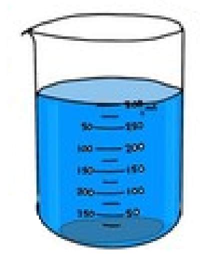
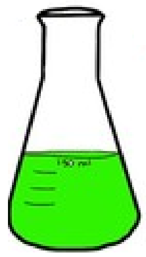
Joseph Leckie Academy

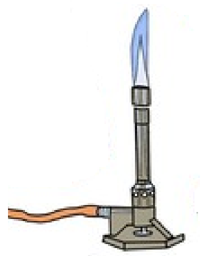
Science Transition Workbook

Science – A Guide to Basic Investigation Skills in Science

"Develop, Inspire, Promote, Encourage & Respect"

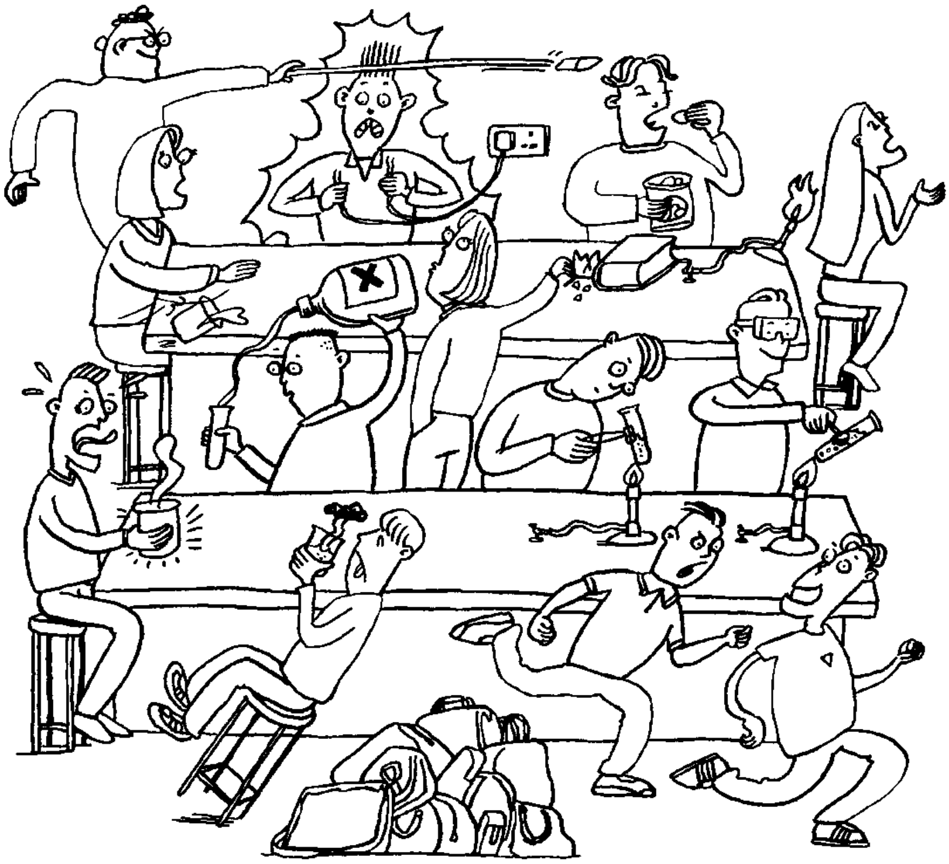




Your tasks: to work through the lessons

Lesson 1:	Safety	
I will be able to...	Aspire:	Justify which are the most important rules for safety in science.
	Challenge:	Design a set of science rules you will follow to keep you safe in science lessons.

Starter activity:



Draw circles around any safety problems you can see in this science lesson.

What could these students do to avoid being unsafe next lesson?

Task	What rules do you think we should have in the science classrooms to ensure that all students are safe? ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ **Extension** Look at your rules – which are the most important? Try to number them in order of importance. If you could only have 5 rules which would you choose? Why do you think this? Be prepared to share this with the class. ____ ____ ____ ____ ____ ____

Knowledge check

Which rules are these students breaking?

Safety Scenario Number One

Jake was sat down measuring out chemicals.

Some of the chemical went on his hands.

He couldn't see very well through his goggles so he took them off and rubbed his eyes.

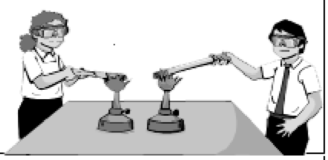
Which safety rules did he break?

Safety Scenario Number Two

Richard was absent the day the investigation was planned.

He collected the equipment and watched Sarah to see what to do without reading the instructions so the test tube ended up pointing at him.

Which safety rules did he break?

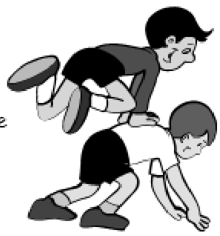


Safety Scenario Number Three

Sam and David had been playing during break and had to come in before they had decided who won.

They finished off the game in their science lesson.

Which safety rules did they break?



Safety Scenario Number Four

Cindy spilled some of the chemicals from her experiment on the table.

She was worried she would get into trouble so she just covered it up with some paper towels.

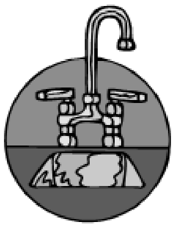
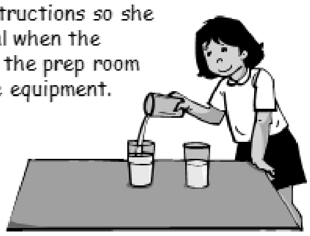
Which safety rules did she break?

Safety Scenario Number Five

Laura was taking part in a practical where she had to use a Bunsen burner.

Her hair was loose and almost set on fire when she turned around.

Which safety rules did she break?

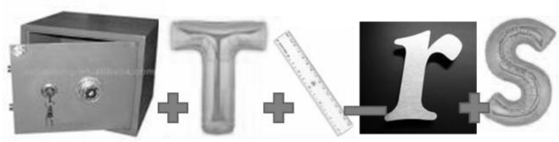
	Safety Scenario Number Six Mike and Collette had a lot of chemicals left from their investigation. They put the chemical in the sink and left the water running in the sink as they left the classroom. Which safety rules did they break?  ______________________________ ______________________________ ______________________________ ______________________________ **Safety Scenario Number Seven** John woke up late so didn't have time for breakfast. During a science experiment he got really hungry so he ate his sandwich from his bag on the floor while the teacher wasn't looking. Which safety rules did he break?  ______________________________ ______________________________ ______________________________ ______________________________ **Safety Scenario Number Eight** Gina didn't pay any attention when the teacher was giving out safety instructions so she started the practical when the teacher had gone to the prep room to collect some more equipment. Which safety rules did she break?  ______________________________ ______________________________ ______________________________ ______________________________
Homework	Design a safety poster to be displayed in your science classroom to make sure everyone stays safe. You can hand draw it or use the computer. Make sure you persuade people to stick to the rules.

Lesson 2:	Science Equipment	
I will be able to...	Aspire:	Evaluate your own use of the science equipment.
	Challenge:	Describe the main science equipment and explain what it is used for.

Starter activity:

Can you work out what these words might be?

____



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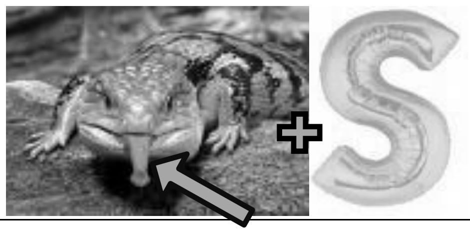

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Task

Measuring in Science

These are the standard units we use in science.

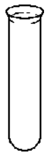
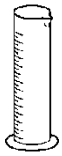
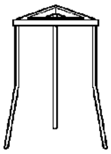
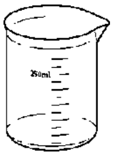
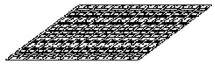
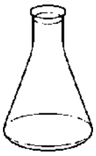
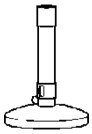
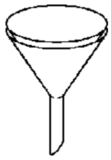
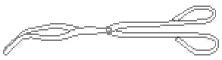
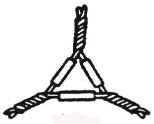
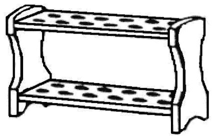
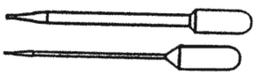
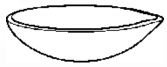
Quantity being measured	Name of unit	Symbol
length	metre	m
mass	kilogram	kg
time	second	s
force	Newton	N
temperature	degrees Celsius	°C
speed	metres per second	m/s
area	square metres	m^2
volume	cubic metres	m^3

Sometimes the standard units are not a convenient size, so we use bigger or smaller versions. An extra part is added to the name of the unit to show when we are using bigger or smaller versions. This is called a prefix.

Prefix	Meaning	Example
kilo	1000	1 kilogram (kg) = 1000 grams
centi	1/100	100 centimetres (cm) = 1 metre
milli	1/1000	1000 milligrams (mg) = 1 gram
micro	1/1 000 000 (1 millionth)	1,000,000 micrometres (µm) = 1 metre

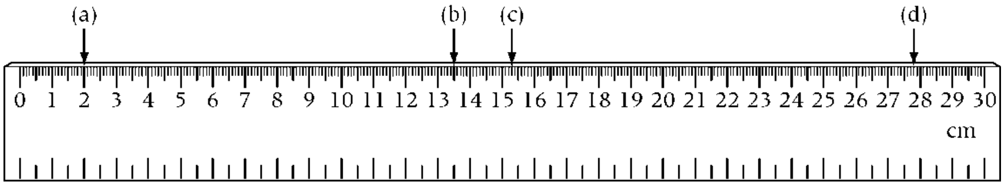
Equipment

Here is some common equipment used in science lessons. You will need to be able to use this equipment properly.

Equipment	Name	Equipment	Name
	Test tube		Measuring cylinder
	Boiling tube		Tripod
	Beaker		Gauze
	Conical flask (i.e. cone-shaped)		Bunsen burner
	Crucible		Filter funnel (with paper)
	Tongs		Test tube holders
	Mortar and pestle		Thermometer
	Pipe clay triangle		Test tube holder
	Stand boss and clamp		Balance
	Dropping pipette		Evaporating basin
	Glass rod		Spatula

Measuring Accurately

You must make sure that you measure any readings accurately. You will have used a ruler to measure in primary school. What are the accurate readings on this ruler?

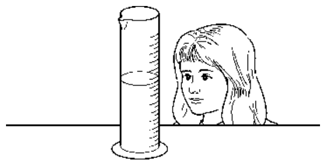


(a) __________ **(b)** __________ **(c)** __________ **(d)** __________

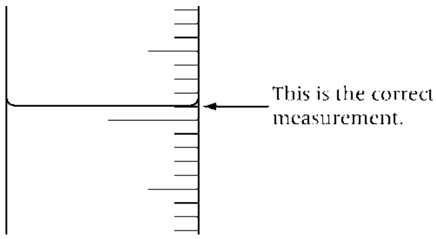
Measuring Liquids

When you need to measure an exact volume of a liquid you use a **measuring cylinder**.

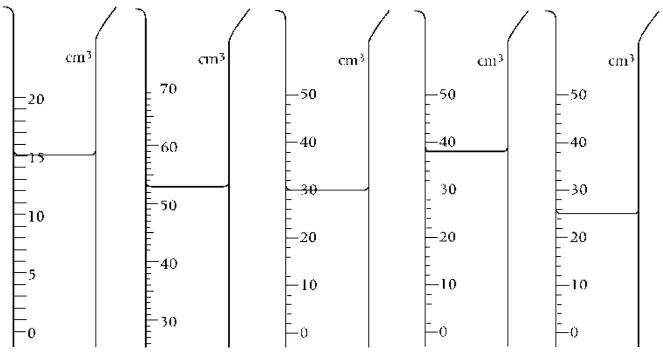
You get a more accurate reading if you bend down so that your eye is level with the liquid in the measuring cylinder.



If you look carefully at the liquid in a tube, it seems to go up at the sides of the tube. The curved shape it makes is called the **meniscus**. You should take your reading from the bottom of the meniscus.



How much liquid is in these measuring cylinders?



________ ________ ________ ________ ________

Have a go at measuring exactly 8cm³ of water in a measuring cylinder.
You can use a pipette to add water drop by drop until it reaches the meniscus.

You can check how accurate you are at measuring water in a measuring cylinder by checking the mass of your water on a balance. Weigh a dry empty measuring cylinder then add exactly 14cm³ water. The mass should be 14g plus the mass of the cylinder.

Cylinder mass ________ Water + cylinder mass ________ Water mass ________

Measuring Mass
Mass is measured using a top pan balance. It is a digital reading. We use grams as the standard units.

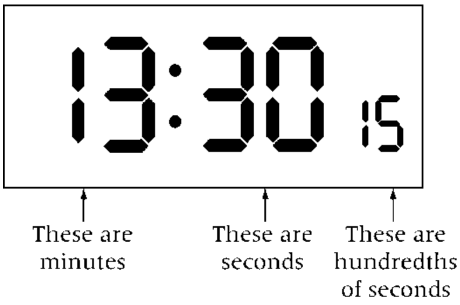
Have a go at using the top pan balance to record the mass of 5 lumps of rock salt in g.

lump 1 _______ lump 2 _______ lump 3_______ lump 4 _______ lump 5 ______

Measuring Time
Seconds are the standard unit for time, but sometimes we use minutes, hours, or even days, depending on what we are measuring.

Most stop clocks give a reading like this:

The clock is *not* showing 13.30 minutes; it is showing 13 minutes and 30 seconds. They are not the same! 30 seconds is half a minute, so the clock is showing 13.5 minutes.

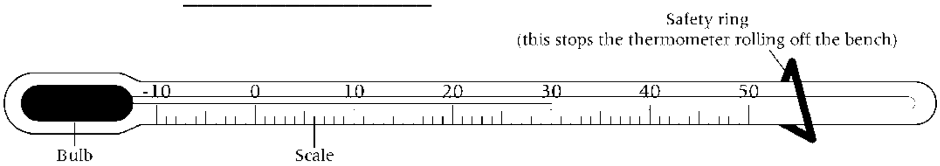


Measuring Temperature

Thermometers contain a liquid that expands (gets bigger) when it gets hotter. The expanding liquid moves up a narrow tube. We use the **scale** to see how far the liquid has moved, and this tells us the temperature.

The thermometer measures the temperature of the liquid in the **bulb**. If a thermometer is lying on a bench in the lab, it will be reading the temperature of the room.
We measure temperature in degrees Celsius (^oC). What is the reading on this thermometer?

____



Have a go at measuring temperature and time.

Pour some water from the kettle into a beaker.

Record the time it takes for the thermometer to stop changing in seconds. ________
You should always aim to leave the thermometer in the liquid for this amount of time so you get an accurate reading.

Record the final temperature reading on the thermometer in ^oC. ________

Mortar and Pestle

A mortar and pestle is used for grinding.

Have a go at using a mortar and pestle to crush up your rock salt lumps into powder.

Stirring

We use a glass rod to stir liquids.

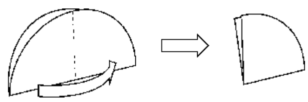
Have a go at measuring 10cm³ of liquid in a measuring cylinder and adding the rock salt. Stir it well with a glass rod.

Filtering

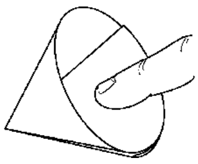
Filtering can be used to separate a mixture of a liquid and a solid that does not dissolve in the liquid. You need a filter funnel and filter paper.

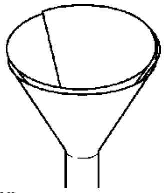
Have a go at filtering out the rock from your mixture.

Fold the filter paper in half, and then in half again.

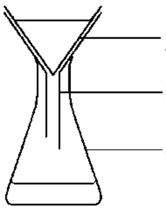


The curved part of your filter paper should now have four layers. Carefully push your finger into the gap between the first and second layers, and push them apart carefully. The paper should make a cone shape.



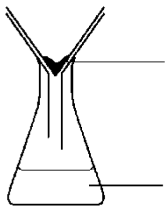


Put the filter paper into the funnel, and add a little clean water so that the paper sticks to the funnel.



Put the funnel into a conical flask or beaker, and carefully pour the mixture into the paper. Do not let the mixture get above the edge of the paper

If you have been careful, you should get all of the solid left on the filter paper. This solid is called the **residue**. The liquid that has gone through the paper is called the **filtrate**.

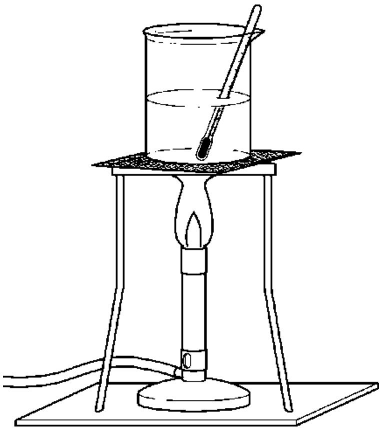
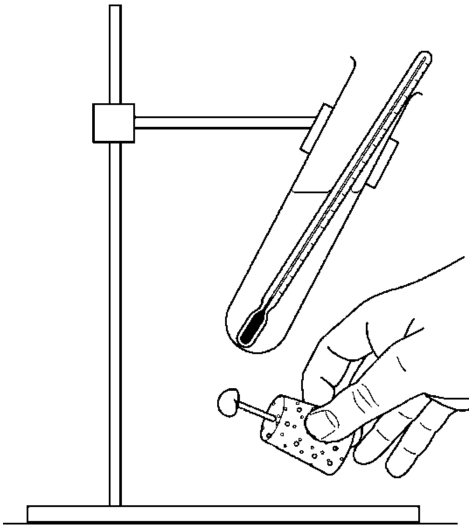
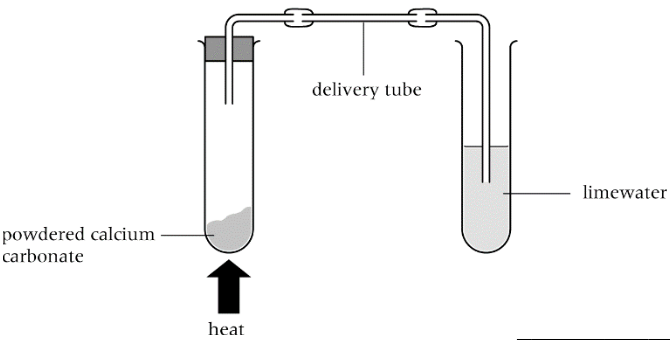


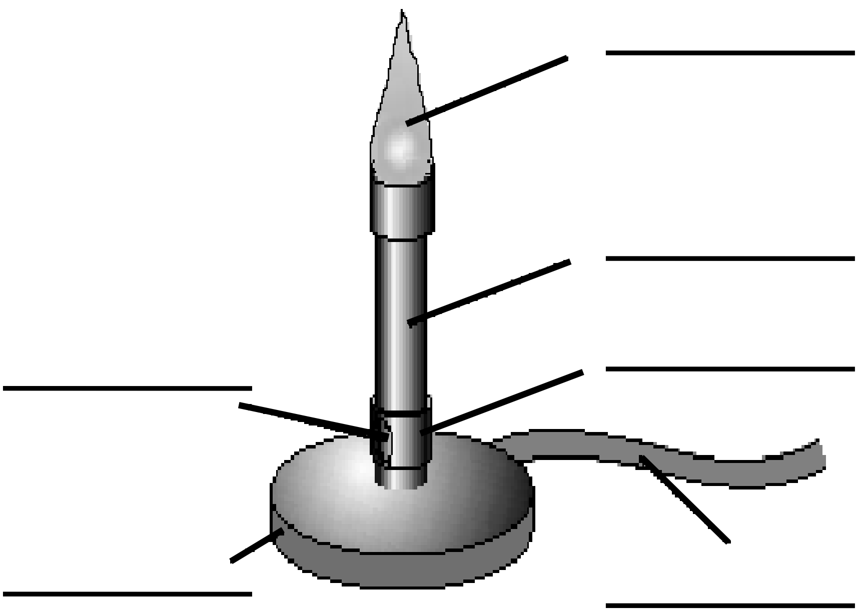
Extension

Which equipment did you find the most difficult to use? Why?

Were you able to accurately measure using the equipment?

What practical/measuring skills do you need to practise?

Knowledge check	What equipment do you need for these experiments?
	 ____________ ____________ ____________ ____________  ____________ ____________ ____________ ____________  ____________ ____________ ____________ ____________

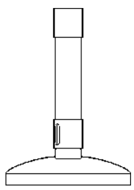
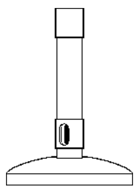
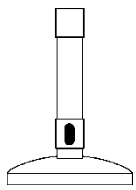
Lesson 3:	The Bunsen burner	
I will be able to...	Aspire:	Evaluate a practical investigation and propose improvements to it.
	Challenge:	Investigate the different flames of the Bunsen burner to establish their different properties.
Starter activity:	Think about the science safety rules. Which rules do you think will be especially important when we use a Bunsen burner? ____ ____ ____ ____ ____ ____ ____ ____	
Task	Label the Bunsen burner using the words below  * Air Hole * Base * Chimney * Collar * Flame * Rubber tubing	

Sort these steps to light a Bunsen burner into the correct order.

Quickly light the gas with the splint	
Turn the collar to get the correct flame for the experiment	
Close the air hole completely	
Place the Bunsen burner onto a heatproof mat	
Light a splint	
Turn on the gas tap	
Put on your eye protection	
Once a flame appears from the Bunsen burner, move your hand away quickly	
Attach the rubber tubing firmly onto a gas tap	
Always leave the air hole closed when you walk away from the Bunsen burner	

The Bunsen burner has three different flames.

Complete the table using your lit Bunsen burner.

Type of flame	**Safety**	**Medium**	**Roaring Flame**
Type of air hole	Closed	Half open	Open
Diagram of flame			
Amount of air mixing with gas			
Amount of noise			
Main colour of flame			

We will investigate which Bunsen burner flame heats water most quickly.

You need to heat water with your Bunsen burner and record the change in temperature.
The water which heats the most shows the hottest flame.

What do we need to keep fair in this test?

____

____

____

____

Why do we need to make it a fair test?

____

____

____

____

Results

Flame	Temperature of water before heating (^oC).	Temperature of water after heating (^oC).
Safety		
Half-open		
Roaring flame		

The hottest flame is the ___________________________________.

	Extension Evaluate the practical Was it really a **fair test**? ____ ____ How could you make it more **fair**? ____ ____ Was it **accurate**? ____ ____ How could you make it more **accurate**? ____ ____ Was it **reliable**? ____ ____ How could you make it more **reliable**? ____ ____
Knowledge check	Which kind of Bunsen burner flame should I use to: a) Heat a beaker of water slowly to gradually heat a test tube containing candle wax. ____ b) Boil water as quickly as possible. ____ c) Show that the Bunsen burner is on but not working. ____

Lesson 4:	Method Writing	
I will be able to...	Aspire:	Justify the choices of equipment and method in terms of how this makes the test fair, accurate and reliable.
	Challenge:	Describe how to conduct an investigation into the effect of salt on boiling water.
Starter activity:	Write a set of instructions explaining how to make a cup of tea with milk and sugar. Imagine the person reading it has never seen it done before. ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ After hearing other people's instructions how would you change yours? ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________	

Task	

Task

Scientists test hypotheses – they find out whether changing one factor will affect another factor.

Once you have identified a question you can think about what the hypothesis would be and how to test it.

Try these – what would the hypothesis be and how could you test it?

Problem	Observations	Hypothesis	Experiment
Your neighbour complains about getting small flies all over her washing hung in the garden.	It seems to happen more to school shirts than to trousers and skirts.		
You notice your fizzy drinks are going flat more quickly than usual.	You've been storing them in a cupboard because the fridge is full.		
The plants in your house keep dying.	You notice that they are on a shelf above the radiator.		
Your apples sometimes go mouldy when you keep them in the fruit bowl.	It happens more often when you have bananas in the bowl too.		

The Outwood Grange Academy kitchen needs to cook for nearly 2000 people each lunchtime. They want to make their water boil faster in saucepans for cooking potatoes, pasta, rice and vegetables. They have heard that adding salt to water affects how fast it boils.

What would your hypothesis be?

____

____

Plan an investigation to test your hypothesis.

You must include;

- The **equipment** that you plan to use
- **How** you will **use** the equipment
- The **measurements** that you are going to make
- How you will make it a **fair test**
- A **risk assessment** (health and safety)

a) What equipment will you be using?

____

____

____

____

____

____

b) Write a step by step method explaining how to do the experiment.

____

____

____

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____

____

c) What measurements will you be making in your investigation?

d) What will you do to make this a fair test? (Try to talk about at least 3 things.)

e) Are there any health and safety things that could go wrong? How likely are they to happen? What will you do to reduce the risk of them happening?

	____ ____ ____ ____ ____ ____ ____ ____ **Extension** Produce a table which you can record your results in. Remember to include full descriptions and units.
Knowledge	PIN mark the method using the sheet on the next page.

check	You may mark your own or peer assess.

Planning an Experiment   This work was marked by ____________________

P	**Praise. What were the positive aspects of the work? What did they do well? What skills did they demonstrate?**						
I	**Improvements. What were the literacy issues in the piece of work?**		*Write in ink.*		*Draw in Pencil.*		*Use a ruler.*
	Always use capital letters at the beginning of a sentence.		Learn the spellings identified in your work.				
	Always use capital letters for proper nouns.		Ensure sentences make sense.				
	Make sure you write on the line and not above or below it.		Use correct punctuation.				
	Use scientific vocabulary appropriate to the task.		Vary your sentences to demonstrate your understanding.				

Level 4 answer		Level 6 answer		Level 8 answer	
Some of the equipment needed is listed.		Most of the equipment needed is listed.		All of the equipment needed is listed.	
The method isn't very clear to follow but they have done a step by step list with some of the main instructions.		The method isn't as clear as it could be but could be followed and get to get good results.		The method is clear and anyone could follow it to get good results.	
The measurements to be made are listed.		The measurements that need to be made are listed, and at least one control variable is listed.		The measurements are listed and several control variables are stated with details of how they will be kept the same.	
Something dangerous is written down, but the way to make it safer is missing or not very good.		Most of the dangers have been listed and some ways to avoid them are given.		All of the dangers have been listed and how likely they are to happen. They have said how to make it safer.	
The method isn't very well organised, they haven't been very detailed and they haven't used proper scientific names.		The method is quite well organised and detailed. They have used some proper scientific names.		The answer is clear and written in an organised way. They have used many proper scientific names.	

N	**Next Steps. How can they score more points on planning an experiment? What didn't they include?**	**Grade**	**Effort**

Lesson 5:	Carrying out an Investigation	
I will be able to...	Aspire:	Analyse and explain the results of the investigation.
	Challenge:	Investigate the effect of salt on boiling water.
Starter activity:	Your teacher will give you a method for today's experiment. Glue it here. Underline anything which makes this experiment **fair** in one colour, **accurate** in another colour and **reliable** in a third colour. Show which is which colour.	
Task	Your teacher will give you a table for this experiment. Glue it here. Follow the method and complete the practical.	

What will we do with this data? We can plot a graph.

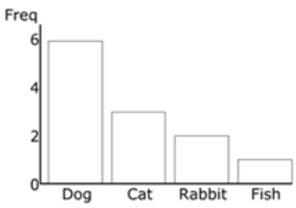
There are three types of variables in science investigations:

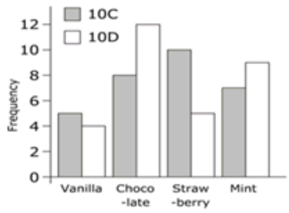
Independent – the thing **I** change.

Dependent – the thing which changes **depend**ing on the thing I change.
(The thing you measure to see the effect of the independent variable.)

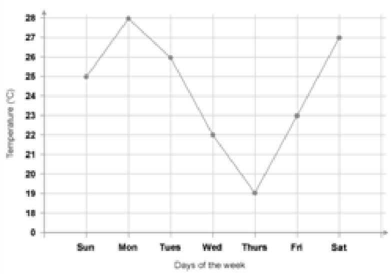
Control – the things you **control** to keep it a fair test.
(All of the things you keep the same.)

Bar charts show how things differ in different categories. The categories can't be put on a scale.
We can compare more than one set of data.



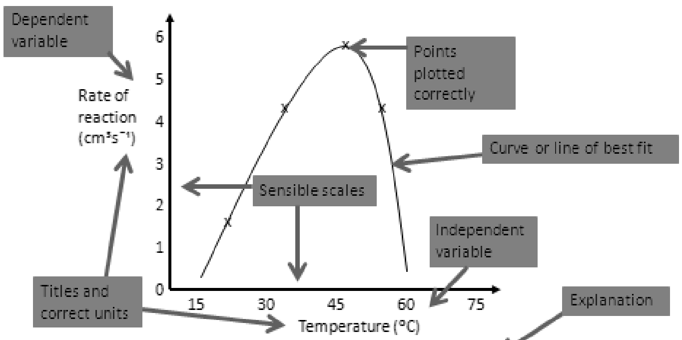


Line graphs show us how the dependent variable changes as the independent variable does.
The independent variable fits along a scale.
We can add a line to show the trends.



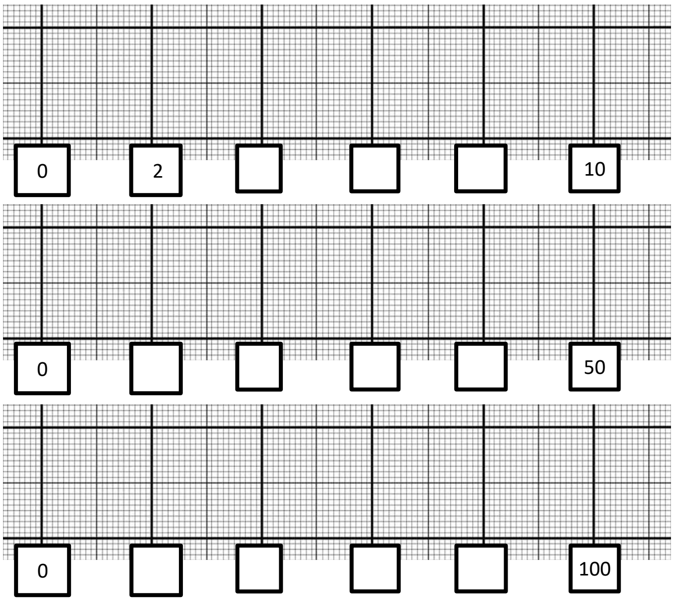
The independent variable **always** goes on the bottom of the graph.

What a Good Graph Looks Like



I have chosen a line graph because the independent variable is a continuous variable (temperature).

<table>
<tr><td></td><td>What type of graph will you plot for this experiment? Why?

Scales
You need to plot a scale that makes sense.
Finish off the scales with numbers.


0-10
0-50
0-100
Extension
What do your results show you? What effect does salt have on the time taken for water to boil? If you want to you can research why you got these results at home.</td></tr>
<tr><td>Knowledge check</td><td>How do your results compare to the other people in the class?
If they are different why do you think they are different?</td></tr>
<tr><td>Homework</td><td>Produce a graph of your results on graph paper.
Your graph must have axis labels and units, a clear and sensible scale, correctly plotted points and a line of best fit. Your teacher has a help sheet if you need it.</td></tr>
</table>

<table>
<tr><td>Lesson 6:</td><td colspan="2">Analysing Results</td></tr>
<tr><td rowspan="2">I will be able to...</td><td>Aspire:</td><td>Analyse results from unfamiliar investigations and evaluate their merit.</td></tr>
<tr><td>Challenge:</td><td>Apply the knowledge from your investigation to the results from other people's investigations.</td></tr>
<tr><td>Starter activity:</td><td colspan="2">Following your investigation into the effect of salt on boiling water what advice would you give to the canteen staff to help them speed up their cooking?
____
____
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______________________________________</td></tr>
<tr><td>Task</td><td colspan="2">a) What were the variables in your experiment?
Independent ______________________________
Dependent ______________________________
Control ______________________________
b) In your experiment you used a range of masses of salt. What was the range of the masses you used? (what was the minimum and maximum amount? – with units)
________________ to ________________
c) Look at your results table and graph. Did you have any results which didn't fit the main pattern? What do you think we should do with these?
____
____
______________________________________</td></tr>
</table>

d) Look at this set of results from a similar experiment.

Amount of salt (pinches)	Boiling Temperature (^{o}C)
No salt	96
2	96
4	95
6	95.5

What would the graph of these look like? Sketch the shape here. Remember the axis labels and units.

e) What do these results show?

f) Their experiment isn't as **accurate** as yours. How could their experiment be improved?

g) Do their results support the advice you gave to the canteen staff? Why?

Extension

The results of an investigation into whether the type of salt used affects boiling point is shown below.

Salt used	Boiling temperature (^{o}C)
Lithium chloride	133
Sodium chloride	109
Potassium chloride	100

Sketch a suitable graph/bar chart of this data. Remember units.

Why did you choose this type of graph?

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Does the type of salt affect boiling temperature?

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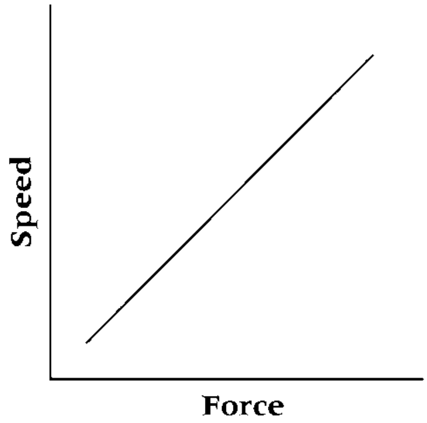
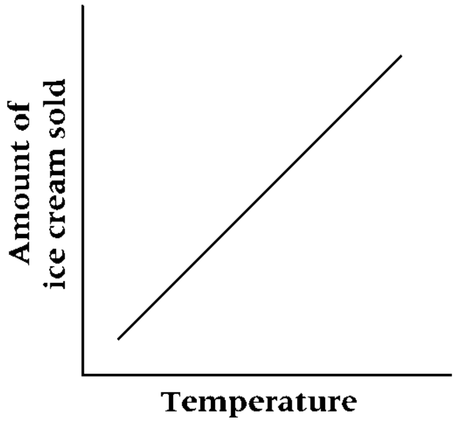
Knowledge check

What do these graphs tell us?

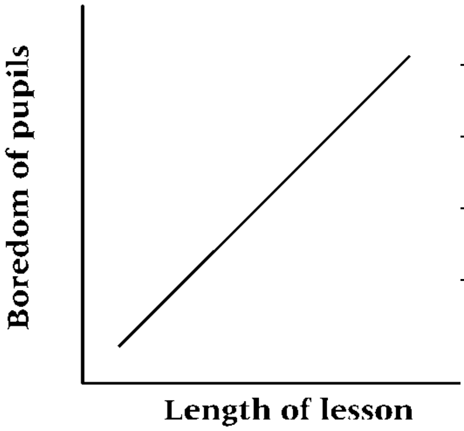
A graph showing the force on the pedals and the speed of a bicycle.



A graph showing the outside temperature and amount of ice-cream sold.



A graph showing the length of lessons and the boredom of the pupils.



Science Investigation Glossary

Accuracy	An accurate measurement is considered to be close to the true value. Accurate readings are done by using suitable equipment.
Anomalies	These are values in a set of results that are not judged to be part of the variation caused by random uncertainty.
Calibration	Marking a scale on a measuring instrument.
Categoric variables	Categoric variables are **labels**. For instance, type of material, brand of shoe or name of plant.
Continuous Variable	A variable that can have a **quantity**, and can be given magnitude by counting (e.g. number of fish) or measuring (e.g. light intensity).
Control Variable	A variable which is kept **constant** so that it does not affect the outcome of the investigation.
Data	Quantitative or qualitative information that has been collected.
Dependent Variable	The variable that is **measured** for each and every change of the Independent Variable.
Evidence	Data which has been shown to be valid.
Fair Test	A test where only the independent variable has been allowed to affect the dependent variable.
Hypothesis	A proposal intended to explain certain facts or observations.
Independent Variable	The variable that has values **changed** or selected by the experimenter.
Interval	The quantity between readings. (e.g. Six readings equally spaced between 0 and 50cm would give an interval of 10cm)
Measurement Error	The difference between a measured value and the true value
Precision	Precise Measurements are ones in which there is very little spread about the mean value.
Prediction	A prediction is a statement suggesting what will happen in the future, based on observation, experience or a hypothesis.
Random Error	Cause readings to unpredictably spread about the true value. Reduced by repeat measurements and the calculation of the mean.
Range	The minimum and maximum values of the Independent and Dependent Variables. Important to detect any existing patterns.
Repeatable	A measurement is repeatable if the experimenter can use the same method and equipment and obtain the same result
Reproducible	A measurement is reproducible if the investigation is repeated by a different person, or by using different equipment or techniques, and the same results are obtained
Resolution	The smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading
Sketch graph	A line graph, not necessarily on a grid, showing the relationship between two variables. No plots or scales used, but axes labelled.
Systematic Error	Measurements that differ from the true value by a consistent amount. Caused by the method used, equipment or the environment.
True Value	This is the value that would be obtained in an ideal experiment.
Uncertainty	The interval within which the true value can be expected to lie, with a given level of confidence or probability. (e.g. The temp. is 20°C ± 2°C)
Valid Conclusion	A conclusion supported by valid data, obtained from an appropriate experimental design and based on sound reasoning.
Validity	Suitability of the investigation to answer the question being asked.
Zero Error	Any indication that a measuring instrument gives a false reading when the true value of a quantity is zero.