Introduction to Science
Separating Mixtures
Junior Science

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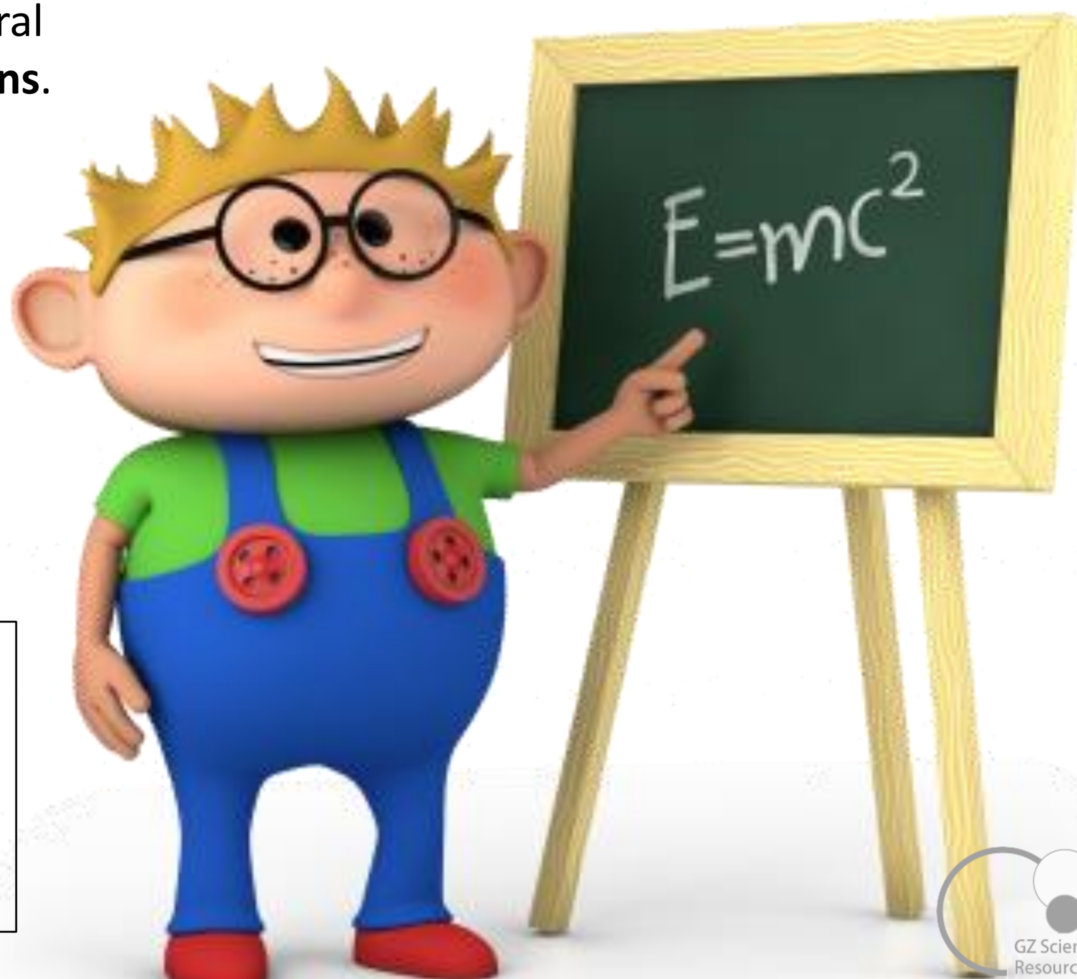
What is Science?

Science is both a collection of **knowledge** and the **process** for building that knowledge.

Science asks **questions** about the natural world and looks for natural **explanations**.

Science works only with **testable** ideas and uses **observations** to make **conclusions**.

Theories are developed based on the **evidence** scientists collect.



Moral judgments, decisions about how to use science discoveries, and conclusions about the **supernatural** are outside the area of science

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Observation in Science

To observe means to record or make note of something we have experienced. We also think of observations as watching something, but in Science, observations may be made with any of our senses (by seeing, feeling, hearing, tasting, or smelling) or even using tools to make observations that are then changed into something our senses detect.

Observation tools include thermometers, microscopes, telescopes, radars, computer sensors and spaces probes. Sometimes these tools are able to observe and collect data that humans cannot directly sense. By using these tools scientists can often make many more observations and much more **precisely** than our senses are able to.

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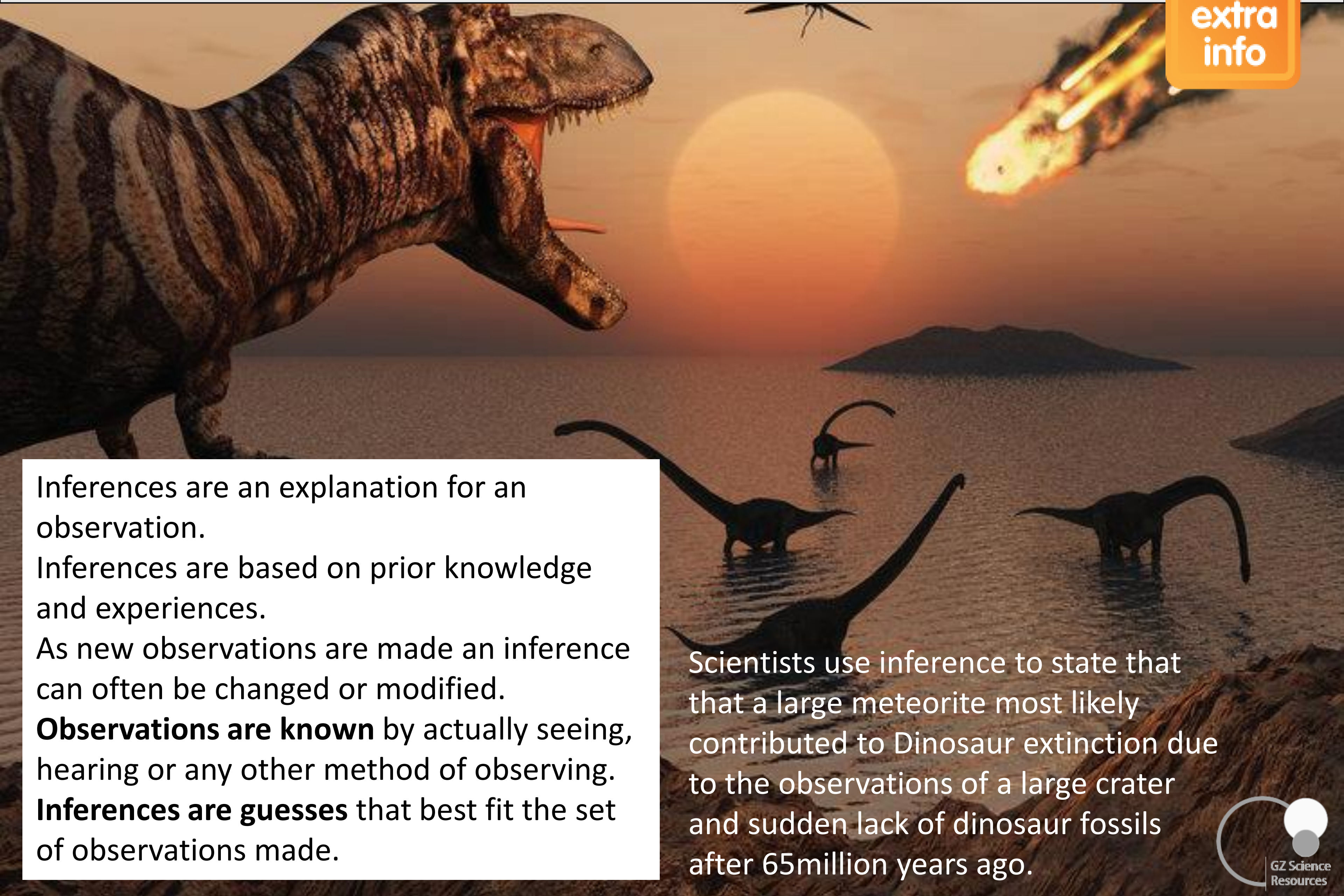
Observation or Inference?



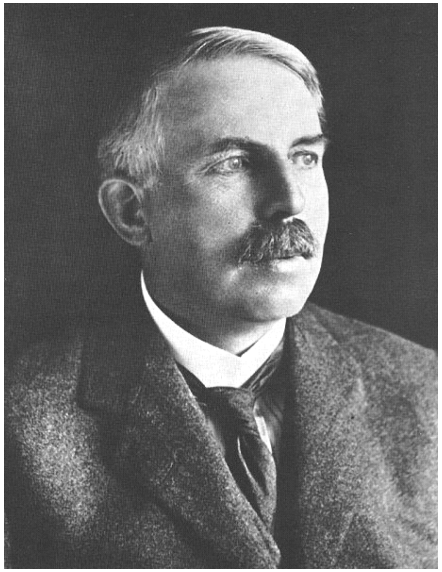
Inferences are an explanation for an observation.
Inferences are based on prior knowledge and experiences.
As new observations are made an inference can often be changed or modified.
Observations are known by actually seeing, hearing or any other method of observing.
Inferences are guesses that best fit the set of observations made.

Scientists use inference to state that that a large meteorite most likely contributed to Dinosaur extinction due to the observations of a large crater and sudden lack of dinosaur fossils after 65million years ago.

Who wants to be a Scientist?

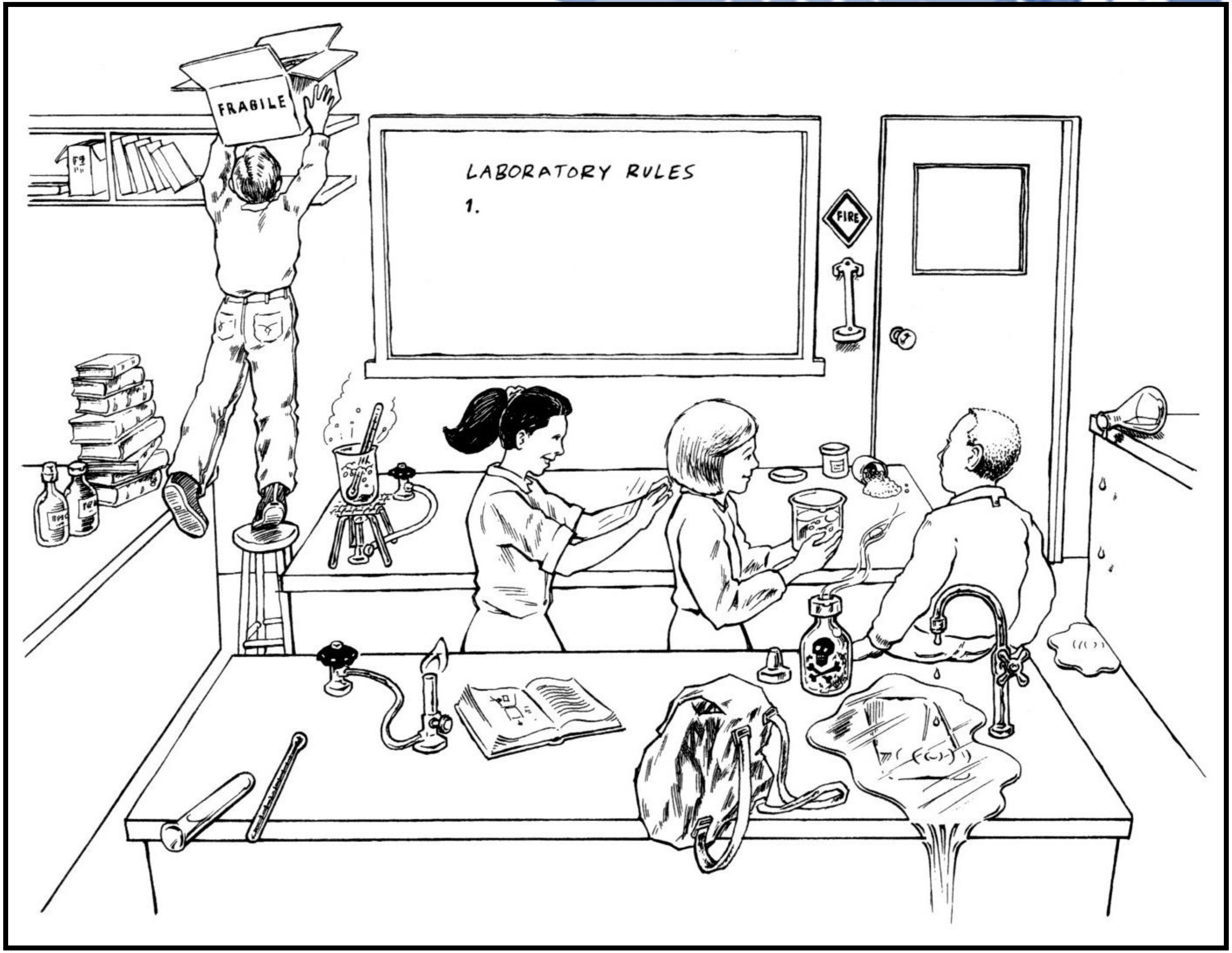
extra info

The New Zealander Joan Wiffen was well known as a tireless hunter of New Zealand Dinosaur bones – disproving the long established idea that no dinosaurs made it across to NZ before it broke away from Gondwana or if they did then New Zealand's active geological past destroyed any evidence of dinosaur fossils. Although she was not formally trained as a scientist, she self taught herself the correct ways of working scientifically.



The New Zealand Scientist Sir Ernest Rutherford completed his secondary schooling and three university degrees here at home then went on to continue his Scientific education at other universities overseas including Cambridge University, England. He was most famously known for inferring the structure of the atom from his testing and tireless observations. Sir Rutherford collaborated with many other scientists and freely shared his evidence with others.

Spot the Dangers in the lab



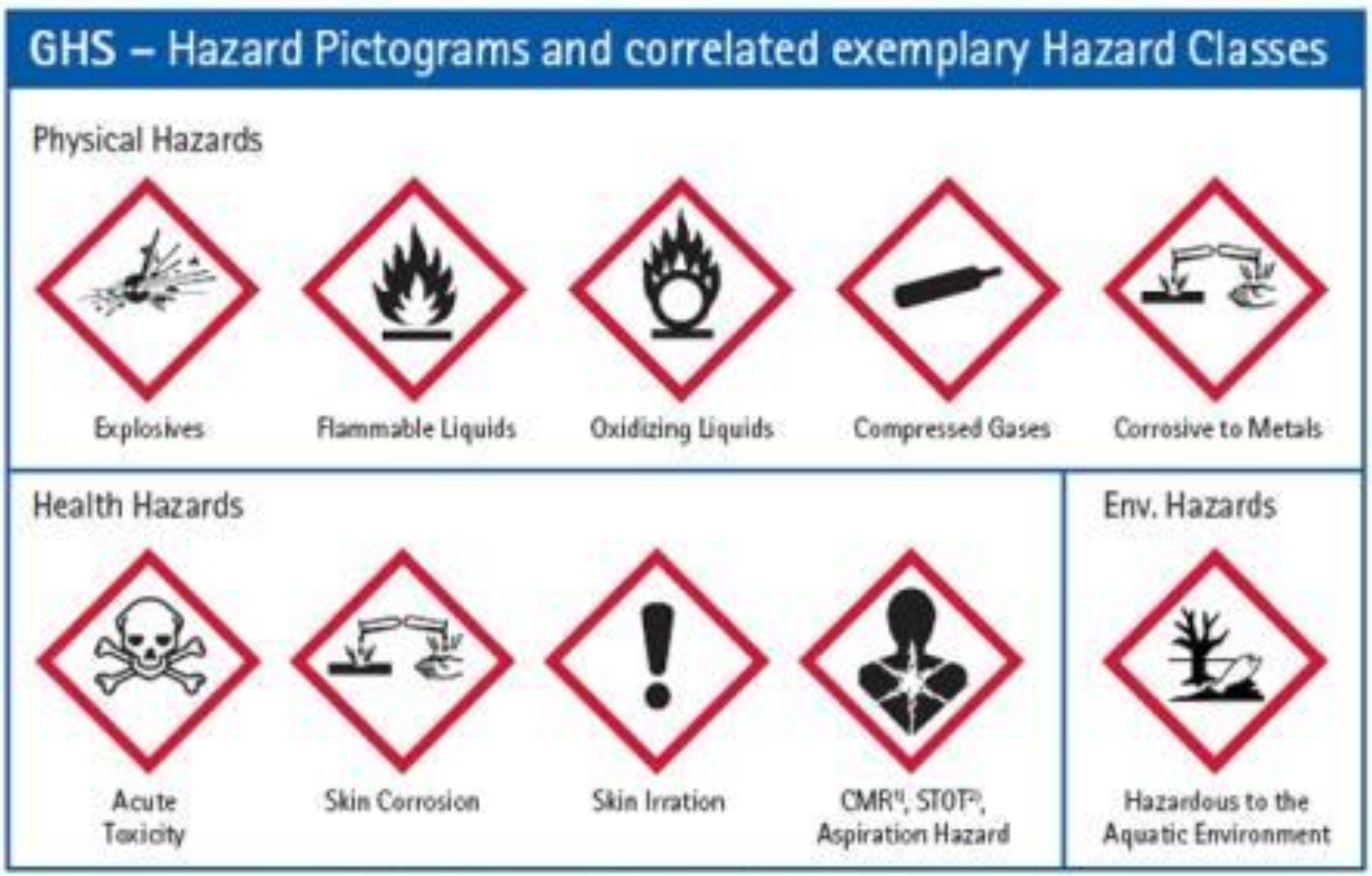
Laboratory Rules

A School Science Laboratory can be a fun place that allows you to investigate and observe Science taking place. It can also be a dangerous place if rules are not followed. To protect yourself and the classroom from harm we need to follow School Lab Rules carefully each time we are in the class or taking part in a practical.

1. Do not smell or taste chemicals.
2. Place bags under your desks.
3. Wear safety equipment if asked.
4. Tie long hair back during practicals.
5. No running in class.
6. Tell the teacher if you break equipment.
7. Clean up your work area after practicals.
8. No eating in the class.
9. …………………
10. …………………

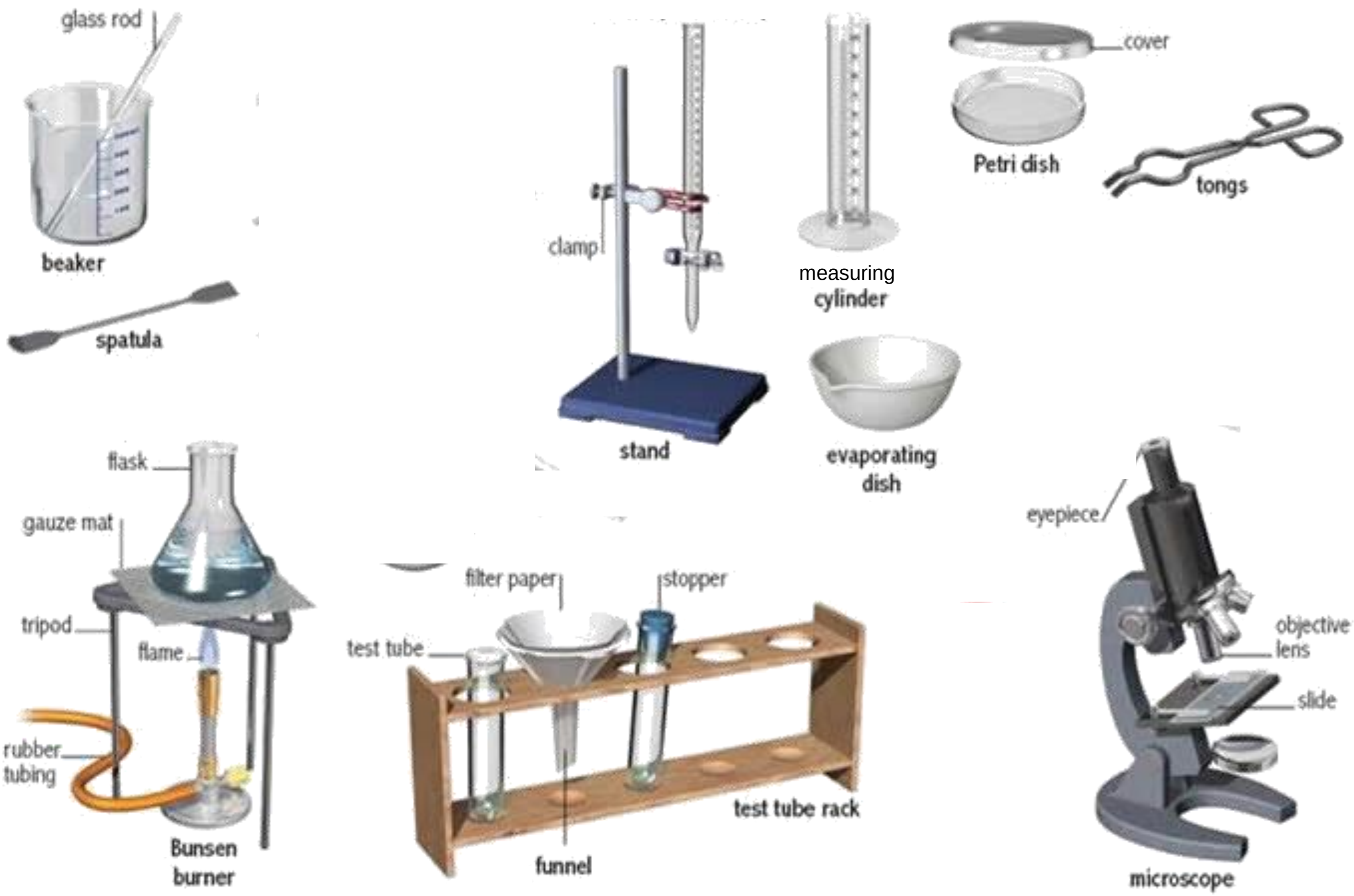
Laboratory safety symbols

Easy to recognise safety Hazchem symbols are often used in Labs and on labels of chemicals when special care is required. A chemical may be poisonous or be explosive or burn when it touches skin. Safety symbols and Lab rules are designed to warn and protect you from dangerous situations.

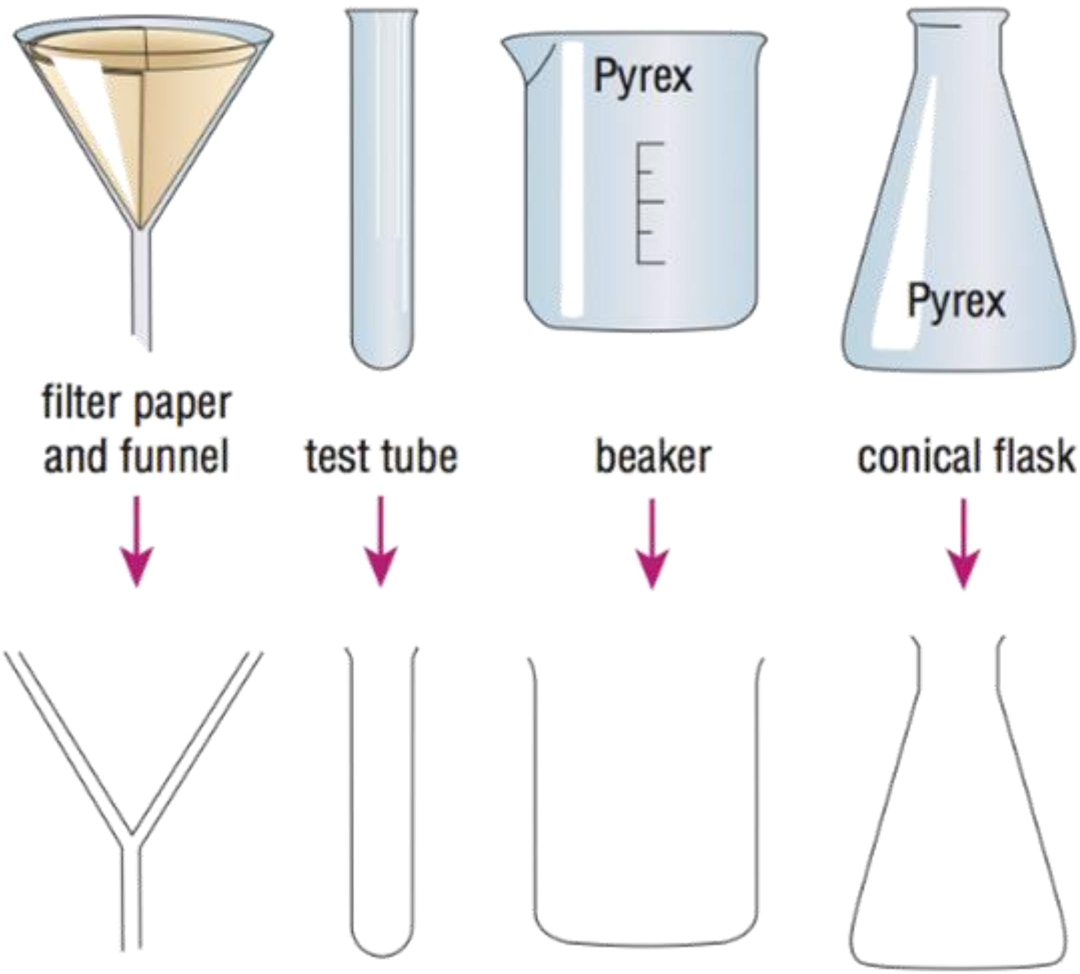


Common Laboratory equipment

Science labs contain equipment that are used to carry out investigations and experiments. This equipment may be quite different from what we have in our homes but it is often designed for specific uses.
The names and uses of the equipment will need to be learnt along with how to use it.

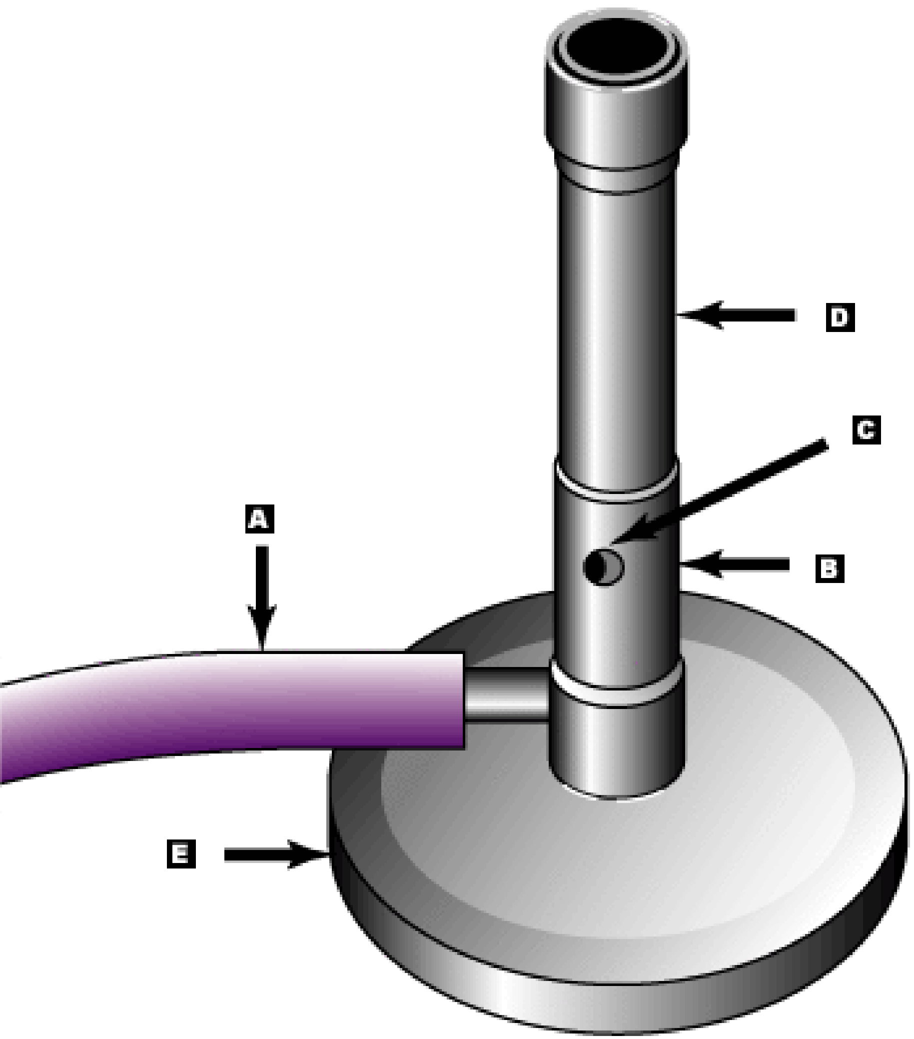


Drawing equipment in Science



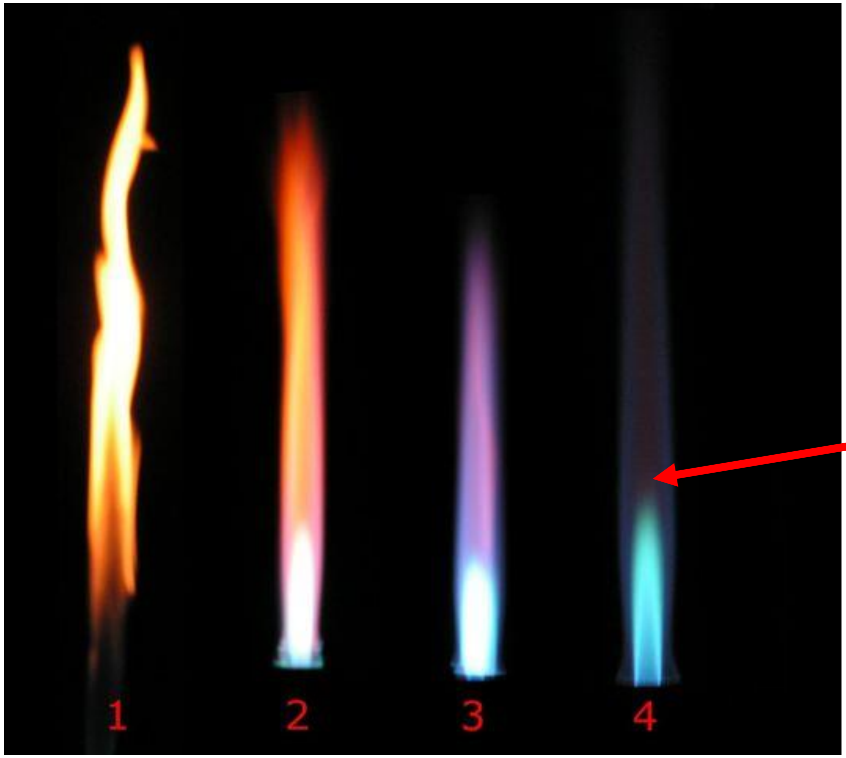
In the science laboratory, we use special equipment. Often we have to draw the equipment. We use diagrams to show the equipment, which saves us time drawing. The scientific diagrams are recognised worldwide.

Draw and label the Bunsen Burner



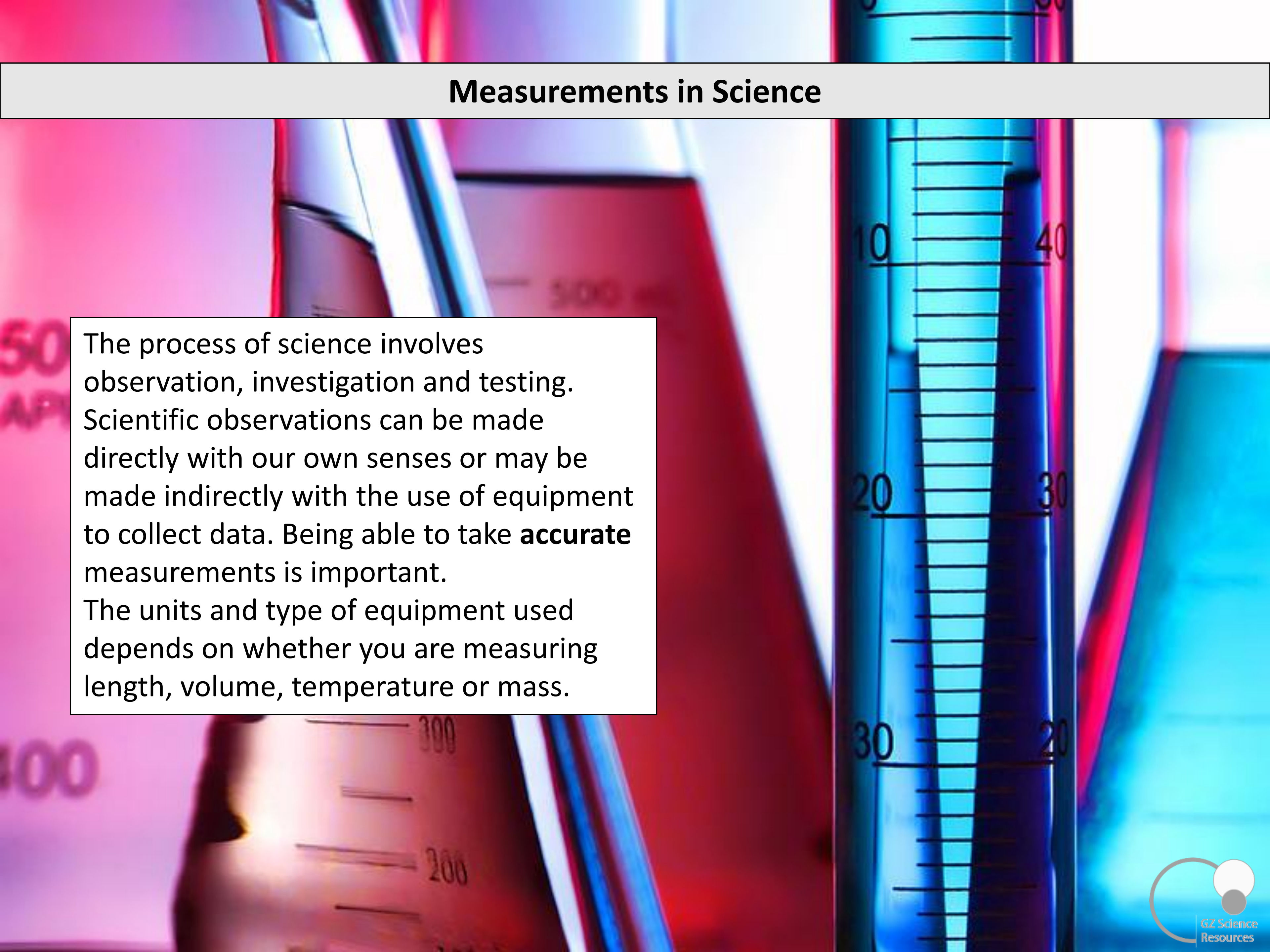
Part of the Bunsen Burner	Function
A. Gas hose	To allow gas to enter the burner
B. Collar	To control the amount of air entering the burner
c. Air Hole	To allow air to enter the burner
D. Barrel	To raise the flame to a suitable height for heating and burning
E. Base	To support the burner and make it more stable

The Bunsen Burner Flame



When using the Bunsen Burner to heat boiling tubes etc. place it at the hottest place at the top of the bright blue flame.

The Bunsen Burner burns gas with oxygen in the air to make a hot flame used in the laboratory. When the air hole is closed, (1) the flame is large and orange. This flame only partly allows oxygen to burn with the gas so is cooler and creates soot. As the air hole is opened, more (2-4) the flame becomes bluer and hotter. The best flame to use is (4), with the air hole mostly open.



Measurements in Science

The process of science involves observation, investigation and testing. Scientific observations can be made directly with our own senses or may be made indirectly with the use of equipment to collect data. Being able to take **accurate** measurements is important.
The units and type of equipment used depends on whether you are measuring length, volume, temperature or mass.

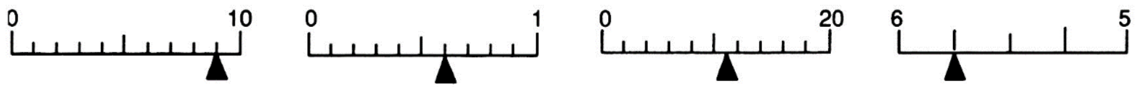
Measuring in Science

Quantity	Unit	Symbol	Equipment used
Volume	litre	L	flask
	millilitre	mL	measuring cylinder
Temperature	Celsius	°C	thermometer
Mass	kilograms	Kg	Scales
	grams	g	Scales
Length	Metres	m	Metre ruler
	millimetres	mm	Hand ruler

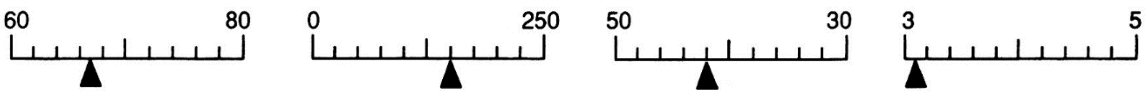
Note: **Weight** is the result of force (gravity) acting on mass and is measured in Newton's using a spring balance. Weight and Mass are often confused.

Measurements in Science

1 Fill in the readings on the scales shown.

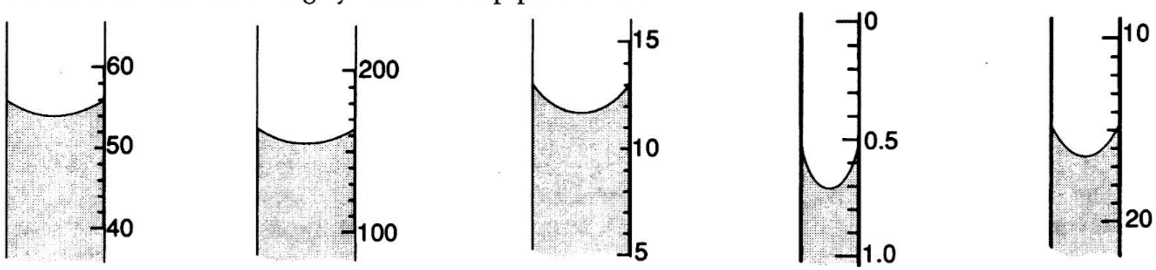


A __________ B __________ C __________ D __________



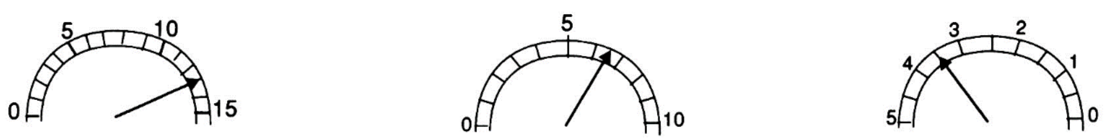
E __________ F __________ G __________ H __________

2 What do these measuring cylinders and pipettes read?



a __________ b __________ c __________ d __________ e __________

3 What amounts do these meters read?



a __________ b __________ c __________

As well as recording the number what must we also record?

Where do we look from when reading measuring cylinders and pipettes?

Why is the surface of the liquid not flat?

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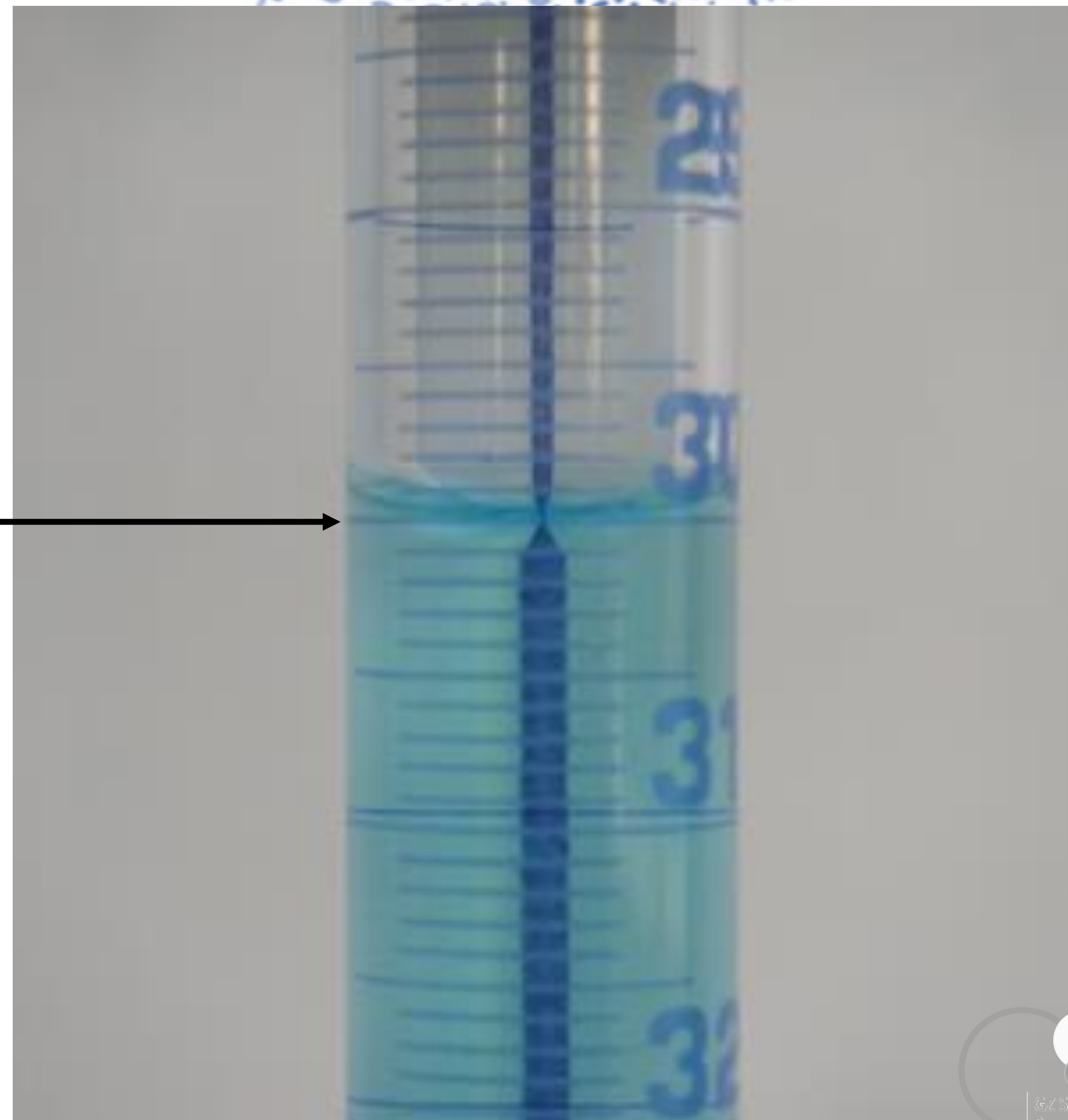
Measuring volume

Water is a liquid that "sticks together". In a narrow tube or measuring cylinder the water surface tends to curve up the sides. This is called a **meniscus curve**. A measurement reading is to be taken from the **bottom** of the meniscus curve because only a very small volume of liquid is actually around the side.



Collecting Data

Data that is collected from an investigation can be analysed (in order to explain and interpret it) easier if placed into a clearly labelled and laid out **data table**. The left column is the data of the variable (factor) that you are changing. The right hand side columns are for the data of the variables you are measuring.

The table must have:

- ❑ **A heading linked to the aim**
- ❑ Labelled quantities, units and symbo
- ❑ Values (often numerical) of data collected

Data tables can also contain **processed data** such as results from multiple trials that have been averaged to give a more reliable value.

Data Collected

This is chart of the numerical data collected in my experiment…

Independent Variable (This is the one thing I changed in my experiment.)	Trial 1	Trial 2	Trial 3	Average (Add the three trials together and divide by three.)

Processing Data - Averaging

When collecting and measuring data in investigations, such as that for calculating speed, errors can occur. This may be due to the measuring instrument and the way it is used. Data can also be recorded incorrectly.
Repeating the investigation a number of times and averaging out the measurements can help reduce random errors and **increase reliability.** This value is called the **mean**.

The mean is the most common measure of average.
To calculate the mean add the numbers together and divide the total by the amount of numbers:
Mean = sum of numbers ÷ amount of numbers

extra info

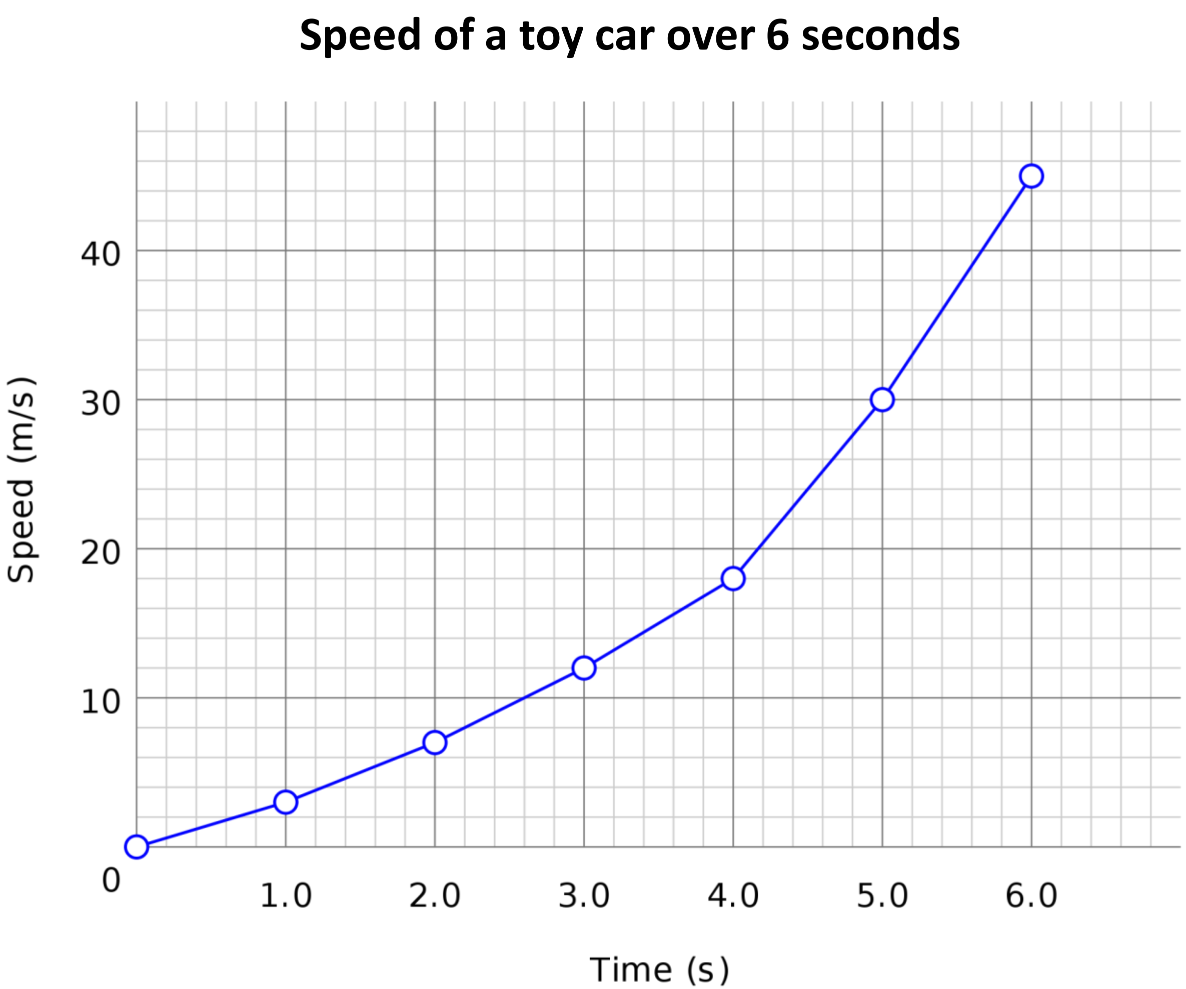
Distance walked in 1 minute

	Trial 1	Trial 2	Trial 3
Distance (m)	113	121	119

Mean = (113 + 121 + 119) **÷ 3**
= 117.7 m

Drawing a line Graph

Graphs are used to show patterns in data more easily than a data table. Often processed (averaged) data is used.



A well-drawn line graph must have the following features:

- ❑ A suitable heading
- ❑ Evenly spaced numbered axes
- ❑ Labels with units
- ❑ Correctly plotted line.

Use the acronym SALT when plotting graphs:
Scales **A**xes **L**abelling **T**itle

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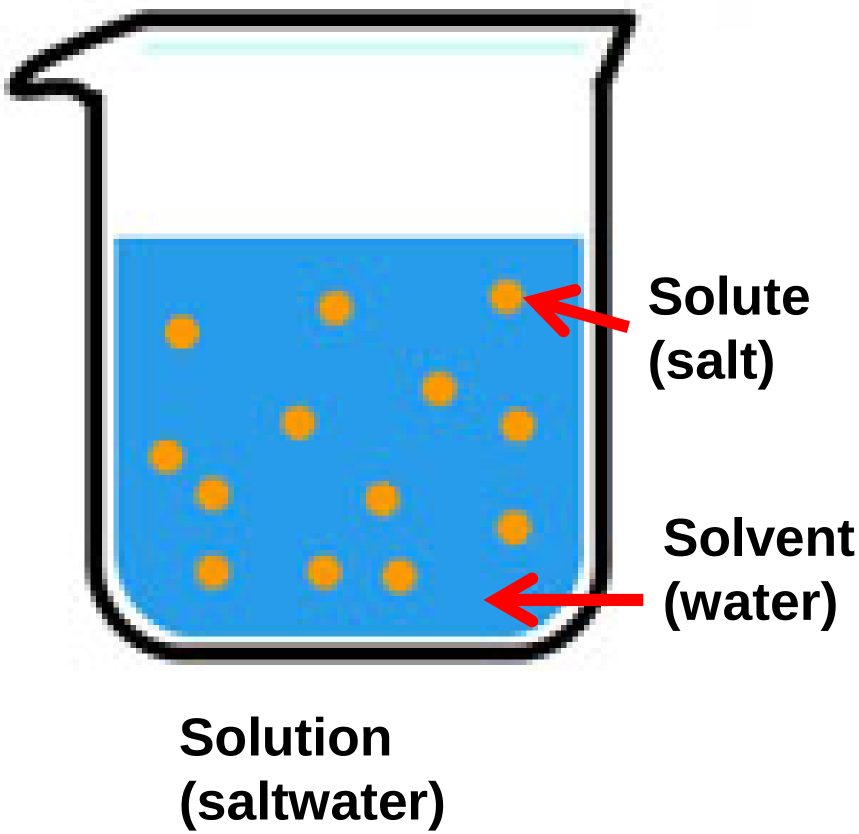
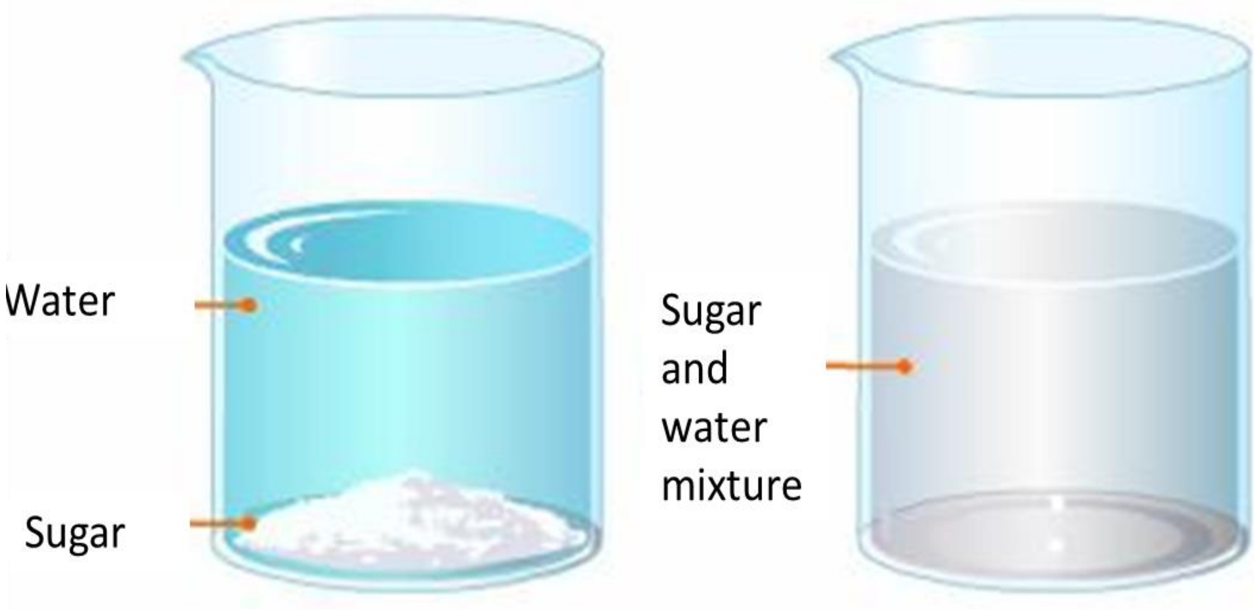
Solutions are made from a solute dissolved in a solvent



A **solution** is made up of a **solvent** and a **solute**. A solvent is a substance such as water that is able to dissolve a solute. The solvent 'pulls apart' the bonds that hold the solute particles together and the solute particles **diffuse** (spread randomly by hitting into each other) throughout the solvent to create a **solution**. The solution is a **mixture** with evenly spread solvent and solute particles. These particles can be physically separated by **evaporation**.

Where has the sugar gone?

When a solid mixes into a liquid and can no longer be seen it has **dissolved**. Often the particles of the solute seemed to have disappeared but they are all still present. They are now just in very small particles, too small to be seen by eye.

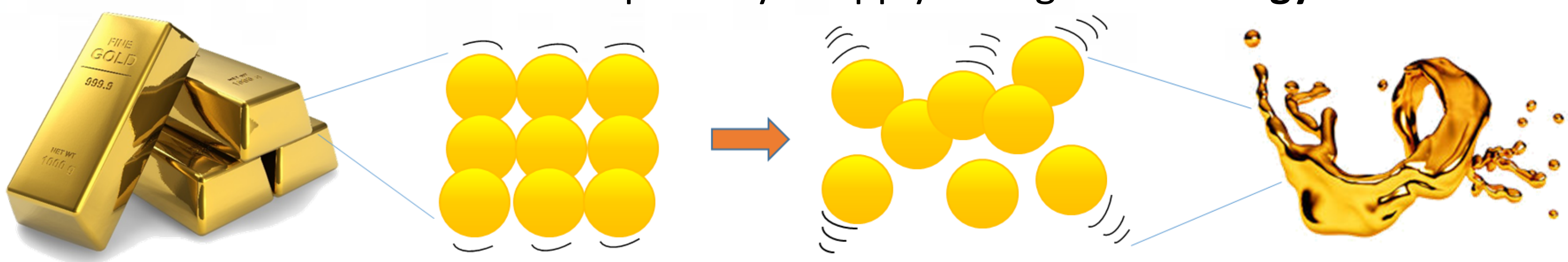


Dissolving of Sugar in Water

Dissolving and melting.

Both dissolving and melting are physical changes but they involve different processes

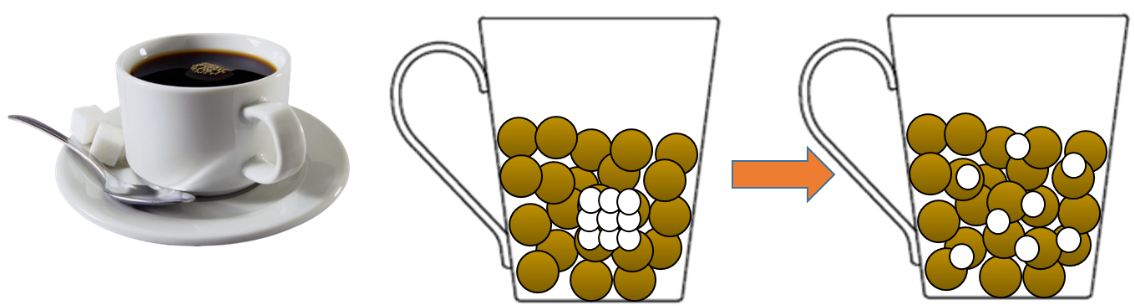
All Solids will **melt** into liquids if you apply enough **heat energy**



Heating adds more kinetic energy to particles

Particles will break free from each other to form a liquid

Some solids will **dissolve** into solvents to form a **solution**, which is a mixture



The solid sugar cubes are added to a cup of coffee (a mixture of water and coffee granules)

The coffee dissolves the sugar and the particles are spread throughout the solution

Everyday solutions

Many drinks we purchase are solutions. Most of them are solutions of mainly sugar (solute) and water (solvent) with a small amount of flavouring, colouring and some minerals mixed in. We do not "see" the sugar because it is dissolved into the water and becomes too small to see. This means a lot of sugar can be hidden in the liquid and we are unaware of the amount of sugar we take in, even in so-called healthy sports drinks.

Mixtures can be separated by physical processes

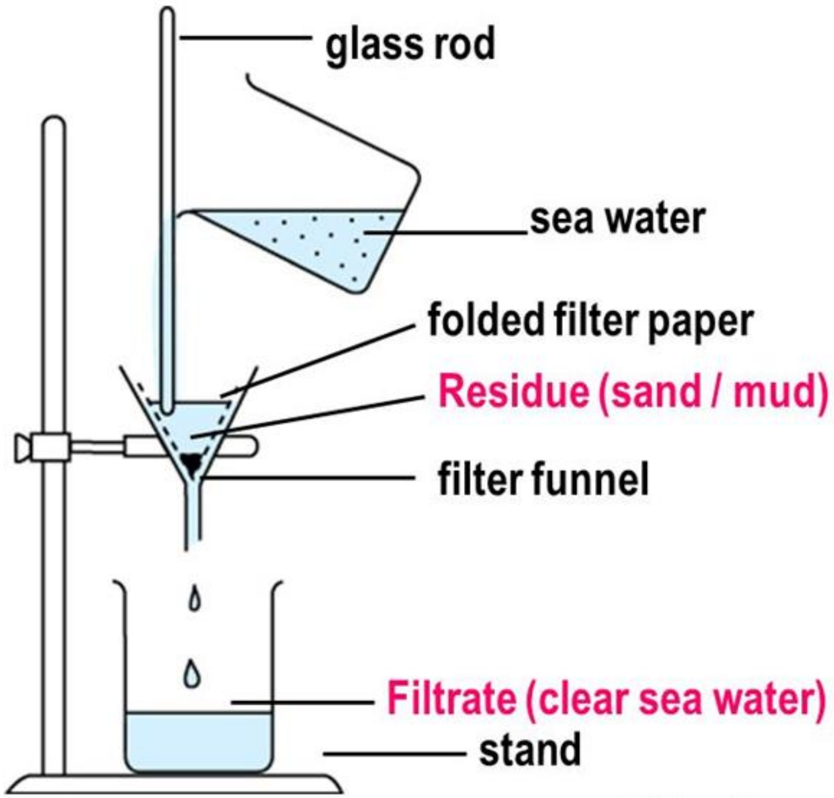
Mixtures of substances are not chemically bonded (joined) to each other so they can be separated by physical techniques.

The state of the various substances in the mixture, such as a liquid and solid or the physical properties of the substances, such as different boiling points will determine which method of separation will be used.

Mixtures can be easily separated physically using methods such as: Filtering

Filtering separates an **insoluble solid** in a mixture from the **liquid** completely.
The solvent molecules (liquid) and any dissolved molecules present in the solution can pass through the filter paper, which has small holes, while the solid particles cannot because they are too large and stay in the filter paper.
The solvent or solution containing dissolved substances passes through the filter paper is called **filtrate**. The solid particles that remain on the filter paper are called the **residue**.

Filtering mud, sand and seawater



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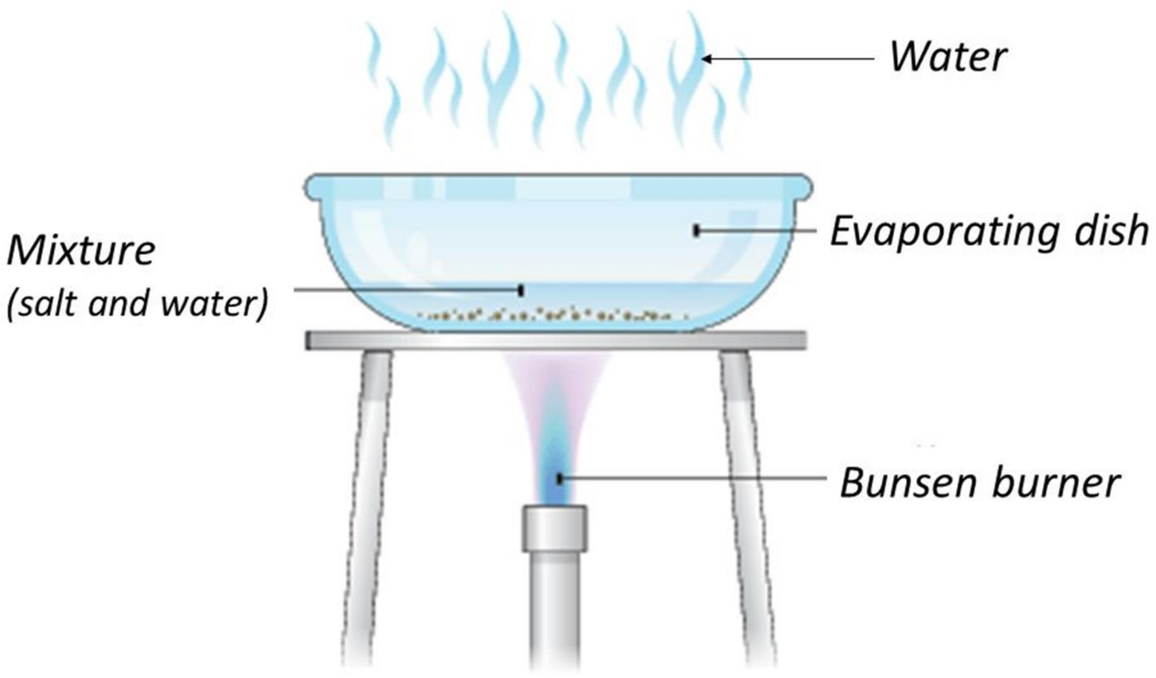
Mixtures can be easily separated physically using methods such as: Evaporating (by boiling)



Evaporating separates a dissolved **solid from a liquid**. The solvent (liquid) is lost into the surroundings.

The liquid will evaporate but evaporation becomes faster at higher temperatures.

The solid remains because it has a higher (often very much higher) boiling point than the liquid.

Mixtures can be easily separated physically using methods such as: dissolving

When two solid substances are mixed together, they can be separated by **dissolving**. A solvent such as water can be added if only one of the substances is soluble. For example; if salt is mixed with dirt then adding water will dissolve the salt (which can later be separated by evaporation) and the remaining dirt can be removed from the solution by filtering. The salt becomes the solute and will go through the filter as it is in solution.

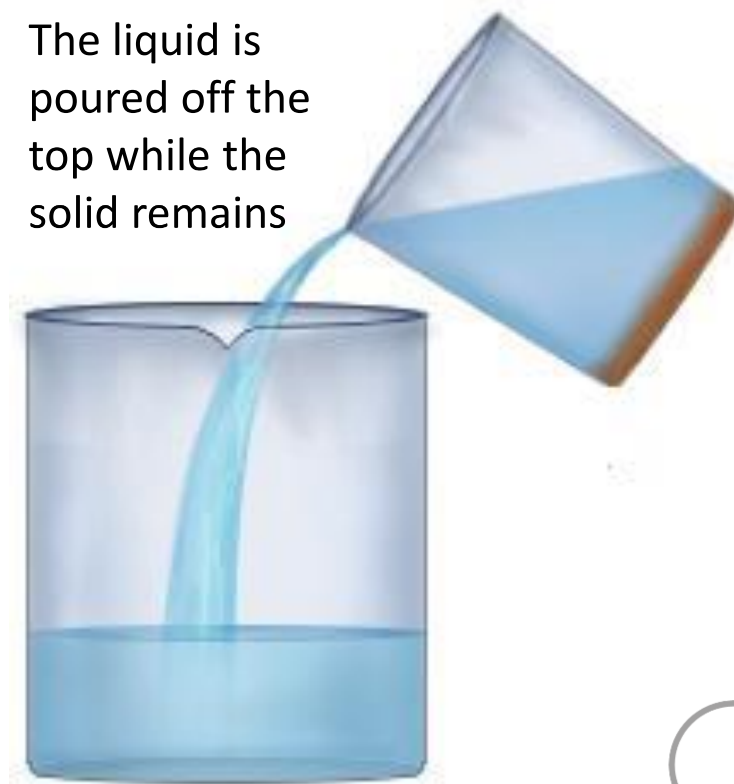
Mixtures can be easily separated physically using methods such as: Decanting

Decanting is simply pouring off a liquid without losing any of the more dense substance (usually an **insoluble solid**) in the bottom of the container. Decanting separates a **heavier substance from a lighter one**. Chemists are most often after the substance at the BOTTOM of the container.

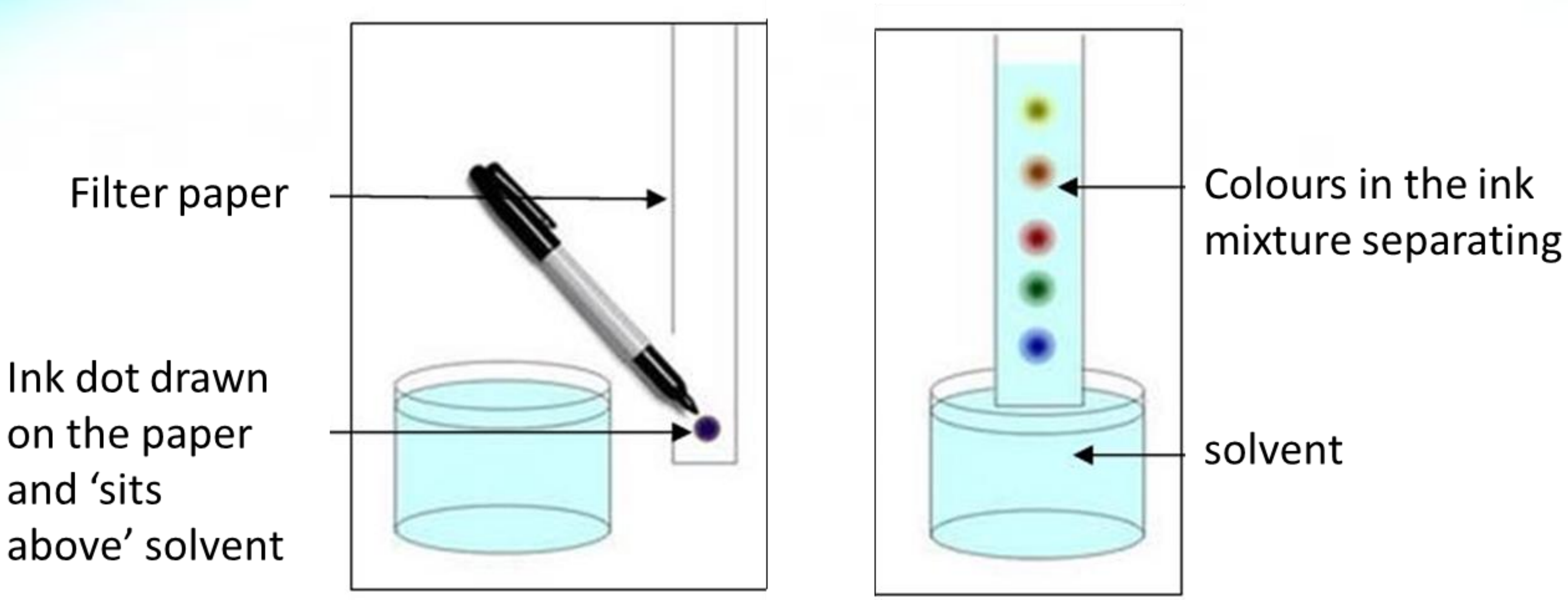
Original mixture of a solid and liquid

Heavier solid is allowed to settle to the bottom

The liquid is poured off the top while the solid remains

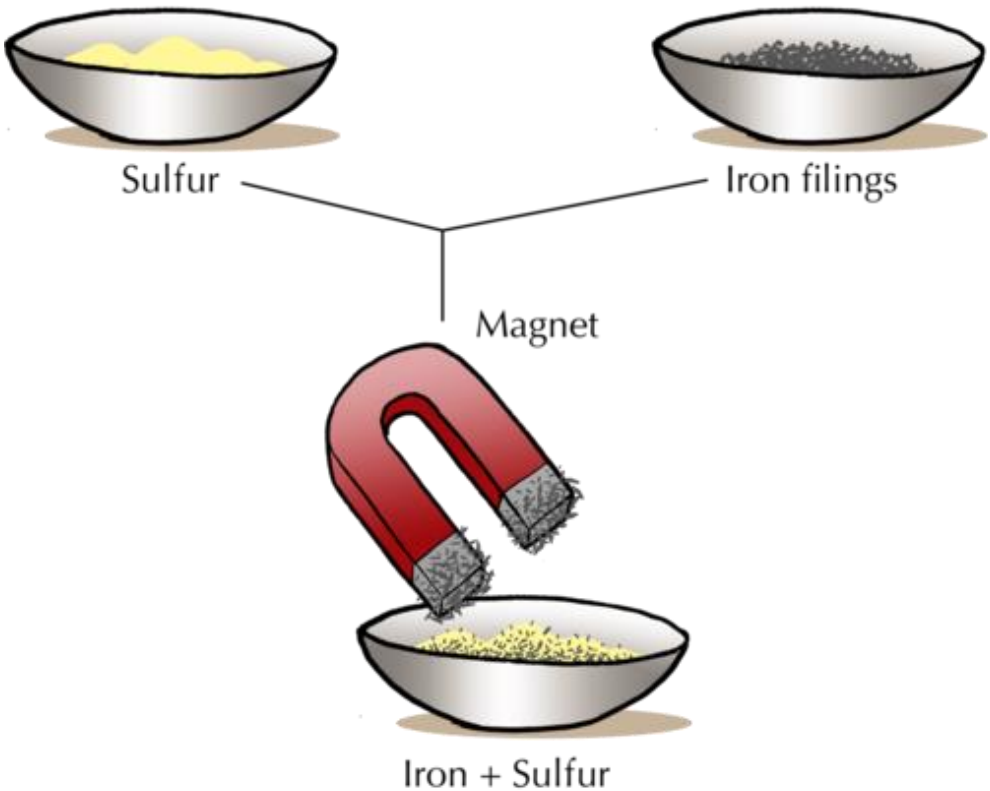


Mixtures can be easily separated physically using methods such as: Chromatography



Chromatography is a method used to separate the various substances in a **mixture of dye or ink**. Substances of the mixture will differ in how much they "stick" to things: to each other, and to other substances. Some of the substances of the ink will stick more tightly to the paper fibres. They will spend less time in the water as it moves along the paper fibres, and they will not travel very far. Other components of the ink will stick less tightly to the paper fibres. They will spend more time in the water as it moves along the paper fibres, and they will travel further through the paper.

Mixtures can be easily separated physically using methods such as: Magnetism



Magnetism can be used to separate a **magnetic substance** (such as iron) from a mixture containing **non-magnetic** substances (such as sulfur or sand). The magnetic substance of the mixture is separated with the help of the magnetic attraction.
A magnet is moved over the mixture containing the magnetic substance e.g., iron filings. These get attracted to the magnet. The process is repeated until the magnetic material is completely separated from the mixture. The non-magnetic substance is left behind.

http://www.mstworkbooks.co.za/natural-sciences/gr7/gr7-mm-02.html

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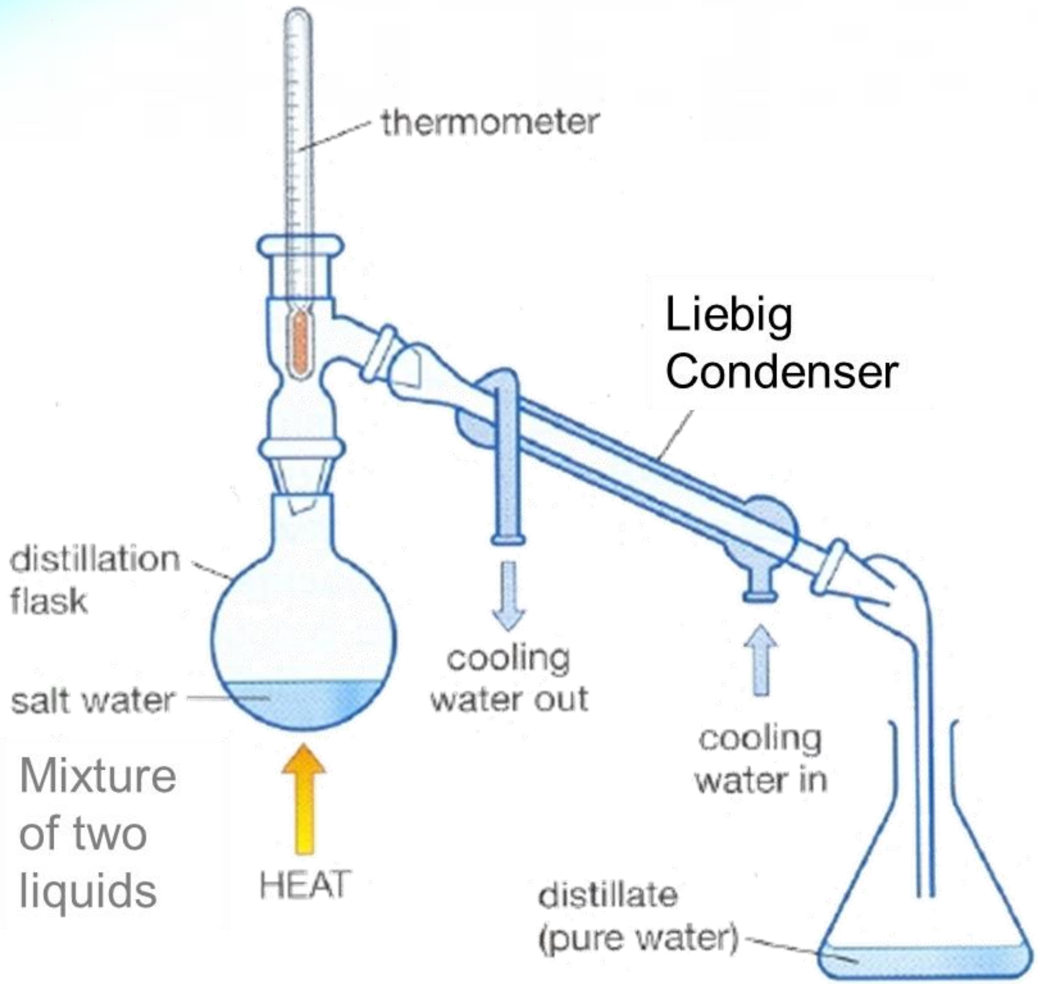
Mixtures can be easily separated physically using methods such as: Distillation



Distillation is a process of boiling a liquid until it forms a vapour and **condensing,** then collecting the liquid. The liquid collected is the **distillate**. The Liebig Condenser cools the vapour back into liquid. The purpose of distillation is separation of a mixture of two liquids. This is possible if the two substances have **different boiling points.** The substance with the lower boiling point turns to gas and is collected while the other substance with a higher boiling point remains as a liquid in the flask.

http://lookgoodandstudyhard.blogspot.co.nz/2015/12/chemistry-unit-2-experimental-techniques.html

Mixtures can be easily separated physically

Separation technique	Property used for separation	example
Magnetic Attraction	magnetism	magnetic iron can be separated from non-magnetic sulfur using a magnet
Decanting	density or solubility	liquid water can be poured off (decanted) insoluble sand sediment less dense oil can be poured off (decanted) more dense water
Filtration	solubility, size of particles	sand can be separated from a solution of sodium chloride in water by filtration
Evaporation	solubility and boiling point	soluble sodium chloride can be separated from water by evaporation
dissolving	solubility	soluble salt can be separated from sand by dissolving into a solvent
Distillation	boiling point	ethanol can be separated from water by distillation because ethanol has a lower boiling point than water