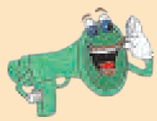
4. Measurement of Matter



➤ **Laws of chemical combination** ➤ **Atom - shape, mass, valency**
➤ **Molecular mass and the concept of mole** ➤ **Radicals**

Can you recall?

1. What is the Dalton's atomic theory ?
2. How are the compounds formed ?
3. What are the molecular formulae of salt, slaked lime, water, lime, limestone ?

In the previous standard we have learnt that compounds are formed by chemical combination of elements. We have also learnt that an important principle of Dalton's atomic theory is that molecules of a compound are formed by joining atoms of different elements.

Laws of chemical combination

The composition of a substance changes during a chemical change. The fundamental experiments is this regard were performed by scientists in the 18^{th} and 19^{th} century. While doing this, they measured accurately, the substances used and formed. The scientists Dalton, Thomson and Rutherford studied the structure of substances and the atom and thus discovered the laws of chemical combination. Scientists could then write the molecular formulae of various compounds on the basis of Dalton's atomic theory and the laws of chemical combination. Here we shall verify the laws of chemical combination by means of known molecular formulae.

Try this

Apparatus : Conical flask, test tubes, balance, etc.
Chemicals : Calcium chloride ($CaCl_2$), sodium sulphate (Na_2SO_4), calcium oxide (CaO), Water (H_2O)

Activity 1

- Take 56 g calcium oxide in a large conical flask and put 18 g water in it.
- Observe what happens.
- Measure the mass of the substance formed.
- What similarity do you find? Write your inference.

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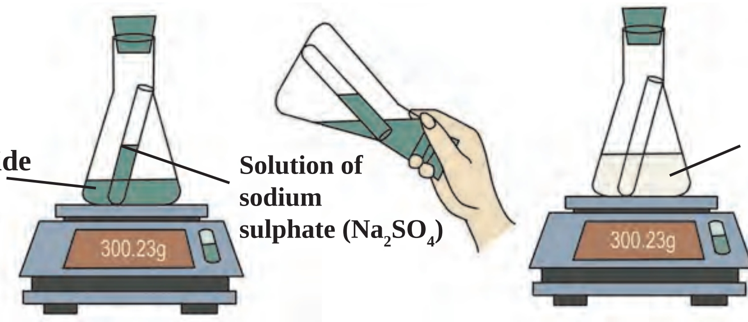
Activity 2

- Take a solution of calcium chloride in a conical flask and a solution of sodium sulphate in a test tube.
- Tie a thread to the test tube and insert it in the conical flask.
- Seal the conical flask with an airtight rubber cork.
- Weigh the conical flask using a balance.
- Now tilt the conical flask so that the solution in the test tube gets poured in the conical flask.
- Now weigh the conical flask again.



4.1 Verification of law of the chemical combination

Law of conservation of matter

In the above activities, the mass of the original matter and the mass of the matter newly formed as a result of the chemical change are equal. In 1785, the French Scientist Antoine Lavoisier inferred from his research that 'there is no rise or drop in the weight of the matter during a chemical reaction.' In a chemical reaction the total weight of the **reactants** is same as the total weight of the **products** formed due to the chemical reactions and this is called the law of conservation of matter.

Law of constant proportion

In 1794 the French scientist J. L. Proust stated the law of constant proportions as "The proportion by weight of the constituent elements in the various samples of a compound is fixed," e.g., the proportion by weight of hydrogen and oxygen in water is 1:8. This means that 9 g water is formed by chemical combination of 1 g hydrogen and 8 g oxygen. Similarly, the proportion by weight of carbon and oxygen in carbon dioxide is 3:8. For example, in 44 g of carbondioxide there is 12 g of carbon and 32 g oxygen so that the proportion by weight of carbon and oxygen is 3:8.

Proust

Lavoisier

An introduction to scientists

Antoine Lavoisier (1743-94)

French scientist, father of modern chemistry, substantial contribution in the fields of chemistry, biology and economics.

- Nomenclature of oxygen and hydrogen.
- Showed that matter combines with oxygen during combustion.
- Was the first to use accurate weighing techniques to weigh reactants and products in a chemical reaction.
- Discovered that water is made up of hydrogen and oxygen.
- Assigned systematic names to the compounds, e.g. sulphuric acid, sulphate, sulphite.
- Author of the first book on modern chemistry.
- Studied the elements such as oxygen, hydrogen, nitrogen, phosphorus, mercury, zinc and sulphur.
- First writer of the law of conservation of mass, in a chemical reaction.

Verification of the law of constant proportion

Many compounds can be made by different methods. For example, two samples of the compound copper oxide, CuO, were obtained, one by decomposition of copper carbonate, $CuCO_3$, and another by decomposition of copper nitrate, $Cu(NO_3)_2$. From each of these samples, a mass of 8g of copper oxide was taken and each was treated independently with hydrogen gas. Both gave 6.4 g copper and 1.8 g water. Let us see how this is a verification of the law of constant proportion.

The reaction of copper oxide with hydrogen yielded two known substances, namely, the compound water and the element copper. It is known that, in the compound water, H_2O, the elements H and O are in the proportion 1:8 by weight. This means that in 9g water there are 8g of the element oxygen. Therefore, 1.8g water contains (8x1.8/9 = 1.6)g oxygen. This oxygen has come from 8g copper oxide. It means that 8g of both the samples of copper oxide contained 6.4g copper and 1.6g oxygen; and the proportion by weight of copper and oxygen in it is 6.4:1.6, that is, 4:1. Thus, the experiment showed that the proportion by weight of the constituent elements in different samples of a compound is constant.

Now let us see what the expected proportion by weight of the constituent elements of copper oxide would be from its known molecular formula CuO. To find out this, we need to use the known atomic masses of the elements. The atomic masses of Cu and O are 63.5 and 16 respectively. This means that the proportion by weight of the constituent elements Cu and O in the compound CuO is 63.5 : 16 which is 3.968:1, or approximately 4:1.

The experimental value of proportion by weight of the constituent elements matched with the expected proportion calculated from the molecular formula. Thus, the law of constant proportion is verified.

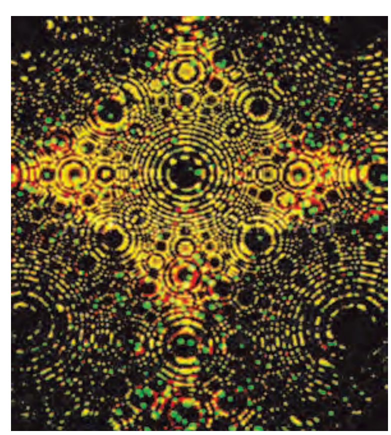
Atom : size, mass and valency

Can you recall?

1. From which experiments was it discovered that atoms have an internal structure? When?
2. What are the two parts of an atom? What are they made up of?

We have learnt that at the centre of an atom is the nucleus and that there are moving electrons in the extra-nuclear part. The electrons are negatively charged elementary particles while the elementary particles that make up the nucleus are positively charged protons and electrically neutral neutrons. Look at the image of an atom obtained with a field ion microscope.

The size of an atom is determined by its radius. The atomic radius of an isolated atom is the distance between the nucleus of an atom and its outermost orbit. Atomic radius is expressed in nanometres..



4.2 Field ion microscope image of iridium atoms (every spot in this image is an atom)

Approximate size of atom

Atomic radius (in metres)	Example
10^{-10}	Hydrogen atom
10^{-9}	Water molecule
10^{-8}	Haemoglobin molecule

$\frac{1}{10^9}$ m = 1nm

1m = 10^9 nm.

Atoms are very very tiny. Modern instruments like the electron microscope, field ion microscope, scanning tunneling microscope have the capacity to show enlarged images of the atom.

The atomic size depends on the number of electron orbits in the atom. The greater the number of orbits the larger the size. For example, an atom of K is bigger than an atom of Na. If two atoms have the same outermost orbit, then the atom having the larger number of electrons in the outermost orbit is smaller than the one having fewer electrons in the same outermost orbit. For example an atom of Mg is smaller than an atom of Na.

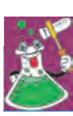
The mass of an atom

The mass of an atom is concentrated in its nucleus and it is due to the protons (p) and neutrons (n) in it. The number (p+n) in the atomic nucleus is called the **atomic mass number**. Protons and neutrons are together called **nucleons**.

An atom is very very tiny. Then how do we determine its mass? Scientists too, struggled with this question. It was not possible for scientists of the 19th century to measure atomic mass accurately. Therefore, the concept of ‘relative mass of an atom’ was put forth. A reference atom was required for expressing the relative mass of an atom. The hydrogen atom being the lightest was initially chosen as the reference atom. The relative mass of a hydrogen atom which has only one proton in its nucleus was accepted as one (1). Therefore, the magnitude of the relative atomic masses of various atoms became equal to their atomic mass number (p+n).

Let us see how to express the relative mass of a nitrogen atom, having accepted the relative atomic mass of hydrogen as 1.

The mass of one nitrogen atom is fourteen (14) times that of a hydrogen atom. Therefore, the relative mass of a nitrogen atom is 14. This is how the relative atomic masses of various elements were determined. On this scale, the relative atomic masses of many elements came out to be fractional. Therefore, in the course of time, different atoms were chosen as reference atoms. Finally in 1961, the carbon atom was selected as the reference atom. In this scale, the relative mass a carbon atom was accepted as 12. The relative atomic mass of one hydrogen atom compared to the carbon atom becomes 12 x 1/12, that is 1. The mass of one proton and of one neutron on the scale of relative atomic masses is approximately one.



Research

The relative atomic masses of some elements in the chart below are given. You have to find the relative atomic masses of the others.

Element	Atomic mass	Element	Atomic mass	Element	Atomic mass
Hydrogen	1	Oxygen	-	Phosphorus	-
Helium	4	Fluorine	19	Sulphur	32
Lithium	7	Neon	20	Chlorine	35.5
Beryllium	9	Sodium	-	Argon	-
Boron	11	Magnesium	24	Potassium	-
Carbon	12	Aluminium	-	Calcium	40
Nitrogen	14	Silicon	28		

Today, we have highly accurate methods for measuring the mass of an atom directly. Hence, instead of relative mass, Unified Mass has now been accepted as the unit of atomic mass. It is called Dalton. Its symbol is ‘u’. $1u = 1.66053904 \times 10^{-27}$ kg

Chemical symbols of elements

Can you tell?

1. How is an element indicated in Chemistry?
2. Write down the symbols of the elements you know.
3. Write down the symbols for the following elements : antimony, iron, gold, silver, mercury, lead, sodium.

Dalton used certain signs represent elements. For example ⊙ for hydrogen, © for copper. Today we use the symbols determined by IUPAC (International Union of Pure and Applied Chemistry). These are offical names and symbols and are used all over the world. The current method of choosing chemical symbols is based on the method invented by Berzelius. According to this method the symbol of an element is either the first letter or the first and second/another specific letter in its name. Of the two letters, the first is a capital letter and the second is small.

Molecules of elements and compounds

Atoms of some elements such as helium, neon have independent existence. It means that these elements are in a mono-atomic molecular state. Sometimes, two or more atoms of an element combine to form molecules of that element. Such elements are in a poly-atomic molecular state. For example, the elements oxygen, nitrogen are in a diatomic molecular state as O_2, N_2 respectively. When atoms of different elements combine with each other, the molecules of compounds are formed. In other words, compounds are formed by chemical attraction between different elements.

Make a list and discuss

Make a list of elements in the mono-atomic and in the diatomic molecular state.

Molecular mass and the concept of mole

Molecular mass

The molecular mass of a substance is the sum of the atomic masses of all the atoms in a single molecule of that subtance. Like atomic mass, molecular mass is also expressed in the unit Dalton (u).

How to deduce the molecular mass of H_2O ?

Molecule	Constituent elements	Atomic mass u	Number of atoms in the molecule	Atomic mass × number of atoms	Mass of the constituents u
H_2O	Hydrogen	1	2	1×2	2
	Oxygen	16	1	16×1	16
Molecular mass = sum of constituent atomic masses (Molecular mass of H_2O) = (Atomic mass of H) × 2 + (Atomic mass of O) × 1					Molecular Mass 18

Use your brain power !

Following are atomic masses of a few elements in Daltons and the molecular formulae of some compounds. Deduce the molecular masses of those compounds.

Atomic masses → H(1), O(16), N(14), C(12), K(39), S(32) Ca(40), Na(23), Cl(35.5), Mg(24), Al(27)

Molecular formulae → $NaCl$, $MgCl_2$, KNO_3, H_2O_2, $AlCl_3$, $Ca(OH)_2$, MgO, H_2SO_4, HNO_3, $NaOH$

Mole

Try this

1. Weigh single grains of *tur dal, masoor dal* and *chana dal* on a balance. What was your experience?
2. Weigh 10g of *tur dal, masoor dal* and *chana dal* each and count the number of *dal* grains of each kind in the weighed portions. Is the number the same in each portion, or different?
3. Draw a line sketch on a paper. Paint it by placing/pasting the dal grains in the sequence Tur, Masoor and Bengal gram. You will need equal number of *dal*-grains of the three kinds. Count that number and therefrom deduce the number of grams of *tur dal, masoor dal* and *chana dal* required for painting the picture. Also find out how many dozens of the respective dal-grains were required.
4. What inference will you draw about the weights of an equal number of its different *dal* grains and the number of its *dal* grains in equal weights of different *dals*?

Think about it

How much of wheat, jowar and bajra seed is required for sowing one acre of land? Can these weights be correlated to the number of grains of the respective cereals they contain?

Can you tell?

1. Is it possible to weigh one molecule using a weighing balance?
2. Will the number of molecules be the same in equal weights of different substances?
3. If we want equal numbers of molecules of different substances, will it work to take equal weights those substances?

When elements and compounds take part in chemical reactions, it is their atoms and molecules that react with each other, and therefore it is necessary to know the numbers of their atoms and molecules. However, while carrying out a chemical reaction it, is convenient to measure out quantities that can be handled instead of counting the numbers of atoms and molecules. The concept of 'mole' is useful for this purpose.

A mole is that quantity of a substance whose mass in grams is equal in magnitude to the molecular mass of that substance in Daltons. Thus, the molecular mass of oxygen is 32u, and therefore 32g oxygen is 1mole of oxygen. The molecular mass of water is 18u. Therefore, 18g of water make 1 mole of water.

1 mole of a compound is the mass of that subtance in grams equal in magnitude to its molecular mass. The SI unit is mol.

$$\text{Number of moles of a substances (n)} = \frac{\text{Mass of subtance in grams}}{\text{Molecular mass of substance}}$$

Avogadro's number

The number of molecules in one mole of any substance is constant. The Italian scientist Avogadro did pioneering work in this context. Therefore this number is called Avogadro's number and is denoted by the symbol N_A. Later scientists demonstrated experimentally that the value of Avogadro's number is 6.022×10^{23}. A mole of any substance stands for 6.022×10^{23} molecules. Just as a dozen has 12 items, a century has 100 or a gross has 144, a mole means 6.022×10^{23}. For example, a mole of water, that is, 18g of water contains 6.022×10^{23} molecules of water.

How many molecules are there in 66 g of CO_2?

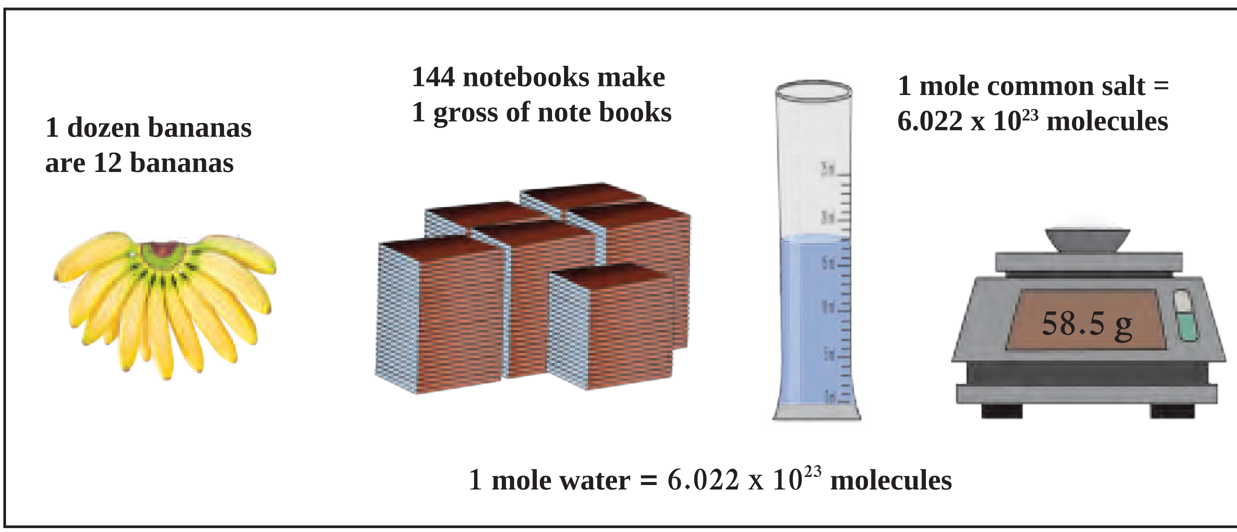
Method : molecular mass of CO_2 is 44.

$$\text{Number of moles in the given } CO_2 \ (n) = \frac{\text{Mass of } CO_2 \text{ in grams}}{\text{Molecular mass of } CO_2} = \frac{66}{44}$$

$\therefore$ n = 1.5 mol

$\therefore$ 1 mol of CO_2 contains 6.022×10^{23} molecules.

$\therefore$ 1.5 mol CO_2 contains $1.5 \times 6.022 \times 10^{23}$ molecules = 9.033×10^{23} molecules



4.3 One mole (Avogadro's number)

Use your brain power !

1. How many molecules of water are there in 36g water?
2. How many molecules of H_2SO_4 are there in a 49g sample ?

Always remember

1. The number of molecules in a given quantity of a substance is determined by its molecular mass.
2. The number of molecules in equal masses of different substances is different.
3. One mole quantities of different substances have different masses measured in grams.

Valency

Can you recall?

1. Determine the valencies of H, Cl, O and Na from the molecular formulae H_2, HCl, H_2O and NaCl.
2. What is the type of chemical bond in NaCl and $MgCl_2$?

The capacity of an element to combine is called its valency. The valency of an element is indicated by a specific number. It is the number of chemical bonds formed by one atom of that element with other atoms. In the 18th and 19th century, the laws of chemical combination were used to find out the valencies of elements. In 20th century, the relationship of the valency of an element with its electronic configuration was recognised.

Sodium atom (Na) Electron configuration (2,8,1) $\xrightarrow{-1e^-}$ Sodium ion Na^+ (2,8)

Chlorine atom (Cl) Electron configuration (2,8,7) $\xrightarrow{+1e^-}$ Chloride ion Cl^- (2,8,8)

$Na^+ + Cl^- \longrightarrow$ NaCl (sodium chloride)

A sodium atom gives away $1e^-$ and a cation of sodium is formed, hence, the valency of sodium is one. A chlorine atom takes up $1e^-$ and forms an anion of chlorine (chloride), and thus, the valency of chlorine is one. After the give and take of electrons is over, the electronic configuration of both the resulting ions has a complete octet. Due to the attraction between the unit but opposite charges on the two ions, one chemical bond is formed between Na^+ and Cl^- and the compound NaCl is formed.

Thus, a sodium atom has the capacity to give away $1e^-$ while a chlorine atom has the capacity to take up $1e^-$. This means that the valency of both the elements sodium and chlorine is one. From this the electronic definition of valency is as follows : "The number of electrons that an atom of an element gives away or takes up while forming an ionic bond, is called the valency of that element."

Science capsule

Positively charged ions are called **cations** while negatively charged ions are called **anions**. For example, $MgCl_2$ contains Mg^{++} and Cl^- as cation and anion respectively. The electrons present in the outermost orbit of an atom are called valence electrons.

Use your brain power !

How will the compounds, $MgCl_2$ and CaO be formed their elements?

The number of electrons that are given away or taken up is always a whole number. Therefore, valency is always a whole number.

The National Chemical Laboratory (NCL), a unit of the CSIR, was established in 1950. Its objectives are to conduct research in the various branches of chemistry, to aid industry and to develop new technology with a view to making profitable use of the country's natural resources. The Laboratory conducts research in fields such as biotechnology, nonotechnology and polymer science.

Complete the following chart.

Element	Atomic number	Electron configu-ration	Valence elec-trons	Valen-cy
Hydrogen	1	1	1	1
Helium	2	2	2	0
Lithium	……	2,1	…..	……
Beryllium	4	…….	…….	2
Boron	5	2,3	……	…….
Carbon	…….	2,4	4	…….
Nitrogen	7	……..	……..	3
Oxygen	…..	2,6	6	……..
Fluorine	9	……	7	…….
Neon	0	……….	……	……..
Sodium	……	2,8,1	1	1
Magnesium	12	……	2	……
Aluminium	13	2,8,3	……	……
Silicon	14	……	4	…….

Some elements that exhibit variable valency

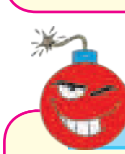
Element	Symbol	Valency	Ion	Nomenclature
Copper	Cu	1 and 2	Cu^{+} Cu^{2+}	Cuprous Cupric
Mercury	Hg	1 and 2	Hg^{+} Hg^{2+}	Mercurous Mercuric
Iron	Fe	2 and 3	Fe^{2+} Fe^{3+}	Ferrous Ferric

Variable valency

Under different conditions the atoms of some elements give away or take up different numbers of electrons. In such cases those elements exhibit more than one valency. This property of elements is called variable valency.

Always remember

Iron (Fe) exhibits the variable valencies 2 and 3. Therefore iron forms two compounds with chlorine $FeCl_2$ and $FeCl_3$.



Research

1. Find out some more elements which have variable valency.
2. Find out the compounds of the above elements which have variable valency.

Radicals

Complete the table Write down the cations and anions obtained from the compounds in the following chart.

Base	Cation	Anion	Acid	Cation	Anion
NaOH			HCl		
KOH			HBr		
$Ca(OH)_2$			HNO_3		

Compounds with ionic bonds have two constituents. These are a cation (positively charged ion) and anion (negatively charged ion).They take part independently in chemical reactions, and are therefore, called radicals. It is seen from the above chart that different bases such as NaOH, KOH are formed when various cationic radicals are paired with the anionic radical, hydroxide. Hence the cationic radicals are also called basic radicals. Different bases are distinguished from each other by the basic radicals in them. On the other hand, different acids, such as HCl, HBr are formed when various anionic radicals are paired with the cationic radical H^+. Therefore, the anionic radicals are called acidic radicals. The difference in the composition of various acids becomes clear by the acidic radicals in them.

Can you tell?

Which are the basic radicals and which are the acidic radicals among the following?

Ag^+, Cu^{2+}, Cl^-, I^-, SO_4^{2-}, Fe^{3+}, Ca^{2+}, NO_3^-, S^{2-}, NH_4^+, K^+, MnO_4^-, Na^+

Generally, basic radicals are formed by removal of electrons from the atoms of metals, such as Na^+, Cu^{2+}. But there are some exceptions, such as NH_4^+. Similarly, the acidic radicals are formed by adding electrons to the atoms of non-metals, such as Cl^-, S^{2-}. But there are some exceptions like MnO_4^-.

Use your brain power !

Classify the following radicals into two types. While doing this use a criterion other than the criteria used above.

Ag^+, Mg^{2+}, Cl^-, SO_4^{2-}, Fe^{2+}, ClO_3^-, NH_4^+, Br^-, NO_3^-

Monoatomic radicals such as Na^+, Cu^+, Cl^- are called simple radicals. When a radical is a group of atoms carrying charge, such as SO_4^{2-}, NH_4^+, it is called composite radical. The magnitude of charge on any radical is its valency.

Chemical formulae of compounds : recapitulation.

The characteristics of a compound formed by ionic bonds is that its molecule has two parts. These are a cation and an anion, that is, a basic radical and an acidic radical. These two parts are oppositely charged. The force of attraction between them constitutes the ionic bond. The name of an ionic compound has two words. The first word is the name of the cation and the second is the name of the anion. For example, while writing the formula of a compound such as sodium chloride the symbol of the cation is written on the left and adjoined to it on the right is the symbol of the anion. The charges are not shown though the number of the ions is written as a subscript on the right of the symbol of the ion. This number is obtained easily by the method of cross multiplication of the valencies. The steps for writing a chemical formula are shown on the next page.

Using ICT

To study 'Measurement of Matter' further and for additional information, visit the websites given alongside.

Prepare a spreadsheet showing the atomic mass of elements, molecular masses, electronic configurations and valencies.

Website for more information

www.organic.chemistry.org

www. masterorganicchemistry.com

www. rsc.org.learnchemistry

Step 1 : To write the symbols of the radicals. (Basic radical on the left.)

$Na \qquad SO_4$

Step 2 : To write the valency below the respective radical.

$Na \qquad SO_4$

$1 \qquad\;\; 2$

Step 3 : To cross-multiply as shown by the arrows the number of the radicals.

$Na \qquad SO_4$

$1 \qquad\;\; 2$

Step 4 : To write down the chemical formula of the compound.

Na_2SO_4

In order to write the chemical formulae of compounds, it is necessary to know the valency of the various radicals. The names and symbols along with the charge of common radicals are given in the chart below.

Ions/Radicals

Basic Radicals				Acidic Radicals			
H^+	Hydrogen	Al^{3+}	Aluminium	H^-	Hydride	MnO_4^-	Permanganate
Na^+	Sodium	Cr^{3+}	Chromium	F^-	Fluoride	ClO_3^-	Chlorate
K^+	Potassium	Fe^{3+}	Ferric	Cl^-	Chloride	BrO_3^-	Bromate
Ag^+	Silver	Au^{3+}	Gold	Br^-	Bromide	IO_3^-	Iodate
Cu^+	Cuprous	Sn^{4+}	Stannic	I^-	Iodide	CO_3^{2-}	Carbonate
Hg^+	Mercurous	NH_4^+	Ammonium	O^{2-}	Oxide	SO_4^{2-}	Sulphate
Cu^{2+}	Cupric/Copper			S^{2-}	Sulphide	SO_3^{2-}	Sulphite
Mg^{2+}	Magnesium			N^{3-}	Nitride	CrO_4^{2-}	Chromate
Ca^{2+}	Calcium					$Cr_2O_7^{2-}$	Dichromate
Ni^{2+}	Nickel			OH^-	Hydroxide	PO_4^{3-}	Phosphate
Co^{2+}	Cobalt			NO_3^-	Nitrate		
Hg^{2+}	Mercuric			NO_2^-	Nitrite		
Mn^{2+}	Manganese			HCO_3^-	Bicarbonate		
Fe^{2+}	Ferrous (Iron II)			HSO_4^-	Bisulphate		
Sn^{2+}	Stannous			HSO_3^-	Bisulphite		
Pt^{2+}	Platinum						

Books are my friends

Essentials of Chemistry, The Encyclopedia of Chemistry, Science and Technology Dictionary.

Use your brain power !

Using the chart of ions/radicals and the cross-multiplication method, write the chemical formulae of the following compounds : Calcium carbonate, Sodium bicarbonate, Silver chloride, Calcium hydroxide, Magnesium oxide, Ammonium phosphate, Cuprous bromide, Copper sulphate, Potassium nitrate, Sodium dichromate

Exercises

1. Give examples.

a. Positive radicals
b. Basic radicals
c. Composite radicals
d. Metals with variable valency
e. Bivalent acidic radicals
f. Trivalent basic radicals

2. Write symbols of the following elements and the radicals obtained from them, and indicate the charge on the radicals.

Mercury, potassium, nitrogen, copper, sulphur, carbon, chlorine, oxygen

3. Write the steps in deducing the chemical formulae of the following compounds.

Sodium sulphate, potassium nitrate, ferric phosphate, calcium oxide, aluminium hydroxide

4. Write answers to the following questions and explain your answers.

a. Explain how the element sodium is monovalent.
b. M is a bivalent metal. Write down the steps to find the chemical formulae of its compounds formed with the radicals, sulphate and phosphate
c. Explain the need for a reference atom for atomic mass. Give some information about two reference atoms.
d. What is meant by Unified Atomic Mass.'
e. Explain with examples what is meant by a 'mole' of a substance.

5. Write the names of the following compounds and deduce their molecular masses.

Na_2SO_4, K_2CO_3, CO_2, $MgCl_2$, $NaOH$, $AlPO_4$, $NaHCO_3$

6. Two samples 'm' and 'n' of slaked lime were obtained from two different reactions. The details about their composition are as follows:

'sample m' mass : 7g
Mass of constituent oxygen : 2g
Mass of constituent calcium : 5g
'sample n' mass : 1.4g
Mass of constituent oxygen : 0.4g
Mass of constituent calcium : 1.0g

Which law of chemical combination does this prove? Explain.

7. Deduce the number of molecules of the following compounds in the given quantities.

32g oxygen, 90g water, 8.8g carbon di oxide, 7.1g chlorine.

8. If 0.2 mol of the following substances are required how many grams of those substances should be taken?

Sodium chloride, magnesium oxide, calcium carbonate

Project :

Prepare models of various radicals using cardboard, small circular magnets and araldite. From these make molecules of various compounds.

◈◈◈