Unit 2 The atmosphere

The earth

The earth surface can be divided into three parts, the **crust**, the **ocean** and the **atmosphere**. Many resources can be obtained from these three regions.

Tick the parts of the earth where the following resources can be obtained.

Resources	Crust	Ocean	Atmosphere
Nitrogen, oxygen and other gases			✓
Sodium chloride and sodium metal		✓	
Coal, petroleum and natural gas	✓		
Iron and aluminium metals	✓		
Building materials such as limestone	✓		

Classification of matter

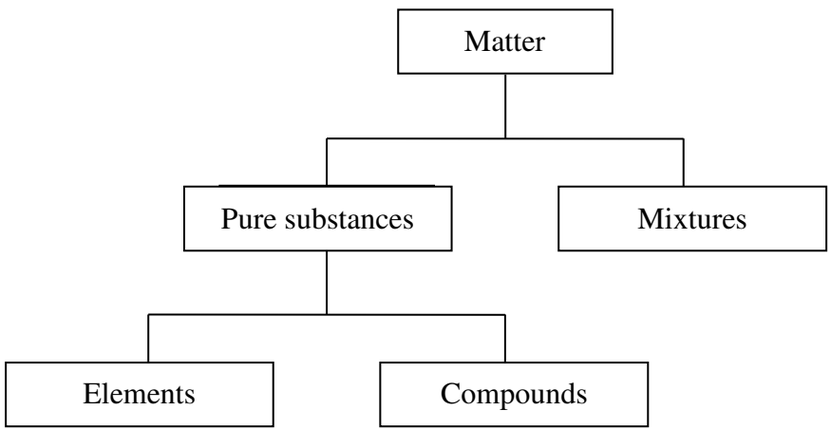
Matter is anything which has a mass and occupies space. They can be solids, liquids or gases. They can be naturally occurring (such as rocks, air and water) or man-made (such as concrete, glass and plastics). Matter can be classified into **pure substances** and **mixtures**.

A single substance that has nothing else mixed with it is a pure substance.

A mixture is made up of more than one substance which has not been chemically joined together.

Elements and compounds

Pure substances can be further classified into **elements** and **compounds**.



Elements are substances which cannot be broken down into anything simpler by chemical methods.

Compounds are substances made up of two or more elements chemically joined together.

For example, water is a compound. It can be broken down into **hydrogen** and **oxygen** by passing electricity through it. Similarly, common salt can be broken down into **sodium** and **chlorine** in the factory by passing electricity through molten salt.

There are about 112 elements known. Over 80% of them can be found on earth in the nature. Others are artificially made by scientists. You can refer to the Periodic Table in the Appendix for deciding whether a pure substance is an element or not. The billions of compounds found on earth are actually made of these 112 different elements chemically joined together.

Differences between a mixture and a compound

	Mixture	Compound
1. Composition by mass	Components in a mixture can exist in any proportion.	The elements in a compound must exist in a fixed ratio.
2. Energy change during formation	No or little energy change when a mixture is formed.	Energy is usually released or taken in forming a compound.
3. General properties	Properties are similar to the substances making up the mixture.	Properties are very different from the elements in it.
4. Melting point and boiling point	It does not have a fixed melting or boiling point.	It has a sharp melting and boiling point.
5. Separating the constituents	The constituents can be separated by simple physical methods.	The constituent elements can only be separated by chemical methods.

Classify the following substances as elements, compounds or mixtures.

Iron	Nitrogen	Carbon dioxide	Ice	Concrete	Tea
Element	Element	Compound	Compound	Mixture	Mixture

The atmosphere

The atmosphere is the layer of gases hundreds of kilometers thick that surrounds the earth. It can be divided into four layers. We live in troposphere, the layer that is the closet to the earth. This layer consists of a mixture of gases called air.

Air contains nitrogen (78%), oxygen (21%) and small amounts of carbon dioxide, water vapour and a group of gases called noble gases. Noble gases in the air (about 1% in the air) include argon, helium, neon, krypton and xenon. (about 1% in the air)

Physical and chemical properties

Physical properties of a substance are properties that can be measured **without changing the chemical composition** of the substance. Examples include the colour, mass, melting point and boiling point etc.

Chemical properties of a substance are properties related to the ability of it to **form new substances**. Examples include whether a substance can be burnt in air and whether a compound would decompose on passing electricity through it.

Physical and chemical changes

During a **physical change**, **no new substance** is formed.

During a **chemical change**, **new substance**(s) is/are produced.

Can you classify the following as physical or chemical changes?

Melting of ice	Physical / Chemical change
Boiling of water	Physical / Chemical change
Freezing of water	Physical / Chemical change
Sublimation of dry ice (solid carbon dioxide)	Physical / Chemical change
Condensation of water vapour	Physical / Chemical change
Dissolving sugar in water	Physical / Chemical change
Burning of a match	Physical / Chemical change
Digestion of food	Physical / Chemical change

Separation of the components in a mixture and a compound

The methods to **separate** the components of a **mixture** can be called **physical methods**. The choice of physical methods actually depends on the physical state of the mixture.

The methods to **separate** the elements in a **compound** are called **chemical methods**. They will be dealt with later.

Some common physical methods used for separating mixtures

Separating process	Separation method(s)	Example
Separating an insoluble solid from a liquid	Decantation Filtration	Separating sand from the sea
Separating a dissolved solid (solute) from a solution	Evaporation Crystallization	Separating common salt from sea water
Separating the solvent from a solution of a solid solute and a liquid solvent	Distillation	Separating pure water from sea water
Separating a mixture of two miscible liquids	Fractional distillation	Separating oxygen and nitrogen from liquid air
Separating a mixture of two immiscible liquids	Use of separating funnel	Separating a mixture of oil and water

Separating oxygen and nitrogen from the air

The method used is fractional distillation of liquid air which works on the difference in the boiling points of the different components in air.

The process is divided into three stages.

Stage A Purification (Steps1 – 2)

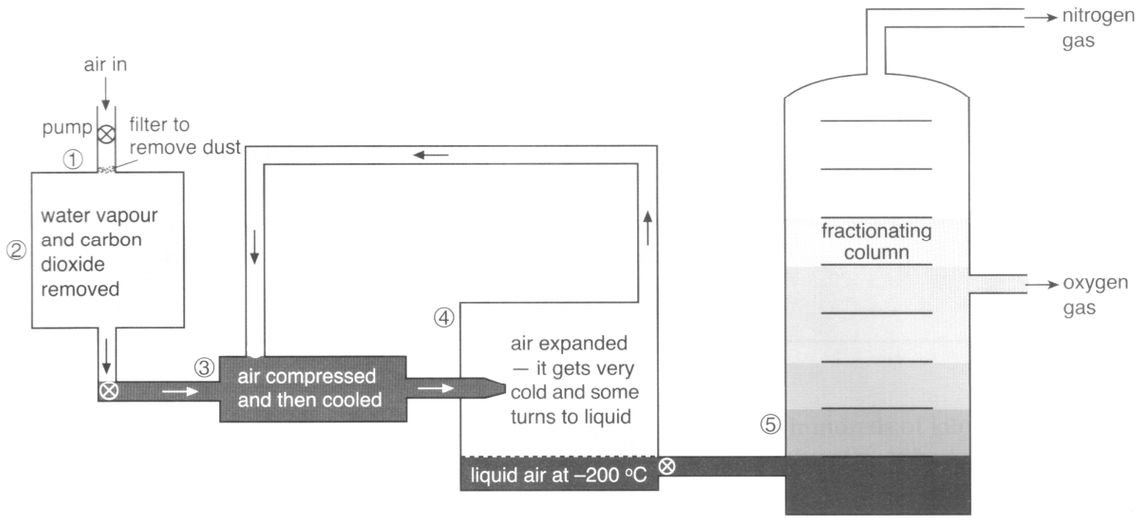
Dust, water vapour and carbon dioxide in the air are removed.

Stage B Liquefaction of air (Steps 3 – 4)

The purified air is compressed at a very high pressure and is then passed through cooling coils. It is passed into an expansion chamber. The rapid expansion will cool down the air. After repeated cycles of compression and expansion, the temperature will fall to -200 ℃. The air then becomes a liquid.

Stage C Fractional distillation of air (Step 5)

The liquid is pumped into a fractionating column. The temperature is slowly raised. Nitrogen boils at -196 ℃, it passes out at the top of column. Oxygen boils at -183 ℃ and is collected at the lower part of the column. Refer to the diagram below.



Tests for the major components in air

Oxygen is a very reactive element and **a simple test for oxygen is that it relights a glowing splint.**

Nitrogen is chemically very inert and there is no simple chemical test for it.