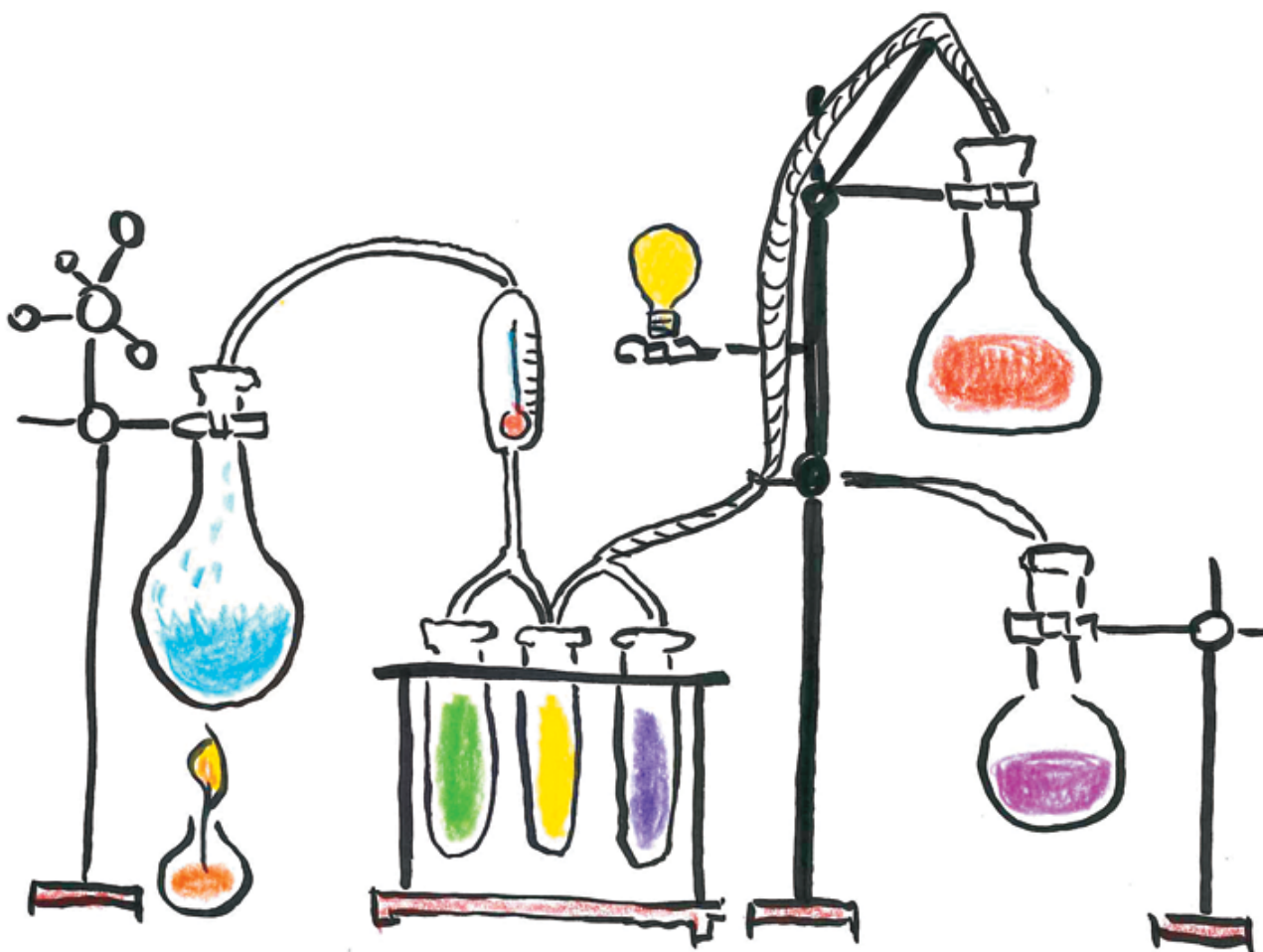


Science Lab

1.1

What is science ?

1.1.1



Learning objectives:

- ➔ To be able to explain how science works.
- ➔ To be able to produce reliable information about the natural world.

Biology, Chemistry and Physics are the major branches of science. These major branches can be further divided into many different sub branches like Genetics or Electromagnetism.

Look at the pictures below and answer the following questions:



What is Biology, Chemistry and Physics ?



PPC, photo montage L. Pin



PPC, P. Woelcher



PPC, photo montage S. Caté, Wikipedia

Biology

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Chemistry

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Physics

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Science is different to other disciplines like languages or history. What do you think science is ?

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What to you ~~isn't~~ science or scientific ?

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What do you think scientists do during their everyday work ?

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Finally, is scientific knowledge different to any other kind of knowledge? Justify your answer.

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Scientists need to develop certain skills
They need to be able to

Explain their
ideas accura-
tely

Explain their
data and
share their
results.

Develop
explanations
using models.



Challenge their
own ideas and
collaborate
with other
scientists

Explain
exactly how
they did their
investigations.

Be ready to
change their ideas
if new data has
emerged.



The Stolen Lunch !

Read the following story about the stolen lunch and each time underline or highlight the suspect that you think did it.

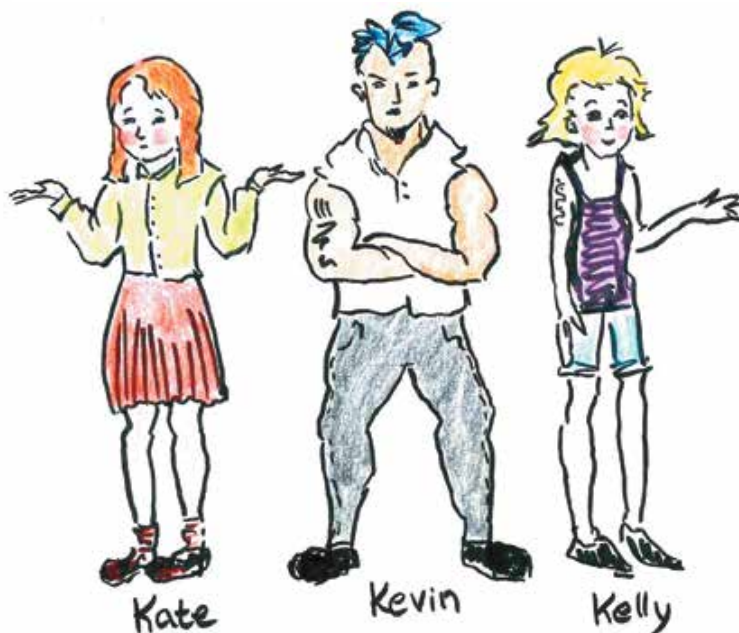


Someone has taken Julie's sandwich and drink!
It was right there on the table a minute ago but now it is gone.... Unfortunately, Julie didn't see who it was. The only thing she can remember is that the culprit had a fake tattoo.



The class teacher wants to solve this incident.

Three students were seen leaving the classroom at the time of the incident. They are....



Kate

Kevin

Kelly



Who do you think took the lunch?



New Evidence!

The teachers have searched the lockers of Kate, Kevin and Kelly.

In Kevin and Kelly's locker were considerable amounts of drinking bottles.



Who did it?

Kate

Kevin

Kelly



New Evidence!

The school's CCTV camera shows that the culprit was not a boy.



Who did it?

Kate

Kevin

Kelly



New Evidence!

The teachers have found out some evidence.

Kevin has recently been buying lots of drinks from the local supermarket and stored them in his locker.



Who did it?

Kate

Kevin

Kelly



New Evidence!

The teachers have found out some evidence.

Kate's mum has been preparing her drinking bottles for school while Kelly's mum is watching TV on the sofa.



Who did it?

Kate

Kevin

Kelly



New Evidence!

The teachers have found out some evidence.

Kate has been storing all of her drinking bottles her mum gave her in her locker. However, she has been supplying a friend with the drinks.



Who did it?

Kate

Kevin

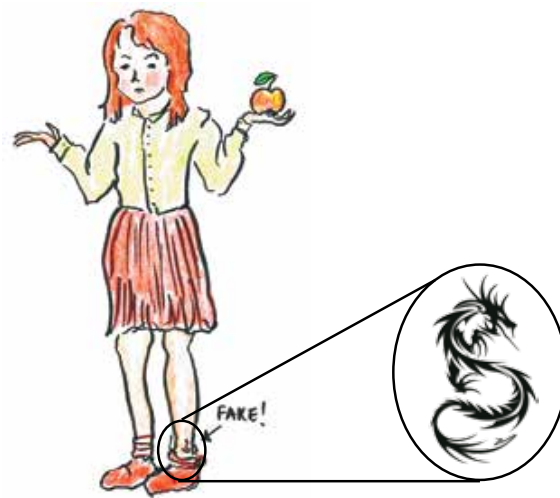
Kelly



New Evidence!

The teachers have found out some evidence.

Kate has a fake tattoo.



Who did it?

Kate

Kevin

Kelly



New Evidence!

The teachers have found out some evidence.

They searched Kate's locker again and found Julie's sandwich and drink in Kate's sport bag !

Kate did it!



As you were reading through the story of the stolen lunch did the person you suspected change?



Why?



Which scientific skill do you think this story has taught you?

Some Famous Scientists



Archimedes
(c.287-212 BCE) was an ancient Greek mathematician and inventor.



Leonardo da Vinci
(1452-1519) was an Italian inventor and artist who lived during a period of history called the Renaissance.



Galileo Galilei
(1564-1642) was an Italian astronomer and physicist. He was one of the first people to test his ideas by experiment.



Benjamin Franklin
(1706-1790) was an American inventor and politician. His most exciting invention was the lightning rod.



Isaac Newton
(1642-1727) was an English mathematician. He worked out how gravity works.



Carl Linnaeus
(1707-1778) was a Swedish botanist, a scientist who studies plants. He came up with the modern method of classifying living things.



Mary Anning
(1799-1847) was a famous English fossil hunter. She discovered the first Ichthyosaurus, which means "fish lizard".



Charles Darwin
(1809-1882) was an English naturalist who showed how animals can change over generations to form new species, a process called evolution.



Ada Lovelace

(1815-1852)
was a British mathematician whose work helped in the development of computers.



Gregor Mendel

(1822-1884) was an Austrian monk and botanist. He is the fathers of genetics.



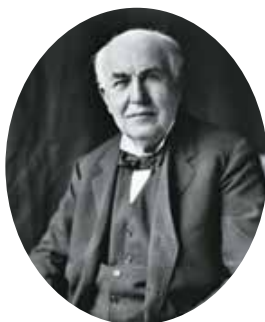
Louis Pasteur

(1822-1895) was a French biologist who worked on vaccinations to stop people getting ill.



Alexander Graham Bell

(1847-1922) was a Scottish-born US inventor who patented the first telephone.



Thomas Edison

(1847-1931) was an American inventor. He improved the telephone and invented the light bulb.



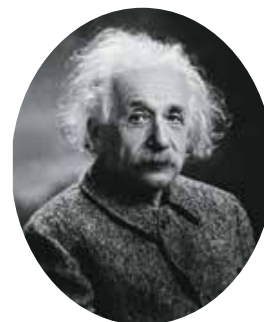
Nikola Tesla

(1856-1943) was a Serbian-American inventor who worked on electrics and radio technology.



Marie Curie

(1867-1934) was a Polish physicist who worked on radioactivity. She pioneered using x-rays.



Albert Einstein

(1879-1955) was a German physicist whose theory of relativity transformed our understanding of the universe.



Rachel Carson

(1907-1964) was an American marine biologist. Her findings helped developing US laws to conserve the oceans.



Alan Turing

(1912-1954) was a British mathematician and computer scientist. He is most famous for solving the German naval enigma code during World War II.



Francis Crick

(1916-2004) was an English scientist who discovered the structure of DNA with James Watson.



James Watson

(1928-) is an English scientist who discovered the structure of DNA with Francis Crick.



Rosalind Franklin

(1920-1958) was an English scientist who made X-ray images of DNA



Jane Goodall

(1934-) is an English scientist famous for her studies of chimpanzees. She discovered that chimpanzees are omnivores like humans and that they make and use tools.



Stephen Hawking

(1942-2018) was an English physicist. He worked on cosmology, the science of the overall structure of the universe.

Source: rewritten from www.dkfindout.com

Notes:

Notes:

Science Lab

1.1

Measurements and units 1.1.2



Centimeter



Liter



tablespoon

Learning objectives:

- ➡ To be able to explain the need for a universal system of measurement in science.
- ➡ To be able to identify and use the most common SI prefixes and how to convert them.

The Story of the Dizzy Dog

Once upon a time there was a dizzy dog who went to the local bakery to do his shopping. He entered the bakery and said "Good morning" to the baker. "I would like to buy a cubic centimetre of bread please."

"Oh, I am ever so sorry" said the baker to the dizzy dog "but today I don't have any cubic centimetre of bread left. Would you like to get a litre of cake instead?" "No, thank you, I will just take an hour of biscuits." "In minutes or seconds?" asked the baker. "In degrees Celsius if you please." said the dizzy dog. "I will also take 7 Euros of bread rolls please."

"I 'm sorry" said the baker again "today I only sell 250 Volts of bread rolls." "Oh that's too much for me I will take two and a half Amps of vanilla slices then."

"Shall I pack them in metres or millimetres for you?" asked the baker. "Well, normally I buy them in calories!"

"Oh no!" said the dizzy dog. "I am late for my meeting!», «I have to run, the meeting starts in 5 kilograms! Good bye" said the dizzy dog to the baker and left the bakery.



The dog and the baker in the story seem to have a problem. Describe the problem the two characters in the story seem to have.



Suggest a possible solution to their problem.

Where Does the English system of Measurement Come From?

People were very creative in times before they had standardised measuring devices. They used familiar objects and parts of their body as measuring devices.

For example, people measured shorter distances on the ground with their feet (one foot) while they measured longer distances by their paces (a „mile“ was a thousand paces).

To measure capacities or volume they used common household items such as cups, buckets and baskets. In fact, the word gallon comes from an old name for a bucket.



One foot



Do you think this was a good way of measuring? What problems could they have using these devices?

Eventually, a standard was set so that all measurements represented the same amount for everyone.

International System of Units

SI

Le **S**ystème **I**nternational d'unités



Why do you think it is important for people, especially scientists, to use a universal system of measure? Justify your answer.

What Is Accuracy and Precision ?

When taking scientific measurements, it is important to be both accurate and precise.

Accuracy represents how close a measurement comes to its true value.

Using bad equipment, poor data processing or due to human error can lead to inaccurate results that are not very close to the truth.

Precision is how close a series of measurements of the same thing are to each other.

If you do an experiment once the result could have occurred from a random error. If however you do an experiment 50 times and you get the same or a similar result each time then your results are more precise.

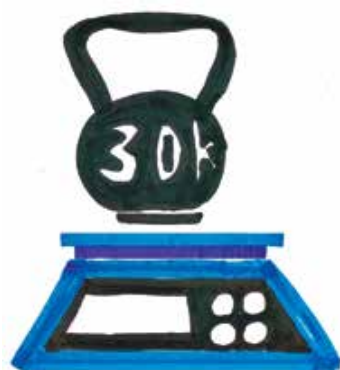
For example:

If you put a 30 kg mass onto a balance and you get a reading of 30.04 then your balance gives you an accurate reading because the value is close to the true value.



30.04 kg

If you put a 30 kg mass 3 times onto the balance and you get a reading of 30.02, 30.08 and 30.04 then your results are precise because each time you got a similar result.



30.02 kg



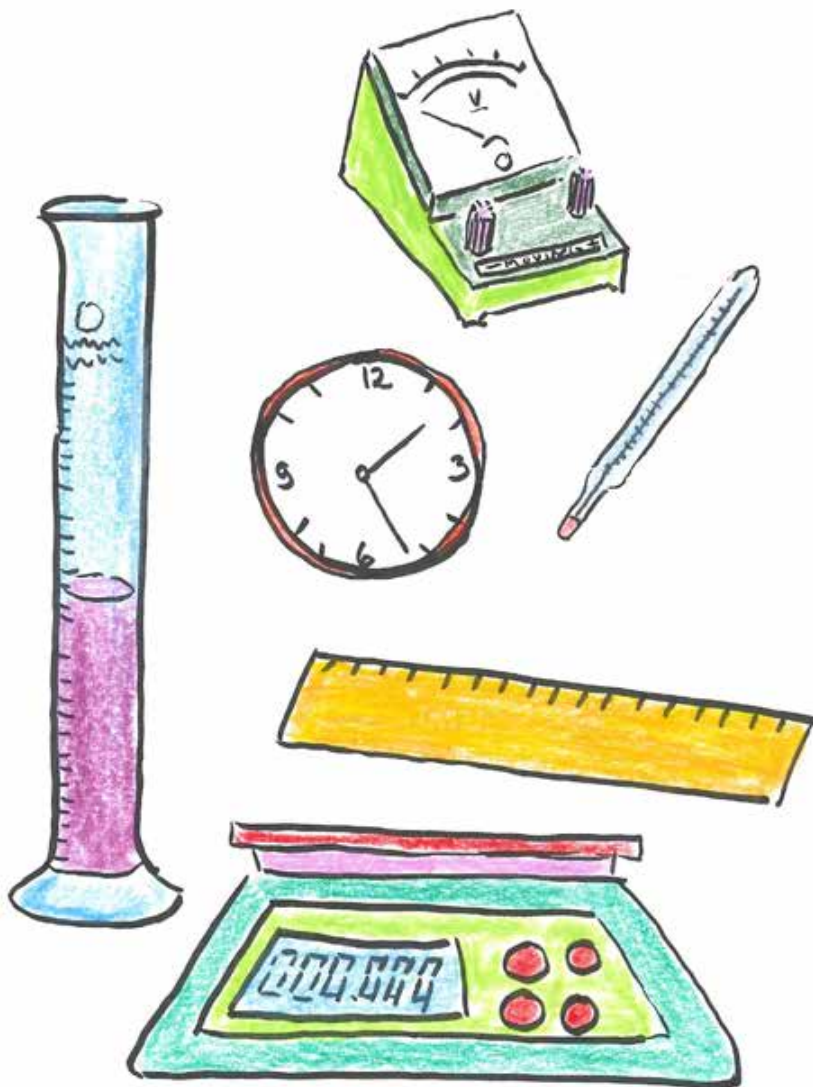
30.08 kg



30.04 kg

Units and Quantities that are Used in Measuring

Look at the different measuring objects below, then fill in the table underneath.



Measuring instrument	Quantity measured (What is measured?)	Units used

Measuring Length

Length is a measure of how **long** or **wide** something is. Rulers, tape measures or trundle wheels can be used to measure length or distance.

The commonly used metric units of length include:

kilometres (km)

metres (m)

centimetres (cm)

millimetres (mm)

Before you measure something you need to estimate how big it is because this will tell you which measuring device and unit would be the best suited.

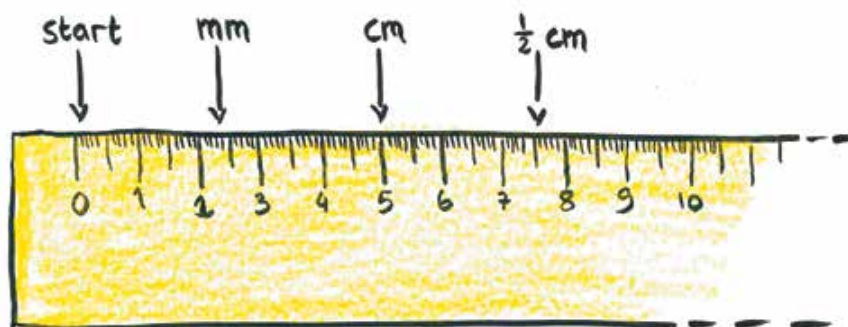
For example: If you want to measure the distance between our school and the local park you should use a trundle wheel and measure in km.



However, if you want to find out how long an insect is you should use a ruler and the unit mm unit.



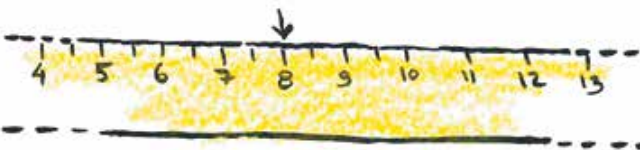
Using a Ruler Correctly



Identify the correct value which the arrows show on the following rulers.



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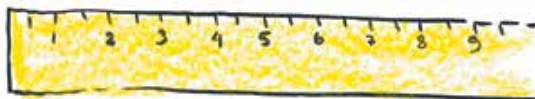


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Draw an arrow to show the correct reading on each ruler...

5 cm



11 cm



9 cm



17 cm

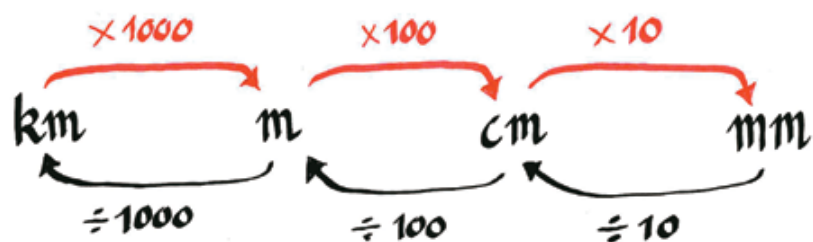


Converting between Units

$$10 \text{ mm} = 1 \text{ cm}$$

$$100 \text{ cm} = 1 \text{ m}$$

$$1000 \text{ m} = 1 \text{ km}$$



Choose 5 objects (list them below) and measure them in cm then use the table to convert them into mm and m.

Object 1

Object 2

Object 3

Object 4

Object 5

	mm	cm	m
Object 1			
Object 2			
Object 3			
Object 4			
Object 5			

Converting Practise

Convert the following measurements into centimetres:

- a) 2 m =
- b) 5 m =
- c) 1.3 m =
- d) 4.6 m =
- e) 7.2 m =
- f) 2.64 m =
- g) 8.12 m =
- h) 5 m 15 cm =
- i) 21 m 6 cm =
- j) 465.86 m =

Convert the following measurements into metres:

- a) 150 cm =
- b) 124 cm =
- c) 365 cm =
- d) 17 cm =
- e) 1324 cm =
- f) 736.4 cm =
- g) 52.1 cm =
- h) 7 cm =
- i) 6.2 cm =
- j) 11620 cm =



Extension:

1. Thomas is 1,53 cm tall. Alice is 25 cm shorter. How tall is Alice in metres?

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2. One book is 25 cm long. Another book is 78 cm long. What is their total length in metres?

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3. Students of a class have measured the length of one window. It is 70 cm long. There are 3 windows in the class room. What is their total length in metres?

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Measuring Mass

Mass is a measure of how **heavy** something is. Scales of different sizes can be used to measure mass.

The commonly used metric units of mass include:

Milligrams (mg)

Grams (g)

Kilograms (kg)

Tons (t)

Like with the length it is a good idea to estimate the weight before you weigh it. Again this will tell you which size scale and unit would be the best suited.



For example: If you want to find out the mass of a letter you could use a letter balance and use the g unit. If however you want to find out your mass you should use a bathroom scale and the kg unit.



Measure Mass in Science Using an Analytical Balance

There are three possibilities of measuring mass using an analytical balance.

1. You can measure the mass directly.

- ➡ Switch the balance on
- ➡ make sure it reads "0"
- ➡ add your object
- ➡ read the mass.

2. You can measure the mass in a container and deduct the mass of the container.

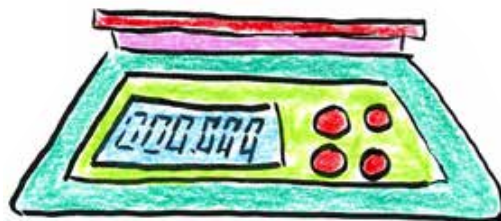
- ➡ Switch the balance on
- ➡ make sure it reads "0"
- ➡ add your container
- ➡ note the mass of the container
- ➡ add your object
- ➡ read the mass
- ➡ deduct the mass of the container from the total mass

3. You can add the container before you switch on the balance.

- ➡ Add your container on top of the balance
- ➡ Switch the balance on
- ➡ make sure it reads "0"
- ➡ add your object
- ➡ read the mass

Should there be a reading on the balance after you switched it on before

you add anything press the **tare button**. Then the balance should read "0".

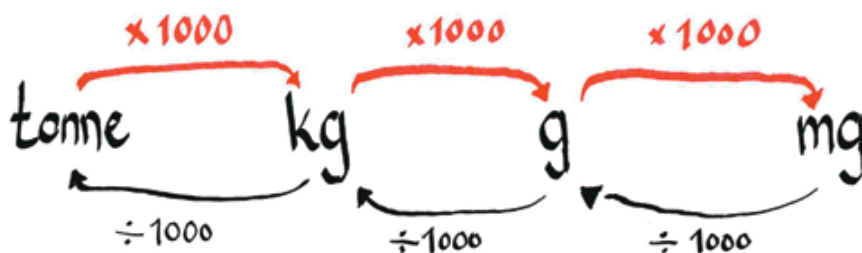


Converting between Units

$$1000 \text{ mg} = 1 \text{ g}$$

$$1000 \text{ g} = 1 \text{ kg}$$

$$1000 \text{ kg} = 1 \text{ t}$$



Choose 5 objects (list them below) and measure their mass in grams (g) using a balance. Then use the table to convert them into mg and kg.

Object 1

Object 2

Object 3

Object 4

Object 5

	mg	g	kg
Object 1			
Object 2			
Object 3			
Object 4			
Object 5			

Converting Practise

Convert the following measurements into grams

- a) 5 kg =
- b) 25 kg =
- c) 130 kg =
- d) 17.5 kg =
- e) 0.85 kg =
- f) 2640 kg =
- g) 8.12 kg =
- h) 7 kg 10 g =
- i) 23 kg 6 g =
- j) 12 kg 15g =

Convert the following measurements into kilograms:

- a) 2000 g =
- b) 7000 g =
- c) 6400 g =
- d) 12000 g =
- e) 21400 g =
- f) 340 g =
- g) 52.1 g =
- h) 4930 g =
- i) 7005 g =
- j) 11366 g =



Extension:

1. A baker wants to bake cookies. He needs 5 packs of flour each with a mass of 250g. What is the total mass (in grams and kilograms) of the flour all together?

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2. A butcher needs 500 grams of spices to make 50 sausages. He has a 2 kg pack spices. With that how many sausages can he make?

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3. A gardener wants to fill plant containers with soil. Each container needs 3 kg of soil. He has to fill 4 containers. How much soil (in grams and kilograms) will he need all together?

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Measuring Capacity

Capacity or **volume** is a measure of how much **space** something takes up.

Measuring cylinders, measuring spoons or measuring jugs can be used to measure capacity.



Metric Units of Capacity

Capacity is measured in **millilitres (ml)** and **litres (l)**.

$$1 \text{ l} = 1000 \text{ ml}$$

Estimating capacity:

➡ 5 ml is about the capacity of a teaspoon.

➡ 1l is about the capacity of a milk carton.

Temperature

Temperature is a measure of how **hot** or **cold** things are. In order to measure temperature you need a thermometer.

Temperature is measured in **degrees Celsius (°C)**.

➡ Ice melts at exactly 0°C.

➡ A hot bath is about 40°C

➡ Water boils at exactly 100°C



Heat always travels from a warmer area to a cooler one. So a hot drink left in a cold place will always lose heat to the surroundings. It will get cooler until eventually it is at the same temperature as its surroundings.

Build a Thermometer

What you need:

- ➔ Small plastic bottle
- ➔ Modelling clay
- ➔ Clear plastic straw
- ➔ Coloured water



What you do:

1. Fill the small plastic bottle with lukewarm coloured water to the top.
2. Insert the straw a few centimetres into the bottle and tightly seal the bottle with the modelling clay. The modelling clay should hold the straw in place and some water should go up the straw.
3. Use a marker to mark the level of the water in the straw.
4. Set the bottle in a bowl of hot water. Watch the water level for awhile and then mark the level again.
5. Set the bottle in a bowl of ice and watch what happens, then mark the level.



What did you observe?

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Why do you think this happened?

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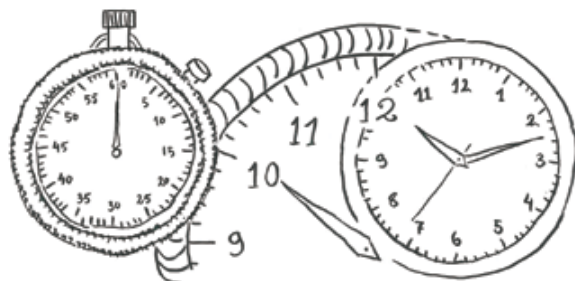
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Measuring Time

Time is measured in hours, minutes and seconds.

There are:

- ➔ 60 seconds in 1 minute
- ➔ 60 minutes in 1 hour
- ➔ 24 hours in 1 day



Time experiment

Find a partner who will take the time whilst you draw then swap and take your partner's time. Record your results at the bottom and compare the time you needed to draw with your class mates.

In the box below draw a house with two windows and a door. In front of the house is a road with a car driving on it and a dog sits next to the door. Also there is one tree standing on the street and there are clouds in the sky.

Time taken:

Notes:

Notes:

Science Lab

1.1

A science lab

1.1.3



Learning objectives:

- ➡ To be able to identify basic scientific instruments.
- ➡ To be able to work safely in a lab.
- ➡ To be able to design a controlled experiment.



Common Laboratory Equipment



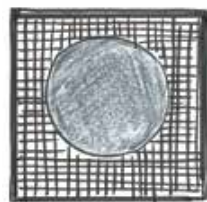
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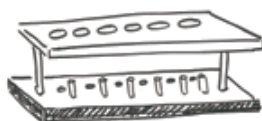
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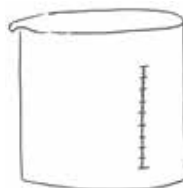
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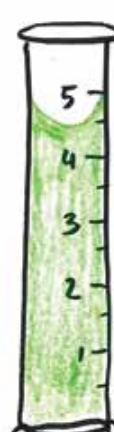
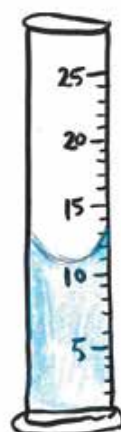
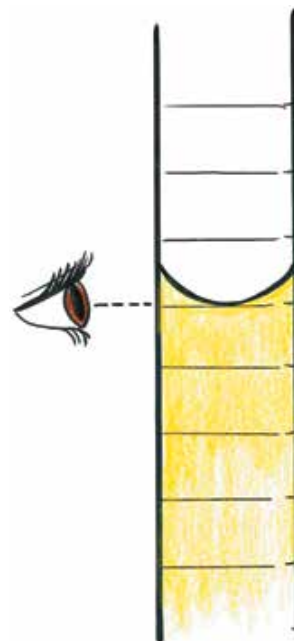


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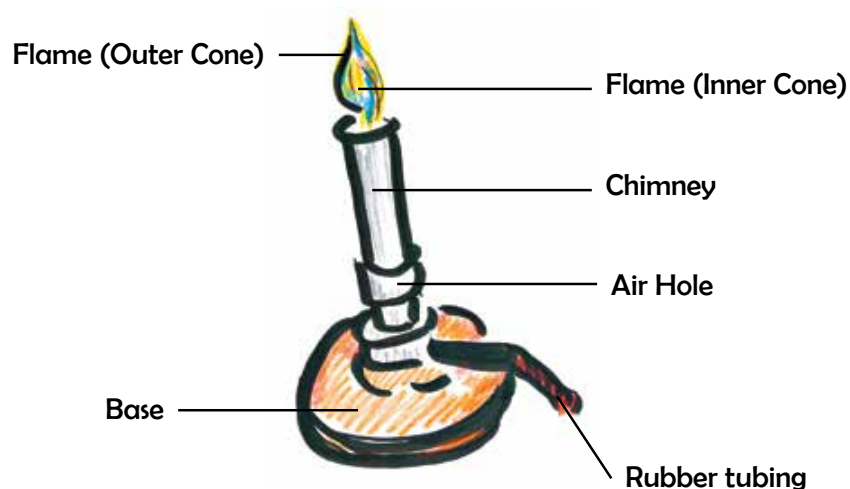


Reading Volume Correctly

- ➔ Place measuring cylinder on a flat surface like a table.
- ➔ Eyes should be level with the liquid.
- ➔ The liquid curves downwards this is called the meniscus.
- ➔ Read the volume at the lowest point of the meniscus



Using a Bunsen Burner



	Air hole closed	Air hole half open	Air hole open
Type of Flame	Safety Flame	Blue Flame	Roaring Flame
When do we need to use this flame?	When we are not using the Bunsen but want to keep it on.	To heat things slowly.	To heat things fast.



Steps to Light a Bunsen Burner

1. Tie back your hair. Fix loose clothing.
2. Place the Bunsen burner flat on the table.
3. Connect the rubber tubing on the Bunsen burner to a gas tap on your desk. Do not turn the gas tap on yet.
4. Make sure the air hole is completely closed on your Bunsen burner and then light a match.
5. Turn on the gas tap that is connected to your Bunsen burner and hold the lit splint at the top of the Bunsen burner. This should light it.

Bunsen Burner Licence

This certifies that

.....

Is able to set up a Bunsen Burner correctly, safely light a
Bunsen Burner and safely adjust the flames.

Date:

Signed:



Why do you think we need Laboratory Safety Rules?

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Think about which Laboratory Safety Rules could be useful?

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Laboratory Safety Rules

- ➔ Go into the lab quietly and sensibly when told to by the teacher.
- ➔ Put your coat and bag away in the correct place.
- ➔ Do not eat or drink in the science lab.
- ➔ Always wear goggles when experimenting.
- ➔ Long hair must be tied back. Take extra care if you have gel or hair spray on your hair.
- ➔ Stand up to do experiments.
- ➔ Do not point a loaded test tube at anyone, do not look down on it.
- ➔ Only use equipment and chemicals that your teacher asks you to use.
- ➔ Move sensibly and quietly around the lab.
- ➔ If someone gets hurt, tell a teacher.
- ➔ If something gets broken, tell a teacher.
- ➔ Never put anything in your mouth.
- ➔ Never smell anything.
- ➔ Never throw anything in the lab.
- ➔ When you have finished, clean and put away apparatus.
- ➔ After experimenting, always wash your hands.



What is wrong in the following pictures ?



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The drawing below shows a lab where there are no safety rules.
Highlight or circle all the things going wrong in this lab.



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Hazard Symbols

Design your own hazard symbol for a given hazard.

- ➡ Dangerous to the environment
- ➡ Toxic
- ➡ Gas under pressure
- ➡ Corrosive
- ➡ Explosive
- ➡ Flammable
- ➡ Caution
- ➡ Oxidising
- ➡ Longer term health hazards



Explain why you have chosen this design.

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Old Hazard Symbols



New Hazard Symbols



You must wear eye protection



You must not drink this water





Lab Report

When we do experiments it is important to record everything about this experiment.

Write down what you would include in a lab report and why?

A lab report needs a.....	Because....

How to Write a Lab Report?

Lab reports always must include the following:

- ➡ Title
- ➡ Equipment List
- ➡ Drawing of the Experiment
- ➡ Purpose of the experiment
- ➡ Risk Assessment
- ➡ Results
- ➡ Hypothesis
- ➡ Method
- ➡ Conclusion
- ➡ Evaluation

Title

Give the experiment a clear title.

Purpose of the experiment

What do you want to investigate?

Hypothesis

What do you think will happen?

Equipment List

List all the equipment that you have used during the experiment. Make sure you list every piece of equipment that you have used.

Risk Assessment

Identify all the equipment, chemicals or procedures which could pose a risk to you and describe what you do to prevent any accidents.

Method

Write it like a recipe. Never include he/she/it/we/you or I.

Drawing of the Experiment

Draw and label the setup of the experiment.

Results

Results should be presented in the easiest way to read as possible. For example: tables, drawings, sentences or graphs.

Conclusion

Write here what happened and what you found out in a scientific way. Include the SCIENCE here! Comment on if this is what you expected.

Evaluation

Write here how your experiment went. Did it go well or not and why? Also comment on what you would change the next time if you were to do the experiment again to make it better.



Plan an individual experiment to answer the following question:

How long does it take to boil 20 ml of water?

Set up the experiment and do your investigation.

Laboratory Report

Title Give the experiment a clear title.

Purpose of the experiment What do you want to investigate?

Hypothesis What do you think will happen?

Equipment List List all the equipment that you have used during the experiment. Make sure you list every piece of equipment that you have used.

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Risk Assessment Identify all the equipment, chemicals or procedures which could pose a risk to you and describe what you do to prevent any accidents.

Equipment/Procedure	Danger	Precautions (What will you do to prevent an accident?)

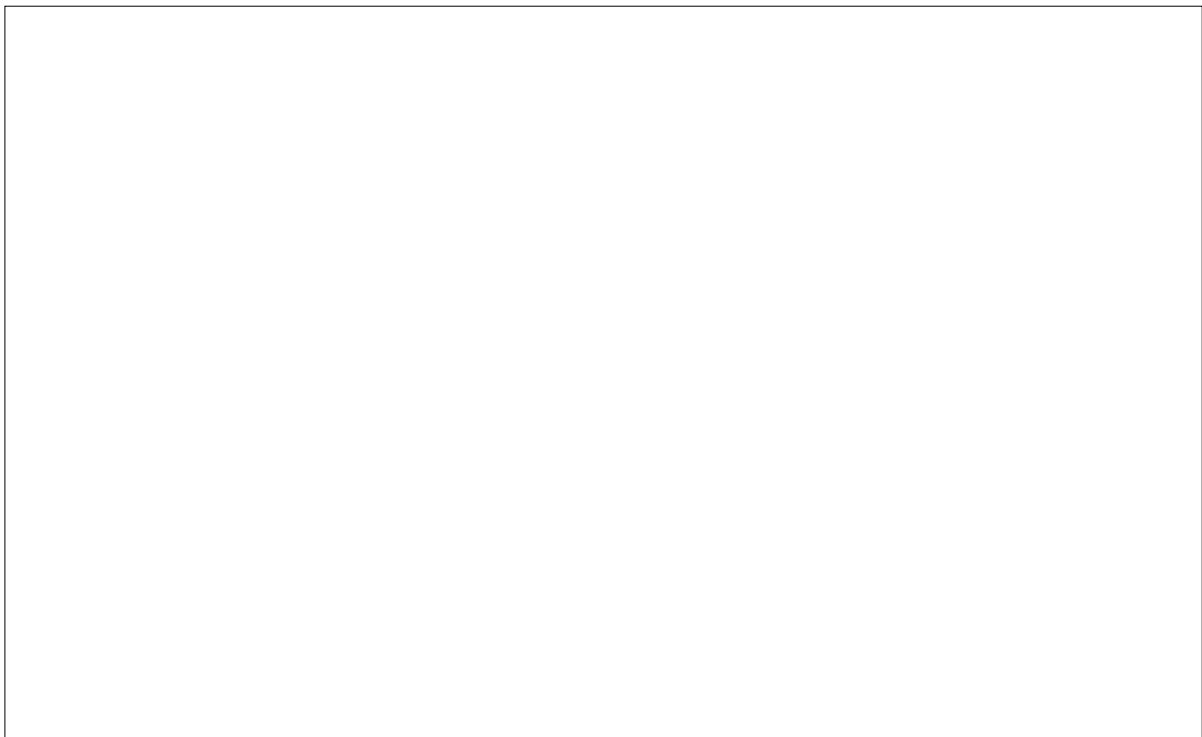
Method Write it like a recipe. Never include he/she/it/we/you or I.

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Drawing of the Experiment Draw and label the setup of the experiment.



Results Results should be presented in the easiest way to read as possible. For example: tables, drawings, sentences or graphs.



Conclusion Write here what happened and what you found out in a scientific way. Include the SCIENCE here! Comment on if this is what you expected.

Evaluation Write here how your experiment went. Did it go well or not and why? Also comment on what you would change the next time if you were to do the experiment again to make it better.

Eureka! - the Story of Archimedes and the Golden Crown

For almost a hundred years, the ancient Greek city of Syracuse had been at war with Carthage. They fought each other for the throne until in 275 BC when the Syracusan troops elected commanders from amongst themselves. One of these was a young general called Hiero.

Hiero had a natural flair and talent for leadership and politics. He managed, through his connections, to enter the city and take over its government, but so smoothly and efficiently, that the citizens of Syracuse, who usually did not approve of soldiers choosing their own commanders, did so in this case. After a great battle in 265 BC, in which Hiero led the Syracusans to victory against their enemies, the people of Syracuse chose Hiero to be their king.

Hiero was grateful to the gods for his success and good fortune, and to show his gratitude, he decided to place a golden crown in their temple. The crown was to be shaped like a laurel wreath. Hiero weighed out a precise amount of gold and appointed a goldsmith to fashion a crown out of the gold, worthy of the gods.

The goldsmith did as he had been ordered, and on the appointed day, he delivered the crown to the king. The crown seemed to weight exactly as much as the gold that the king had given the goldsmith. Hiero was pleased and paid the goldsmith handsomely. The goldsmith, receiving his payment, went away.

Hiero made preparations for the ceremony to place the crown in the temple. But a few days before the ceremony, he heard rumours that the goldsmith had cheated him, and given him a crown not of pure gold, but of gold that had silver mixed in it. The goldsmith, the rumours said, had replaced some of the gold that Hiero had given him, with an equal weight of silver.



Hiero was furious to learn that he might have been tricked. But he was a fair-minded man and wished to determine the truth before he punished the goldsmith.

If the goldsmith had indeed cheated him and mixed silver into the gold, then the goldsmith would have to be punished, and the crown could no longer be given as an offering to the gods. But if the goldsmith had been honest, then the crown remained what it had been intended to be, a sacred offering, and it would be placed in the temple as planned. So it was important that Hiero find out the truth quickly, before the day fixed for the ceremony, and without damaging the crown in any way.

Hiero believed there was only one man in Syracuse capable of discovering the truth and solving his problem. This was his cousin, Archimedes, a young man of 22, who was already renowned for his work in mathematics, mechanics and physics.

Deep in thought, pondering how best to solve the king's problem, Archimedes walked to the public baths for his daily bath. Still thinking about the golden crown, he went through the rituals of cleansing and washing, and stepped into a tub of cool water for his final dip. As he began to lower himself into the water, the water in the tub began to spill out over the sides. Curious, Archimedes continued to lower himself slowly into the water, and he noticed that the more his body sank into the water, the more water ran out over the sides of the tub. He realised that he had found the solution to Hiero's problem.

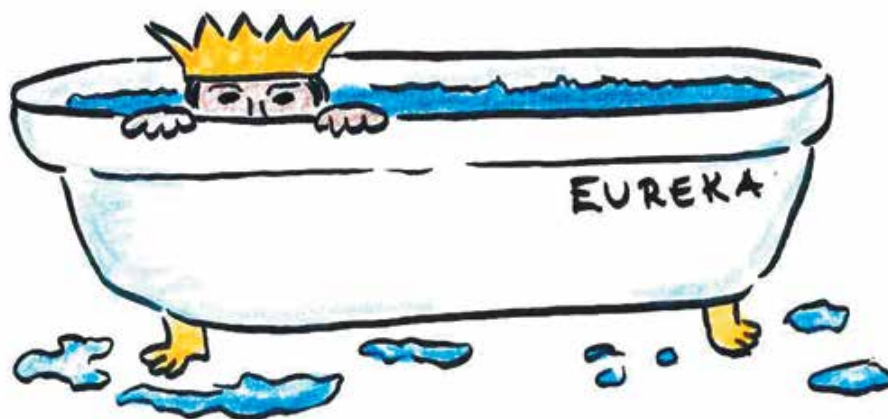
He was so excited by his discovery that he jumped out of the tub at once, and ran all the way home without remembering to put his clothes on, and shouting 'Eureka, Eureka!' - which in Greek means, 'I have found it! I have found it!'

What Archimedes had found was a method for measuring the volume of an irregularly-shaped object. He realised that an object, when immersed in water, displaced a volume of water equal to its own volume, and that by measuring the volume of the displaced water, the volume of the object could be determined, regardless of the object's shape. So, he could measure the volume of the crown by measuring the volume of the water spilled from a container filled with water to the brim when the crown was fully dipped in it.

How then, would this realisation help him to

answer Hiero's question - had the goldsmith mixed silver in the golden crown or not? Let us see how Archimedes used his discovery to solve the king's problem.

In physics, when we speak of the density of an object, we are comparing its mass with its volume, or, in simpler words, considering how



heavy it is in relation to its size. For example, iron is denser than cork. So a lump of iron is much heavier than a piece of cork of the same size, or much smaller than a piece of cork of the same weight.

Archimedes knew that gold was denser than silver - so a piece of gold weighing a certain amount would be smaller than a piece of silver weighing the same.

Thus, if the goldsmith had stolen some of the gold the king had given him, and replaced it with an equal weight of silver in the crown, then the total volume of the gold + silver crown would be greater than the volume of the original amount of gold.

So now, all that remained for Archimedes to do was to compare the volume of the crown to the volume of the amount of gold that Hiero had given the goldsmith.

The simplest method of determining the volume of the crown would have been to melt it down, shape it into a cube and measure its volume. But Hiero had given strict instructions that the crown was not to be damaged in any way. So how was the volume to be determined? This is where Archimedes' discovery came in useful.



First, Archimedes took a lump of gold and a lump of silver, each weighing exactly the same as the crown, and filled a large vessel with water to the brim, precisely measuring how much water was contained in the vessel.

He then gently lowered the lump of silver into it. This caused as much water to spill out over the sides of the vessel as was equal in volume to the lump of silver. Archimedes took the lump of silver out of the water and carefully measured the amount of water left in the vessel, thus arriving at the amount of water that had been displaced by the silver.

Doing the same experiment with the lump of gold, he found that a smaller quantity of water had been displaced by the gold than the silver, and the difference was equal to the difference in volume between a lump of gold and a lump of silver of the same weight.

He filled the bowl with water to the brim a final time, taking care to fill it with exactly the same amount of water as before. This time he lowered the crown into the water. He knew that if the crown was pure gold, its volume would be the same as that of the lump of gold (which he had made sure weighed the same as the crown), regardless of shape, and that it would displace the same amount of water as the gold. If the goldsmith had replaced some of the gold with silver, then the volume of the gold + silver crown would be greater than the

volume of the gold, and so the crown would displace more water than the gold.

Archimedes found that the crown did, in fact displace more water than the lump of gold of equal weight. Thus he came to the conclusion that the crown was not pure gold, and that the goldsmith had indeed mixed some silver (or other, lighter metal) into the gold in an attempt to cheat the king.





Plan a group experiment to answer the following question:

How can we find out the density of a stone?

Set up the experiment and do your investigation.

Laboratory Report

Title Give the experiment a clear title.

Purpose of the experiment What do you want to investigate?

Hypothesis What do you think will happen?

Equipment List List all the equipment that you have used during the experiment. Make sure you list every piece of equipment that you have used.

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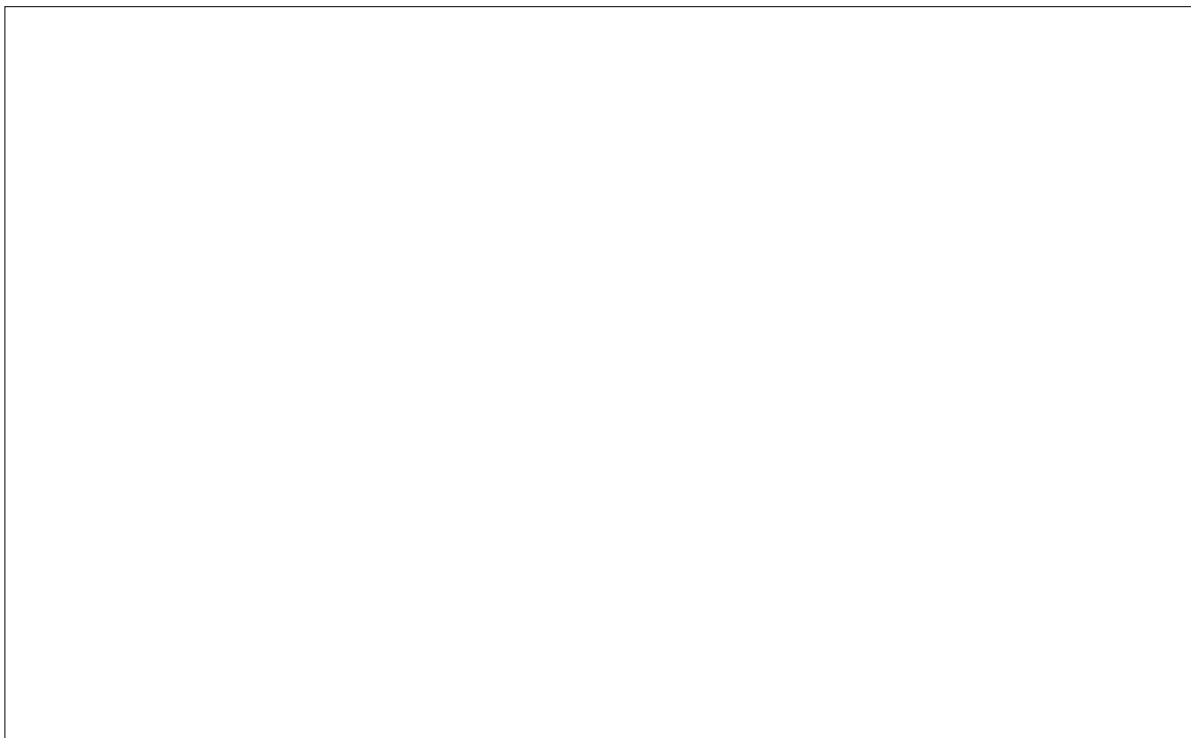
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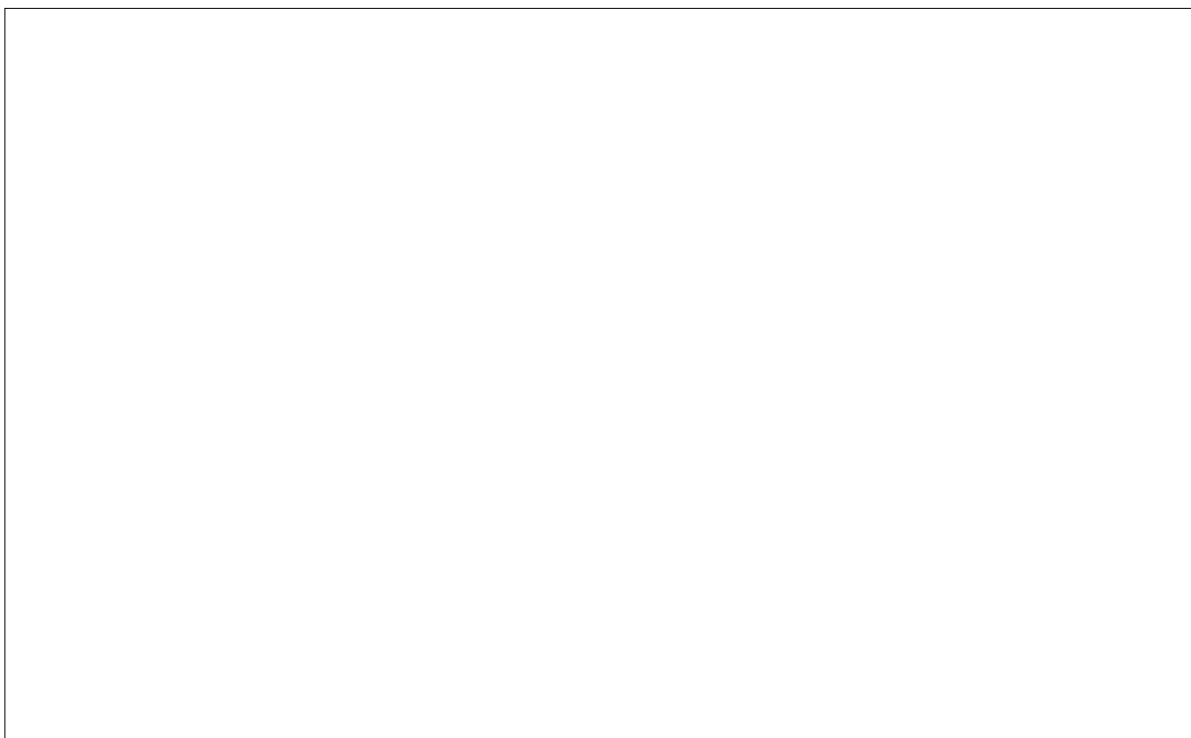
Method Write it like a recipe. Never include he/she/it/we/you or I.

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Drawing of the Experiment Draw and label the setup of the experiment.



Results Results should be presented in the easiest way to read as possible. For example: tables, drawings, sentences or graphs.



Conclusion Write here what happened and what you found out in a scientific way. Include the SCIENCE here! Comment on if this is what you expected.

Evaluation Write here how your experiment went. Did it go well or not and why? Also comment on what you would change the next time if you were to do the experiment again to make it better.



Plan a group experiment to answer the following question:

How precisely will a group of students calculate the time of a runner?

Set up the experiment and do your investigation.

Laboratory Report

Title Give the experiment a clear title.

Purpose of the experiment What do you want to investigate?

Hypothesis What do you think will happen?

Equipment List List all the equipment that you have used during the experiment. Make sure you list every piece of equipment that you have used.

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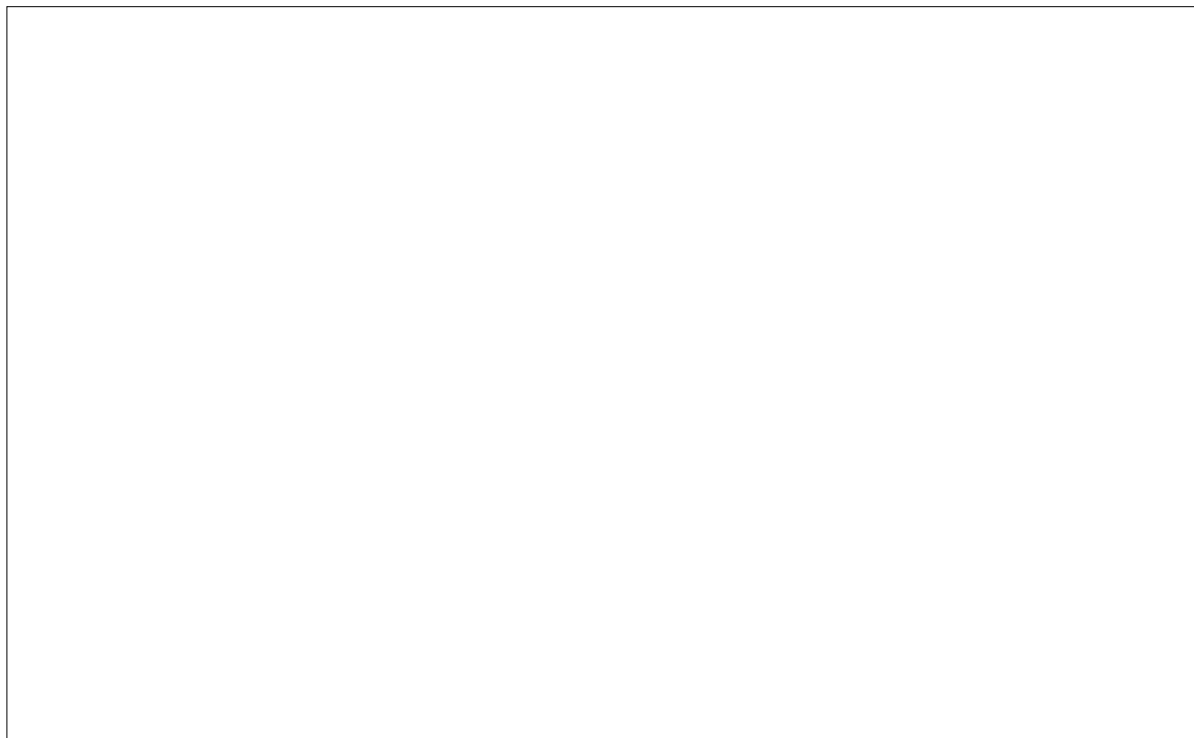
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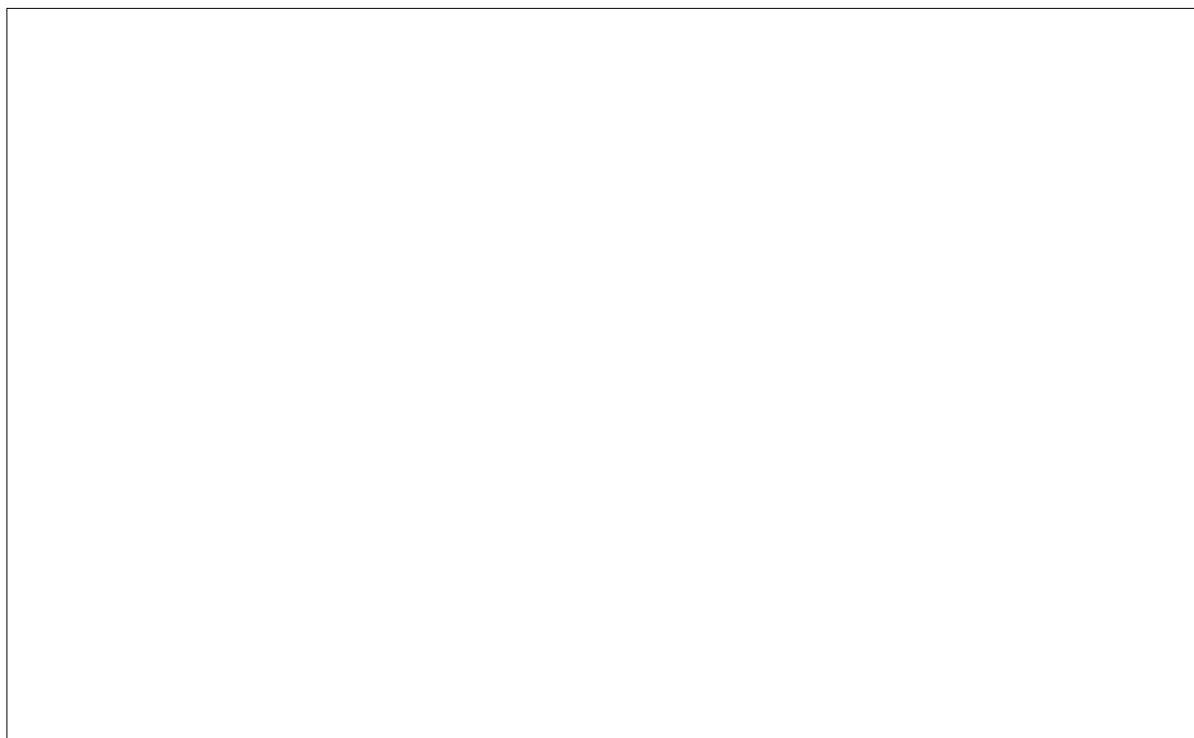
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