INTRODUCTION TO AIR & WATER

THE ATMOSPHERE

Like everything else, the layer of air which surrounds our planet is made up of atoms. This layer of air is called the atmosphere. The atoms in the atmosphere join together in different ways to form all sorts of different molecules. As plants and animals grow and die, their atoms are used over and over again.

We often take the atmosphere that surrounds us for granted. We usually don't notice it unless there is a strong wind blowing. But air is a very important substance. It contains the gas that allows us to breathe and survive!

Air is a mixture of gases. It is a mixture of nitrogen, oxygen, carbon dioxide, small amounts of argon (an inert gas) and water vapour.

Composition of Air

Gas	Proportion
Nitrogen	78%
Oxygen	21%
Carbon Dioxide	0.038%
Argon	1%
Water	Variable

Separating the gases in air from one another is a very important industrial process. This is done by compressing the air and cooling it down to a very low temperature (about -190^{o}C) until it turns to a liquid. It is then allowed to heat up slowly again. The different substances in air turn into a gas at different temperatures. This means they can be collected separately as they boil off.

OXYGEN

Oxygen is a colourless, odourless gas and it makes up about 21% of the earth's atmosphere. It is the part of air that our bodies use. In fact, oxygen is vital for respiration in plants and animals. It reacts with our food to give us energy. Without it, we would die.

So, how come we don't run out of oxygen if plants and animals are using it all the time? Well, green plants also produce alot of oxygen during daylight hours in a process called photosynthesis. This ensures that the amount of oxygen in the atmosphere remains steady.

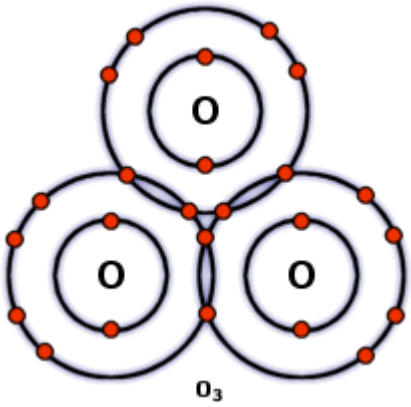
Oxygen can be produced in the laboratory by decomposing hydrogen peroxide in the presence of a catalyst, manganese dioxide.

$$2H_2O_2 \xrightarrow{MnO_2} 2H_2O + O_2$$

Oxygen is also an important gas in burning. If, for example, a piece of charcoal is burning in air, adding oxygen makes it burn much more fiercely.

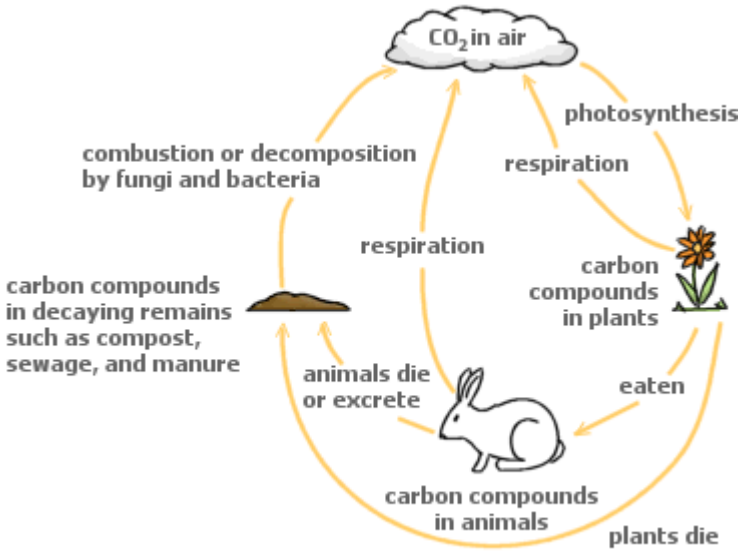
Oxygen is a very reactive substance and reacts with many other elements to make compounds. Such compounds involving oxygen and other elements are called oxides. Taking the example of the piece of charcoal again, when this piece of wood, which is carbon, reacts by burning with the oxygen in air, an oxide called carbon dioxide is formed.

Ozone (O_3) is a form of oxygen where the molecule is tri-atomic. It is extremely poisonous. Ozone is formed from electrical discharges or ultraviolet light acting on O_2. It is an important component of the atmosphere and is vital in preventing the harmful ultraviolet rays of the sun from reaching the earth's surface.



CARBON DIOXIDE

Carbon dioxide is also a colourless, odourless gas. It is continually cycled through the Earth's water, air and animal and plant life. Humans and other animals exhale carbon dioxide as they breathe, it is one of the products of respiration. Green plants absorb carbon dioxide from air and they use it in photosynthesis.



The Carbon Cycle

Carbon dioxide is denser than air. It does not support combustion, that is, things don't burn in carbon dioxide. That's why it is used in fire extinguishers.

Carbon dioxide is an acidic oxide, which means it will turn moist litmus paper red. It can be made in the laboratory by the action of hydrochloric acid (HCl) on marble chips ($CaCO_3$).

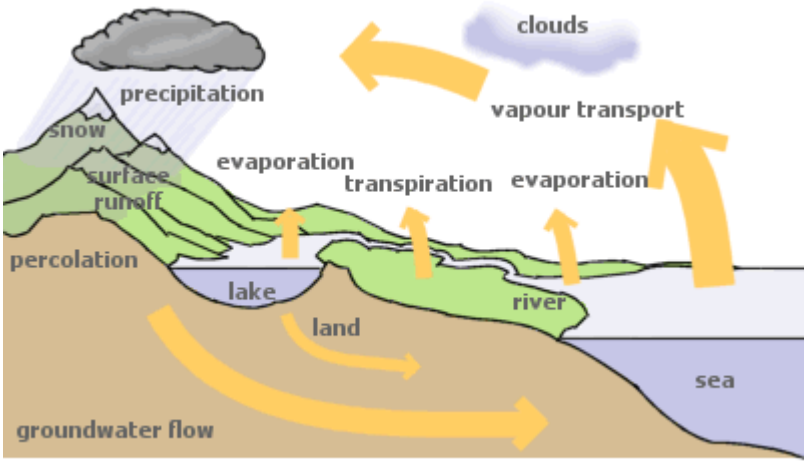
$$2HCl + CaCO_3 \longrightarrow CaCl_2 + H2O + CO_2$$

WATER

Water, like carbon, is constantly being cycled between the atmosphere, the oceans and land. This cycling is a very important process — it helps to sustain life on earth.

The amount of water vapour in the air varies depending on the temperature and the weather. As water evaporates, the vapour rises and condenses into clouds. The clouds move over land and precipitation falls

in the form of rain, ice or snow. The water fills streams and rivers, and eventually flows back into the oceans where evaporation starts the process again.



The Water Cycle

Water is often referred to as the universal solvent because it dissolves more substances than any other liquid. This means that wherever water goes, either through the ground or through our bodies, it takes along valuable chemicals, minerals and nutrients with it.

All living things need water. Mostly, they use it to dissolve their supplies of food, oxygen and other components of life processes. Fish, for example, take the oxygen they need from the water around them.

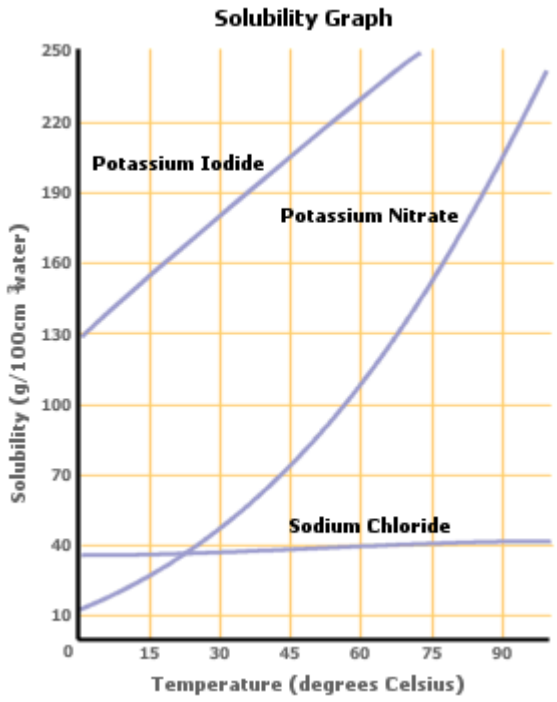
Hard water contains dissolved substances that are usually compounds of calcium. Hard water is particularly common in areas where the underlying rocks are made of limestone. Hard water prevents soap from lathering well and forms solid deposits called 'fur' in kettles and pipes. The substances that cause hardness in water can be removed using an ion-exchanger.

SOLUTIONS

When a solute dissolves in a solvent, a *solution* is formed. A solution that has a lot of solute in a certain volume of solvent is called a concentrated solution. On the other hand, a dilute solution has very little solute in a certain volume.

If you continue adding solute to a solution it gets more and more concentrated until eventually no more solute dissolves. At this stage we say that the solution is *saturated*.

If a saturated solution is left in an open container, the water slowly evaporates. When there isn't enough water left to dissolve the solute, the solute comes out of solution forming crystals. It *crystallises*.



The extent to which a solute will dissolve in a solvent is called its *solubility*. You can measure the solubility of a substance by measuring the number of grams of solute that will dissolve in a hundred grams of the solvent. By seeing how many grams of solute dissolve in 100g of solvent at different temperatures we can produce a *solubility curve*.

The solubility of a substance depends on its temperature. Solids, for example, tend to be more soluble at higher temperatures. Think of a spoonful of sugar — it dissolves better in hot water than in cold water. Gases, on the other hand, are less soluble at higher temperatures. Think of fizzy drinks — they tend to go flat quite quickly if they get warm.

If you had a hot saturated solution of something and you allowed it to cool down, you would find that crystals of solid solvent form. This confirms that solubility decreases when the temperature is reduced.