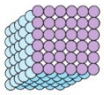
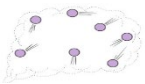
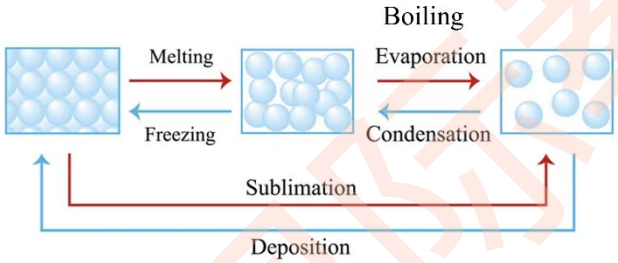
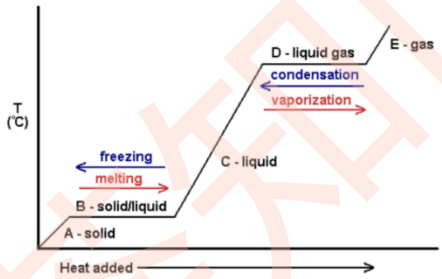
# chapter 1 States of matter

## 1.1 Solids, liquids and gases

| | Solid | Liquid | Gas |
|---|---|---|---|
| |  |  |  |
| arrangement | In a regular arrangement or lattice;<br>Fixed pattern | in a irregular arrangement<br>no fixed pattern; | arranged totally irregularly |
| motion | not able to move freely,<br>but simply vibrate in their fixed position | move around past each other | move randomly |
| separation | close together | close together | particles far apart |
| volume and shape | fixed volume and shape | take up the shape of their container | no definite volume. |

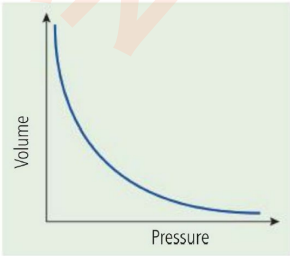


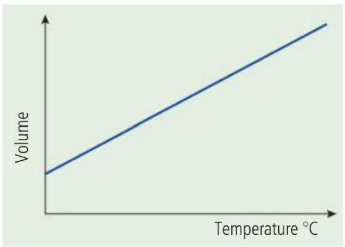

### Heating and cooling curves




When heating a solid, energy is absorbed and raises the temperature of the solid. At the melting point, the energy is absorbed to overcome the attractive force between the particles rather than raising the temperature. That is why there is a flat part to the heating curve.

### Volume, Pressure and temperature




The closer the particles in a gas, the higher the pressure and the lower the volume.
Increasing the temperature of a gas increases the speed at which its particles move.

## 1.2 Diffusion

**Diffusion:** the process that occurs when particles move from a region of high concentration to a region of low concentration. Eventually, the particles are evenly spread their concentration is the same throughout.

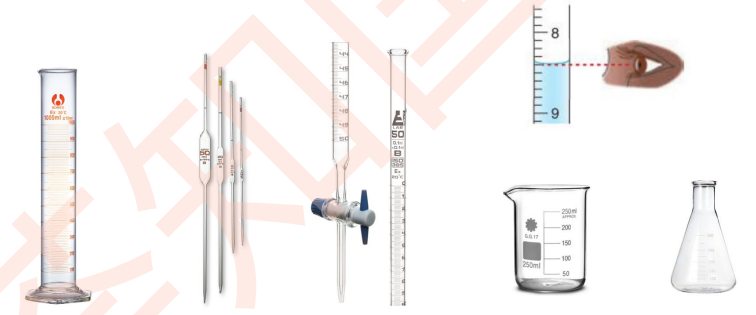
Factors that affect the rate of diffusion:

1) Temperature increases → rate of diffusion increases
2) Lower relative molecular mass→ rate of diffusion is higher

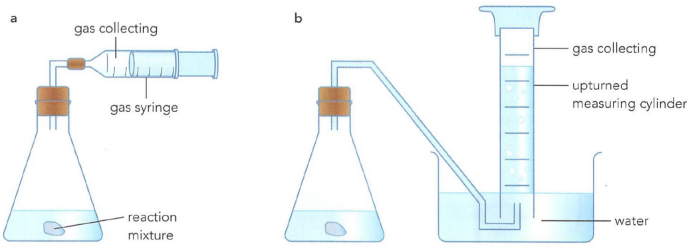
# chapter 2 Experimental Techniques

| Variable | Unit | Apparatus |
|---|---|---|
| Time | min/sec | Stopwatch |
| Temperature | ℃ | Thermometer [liquid in glass, thermistor or thermocouple] |
| Mass | grams | Balance |

## Measuring volume of liquid



## Measuring volume of gas



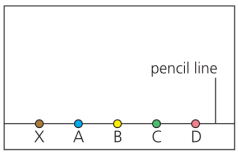

gas syringe upturned measuring cylinder

## Pure substances

| | |
|---|---|
| Pure substances | Have a definite, sharp m.p./b.p. |
| Impure substances | Have a lower m.p and a higher b.p |

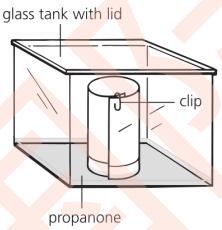
## Paper Chromatography

Principle: solubilities of different substance in the solvent are different.

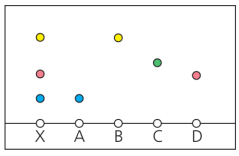



**1** Prepare concentrated solutions of **X**, **A**, **B**, **C**, and **D**, in propanone. Place a spot of each along a line, on chromatography paper. Label them.

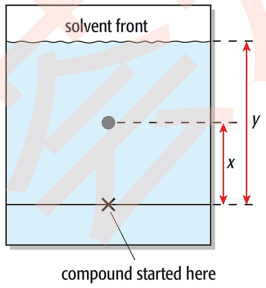
Note that you must use a pencil to draw the line on the chromatography paper. If you use a biro or felt-tipped pen, the ink will run.




**2** Stand the paper in a little propanone, in a covered glass tank. The solvent rises up the paper. When it's near the top, remove the paper.




**3** **X** has separated into three spots. Two are at the same height as **A** and **B**, so **X** must contain substances **A** and **B**. Does it also contain **C** and **D**?



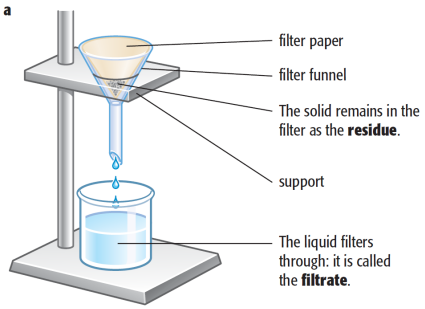

$$R_f = \frac{\text{distance moved by the substance}}{\text{distance moved by the solvent front}}$$

$R_f$ value is $\frac{x}{y}$

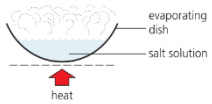
For colourless substance, for example amino acid , need use locating agents to make them visible

## 2.3 Separation and purification

## Filtration



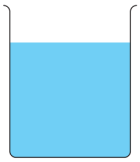

## Evaporation all the solvent



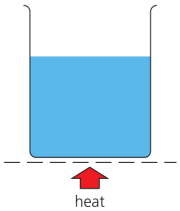

To obtain salt from an aqueous solution, you need to keep heating the solution, to evaporate the water.


When there is only a little water left, the salt will start to appear. Heat carefully until it is dry.

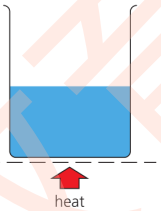
## Crystallization



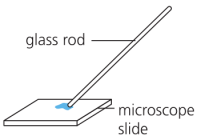
**1** This is a solution of copper(II) sulfate in water. You want to obtain solid copper(II) sulfate from it.



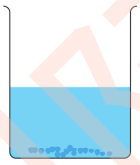

**2** So you heat the solution to evaporate some of the water. It becomes more concentrated.



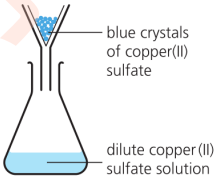

**3** Eventually the solution becomes **saturated**. If you cool it now, crystals will start to form.




**4** Check that it is ready by placing a drop on a microscope slide. Crystals will form quickly on the cool glass.

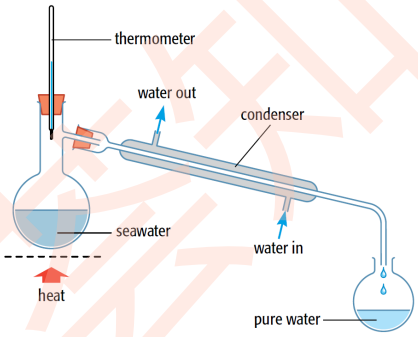


**5** Leave the solution to cool. Crystals start to form in it, as the temperature falls.

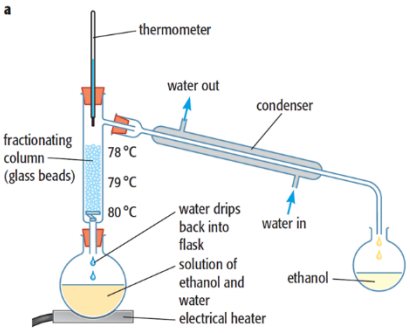



**6** Remove the crystals by filtering. Then rinse them with distilled water and dry them with filter paper.

## Simple distillation




## Fractional distillation




Fractional distillation is a method of separating two (or more) miscible liquids with different boiling points

the most volatile liquid (lowest boiling point ) in the mixture distils first;

the least volatile liquid (highest boiling point) distils last.

# chapter 3 Atoms, elements and compounds

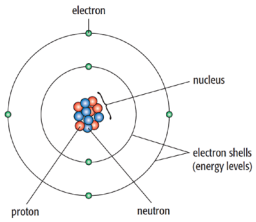
## 3.1 Elements, compounds and mixtures

**Elements：** a substance made up of only one type of atom is called an element.
For example, $H_2$, $O_2$, $N_2$, $Cl_2$

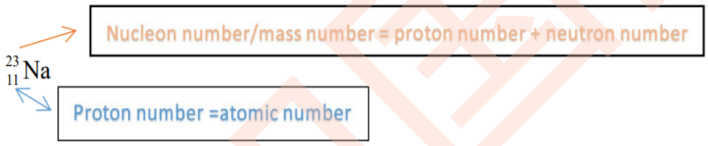
**Compounds：** a compound is a substance made up of two or more different types of atom joined together by chemical bonds.
For example, Sodium chloride, NaCl, Carbon dioxide,$CO_2$, Copper(II) nitrate ,$Cu(NO_3)_2$

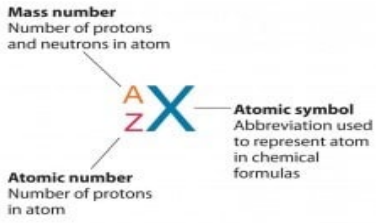
**Mixtures：** a mixture contains two or more elements or compounds that are not chemically bonded together.

## 3.2 Atoms




| sub-atomic particle | relative mass | relative charge |
|---|---|---|
| proton | 1 | +1 |
| neutron | 1 | 0 |
| electron | 1/1836 | -1 |




Proton number = atomic number
Proton number= electron number, so atoms have no overall charge.
Nucleon number is the total number of protons and neutrons in an atom.
To get the number of neutron ,
#Neutron=#nucleon -#proton


## 3.3 Isotopes

***Isotopes*** are atoms with the same number of protons but different numbers of neutrons.

1) Isotopes have the same chemical properties because they have the same electronic configuration (arrangement of electrons in their shells).
2) The accurate relative atomic mass of an element is calculated using the mass and percentage abundance of each of its isotopes.

**the value we use for the atomic mass of an element is an average mass.**

Chlorine has two isotopes, chlorine-35 and chlorine-37, in an approximate ratio of 3: 1 (or 75.0%: 25.0%).

This value for the relative atomic mass of chlorine can be calculated by finding the total mass of 100 atoms.

Mass of 100 atoms of chorine = (35 × 75.0) + (37 × 25.0) = 3550

Then the average mass of one atom = $\frac{3550}{100}$ = 35.5

Thus, for chlorine $A_r$ (Cl) = 35.5

## 3.4 Electronic configuration of element

The electron shells for the first 20 elements