Worksheet 16 Subject: - Science Class: - VII Teacher: - Mrs. Harpreet Kaur

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Ch 3: Structure of Matter

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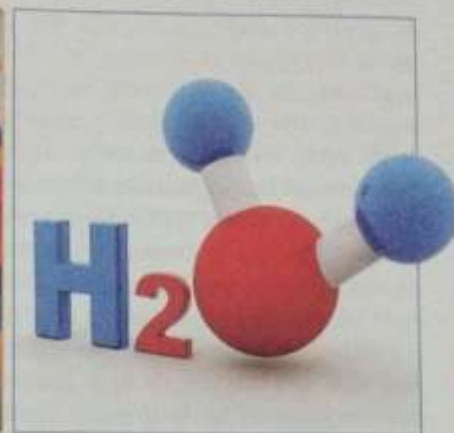

SCAN PAGE*

Structure of Matter

WHAT IS MATTER MADE UP OF?

Let us recall what we learnt about the structure of matter in Class 6. **Kanada**, the great Indian sage of ancient times was probably the first to suggest that all matter is composed of very small particles. He gave the name *'anu'* to these particles.

Let us take an example. A piece of iron is made of matter. If this piece of iron is broken, what happens? It forms smaller pieces of iron. If we continue breaking this piece of iron, it forms still smaller and smaller pieces. However, this must end somewhere. It should be possible to get the smallest piece of iron that cannot be broken any further. **John Dalton**, a scientist of the nineteenth century, named this smallest piece of iron as the iron **atom**. Similarly, the smallest piece of gold is a gold atom.

Atoms are so small that they cannot be seen even by the most powerful microscope. Approximately, 4 million gold atoms, placed end to end, form a line of only 1 mm length!

The smallest particles of gold and iron are gold atom and iron atom respectively. However, the smallest particle of water is not a water atom. Why? This is because water is made up of two different kinds of atoms—oxygen atom and hydrogen atom. The smallest particle of water contains two atoms of hydrogen and one atom of oxygen. These form one **molecule** of water.

IN THIS CHAPTER

WHAT IS MATTER MADE UP OF? • ELEMENTS AND COMPOUNDS • MIXTURES • TOOLS FOR CHEMICAL COMMUNICATION—SYMBOLS, FORMULAE AND CHEMICAL EQUATIONS

*For detailed instructions, see inside front cover.

ELEMENTS AND COMPOUNDS

Iron, gold, hydrogen and oxygen are some examples of substances made up of only one kind of atoms. They are called elements. A substance made up of only one kind of atoms that cannot be broken down into simpler substances by chemical methods is called an **element**. The smallest particle of an element is an atom, though some atoms cannot exist independently, as we will see a little later.

There are about 118 different elements known to us. Out of these, 92 elements occur naturally on the earth (Fig. 3.1). The others have been made by scientists in laboratories.

Water is made up of two elements—hydrogen and oxygen. It is a compound. A substance formed by the chemical combination of two or more elements in fixed proportions is called a **compound**. The smallest particle of a compound is a molecule.

How elements form compounds

Think of atoms like the letters of the alphabet. We join different letters to make words. Thousands of words can be made from just 26 letters. In the same way, atoms combine together to make molecules. Millions of different kinds of molecules can be made from only about 118 different kinds of atoms. That is why we see millions of compounds all around us. Water, sugar, chalk, vinegar and salt are all compounds.

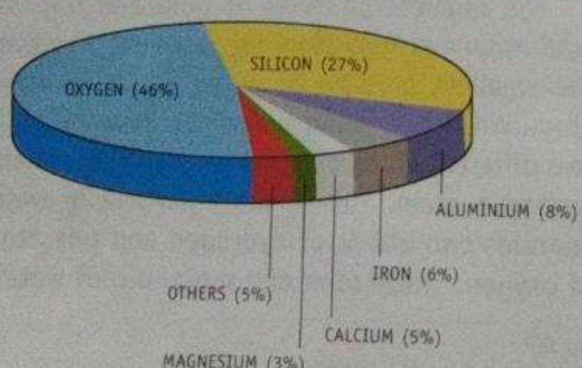

FIG. 3.1 Major elements in the earth's crust

Their molecules are different from each other. This difference in the molecules is the reason why salt is 'salty' and sugar is 'sweet'!

Let us define atoms and molecules.

- An **atom** is the smallest particle of an element that can take part in a chemical reaction. It may or may not exist independently.
- A **molecule** is the smallest particle of an element or a compound that can normally exist independently.

It is fascinating to see that atoms of two gases, hydrogen and oxygen, can combine together to form water, which is a liquid. Or, that atoms of two poisonous substances, sodium and chlorine, can combine together to form salt, a compound we use every day!

Occurrence

Many elements have a great tendency to combine with each other to form compounds. These elements are, therefore, not found in the free state in nature. They only occur in combined form as compounds. Very few elements occur in the free state in nature. Some of these are oxygen, nitrogen and gold. Most of the pure elements are obtained by breaking up a compound into its constituent elements. For example, oxygen and hydrogen can be obtained by electrolysis of water.

Properties of compounds

- A compound can be broken down into its constituent elements by chemical methods. For example, each water molecule is made up of two atoms of hydrogen and one atom of oxygen. Water can be broken down into the elements—hydrogen and oxygen—by passing electricity through water.
- A compound always contains the same elements combined together chemically in a fixed ratio. No matter from where you take water, it will always contain hydrogen and oxygen in the ratio of 2:1 by volume. Sugar

is a compound of carbon, hydrogen and oxygen. Its molecule contains 12 atoms of carbon, 22 atoms of hydrogen and 11 atoms of oxygen. This proportion of 12:22:11 will remain constant no matter how and where sugar is produced.

- The properties of a compound are different from those of its constituent elements. For example, the properties of water (a liquid) are different from its constituent elements, i.e. hydrogen (a gas) and oxygen (a gas). Water puts off fire, whereas hydrogen burns and oxygen supports burning.

MIXTURES

When two or more elements or compounds are mixed together, and there is no chemical change between them, we get a **mixture** of the elements or compounds. In a mixture, no new molecules are formed.

When two or more elements or compounds are brought together they do not always react chemically. Firstly, not all elements or compounds can react with each other. Secondly, even if they can react with each other, they will not do so until conditions are favourable. For example, some compounds may have to be heated together to make them react. Others may have to be dissolved in water before they can react.

Differences between a compound and a mixture

Most substances around us are mixtures. Air is a mixture of several gases. Even tap water is a mixture. It contains several compounds dissolved in pure water.

While a mixture can be made by mixing together two or more elements or compounds in any ratio, a compound is always made up of elements combined in a certain fixed ratio that always remain the same. Let us do the following activity.

ACTIVITY 1 (Experimental investigation)
Put some powdered iron and some powdered sulphur in a china dish. Mix them thoroughly. Now bring a magnet near them (Fig. 3.2). You will find that the powdered iron in the mixture is attracted by the magnet. The magnet can be used to completely separate iron and sulphur.

It is clear from the above activity that iron and sulphur have not reacted chemically. What we had was a mixture of iron and sulphur that could easily be separated by a physical method. You can mix any amount of sulphur with any amount of iron to form a mixture of the two.

ACTIVITY 2 (Experimental investigation)
Now mix 8 g of sulphur and 14 g of iron in a china dish and heat the mixture. After some time the mixture will begin to glow and give off heat. A black substance called **iron sulphide** is formed. The particles of iron and sulphur cannot be seen separately now. Nothing happens if a magnet is brought close to this substance (Fig. 3.2).

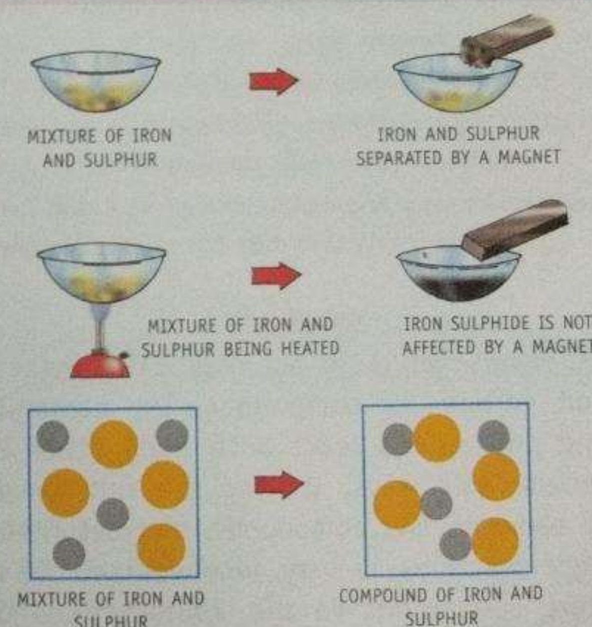

FIG. 3.2 Difference in the properties of a compound and a mixture

TABLE 3.1 Differences between compounds and mixtures

PROPERTY	COMPOUNDS	MIXTURES
1. combination of constituents	constituents are combined together chemically	constituents are combined together not chemically but physically only
2. ratio of constituents	same constituents are present in a fixed ratio	constituents can be present in any ratio
3. separation of constituents	constituent can be separated only by chemical methods	constituents can be separated by physical methods
4. properties	have properties different from those of their constituents	properties are those of their constituents
5. energy changes	often energy is absorbed or released during the formation of compounds	often no energy is absorbed or released when a mixture is formed

One molecule of iron sulphide contains 1 atom of iron and 1 atom of sulphur. If we use 20 g of iron powder and 8 g of sulphur, and heat the mixture, the reaction will still take place. But, the extra 6 g of iron will be left over. Had there been extra sulphur in the mixture, that would also have been left over. This shows that in iron sulphide, iron and sulphur are present in a fixed ratio by weight. This ratio is always 14:8 or 7:4. If the mixture contains iron or sulphur more than this fixed ratio, then the extra sulphur or iron will be left over.

Table 3.1 summarises the differences in the properties of mixtures and compounds.

ORAL QUESTIONS

1. What is the difference between the smallest particle of an element and the smallest particle of a compound?
2. For all elements, the smallest particle that can exist independently is an atom. Do you agree? Give reasons.
3. Most elements are found in the free state in nature. Do you agree? Give reasons.
4. A scientist found that two samples of the same compound had the same elements combined in different ratios. Was the finding correct?
5. The same scientist as above found that two samples of a mixture of the same elements had the elements mixed in different ratios. Was the finding correct this time?

SYMBOLS

We know that there are only 118 elements and millions of compounds. The elements and compounds react with each other in innumerable ways. Writing the full names of elements and compounds, and describing their reactions is very inconvenient. It is more convenient to use abbreviations or symbols.

We use **symbols** to represent elements. A compound is represented by a **formula** which contains symbols of all the elements present in a molecule of that compound.

Early scientists and **alchemists** used picture symbols to represent elements. Later, Dalton improved over these symbols (Fig. 3.3). He used the symbol ⊙ for hydrogen and ○ for oxygen. But as the number of known elements and compounds increased, this method too became very tedious.

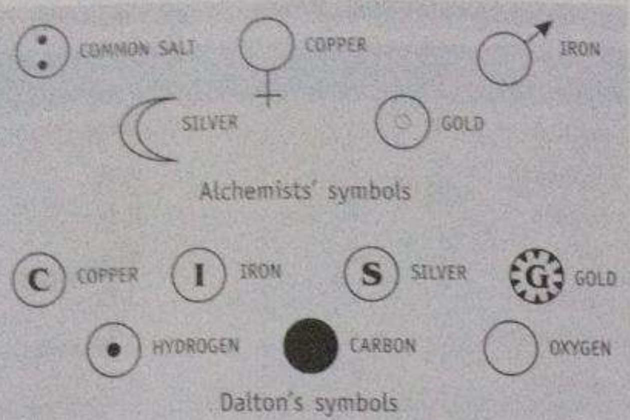

Fig. 3.3 Some of the symbols used by alchemists and Dalton

The present system uses letters of the English alphabet to represent elements. It was first suggested by **Berzelius**. The system is as follows:

- Some elements are represented by using the first letter (in capitals) of the name of the element, for example, C for carbon, N for nitrogen, O for oxygen.
- Names of some elements have the same initial letter, for example, carbon, calcium and cobalt. In such cases, the first letter is taken in capitals together with letter (in small) from its name, for example, Ca for calcium, Co for cobalt, Ba for barium, Br for bromine.
- The symbols of some elements are derived from their Latin names. For example, the Latin name of copper is *cuprum* and its symbol is Cu. The Latin name of potassium is *kalium* and its symbol is K.

Table 3.2 lists of some common elements and their symbols. Latin names of elements whose symbols are derived from them are also given.

FORMULAE

We know that a molecule of water contains two atoms of hydrogen and one atom of oxygen. The formula of water should, therefore, contain symbols of hydrogen and oxygen. It should also show the number of atoms of each element in a molecule. We write the formula for water as H_2O_1 or simply H_2O.

Common salt (sodium chloride) is made up of sodium and chlorine. One molecule of common salt contains 1 atom of sodium and 1 atom of chlorine. So, the formula of common salt is Na_1Cl_1 or simply NaCl.

One molecule of ammonia contains 1 atom of nitrogen and 3 atoms of hydrogen. Its formula is NH_3.

Atoms of some elements cannot exist independently in nature. They form molecules containing two or more atoms. Thus, H_2 represents a molecule of hydrogen, O_2 a molecule of oxygen, Cl_2 a molecule of chlorine and N_2 a molecule of nitrogen.

Table 3.3 gives formulae of some common compounds.

Table 3.2 Some common elements and their symbols

ELEMENT	LATIN NAME	SYMBOL	ELEMENT	LATIN NAME	SYMBOL
aluminium		Al	iron	*ferrum*	Fe
calcium		Ca	nitrogen		N
carbon		C	oxygen		O
chlorine		Cl	potassium	*kalium*	K
copper	*cuprum*	Cu	sodium	*natrium*	Na
gold	*aurum*	Au	sulphur		S
helium		He	tungsten	*wolfrum*	W
hydrogen		H	zinc		Zn