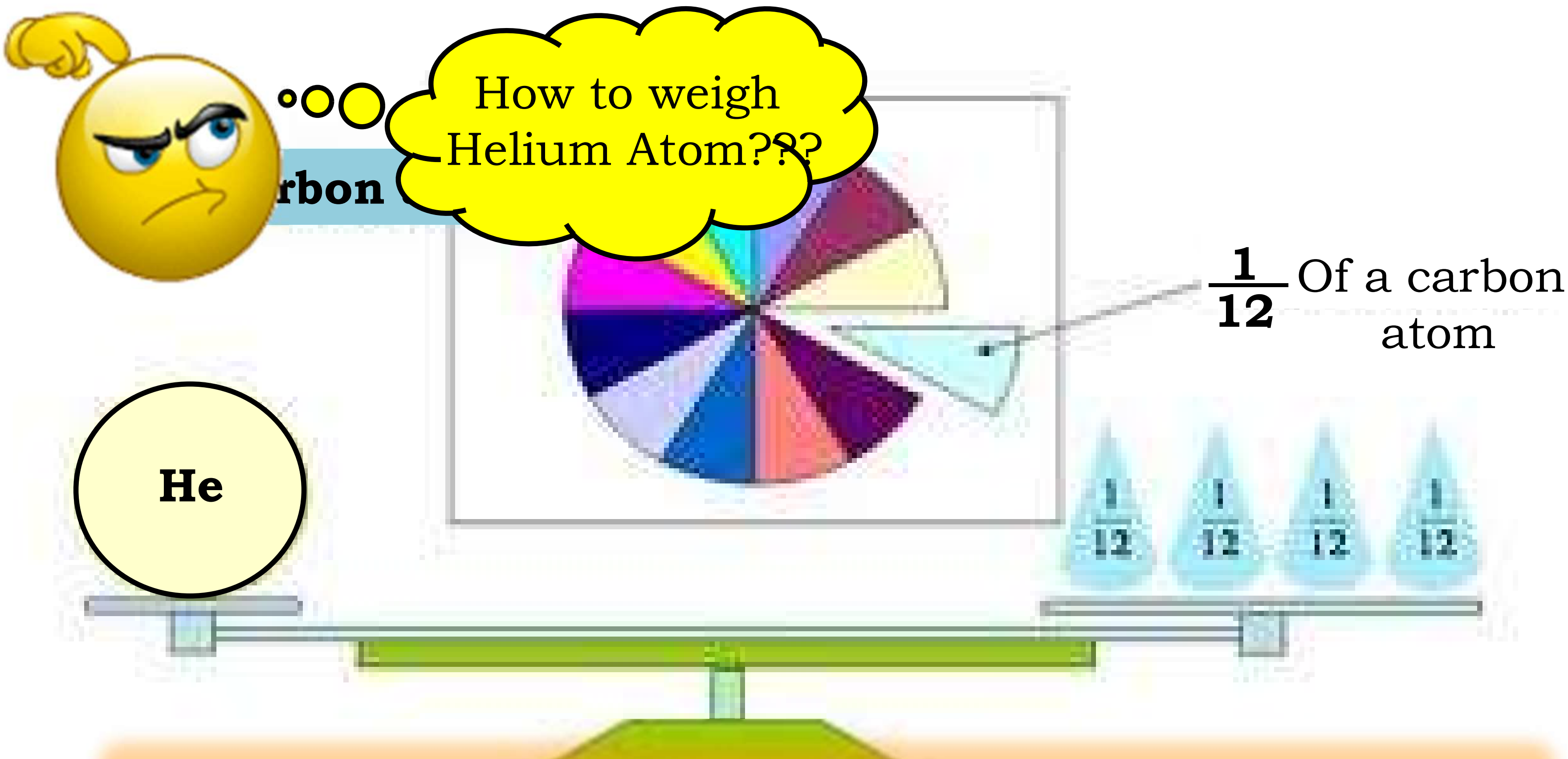
Definition of Atomic Mass



… mass of an element is defined …ge mass of all the isotopes of … as compared to 1/ 12th of the …one carbon -12 atom.

… of an element is a ratio and … and is expressed in **amu.**

…t IUPAC recommendations … replaced by **'u'**, which is …**ed mass.**



Mass of 1 Helium atom is **4** times $\frac{1}{12}$ mass of carbon atom
Atomic mass of helium is **4 u**.

Atomic masses of a few important elements

Element	Atomic mass (u)
Hydrogen	1
Carbon	12
Nitrogen	14
Oxygen	16
Sodium	23
Magnesium	24

Element	Atomic mass (u)
Aluminium	27
Phosphorus	31
Sulphur	32
Chlorine	35.5
Potassium	39
Calcium	40

MODULE : 11

- **Chemical formula of compounds**

LET’S STUDY HOW TO WRITE MOLECULAR FORMULA

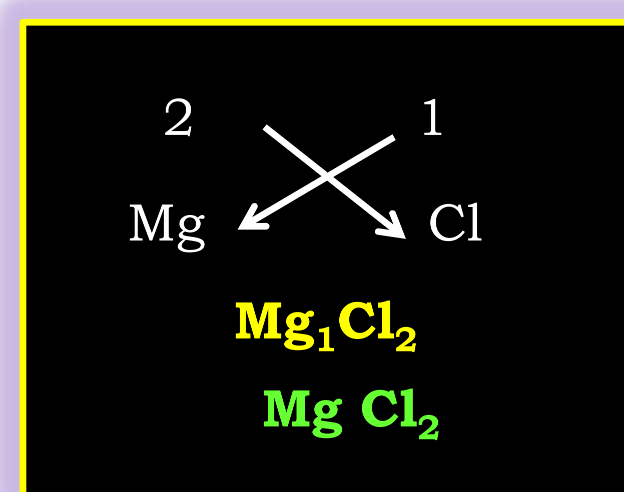
The following steps should be taken while writing the chemical formula of magnesium chloride.

1. Write the symbol of each atom side by side, usually the cation first and anion next Mg Cl.

2. Write the valency of each atom above its symbol

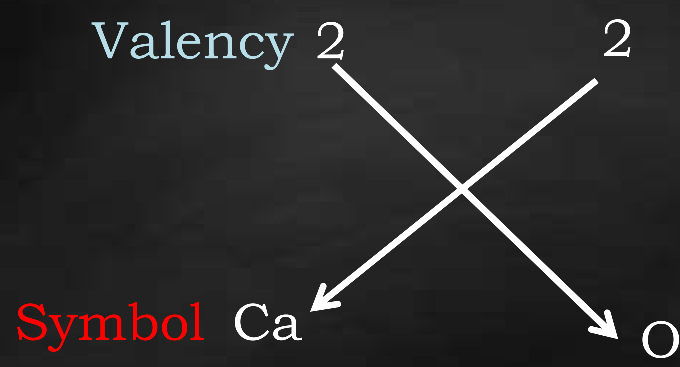
3. Interchange the valency and write the number to the lower right of the constituents as their subscript Mg_1Cl_2

4. If any constituent receives the number 1, ignore it while writing the formula.



5. If a constituent has more than one atom enclose it within brackets.

(b) Formula for Calcium oxide:



Here, the valencies of the two elements are the same.

You may arrive at the formula Ca_2O_2. But we Simplify the formula as CaO.

(b) Formula of Calcium hydroxide:

	Ca	OH
valency	2	1
Symbol/ Formula	Ca	OH

Formula : $Ca(OH)_2$

Here, the formula of calcium hydroxide is $Ca(OH)_2$ and not $CaOH_2$. We use bracket (OH) when we have two or more of the same ions in the formula.

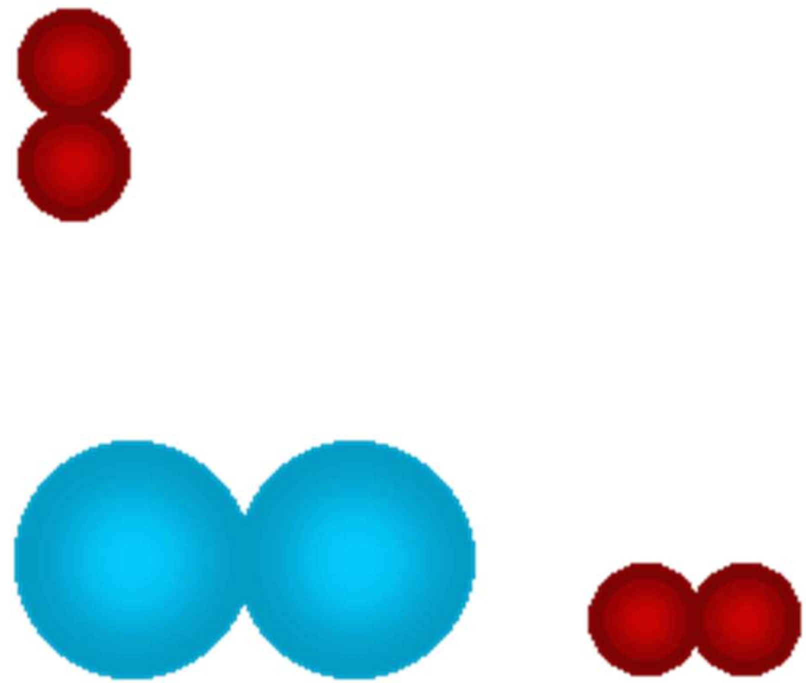
Note, that the bracket around OH with a subscript 2 indicates that there are two hydroxyl (OH) groups joined to one calcium atom. In other words, there are two atom each of oxygen and hydrogen in calcium hydroxide.

MODULE : 12

- **Molecular mass and Numericals**

Molecular Mass

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 a molecule expressed in unified mass units.(u)



Molecular Mass

Calculate the molecular mass of HNO_3 (Nitric acid)

$$1\begin{pmatrix}\text{Atomic mass}\\ \text{of hydrogen}\end{pmatrix} + 1\begin{pmatrix}\text{Atomic mass}\\ \text{of Nitrogen}\end{pmatrix} + 3\begin{pmatrix}\text{Atomic mass}\\ \text{Of Oxygen}\end{pmatrix}$$

$$= 1(1) + 1(14) + 3(16)$$

$$= 1 + 14 + 48$$

$$\boxed{= \mathbf{63}\boldsymbol{u}}$$

Molecular mass of $\mathbf{HNO_3}$ is $\mathbf{63}\boldsymbol{u}$

Molecular Mass

Molecular Mass = Sum of Atomic Masses

H_2O = (No of 'H' atoms × Atomic Mass of H) + (No of 'O' atoms × Atomic Mass of O)

H_2O = (No of 'H' atoms 2 × Atomic Mass of H 1) + (No of 'O' atoms 1 × Atomic Mass of O 16)

= 2 + 16

= 18 u

Calculate the molecular mass of H_2SO_4

2 atomic mass of hydrogen (atomic mass of sulphur)

(4 × atomic mass of oxygen) = (2 ×1) + 32 + (4 × 16) = 98u

MODULE : 13

- **Mole concept theory**

- Banks have an extremely large number of coins of various denominations.
- Counting of such a large number of coins is a difficult job.

- So, in banks, they weigh coins, rather than count them.
- The bank people know that a fixed number of a particular coin will always have the same mass.
- In chemistry also, scientist link the mass of an element or compound to the number of atoms or molecules present in them .

Mole Concept

Take an example of th
and oxygen to form wa

$2H_2 + O_2 = 2H_2O$

The above reaction inc

i) Two molecules of h
oxygen to form two

It is more convenient to refer to the quantity of a substance in terms of the number of its molecules or atoms rather than their masses.

So, a new unit "mole" was introduced.

One mole of any species (atoms, molecules, ions or particles) is that quantity in number having a mass equal to its atomic or molecular mass in grams.

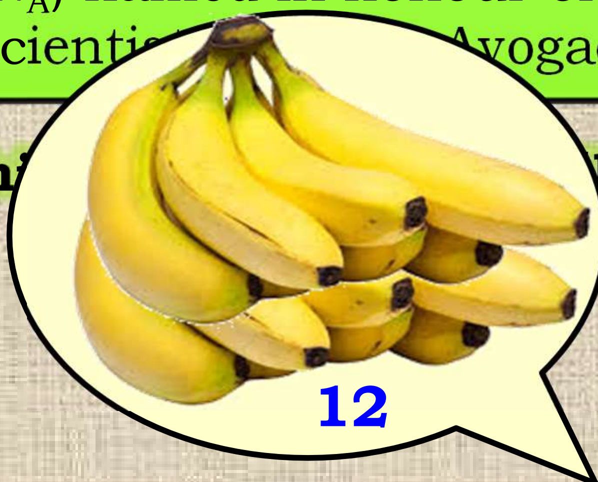
MODULE : 14

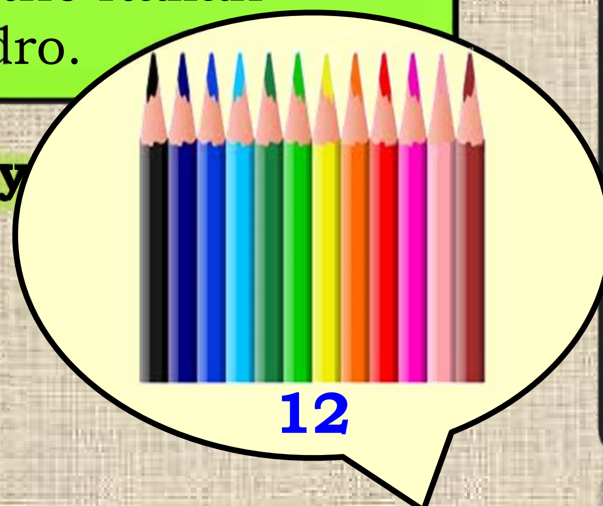
- **Molar mass and Numericals**

The number of particles (atoms, molecules or ions) present in a mole of any substance is fixed, with a value of 6.022×10^{23}.

This number is called Avogadro constant (N_A) named in honour of the Italian scienti… …vogadro.

Thi… …ly





1 mole (of anything) = 6.022×10^{23} in number,

as, 1 dozen = 12 nos.

as, 1 gross = 144 nos

Molar Mass

When molecular mass is expressed in gram it is called as Molar mass

For example molecular mass of water (H_2O)=18u.

Molar mass of water = 18 g

18 u water has only one molecule of water.

But 18 g water has one mole molecules of water that is 6.022×10^{23} molecules

Molar mass of $CaCO_3$

$= \text{Mass of Ca} + \text{Mass of C} + \text{Mass of O} \times 3$

$= 40+12+16 \times 3$

$= 40+12+48$

$= 100g$

1 Mole of $CaCO_3$ =100gm and contains 6.022×10^{23} Molecules of $CaCO_3$

1. How many moles are 5 grams of calcium? (Atomic mass of calcium = 10μ)

Solution : We know that

1 mole of atoms = Gram atomic mass

So, 1 mole of Calcium atoms = 40 g

So, x mole = 5 g

$$\therefore \quad x = \frac{\cancel{5}}{\cancel{40}}$$

$$\therefore \quad x = \frac{1}{8}$$

$$\therefore \quad x = \boxed{\mathbf{0.125\ mole}}$$

Thus, there are 0.125 mole in 5 g of calcium.

OR

$$\therefore \quad \text{No of moles} = \frac{\text{Mass in grams}}{\text{Gram atomic mass}}$$

$$\text{i.e} \quad n = \frac{m}{M}$$

$$n = \frac{\cancel{5}}{\cancel{40}}$$

$$n = \frac{1}{8}$$

Ans : $\boxed{\mathbf{n = 0.125\ mole}}$

2. What is the mass of 4 moles of aluminium atoms ? (Atomic mass of A1 = 27μ)

Solution : 1 Mole of al A1 atoms = 27 g

So, 4 males of A1 atoms = 27 × 4 g

$$\boxed{= 108\text{ g}}$$

Thus, the mass of 4 moles of A1 atoms is 108 grams

OR

$$\therefore \quad N = \frac{m}{M}$$

$$\therefore \quad N = 4 \text{ moles}$$

$$M = 27 \text{ g}$$

$$\text{so, } \quad 4 = \frac{m}{27}$$

$$m = 4 \times 27 \text{ g}$$

Ans : $\boxed{m = 108\text{ g}}$

3. How many moles are 9.033×10^{24} atoms of helium (He) ?

Solution : 1 mole = 6.022×10^{23} atoms

So, x mole = 9.033×10^{24} atoms of helium

$$\therefore \quad x = \frac{9.033 \times 10^{24}}{6.022 \times 10^{23}}$$

$$\therefore \quad x = \frac{3}{2} \times 10^{24-23}$$

$$x \quad \boxed{= \mathbf{15\ moles}}$$

OR

$$n = \frac{N}{N_A}$$

n = no. of moles

n = given number of particles

N_A = Avogadro's number = 6.022×10^{23}

$$\therefore \quad n = \frac{9.033 \times 10^{24}}{6.022 \times 10^{23}}$$

$$\therefore \quad n = \frac{3}{2} \times 10^{1}$$

$$\therefore \quad n = 1.5 \times 10$$

Ans : **n = 15 moles**

4. What is the number of molecules in 0.25 moles of oxygen ?

Solution :

1 mole of oxygen contains = 6.022 × 1023 molecu

OR

So, 0.25 mole of oxygen contains = x

$$\therefore \quad x = 6.022 \times 10^{23} \times 0.25$$

$$\therefore \quad x = \boxed{\mathbf{1.505 \times 10^{23}\ molecules}}$$

Thus, 0.25 mole of oxygen contains 1.505 × 10^{23} molecules.

$$n = \frac{N}{N_A}$$

$$\therefore \quad 0.25 = \frac{N}{6.022 \times 10^{23}}$$

$$\therefore \quad N = 6.022 \times 10^{23} \times 0.25$$

Ans : **N = 1.505 × 10^{23} molecules.**

5. Calculate the number of iron atoms in a piece of iron weighing 2.8 g. (Atomic mass of iron = 56 μ)

Solution : 1 mole of iron = Gram atomic mass of iron

= 56 grams

Also 1 mole of iron element = 6.022×10^{23} atoms

Now, 56 g of iron = 6.022×10^{23} atoms

So, 2.8 g of iron = x

$$\therefore \quad x = \frac{6.022 \times 10^{23} \times 2.8}{56}$$

$$\therefore \quad x = \frac{6.022 \times 10^{22}}{2}$$

$$x \boxed{= \mathbf{3.011 \times 10^{22}\ atoms}}$$

OR

$$N = \frac{m}{M} \times N_A$$

$$\therefore \quad n = \frac{2.8}{56} \times 6.022 \times 10^{23}$$

$$\therefore \quad n = \frac{6.022 \times 10^{22}}{2}$$

$$\therefore \quad n = 1.5 \times 10$$

Ans : $\boxed{\mathbf{N = 3.011 \times 10^{22}\ atoms}}$

6. Calculate the mass of 3.011×10^{24} molecules of nitrogen molecule (N_2)(Atomic mass = 14 μ)

Solution :

$$1 \text{ mole of } N_2 = \text{Molecular mass of } N_2 \text{ in grams}$$

$$= 28 \text{ grams}$$

$$1 \text{ mole of } N_2 = 6.022 \times 10^{23} \text{ molecules}$$

$$6.022 \times 10^{24} = x$$

$$\text{So, } 2.8 \text{ g of iron} = x$$

$$\therefore \quad x = \frac{28 \times 3.011 \times 1024}{6.022 \times 1023}$$

$$x \boxed{= \quad \mathbf{140\ g}}$$

OR

$$N = \frac{m}{M} \times N_A$$

$$\therefore 3.011 \times 10^{24} = \frac{m}{28} \times 6.022 \times 10^{23}$$

$$\therefore \quad m = \frac{28 \times 3.011 \times 10^{24}}{6.022 \times 10^{23}}$$

Ans : $\boxed{\mathbf{m = 140\ g}}$