9. ATOMS, ELEMENTS AND COMPOUNDS

9.1 MATTER AND MATERIALS

Everything except empty space is made of matter. Matter exists in three familiar states – solid, liquid and gas – but there are thousands of different kinds of matter. Matter includes materials such as rocks and soil, plastic and metal, cotton and silk – substances such as salt and sugar, water, cooking oil and petrol, air and smoke.

Natural and man-made materials. Think about a kitchen knife with a wooden handle. Is a kitchen knife a natural object or a man-made object? Someone made it so it is a man-made object. What about the materials in the knife – wood and steel? Are they natural or man-made? Someone shaped the wooden handle, but no one made the material – the wood. The wood is a natural material, which grew as part of a tree. What about the blade? The blade is made of steel and is a man-made material. You do not find steel in the natural world. Steel is about 98% iron. Ancient man made iron by heating together charcoal, and a red mineral called haematite, in a very hot fire. Iron and steel are still made by the chemical industry in a very similar way. The first picture below shows molten iron being poured. The kitchen knife contains both a natural material (wood) and a man-made material (steel). The chemical industry produces many useful, man-made materials including cement, metals, plastics, man-made fibres (such as polyester and nylon), glass, artificial fertilisers, medicines and a lot of others.

Materials and their uses must be well matched. It would be foolish to make a saucepan out of plastic or wood because plastic melts, and wood burns. Metals such as iron or aluminium are best for making saucepans because metals have the right properties. Metals are strong and conduct heat well without melting or burning. Plastic or wood make good handles for saucepans. Plastic and wood are good insulators so you can pick up a hot pan without burning your hands.

Chemistry is the study of materials or substances. Chemists want to find out what they are made of. They also try to discover and make new substances, and study their properties. In this chapter you will meet some of the basic ideas of chemistry. You will learn about the kinetic theory, which explains how matter behaves by thinking about the tiny particles called atoms that everything is made of. You will also learn about the chemical elements – simple substances that contain only one kind of atom – about compounds in which two or more elements are combined together, and about the symbols and formulae that chemists use to represent elements and compounds.

- 1. Which of these materials are man-made? Plastic, water, glass, aluminium, cotton, salt, haematite, charcoal.
- 2. List 7 substances you can find in the kitchen at home.
- 3. What property of (i) copper makes it suitable for electric wires; (ii) plastic makes it suitable for covering electric wires.
- 4. Guess what are (i) bio-chemistry, (ii) organic chemistry.
9.2 THE KINETIC THEORY

Matter is composed of tiny particles called atoms. In some substances, the atoms are joined together in small groups called molecules. Atoms are very, very tiny. They are much too small to be seen, even with the best microscopes. More than 100,000,000 atoms \( (10^9) \) can fit on a full stop like this.

**Atoms:** More than 400 years before the birth of Christ, Greek philosophers suggested that matter was made of particles. The word atom comes from the Greek atoms, which means something that cannot be divided. However it was only about 200 years ago that chemists started to be sure about atoms. This was because of the work on an Englishman named John Dalton. John was born in the North of England in 1766. He went to a village school and did so well that he became a teacher at the age of 12. By 19 he was a headmaster! He studied science and at 27 became a Professor of Mathematics and Natural Philosophy in the city of Manchester. In 1808 he published his ideas about atoms in a book called “New Systems of Chemical Philosophy”. Even though John never saw an atom, he reasoned that they must exist to explain many of the facts of chemistry. Gradually the idea of atoms came to be accepted by all scientists. John continued studying chemistry until he died in 1844. More than 100 years after his death, large molecules (groups of atoms) were finally observed using electron microscopes. There is a statue of John Dalton at the entrance to Manchester City Hall.

The kinetic theory is a model that shows how particles are arranged, and how they behave, in solids, liquids and gases. The particles in the kinetic model may be atoms or they may be molecules (groups of atoms joined together). The particles have energy, so they can move. The diagrams show the kinetic model for solids, liquids and gases. Read the notes below each diagram to find out how the particles behave.

<table>
<thead>
<tr>
<th>Example of a solid – iron</th>
<th>Example of a liquid – water</th>
<th>Example of a gas – oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Particles are packed tightly in a regular pattern.</td>
<td>• Particles are close together but not in a regular pattern.</td>
<td>• Particles are much further apart.</td>
</tr>
<tr>
<td>• Particles vibrate but do not change position.</td>
<td>• Particles jostle past each other like people in crowds.</td>
<td>• Particles move around freely at high speed.</td>
</tr>
</tbody>
</table>

In iron the particles are atoms. In solids the particles are arranged in regular patterns. They have enough energy to vibrate, but they do not change position. In water the particles are molecules. Each water molecule contains three atoms joined together. You will learn about water molecules in Module 9.6. In liquids the particles are crowded close together but they are always on the move, like people jostling in a crowd. In oxygen the particles are molecules that contain two atoms joined together. You will learn about molecules of oxygen in Module 9.4. In gases, the particles are far apart. They have lots of energy and fly around at high speed!

- 1. Why do you think the Greeks called atoms “Things that can not be divided”?  
- 2. What is a molecule?  
- 3. According to the kinetic theory, (i) which have the most energy, the particles in solids, liquids or gases? (ii) what do you think happens to the particles in water when the water is heated until it boils?
9.3 USING THE KINETIC MODEL TO EXPLAIN THINGS

Theories in science. Scientists use their imaginations to invent theories to help them explain what they observe (see Module 1.7). If a theory explains many observations, and if it helps scientists to make correct predictions, then the theory is accepted as true. Later, if new observations are made, which do not agree with the theory, then the theory has to be changed, or replaced by a better theory. The present form of the kinetic theory has existed for more than 100 years. Some of the things it helps to explain are described on the remainder of this page.

Changes of state. An important part of the kinetic theory is that the hotter particles get, the faster they move! When we heat a solid, the particles vibrate faster and faster. If we continue heating, they eventually gain so much energy they start pushing past one another! When this happens, the solid melts. The particles stay together in a crowd but they are all moving, so they can flow into any shape. When a liquid is cooled, the particles slow down. The reverse changes occur and the liquid freezes.

When we heat a liquid, the particles move faster. A few particles may gain so much energy that they fly away from the crowd! This is what happens when a liquid evaporates. As we continue heating the liquid, more particles evaporate. When all the particles start leaving the crowd, the liquid boils. All the particles are free to fly anywhere! The reverse changes occur when a gas is cooled and condenses into a liquid.

Diffusion in gases. Sometimes your nose tells you there are beautiful flowers nearby, or what is for dinner before you see it! The smell diffuses (spreads out) through the air, from the flower or your dinner to your nose. The kinetic model makes diffusion easy to explain. Molecules evaporate from anything that smells and fly about between the particles of air. Some of the molecules from the flower or the food reach your nose. An example of diffusion that you can see, is smoke diffusing through the air.

Dissolving and diffusion in liquids. The kinetic model helps to explain what happens when a solid dissolves in a liquid. When a little sugar is added to water, the molecules of water bump against the sugar crystals. Some of the sugar molecules are knocked off the crystals (they dissolve) and are carried away in the jostling crowd of water molecules (they diffuse). After some time, all the sugar molecules dissolve and diffuse throughout the water. Heat speeds up dissolving and diffusion because heat makes the water molecules move faster.

The shapes of crystals can be explained by the stacking of particles in solids. The models below are made from fruits. Silver crystals are diamond shaped and salt crystals are cubic.

Some properties of solids, liquids and gases

A solid has a fixed volume and a fixed shape. This is because the particles in a solid cannot change their position.

A liquid has a fixed volume, but it takes the shape of any container. The volume is fixed because the particles remain together in a crowd or group, but the shape of the crowd can change because the particles can move.

A gas has no fixed volume or shape. It expands to fill any container. This is because the particles in a gas do not remain together and are completely free to move anywhere.

Thermal expansion. When a solid is heated, the particles vibrate more and take up just a tiny bit more room. That is why solids expand, but not very much. Liquids and gases expand more because the particles are free to move faster. In gasses, a little heat speeds them up a lot so they take up much more room.

- 1. Copy the diagram in Module 9.2 that shows the kinetic model for a liquid. Label any particles that are evaporating.
- 2. Use the kinetic theory to explain a solid dissolving in a liquid using the words solute, solvent, solution.
- 3. Use the kinetic theory to explain why air and other gases are compressible, but not liquids and solids.
- 4. Imagine you are a water molecule. Describe what happens to you when you are (i) put in a freezer, (ii) boiled in a kettle.
Elements are the simple basic substances from which everything else is made. An atom is defined as the smallest particle of an element. An element is defined as a substance that contains only itself—only one kind of atom. The atoms of one element are all exactly the same, but they are different from the atoms of all other elements. There are 90 different elements that occur in nature. Everything else is made of these 90 elements. Four of the most common elements are oxygen, carbon, nitrogen and hydrogen. In the box on the right is a list of the elements you have already met in this book. What do you remember about each of them?

Elements you already met in this book
aluminium, helium, nitrogen, radon,
argon, hydrogen, oxygen, tungsten,
calcium, iodine, potassium, silver,
carbon, krypton, sulphur, tungsten,
chlorine, manganese, nickel, xenon,
cobalt, mercury, argon, iron,
copper, neon, aluminium, helium.

Chemical symbols are used to represent each element. For oxygen the symbol is O, for carbon C, for nitrogen N and for hydrogen H. Several elements start with the same letter, so the symbols for most elements use two letters, the first a capital and the second a small letter. For example, aluminium is Al, argon is Ar and calcium is Ca. For a few elements, an old name is used. For example, iron is Fe (for ferrum) and copper is Cu (for cuprum). Appendix B, at the end of this book, contains a list of important elements and their symbols. Turn to Appendix B and study it for a few minutes. Every time you meet a new element, you should look up its symbol and try to remember it.

Symbols can be used as a short hand for elements, but chemists like to use each symbol to represent just one atom of the element. In most elements, each atom is separate. But in a few gases, including oxygen, nitrogen and hydrogen, the atoms are joined together in pairs. Small groups of atoms joined together are called molecules. Chemists show two atoms joined together in a molecule by writing a subscript ‘2’ after the symbol. The formula for a molecule of oxygen is O₂. The formulae for molecules of nitrogen and hydrogen are N₂ and H₂.

The states of the elements. At room temperature most elements are solids - 11 are gases and only 2 are liquids. Try to find the 10 gases and 1 liquid in the list of at the top of this page.

Dangerous strangers. The missing gas is a yellowish gas called fluorine (symbol F), and the missing liquid is a dark red liquid called bromine (symbol Br). Fluorine and bromine are both very dangerous, poisonous elements.

- 1. List the two liquid elements and the eleven gaseous elements.
- 2. Find the symbols for lead, silver, gold and zinc.
- 3. Explain exactly what H₂ means.
- 4. (i) Where, earlier in this book, have you met iodine, chlorine and sulphur? (ii) What substances have you met that contain carbon, hydrogen and oxygen combined together? (iii) What substances have you met that contain those same three elements and also nitrogen?
Chemists classify elements as metals or non-metals. Three common metal elements are iron, aluminium, and copper. Three common non-metal elements are carbon, oxygen and nitrogen.

Some properties of metal and non-metal elements are summarised in the table on the right. Metals are usually strong, flexible solids. They bend before they break. Non-metal elements are often gases or liquids. If they are solids, they are brittle. They do not bend. If they break, they shatter into many pieces.

Metals can be squeezed or beaten into sheets and pulled out into wires. They are good conductors of heat and electricity and they can take a high polish. Non-metals generally do not have these properties (but remember that graphite, which is a form of carbon, is a good conductor of electricity).

Some metal elements and their uses are shown in the table and sketches below.

### General properties of metals and non-metals

<table>
<thead>
<tr>
<th><strong>Metals</strong></th>
<th><strong>Non-metals</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tough (bend before breaking in one place)</td>
<td>Brittle (does not bend, breaks into pieces)</td>
</tr>
<tr>
<td>Malleable (can be beaten into sheets)</td>
<td>Not malleable</td>
</tr>
<tr>
<td>Ductile (can be pulled out into wires)</td>
<td>Not ductile</td>
</tr>
<tr>
<td>Good conductors of heat and electricity</td>
<td>Good insulators of heat and electricity</td>
</tr>
<tr>
<td>Shiny (can be polished like a mirror)</td>
<td>Not shiny (will not take a high polish)</td>
</tr>
</tbody>
</table>

### Uses of some metal elements:

<table>
<thead>
<tr>
<th>Metal</th>
<th>Colour</th>
<th>Some uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>silver grey</td>
<td>steel for bridges, vehicles, machines and buildings</td>
</tr>
<tr>
<td>Aluminium</td>
<td>silver white</td>
<td>pans, window frames, boats, aeroplanes, vehicle bodies</td>
</tr>
<tr>
<td>Copper</td>
<td>red brown</td>
<td>electric wires</td>
</tr>
<tr>
<td>Zinc</td>
<td>blue white</td>
<td>galvanising iron (Module 6.7)</td>
</tr>
<tr>
<td>Gold</td>
<td>gold</td>
<td>jewellery and coins</td>
</tr>
</tbody>
</table>

### Non-metal elements and their uses.
The non-metal elements include all the 11 gaseous elements and the liquid bromine (the other liquid element, mercury, is a metal). The solid non-metal elements are carbon, silicon, sulphur, phosphorus, iodine and boron. You learnt about most of the gaseous elements in Chapter 6. Carbon is the black element found in soot, charcoal and graphite. It is used to extract metals from certain minerals called ores. Silicon is a grey substance that can be extracted from sand. It is used in making computer chips and similar electronic parts. Sulphur is a bright yellow element that is often found near volcanoes. It is used to make sulphuric acid. Most non-metal elements combine with one another, and with metals, to form a wide range of interesting and useful substances called compounds (Modules 9.6 and 9.7).

- 1. What do the following words mean: brittle, ore, inert?
- 2. Find the symbols for sodium, potassium and silicon.
- 3. Why is: (i) steel used for building bridges? (ii) zinc used for 'galvanising' iron? (iii) gold used for making jewellery and coins?
9.6 COMPOUNDS AND THEIR FORMULA

A compound is a substance that contains two or more elements combined together. The most familiar compound is water. Water is a combination of hydrogen and oxygen. The smallest particle of water is a molecule. Every molecule of water contains two atoms of hydrogen combined with one atom of oxygen. The formula for a molecule of water is \( \text{H}_2\text{O} \). The \( \text{H} \) with the subscript 2 after it means two atoms of hydrogen, and the \( \text{O} \), with no subscript after it, means one atom of oxygen.

Another familiar compound is carbon dioxide. A molecule of carbon dioxide contains one atom of carbon and two atoms of oxygen, so the formula for carbon dioxide is \( \text{CO}_2 \).

Compounds are different from the elements they contain. The properties of compounds are always completely different from the properties of the elements they contain. Think about the example of water. Hydrogen and oxygen are both gases, but water is a liquid. Hydrogen burns in air and oxygen supports combustion, but water is used to put out fires! Molecules of water behave quite differently from atoms of hydrogen or atoms of oxygen. Now think about the sugar you buy in the store. Table sugar is a compound that contains carbon, hydrogen and oxygen with the formula \( \text{C}_{12}\text{H}_{22}\text{O}_{11} \). As you can see, the molecule of sugar is quite a big one - it contains 12 atoms of carbon, 22 atoms of hydrogen and 11 atoms of oxygen. Carbon is familiar to most people as the black substance in soot or charcoal, and hydrogen and oxygen are colourless gases. Obviously the compound sugar is not at all like the elements it contains.

Compounds that contain metals. Most simple compounds of metals do not have molecules. Ordinary table salt is a good example. Salt is a compound of the metal sodium (Na) and the gas chlorine (Cl). The chemical name for salt is sodium chloride and its formula is \( \text{NaCl} \). There are no molecules of sodium chloride. In a crystal of salt, the atoms of sodium and chlorine are changed into new particles called ions, which are laid out alternately in rows. Study the diagram of a sodium chloride crystal below. Every ion of sodium is surrounded by ions of chlorine, and every ion of chlorine is surrounded by ions of sodium. Since there is one ion of chlorine for each ion of sodium, the formula is written \( \text{NaCl} \). You will learn more about ions in Chapter 13.

Table salt is also called common salt or just salt. Salt is obtained from the sea (which contains about 3% salt by weight), or from the remains of dried up seas. From the arrangement of the ions of Na and Cl you can see why crystals of salt are shaped like cubes.

Although sodium and chlorine are both dangerous and poisonous elements, salt is completely safe. Since ancient times, salt has been used for seasoning and preserving food. In the old days salt was so precious, especially for people who lived a long way from the sea, that it was often used as a kind of money.

- 1. What are (i) a compound, (ii) a molecule?
- 2. How many atoms are there in one molecule of (i) \( \text{CO}_2 \) (ii) \( \text{C}_{12}\text{H}_{22}\text{O}_{11} \) (iii) \( \text{NaCl} \)?
- 3. Explain in your own words how the properties of a compound relate to the properties of the elements it contains.
Chemists classify compounds as either organic or inorganic. **Organic compounds** are the compounds of carbon and **inorganic compounds** are all the rest!

**Organic compounds** are the compounds of carbon. Carbon atoms can join with one another, and with a few other non-metal atoms (mainly oxygen, hydrogen, nitrogen, sulphur and phosphorus), to form chains and rings. Look at the molecule of aspirin illustrated below. Just as a few letters of the alphabet can make many different words, so these few elements can make many different compounds. In fact there are **millions** of organic compounds, many of them very complex. They include medicines, vitamins, plastics, natural and man-made fibres, as well as all the carbohydrates, proteins, oils, fats and other compounds found in living things. Most organic compounds are not suitable for study in this book, but you already know a lot about carbon dioxide. You also know the formula for table sugar, and you will learn about plastics in Chapter 13.

![Formula of aspirin](image)

**Inorganic compounds** are all the compounds that do not contain carbon. They are found in the ground under our feet and in almost everything around us that does not come from living things. The most important inorganic compound is probably water (H\textsubscript{2}O). Another very common one is silicon dioxide (SiO\textsubscript{2}), which is usually known as silica or quartz. Silica is found in most rocks and in sand. Many inorganic compounds contain a metal element combined with one or more non-metal elements. Some examples are listed in the table below. You should also study the box about the naming of inorganic compounds. Going by the rules, the chemical name for water should be ‘di-hydrogen oxide’, but no one ever calls it that!

![Some products made of organic compounds](image)

<table>
<thead>
<tr>
<th>Common name</th>
<th>Chemical name</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>water</td>
<td>H\textsubscript{2}O</td>
</tr>
<tr>
<td>Silica, quartz</td>
<td>silicon dioxide</td>
<td>SiO\textsubscript{2}</td>
</tr>
<tr>
<td>Table salt</td>
<td>sodium chloride</td>
<td>NaCl</td>
</tr>
<tr>
<td>Rust</td>
<td>iron oxide</td>
<td>Fe\textsubscript{2}O\textsubscript{3}</td>
</tr>
<tr>
<td>Limestone, coral, marble</td>
<td>calcium carbonate</td>
<td>CaCO\textsubscript{3}</td>
</tr>
<tr>
<td>Blue vitriol</td>
<td>copper sulphate</td>
<td>CuSO\textsubscript{4}</td>
</tr>
</tbody>
</table>

**Some rules for naming inorganic compounds**

- If one of the elements is a metal (or hydrogen) that is placed first, for example sodium chloride NaCl.
- Prefixes di-, tri- and so on are used sometimes to show the presence of 2, 3 or more atoms in the formula, for example silicon dioxide SiO\textsubscript{2}.
- When only two elements are present, the ending of the name of the second element is changed to -ide, for example rust is iron oxide, Fe\textsubscript{2}O\textsubscript{3}.
- The ending -ate shows the presence of oxygen in addition to the other elements named, for example copper sulphate, CuSO\textsubscript{4}.

**Note:** At this stage, there is no simple way you can work out formulae from names. For now, you just have to learn each formula.

• 1. What is (i) a carbohydrate, (ii) the formula for sugar?

• 2. Why are there so many organic compounds when they all contain the same few elements?

• 3. What common inorganic compounds are found in (i) rocks and sand, (ii) the atmosphere and the sea?

• 4. (i) What is the formula of iron oxide and what is its common name? (ii) What is calcium carbonate used for? (iii) Guess the chemical name of KNO\textsubscript{3}.
9.8 CHEMICAL CHANGES

It is useful, in science, to distinguish chemical changes from other kinds of change. A chemical change occurs whenever a new substance is made. The elements and compounds present after a chemical change, are not the same as the elements and compounds you started with. Any chemical change (which can also be called a chemical reaction) can be summed up by this simple equation:

\[
\text{REACTANTS} \rightarrow \text{PRODUCTS}
\]

The reactant is the substance or substances that you start with, and the product is the new substance or substances produced by the change. The combustion of wood is a good example of a chemical change. Like most living things, wood is a complex mixture of carbohydrates, proteins and other organic compounds. During combustion, all these compounds burn in oxygen from the air and are changed mainly into carbon dioxide and steam. Minor products include other oxides and some carbon in the form of charcoal and particles of smoke.

\[
\text{oxygen + wood (carbohydrates etc)} \rightarrow \text{carbon dioxide + water (steam) + carbon (smoke/charcoal)}
\]

Two good examples of chemical change in living organisms are respiration and photosynthesis. Look at the respiration and photosynthesis equations in Chapter 6. In each case, try to identify the reactants and the products. The laboratory preparations of oxygen and carbon dioxide (in the same chapter) are also good examples of chemical reactions.

A change of state is not a chemical change.

For example when water is frozen to make ice, or boiled to make steam, the ice and steam are still the same compound - the formula is still H₂O. If we heat iron in a fire it becomes red hot. We can see a change of colour, but the iron is still iron so it is not a chemical change. In the box below are five simple activities that your teacher may be able to show you. Try to decide whether each one involves a chemical change or not.

In each of these activities, decide whether there is a chemical change or not:

1. Using tongs or a clothes peg, a strip of magnesium metal is held in a flame. The magnesium catches fire and burns brightly. A white ash (magnesium oxide) falls onto the table.
2. Using a suitable burner, white zinc oxide powder is heated in a test tube. It turns bright yellow. When it cools, it goes white again. It is still zinc oxide.
3. Using a suitable burner, a small heap of orange crystals is heated on a tin lid. The heap flames and swells up, giving off lots of smoke and leaving a green powder.
4. Using a suitable burner, a few black crystals of iodine are heated very gently in a test tube. A beautiful purple gas fills the tube. Shiny black crystals condense around the top of the test tube where it is still cold. The crystals are iodine.
5. Using a suitable burner, a little sugar is heated in a test tube. The sugar melts and then turns black. Steam comes out of the test tube.

More about chemical changes. Notice that combustion and respiration both produce energy. Photosynthesis absorbs energy. In fact, all chemical changes either give out, or absorb energy.

- 1. List the reactants and products in (i) respiration, (ii) photosynthesis, (iii) the laboratory preparation of carbon dioxide.
- 2. Think about the activities in the box above. Which are the chemical changes? Explain why (what is your evidence?)
The diagram sums up some of the things you have learned in this chapter. Matter is either a pure substance or a mixture of pure substances. Pure substances may be elements or compounds. Elements can be metals or non-metals, and compounds can be organic or inorganic.

When the components of a mixture are mixed, there is no chemical change. No new elements or compounds are formed. The components are still present and we can often see them. Try looking at mixtures like rocks, sand or soil with a hand lens.

Most of the materials we meet every day are not pure, they are mixtures. Rocks are a mixture of different minerals, soil is a mixture of broken-down rock and bits of dead organisms, and air is a mixture of gases. Living organisms contain the most complex mixtures of all!

Separating mixtures. Mixtures can usually be separated by physical means (that is, without using chemical change).

Two solids can sometimes be separated by picking out one of them by hand, leaving the other behind. But that is usually too tedious! If the pieces have different sizes, you can use a sieve to separate them. If you can find a solvent that dissolves one, but not the other, you can stir the mixture with the solvent and then filter it. The insoluble solid remains on the filter paper. The soluble solid can be obtained from the filtrate by evaporating the solvent. See Module 3.6 for the example of separating salt and sand.

A solid and a liquid. If the solid does not dissolve, you can easily separate them by filtering. If the solid dissolves, you can evaporate the liquid to obtain the solid. You can use distillation to obtain the liquid too.

Two liquids. If the liquids do not dissolve one another, you can use a separating funnel to separate them (see Module 3.5). If they dissolve one another, fractional distillation is usually possible. When the mixture is distilled, the liquid with the lower boiling point starts to distil first. If the temperature is not allowed to rise any further, that liquid alone can be distilled. The other liquid remains behind in the distilling flask.

Pure substances are not very common in everyday life. The purest compounds we meet are probably the salt and sugar we add to our food. The water we drink should be reasonably pure too. However, drinking water always contains small amounts of minerals dissolved in it. And in towns and cities, chlorine has probably been added to kill bacteria (see Module 3.12). Most of the fairly pure elements we meet are metals. They include the gold and silver used in jewellery, the copper used in copper wires, the aluminium used to make saucepans and the iron used to make roofs and railings. Soot and charcoal are sometimes reasonably pure carbon.

- 1. Explain these terms: (i) minerals, (ii) components, (iii) bacteria, (iv) solute and solvent, (v) filtrate, (vi) distillation.

- 2. Describe how you would obtain (i) rice from a mixture of rice and sand, (ii) salt from a solution of salt in water, (iii) pure water from sea water.