Natural Sciences
Grade 7-A (CAPS)

sasol
reaching new frontiers

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71 La-Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103 Ac-Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo

No
Element

- Transition Metal
- Metal
- Metalloid
- Non-metal
- Noble Gas
- Lanthanide
- Actinide

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Natural Sciences

Grade 7-A

CAPS

developed by

funded by

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This book was written by Siyavula with the help, insight and collaboration of volunteer educators, academics, students and a diverse group of contributors. Siyavula believes in the power of community and collaboration by working with volunteers and networking across the country, enabled through our use of technology and online tools. The vision is to create and use open educational resources to transform the way we teach and learn, especially in South Africa.

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To learn more about the project and the Sasol Inzalo Foundation, visit the website at:

www.sasolinzalofoundation.org.za

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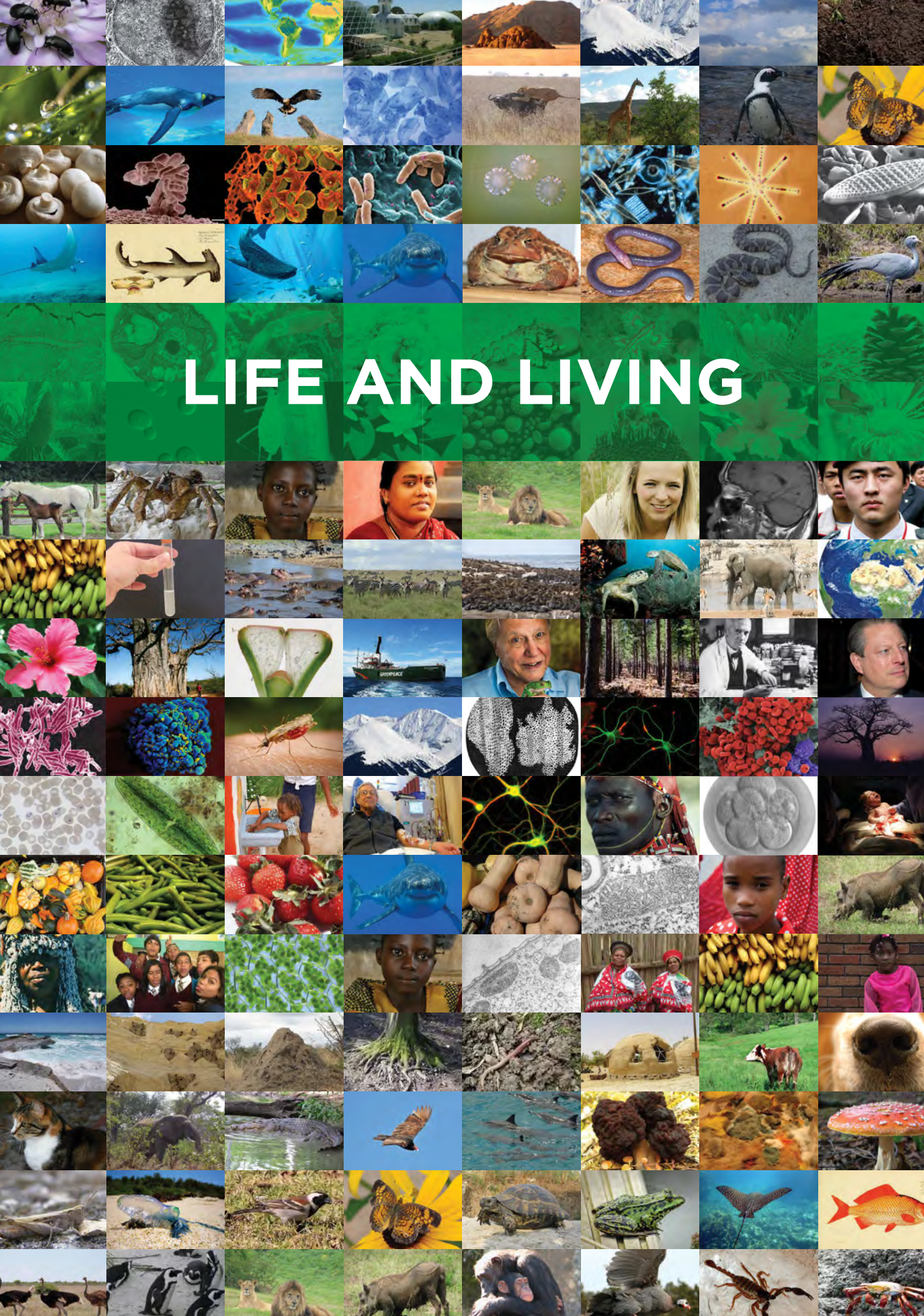

LIFE AND LIVING

1 The Biosphere

KEY QUESTIONS:

- What is the biosphere?
- What are the coldest or hottest places where life can exist?
- How deep can you go in the sea before you do not find anything living anymore?
- Are there living organisms on top of the world's highest mountains?
- How can you tell if something is alive or if it was never alive?
- What do organisms need to stay alive?
- How come some organisms can live in certain places while others cannot?

NEW WORDS

- atmosphere
- biosphere
- depend
- environment
- habitat
- microorganism
- organism

Let's start exploring the world around us and how it works! Remember that this is your book! You must use it to explore and ask questions about the world around you, and also to learn about yourself and who you are. Do not be afraid to take notes in the margins of this book - make your own scribbles and notes to yourself about points to remember or questions you would like to ask. Be curious! Explore and imagine the possibilities of what you can do with science!

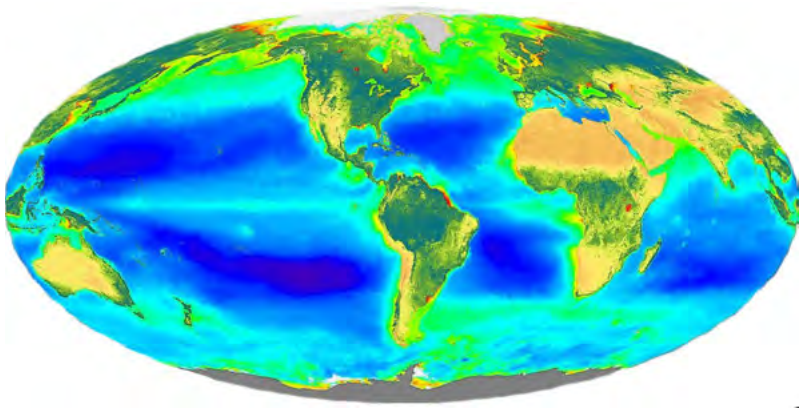
1.1 What is the biosphere?

Have you heard the word 'sphere' before? Do you know what it means? A sphere is normally used when talking about a round shape (like a ball). Now, what do we mean when we talk about the **biosphere**? The prefix 'bio-' indicates something to do with life. For example, 'biology' is the study of living organisms. So, can you put these two meanings together to work out what 'biosphere' means?

The biosphere is the place where life exists on planet Earth. When we talk about the biosphere, we are talking about a huge system (the whole world!) and how all the different parts work together to support life. We will look at these different parts in more detail a bit later.

TAKE NOTE

All the 'New words' listed in the boxes in the margin are defined in the glossary at the end of this strand.



The biosphere is where life exists on our planet, including the soil and rocks, water and air.

We can also use the term biosphere in different ways. When we speak of all life on Earth as it interacts with the non-living rocks and soil, water and air (**atmosphere**), we call this the biosphere.

Biosphere 2 is a man-made research centre in America, in the Arizona desert, where scientists have built a large enclosed artificial biosphere.

VISIT

Learn more about Biosphere 2, a fascinating ongoing project to maintain a man-made biosphere

bit.ly/18cwCth

We can also call a specific part or region on Earth that supports life, a biosphere, especially when we refer to the living organisms and the **environments** in which they live.

ACTIVITY: Where do you think life exists on Earth?

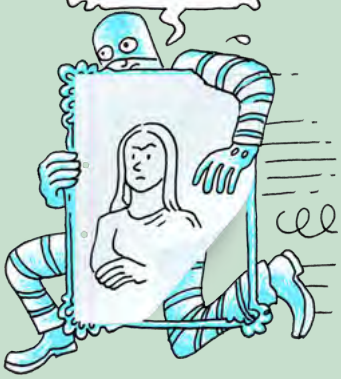
INSTRUCTIONS:

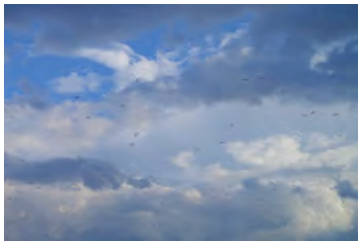
1. The following table contains some photos of different places on Earth. Describe what each photo is showing.
2. Then decide if you think life exists there or not. If you do think so, list some of the organisms which you think live in this place.

A place on Earth	What is this image showing?	Do you think there is life there? If so, what?
		

TAKE NOTE

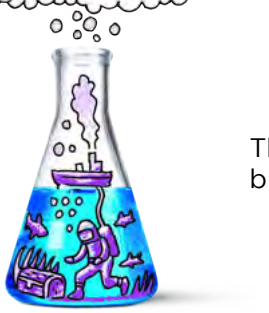
The 'Visit' boxes in the margins contain links to interesting websites and videos. Simply type the link exactly as it is into the address bar in your browser.



NEW WORDS

- adapt
- aquatic
- component
- hydrosphere
- lithosphere
- marine
- matter
- organic
- photosynthesis
- respire



After doing this activity, did you see that life exists everywhere on Earth? From the highest mountains to the deepest oceans, from the hottest deserts to the thickest jungles, there is life. Did you also notice that when describing the places on Earth where life exists, you used words such as soil, rocks, water, air? These are all part of the biosphere and have special names.

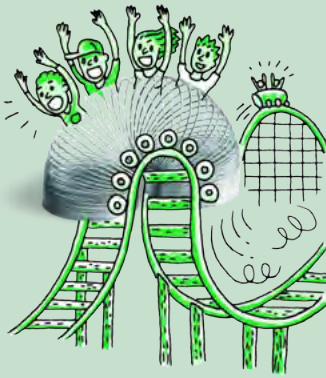
Components of the biosphere

In the previous activity we saw that life can be found in water, soil and rocks or the air around us. These **components** form part of the biosphere and have special names:

- **Lithosphere** which includes the soil and rocks.
- **Hydrosphere** which includes all the water.
- **Atmosphere** which includes all the gases.

The biosphere includes the lithosphere, hydrosphere and atmosphere. The biosphere includes all living organisms, and also dead **organic matter**.

ACTIVITY: Describe the components of the biosphere



INSTRUCTIONS:

1. Study the following photo that shows the components of the biosphere.
2. Identify and describe the elements of the lithosphere, hydrosphere and atmosphere that you can see in the photo.

The lithosphere, hydrosphere and atmosphere on Earth.

1. Lithosphere:

_____

_____

_____

2. Hydrosphere:

_____

_____

_____

3. Atmosphere:

_____

_____

_____

DID YOU KNOW?

The Earth's atmosphere has changed over time. Our oxygen rich atmosphere was formed by algae millions of years ago.

4. Even though you cannot see living organisms in this photo, there are many living and dead plants and animals that could live on a beach such as this one. Make about 10 plausible (believable) guesses of the types of organisms which would live in this environment. (Hint: think about what might be living in the sea, sand or air.)

_____

_____

_____

_____

VISIT

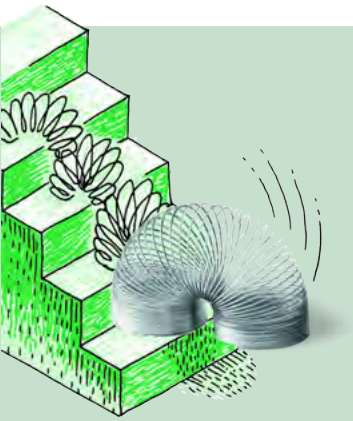
Our atmosphere is escaping! (video)

bit.ly/1beNzVB

Different organisms can exists in different places in the biosphere. Let's have a look at the different components of the biosphere and which types of organisms exist there.

Atmosphere

The atmosphere is the layer of gases that surrounds the Earth. The three most important gases in the atmosphere are nitrogen, oxygen and carbon dioxide. The atmosphere is made up of several layers.



ACTIVITY: The atmosphere

QUESTIONS:

1. Discuss with your partner whether you think organisms could live on Earth without the atmosphere. Explain why you think so.

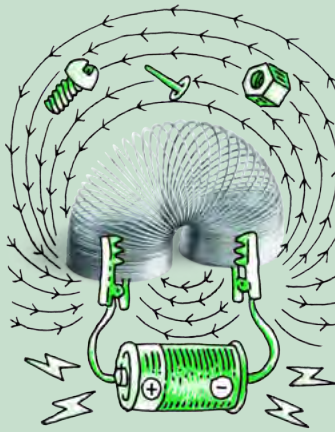
_____

_____

_____

Hydrosphere

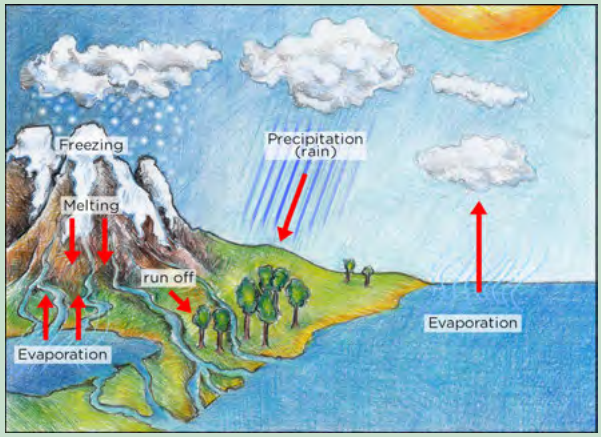
The hydrosphere consists of all water on Earth in all its forms.



ACTIVITY: The water cycle

INSTRUCTIONS:

1. Study the following diagram describing the water cycle on Earth.
2. Answer the questions that follow.



QUESTIONS:

1. Do you remember learning about the different states of matter? The hydrosphere includes all water in all the states of matter. Look at the diagram of the water cycle and identify water in the different states of matter.

_____

_____

_____

2. The water cycle shows different sources of freshwater and saltwater. Many plants, animals and microorganisms have adapted to live in an aquatic habitat. A very small percentage of the world's water sources are freshwater and the rest is saltwater. Write down as many different types of aquatic habitats that you can think of where different organisms exist.

_____

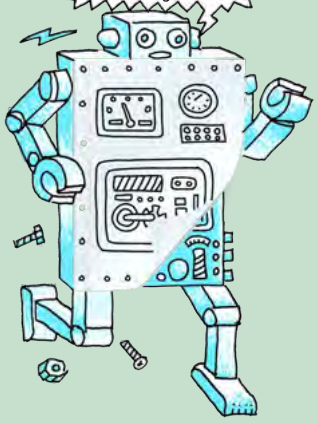
_____

_____

_____

TAKE NOTE

The word 'aquatic' is used to describe something to do with water. Therefore aquatic animals are animals that live in or near water. The word 'marine' describes organisms that live in saltwater or the sea. So someone studying the organisms in the sea is called a marine biologist.



Lithosphere

As we have said, the lithosphere includes the rocks, soil and sand on Earth. Organisms **depend** on the lithosphere in many different ways. We find out how in the next activity.

ACTIVITY: How do organisms depend on the lithosphere?

INSTRUCTIONS:

1. Below are several photos depicting different ways that organisms depend on and interact with the lithosphere.
2. Use these images to write a paragraph about how different organisms depend on the lithosphere in different ways.

Bird nests

A rock pool

A termite mound

A tree growing in the ground

An earthworm in soil

A mud hut

NEW WORDS

- abiotic
- cellular respiration

We have now looked at the different parts of the biosphere and seen that there are many different types of organisms that exist. Each of the organisms that we have seen so far needs to be able to stay alive in those specific conditions. We say they need to **adapt** to live in their particular habitat. What does it mean to stay alive though?

Characteristics of living plants and animals

There are seven processes that all living organisms perform that determine whether they are alive or not. Let's have a look at the seven life processes:

1. All living things need to be able to **move**. Moving does not have to consist of big movements. Even plants move, for example as the flowers and leaves turn to face the sun during the course of the day.
2. All living things need energy to perform the life processes. Organisms release energy from their food by a process called **cellular respiration**.
3. All living things need to be **sensitive** to their environment. Think of an example of why animals need to sense their environment and write it down below.

4. All living things need to be able to **grow.**
5. All living things need to be able to **reproduce** so that they do not die out.

VISIT

Video about the seven life processes

bit.ly/1cxrrZT

NEW WORDS

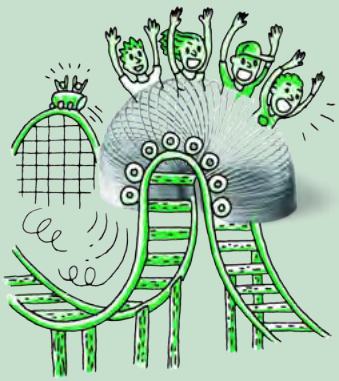
- favourable
- requirement
- sustain

6. All living things need to be able to **excrete** waste.
7. All living things need **nutrition,** as they need to break down nutrients during cellular respiration to release energy.

Now that we can determine whether something is living or not, we can take a look at what living things need to survive. In other words, what are the requirements for life?

1.2 Requirements for sustaining life

After studying the seven life processes, we now know what animals, plants and other living organisms need to *do* in order to be classified as living. In order to stay alive these living organisms **require** (need) certain things or specific conditions. In this section we are going to study the requirements necessary to **sustain** life.



ACTIVITY: Identify the requirements for sustaining life

Imagine that you are the design team for the first International Moon Space Station, similar to the International Space Station already orbiting Earth, but situated on the Moon!

The international space station that orbits Earth, seen from above.

VISIT

Find out more about life on the International Space Station as astronauts perform their everyday tasks.
bit.ly/178CXVe or
bit.ly/1cfDcF7

INSTRUCTIONS:

1. Work in groups of four.
2. What do you think the astronauts and plants living on the new Moon Station will need in order to live? Discuss the five most important requirements that you need to provide in order for the astronauts and plants to remain alive on your Moon Space Station.
3. Explain why your group chose these five requirements as the most important to sustain life. Write down your notes from your group discussion on the lines provided. Decide which member of your group is going to report back your findings to the rest of the class.
4. Have a class discussion after you have finished discussing this in your group.

VISIT

Learn more about the seven life processes

bit.ly/16Cj2jz

Living organisms require certain conditions or things to be able to stay alive. We say that these things or conditions sustain life.

You would have discussed some of these requirements in the last activity. Did you come up with the same or similar requirements? Living organisms require the following to survive:

- energy
- gases
- water
- soil
- favourable temperatures

Next, we look at these in a bit more detail.

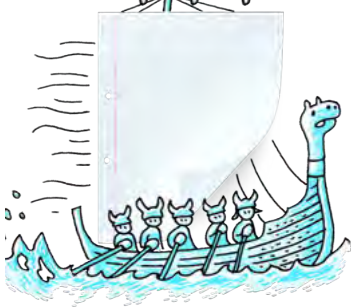
Energy: All living organisms need energy to stay alive and perform the life processes. Plants need energy from sunlight in order to photosynthesise. Other organisms get their energy from the food that they eat.

All living things need a source of energy. The grass and trees get their energy from the Sun to photosynthesise. The cow gets its energy by eating the grass.

All living things need oxygen to respire, such as this dog which is breathing air in through its nose.

TAKE NOTE

'Sustain' means to keep things alive or in existence. We also use the word sustainable when we want to say that something can continue or be continued for a long time.



DID YOU KNOW?

When astronomers search for life outside of our solar system, they search for planets that might contain liquid water, believing that where there is water there may be life.

Gases: All living things require oxygen for cellular respiration. Oxygen is used to release energy from nutrients and carbon dioxide and water is produced as a waste product of respiration. Green plants also need carbon dioxide to photosynthesise.

Water is vital to life. Every organism on our planet needs water to live.

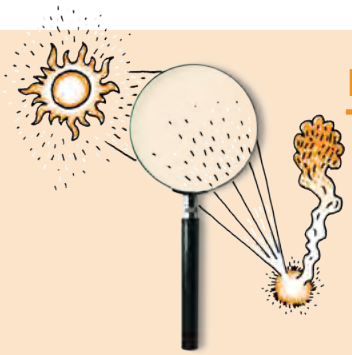
Water is vital for life on Earth.

Most plants need soil to grow in.

Soil sustains life on Earth. Most plants depend on soil for support, minerals and water. Without the soil, plants would not be able to produce the food that animals and other organisms depend on.

Favourable temperatures: All organisms are adapted to live in a particular temperature. In general, our planet has favourable temperatures to support life. Earth is at an optimal distance from the sun so that it is not too hot, like on Mercury, and not too cold, like on Neptune.

Let's find out what the requirements are to grow seedlings. We will learn how to conduct a scientific investigation to do this.



INVESTIGATION: What are the requirements to sustain life in plants?

In this investigation, we are going to germinate bean seeds (or any other seeds that your teacher provides you with). Each group in the class is going to be testing a different requirement for germination and growth of the seedling.

AIM:

A scientific investigation always has an aim or question that needs to be answered. What is the aim of this investigation? Write down what you aim to find out.

HYPOTHESIS:

A hypothesis is where you propose (suggest) what the outcome of the investigation will be. It is a prediction of what the results will be. Write a hypothesis for this investigation.

NEW WORDS

- dependent variable
- hypothesis
- independent variable
- scientific method
- variables

VARIABLES:

Scientists often use investigations to search for cause and effect relationships. This means that they design experiments to investigate how changes to one part will cause an effect on another. These changing quantities are called **variables**. There are usually three kinds of variables:

1. **Independent variables:** This is the thing that you are changing in the investigation. You are in control of the independent variable. For example, if you wanted to investigate if eating a lot of sugar makes you gain weight, then the amount of sugar you eat is the independent variable. You control how much sugar you eat. We want to achieve something called a FAIR TEST which means that only ONE independent variable is changed at one time. Once the independent variable has been changed the scientist then observes what the effect will be. In the example of investigating if sugar makes you gain weight, you cannot at the same time investigate whether exercise makes you lose weight. This would not be a fair test.
2. **Dependent variables:** The dependent variable is the thing that you observe in an investigation. You do not change it. The dependent variable will change depending on the independent variable. For example, in the investigation to see if eating a lot of sugar makes you gain weight, then the dependent variable will be how many kilograms you gain (or lose) as a result of eating sugar. How much weight you gain depends on how much sugar you ate. Dependent variables should be measured in an objective way using numbers as far as possible.
3. **Controlled variables:** These are the quantities that a scientist wants to remain the same or unchanged throughout the experiment. The controlled variable needs to be carefully monitored to make sure that it stays the same. In the example to see if sugar makes you gain weight, you could have one person eat a lot of sugar and the other person eat no sugar and then see the changes in weight. There are some things that need to stay the same for both of these people so that it is a fair test. For example, both people must do the same amount of exercise so that this does not influence their weight. This is a controlled variable.

TAKE NOTE

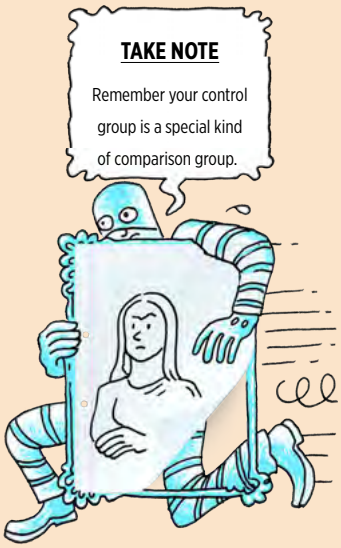
A hypothesis is an educated guess about what the outcome of the investigation will be. The hypothesis is stated before starting the investigation and must be written as a statement and must be in the future tense.

You can also do a control test. For example, in this investigation about the growth of plants, you will be taking away one of the requirements for growth. You need to do a control test where another plant is given all the requirements, including the one you took away in the other plant. You can then compare your plant where you took one requirement away to the control plant which has that requirement to see if there is a difference.

Identify the variables for this investigation.

1. **Independent variable**. What will you change?

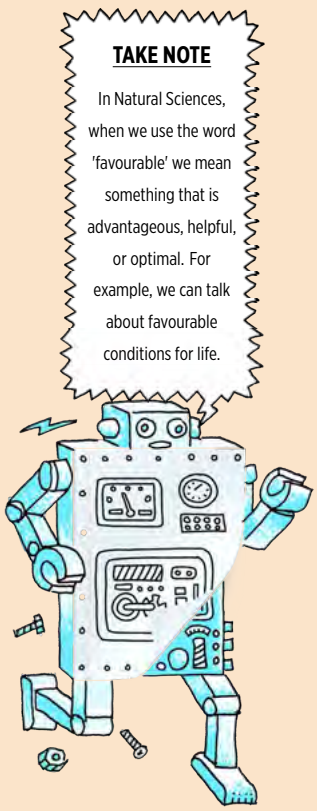
2. **Dependent variable**. What will you measure to see the effect of the independent variable on the germination and growth of the plant?



3. **Controlled variables and control group**. What will your control test be and what will you keep the same between the control plant and the tested plant?

METHOD:

In your group, plan how you are going to do the investigation. Think about which requirement you are testing and how you will take this requirement away. For example, if you are looking at light, where could you place the seeds so that they do not receive light? Remember, if you are looking at light, then you need to make sure the control and test seeds both receive the same amount of water. Once you have planned the investigation on rough paper and discussed it with your teacher, write up the method below (in numbered steps) explaining what you will do.



MATERIALS AND APPARATUS:

Write a list of all the materials and apparatus that you will be using in this investigation.

RESULTS AND OBSERVATIONS:

Use this space to record the results for your investigation. If you are seeing whether plants germinate or not, then you need to draw a table to show this. If you are measuring how much the plants grow, then you will also need a table for this.

DID YOU KNOW?

Every solar system has a 'Goldilocks' zone which is a region that is not too hot (close to the sun), and not too cold (far from the sun) to be able to sustain life. Earth is in the middle of our solar system's Goldilocks zone!

ANALYSIS:

Once we have collected our results in a scientific investigation, we need to analyse them. This often involves drawing a graph. If you measured the growth of the seedlings over time, then you can draw a line graph to show this. If you have counted the number of seeds that germinated you can express this using a bar chart (provided you used the same number of seeds in each group), or you can express the percentage of seeds that germinated as a pie chart. Your teacher will help you do this.

VISIT

Read more about the 'Goldilocks Zone' bit.ly/13ITCQU and bit.ly/11OlY9R

DID YOU KNOW?

Not all plants need to grow in soil. Epiphytes, such as mosses and orchids, are a group of plants which grow on other plants or rocks. They get their moisture and minerals from the air and rain.

CONCLUSION:

After collecting all your results and drawing a graph using these results, you will need to use this to draw a conclusion about the requirements to sustain life in plants. The following questions will guide you in drawing your conclusion.

1. I found out...

2. I know this because...

3. The investigation was fair because...

4. I can trust the results because...

5. While I conducted (did) this investigation I also discovered that...

6. If I did this investigation again I could improve it by...

What did you learn from doing this scientific investigation?

Write 3 to 5 sentences explaining what you learnt from doing this scientific investigation following the scientific method.

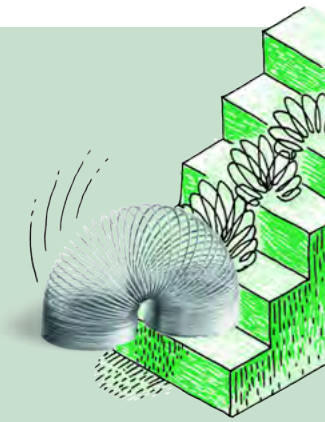
Each organism is able to survive and continue to survive in their environment because they have acquired the characteristics that allow them to do things in a special way in their particular environment. We say they have adapted to life in their particular type of environment.

Adapted for life

Do you think you could put a polar bear in the Kalahari desert or a gemsbok in Antarctica and they would survive? Why, or why not?

These animals are specifically adapted to live in their specific environments. All organisms are adapted to their specific environments. In the next activity we examine some more examples of how organisms are adapted to their environments.

ACTIVITY: Adaptations in organisms



INSTRUCTIONS:

1. Study the photos below showing different organisms in different environments.
2. Answer the questions.
3. You might need to do some extra research in books and on the Internet to complete your answers.

QUESTIONS:

Look at the photos of a penguin in the water and an eagle flying in the air. Both of these are birds, but they live in very different environments that make the penguin adapted for the water and the eagle adapted for flight.

A penguin in the water.

A flying fish eagle about to catch some food.

1. How do you think the penguin is adapted to swim in water? Hint: What are its wings used for? Does it have small or large feathers? How do you think this helps?

2. How do you think the eagle is adapted to fly and catch its prey? Hint: Look at its feathers and wings.

South Africa is home to two very skilled predators, the great white shark and the lion. Both of these animals are very skilled at catching their prey, but in very different environments.

A great white shark in Gansbaai, Western Cape.

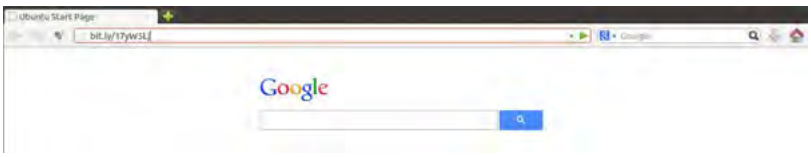
A lioness attacking a buffalo in Kruger National Park.

3. What characteristics does the shark have that makes it adapted to living and feeding in the sea? Hint: Look at its streamlined body shape and sharp teeth.

4. What characteristics does a lion have that makes it adapted to living and hunting in the savanna? Hint: Look at the colour of its fur and the colour of the grass and its strong limbs.

We have now looked at how a few of the animals on Earth are adapted to their environments. There are many, many more organisms with very unique and interesting adaptations. In the next chapter we will learn more about the diversity of plants and animals on Earth.

Have you noticed the **VISIT** boxes in the margins which contain links? You simply need to type this whole link into the address bar in your Internet browser, either on your PC, tablet or mobile phone, and press enter, like this:



It will direct you to our website where you can watch the video or visit the webpage online. **Be curious and discover more online on our website!**

SUMMARY:

Key Concepts

- Life on planet Earth exists in the biosphere.
- The biosphere consists of the lithosphere, hydrosphere and atmosphere, as well as the many living organisms and dead, organic matter.
- Many different kinds of living organisms exist in the biosphere.
- Things can be classified as living if they perform the seven life processes:
  - Movement
  - Reproduction
  - Sensing the environment
  - Growth
  - Respiration
  - Excretion
  - Nutrition
- Living things need energy, gases, water, soil and a favourable temperature to survive.
- Living things are suited or adapted to the environment in which they live.

Concept Map

Do you know what a concept map is? This year in Natural Sciences, we are going to learn more about how to make our own concept maps.

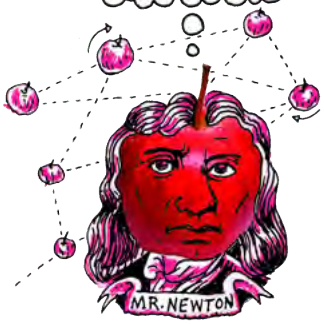
Above you have the 'Key concepts' for this chapter. This is a written summary and the information from this chapter is summarised using words. We can also create a concept map of this chapter, which is a map of how all the concepts (ideas and topics) in this chapter fit together and are linked to each other. A concept map gives us a more visual way of summarising information.

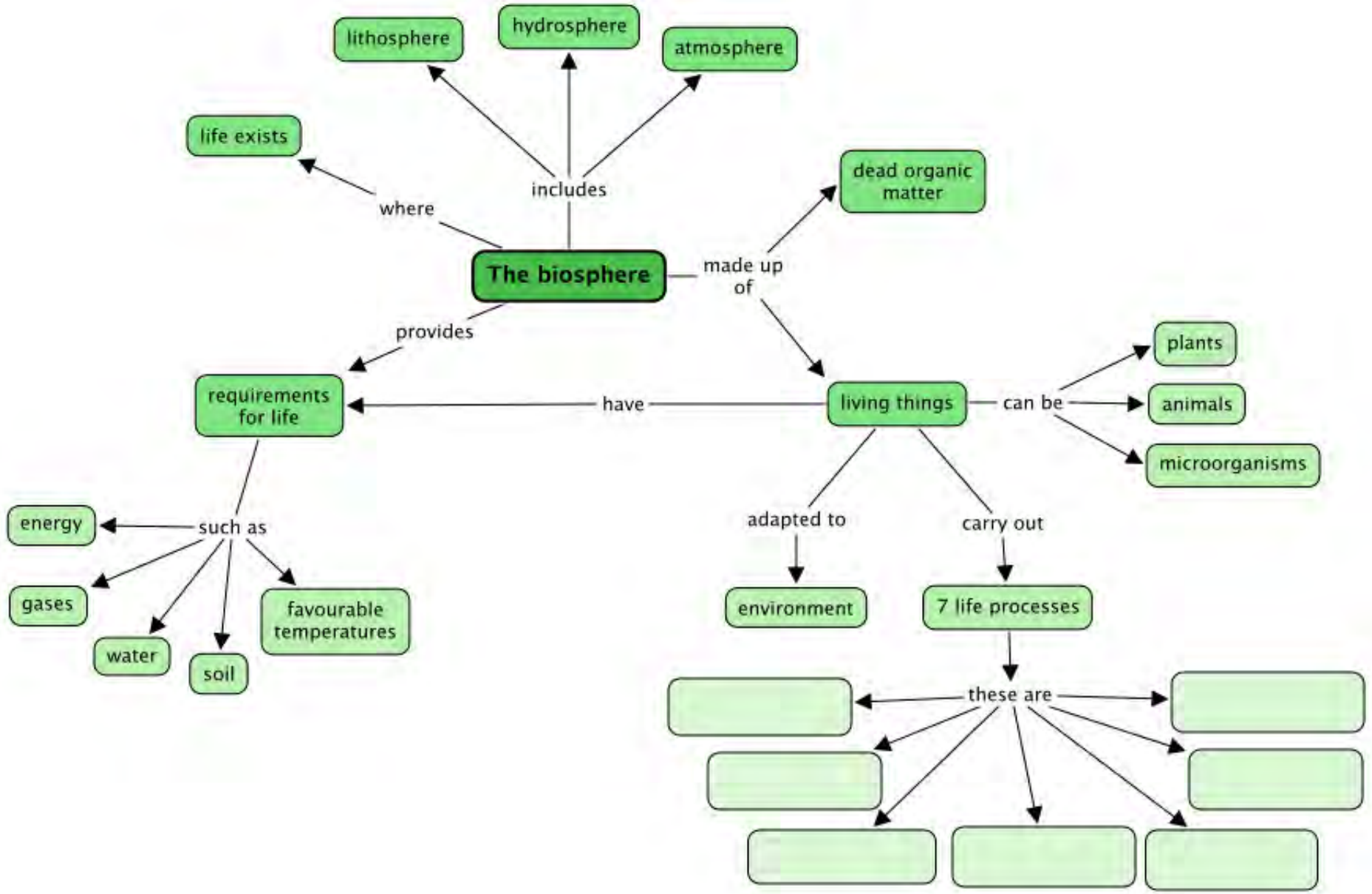
Different people like to learn and study in different ways: some people like to make written summaries, whilst others like to draw their own concept maps when studying and learning. These are useful skills to have, especially for later in high school and after school!

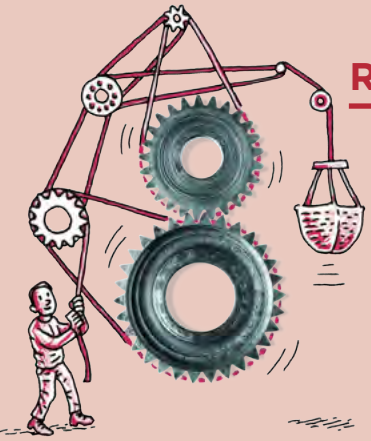
Have a look at the concept map for 'The Biosphere' on the next page. Complete the concept map by filling in the 7 life processes in the blank spaces.

DID YOU KNOW?

The first person to use the term 'biosphere' was the geologist Eduard Suess in 1875 when he wrote a definition for the biosphere as *'the place on Earth's surface where life dwells'.*




lithosphere
hydrosphere
atmosphere
includes
life exists
where
The biosphere
made up of
dead organic matter
provides
requirements for life
have
living things
can be
plants
animals
microorganisms
such as
energy
gases
water
soil
favourable temperatures
adapted to
carry out
environment
7 life processes
these are



REVISION:

1. Explain what the biosphere is. [2 marks]

2. Give an example of something that is found in each of the following: [3 marks]
   a) Lithosphere:

   b) Hydrosphere:

   c) Atmosphere:

3. Discuss why the atmosphere is important for life on Earth. [2 marks]

4. Imagine an alien creature arrives on Earth attached to a meteorite (fallen space rock). You were tasked with deciding whether it lives in the conventional way that we understand organisms to live. Draw up seven questions to determine how this organism lives and whether it can be classified as alive. [7 marks]

5. What are the requirements for sustaining life on Earth? [5 marks]

6. Look at the following photos of different organisms in their environments. Answer the questions about how they are adapted.
   a) Giraffe

How are giraffe adapted to eat their food? Hint: They eat the leaves of trees. [1 mark]

   b) A cactus

This cactus is adapted to live in hot environments? How do you think it stores water for long periods? Hint: Look at its leaves. [1 mark]

How do you think the cactus has adapted to prevent other animals from eating it? Hint: What is on the leaves? [1 mark]

Can you see the stick insect in this photo? How do you think it is adapted, especially to hide away from predators? [1 mark]

7. Think back to the scientific investigation you did in this section. Evaluate how well you think you followed the scientific method to make your experiment fair or not fair. [2 marks]

Total [25 marks]

Here is your chance to discover the possibilities. What can this apple become?

2 Biodiversity

KEY QUESTIONS:

- How do we group or classify all the living organisms in the world?
- Why do we need to group or classify living things?
- How can we classify all the animals on Earth?
- What is the difference between reptiles and amphibians?
- Are insects and arachnids (spiders) different?
- Is there a way to classify plants?
- What is the diversity of plants and animals in South Africa?

Over millions of years each species living today has changed and adapted to live in a specific type of environment in order to ensure the survival of that species. Biodiversityis a term used to describe the great variety of living organisms on Earth and their varied habitats.

There are just so many types of organisms. How can we make sense of all the organisms on Earth? We need some way to group them. This is called classifying. Let's find out how we do this!

2.1 Classification of living things

Grouping has been a common activity in humans for thousands of years as we make sense of the world around us.

ACTIVITY: Group some everyday objects

MATERIALS:

- objects from home
- shoe boxes/ ice-cream tubs

INSTRUCTIONS:

1. Work in groups of four.
2. Each member of the group should bring five items from home. Choose items that are easy to carry around and that will fit into a standard shoe box.
3. Carefully observe each of the items that everyone in your group brought.
4. Use the shoe boxes to group the items according to your observations.
5. Place all objects brought by the whole class on a display table in the front of the class.
6. Discuss the different grouping methods that each group has used as a class. Work towards a standard grouping or classifying method that you could use to **classify** ALL the items that you all brought to school.

QUESTIONS:

1. Draw a table in the space below and record all the items in your class in the groups you assigned them to.

2. How did your small group classify your items to begin with? What features did you use to classify the items?

3. Write three or four sentences about the standard classification method that you decided to use in your class. What **characteristics** of the items did you use to classify and group them? Were these different to what you used in your small group?

TAKE NOTE

When you observe you use your senses to tell you more about something. How does it feel or look? Does it have a special smell or taste? Is there a specific sound coming from it?

NEW WORDS

- characteristic
- class
- classify
- kingdom
- order
- phyla

Aristotle was a Greek philosopher and thinker who lived about 2400 years ago. Aristotle came up with the following grouping system that was used for almost 2000 years after his death!

- He divided all organisms into either animals or plants.
- Then he divided animals into those 'with blood' and those 'without blood'.
- Lastly animals are divided into three groups based on their method of movement: walkers, flyers or swimmers.

Plato and Aristotle in a famous painting by Raphael called "School of Athens".

ACTIVITY: Aristotle's classification system

INSTRUCTIONS:

1. Look at the following photos of different kinds of animals.
2. Use Aristotle's method of classification to group the animals based on the way that they move.
3. Draw a table of your groupings in the space provided after the photos. Give your table a heading.

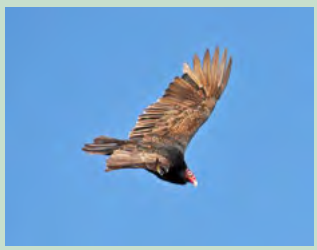
A penguin

A butterfly

A cat

An elephant

A crocodile



An eagle

A human

Dolphins

Bats

QUESTIONS:

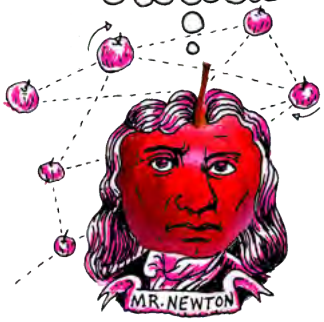
1. Were there any animals which you battled to classify into one group? Which ones were these?

2. Do you think Aristotle's classification system has any problems? Explain any problems that you might find when using it.

As more and more animals, plants and microorganisms were discovered, scientists started questioning Aristotle's classification system. It was not working as well as everyone had believed it would. Why do you think it is important to evaluate *how* we classify things?

DID YOU KNOW?

Scientists estimate that there are up to 30 million species of organisms on Earth! If they use systems to classify these organisms they can see patterns in nature and can see how organisms relate to each other.



TAKE NOTE

The kingdom Bacteria is often also referred to as **Monera**.

In the 1700s Carl Linnaeus developed the classification system that classified organisms according to their similarities, functions and relationships with other organisms.

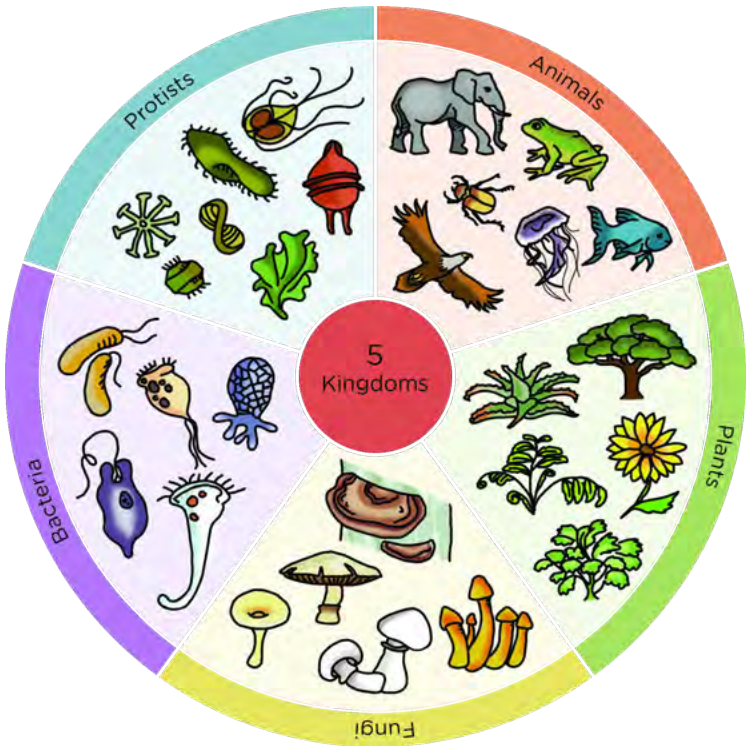
Today with the use of modern microscopes and genetics we can classify living organisms very accurately. In this way we are able to classify living organisms according to their shared characteristics.

Carl Linnaeus

Our classification system

All living organisms can be divided into five **kingdoms**:

1. **Animals**
2. **Plants**
3. **Fungi**
4. **Protists**
5. **Bacteria**



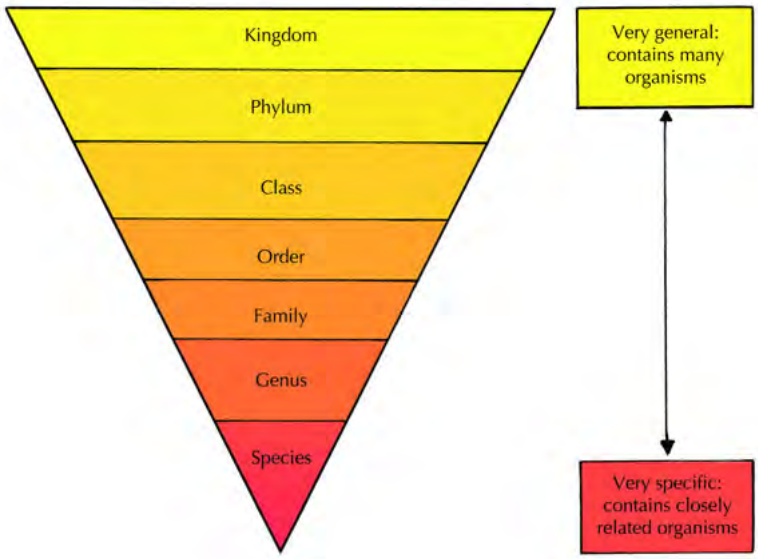
What are humans? Which kingdom do we belong to?

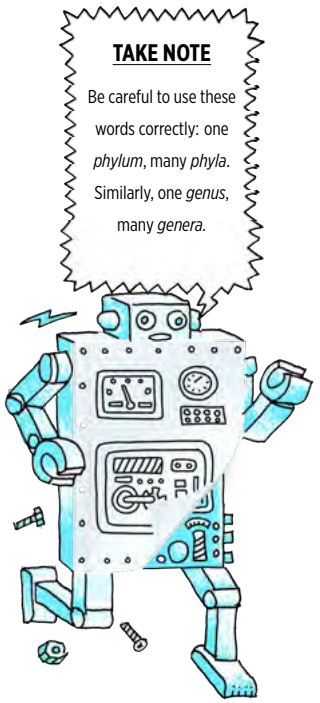
Think back to the example of how we classify learners at school. First, school is divided into pre-primary school, primary school and high school. If we compare school to the way we classify organisms, we can say that the school system has three kingdoms. But, we need to divide learners up further. So primary school is divided into seven grades (Gr. 1-7) and high school is divided into five grades (Gr. 8-12). The classification system for organisms also needs to divide organisms up further as each kingdom contains thousands of different types of organisms.

Each kingdom is divided into smaller groups or divisions called **phyla**. Organisms with similar traits (characteristics) will occupy a similar phylum. In each phylum, smaller divisions called **classes** are found and each class is further divided into **orders**, **families**, **genera** and then **species**.

Think of your school again. Your primary school contains many learners. When you divide your entire school into grades, there are fewer learners in each grade. Your grade might be divided into different classes, and each class has fewer learners in it. When we classify organisms, the same thing happens. A kingdom is a very big group, whereas a species is a much smaller group.

Study this diagram to help you remember the order:





King **P**hil **C**uts **O**pen **F**ive **G**reen **S**nakes

We need to be able to distinguish between organisms too. So how do we name organisms?

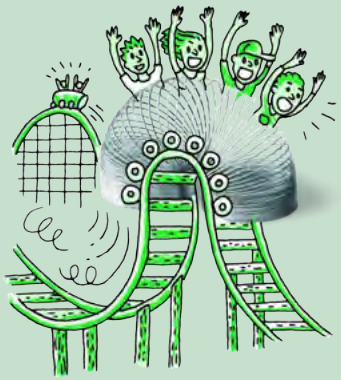
Carl Linnaeus designed a special naming system called the **binomial nomenclature** to name all organisms. All organisms are therefore given **two** (bi- means two) words in their name.

- The first part of the name refers to the genus that the organism belongs to. This is always written with a capital letter.
- The second part of the name refers to the species within the genus
- If you are typing you will put both these names in *italics* but if you are doing a handwritten piece you underline it. This shows that you are identifying the organism by its scientific name.

For example, the scientific name for the African elephant is *Loxodonta africana*. Humans belong to the genus *Homo* and to the species *sapiens* so we are *Homo sapiens*.

Now that we have seen how to classify organisms, let's take a closer look at the differences between the kingdoms.

Plants and animals



ACTIVITY: Comparing plants and animals

INSTRUCTIONS:

1. Study the diagram that shows the five kingdoms that we commonly use to classify organisms. Pay close attention to the plants and animals.
2. Answer the following questions.

QUESTIONS:

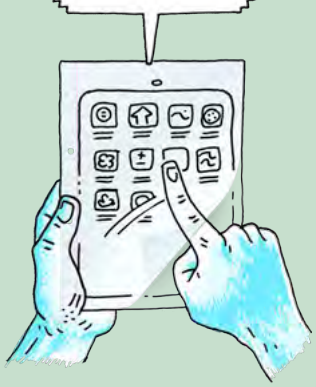
1. Study the organisms in the animal kingdom. What are some common features that you can see in all the animals?

2. Study the organisms in the plant kingdom. What are some features that are common to all plants?

3. Draw a table in the space below and compare the characteristics of plants that make them different to animals. Discuss your plant and animal comparisons with your group and then with the class.

TAKE NOTE

When we compare plants and animals we can often compare them based on the way that they move, what and how they get food or nourishment, and how they reproduce.



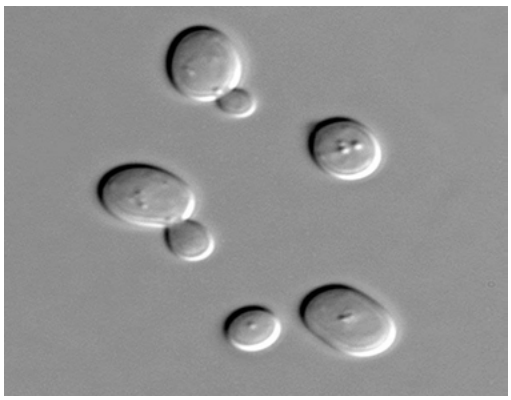
Fungi

Most people will not eat bread covered in bread mould but will eat a plate of fried mushrooms, truffles and morels. These are all examples of fungi, including yeast.

Morel

A truffle

Bread mould



Yeast cells

A very poisonous mushroom

Button mushrooms (like we buy in the shops)

Fungi play a very important role in our biosphere since they break down dead organic material and return nutrients to the soil for plants to use. Some fungi cause diseases while others, such as penicillin (an antibiotic) are very useful to us. Yeast is used in many of our products, such as making bread rise and fermenting wine and beer.

VISIT

Learn more about the kingdom Animalia

bit.ly/18djDrj

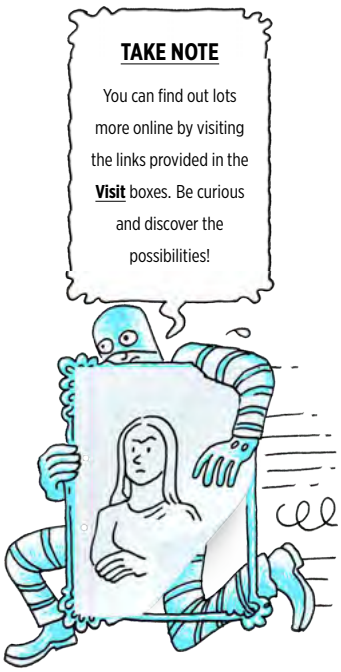
DID YOU KNOW?

Morels are a type of edible mushroom. They are distinctive for the appearance of their caps, which are have pits and ridges that resemble a honeycomb.

VISIT

The phylogame (a card game which could be played in class)

bit.ly/14o3yPp

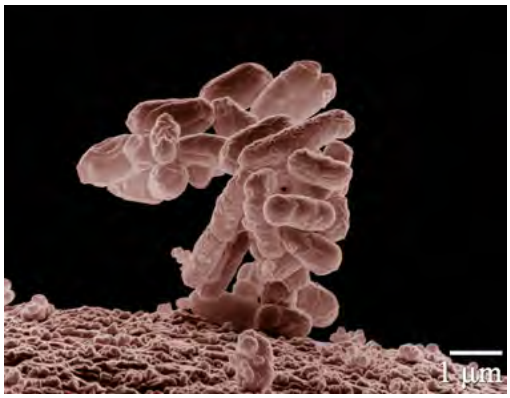


Protists and Bacteria

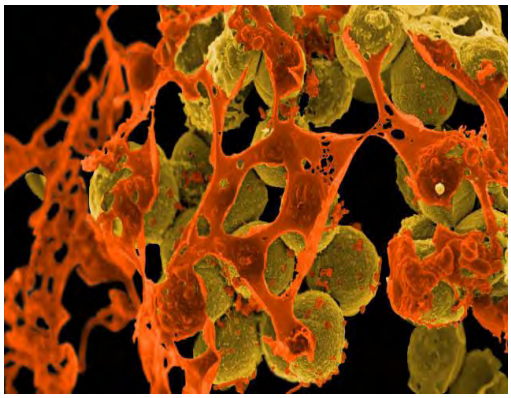
We will look at Protists and Bacteria in more detail later on in Gr. 9. For now, lets look at some of the basic features of these kingdoms.

Organisms in these two kingdoms are microscopic which means you cannot see them with your naked eye. However we can see them if we look at them under a microscope.

Different bacteria:



Escherichia coli bacteria, commonly found in the intestines of animals

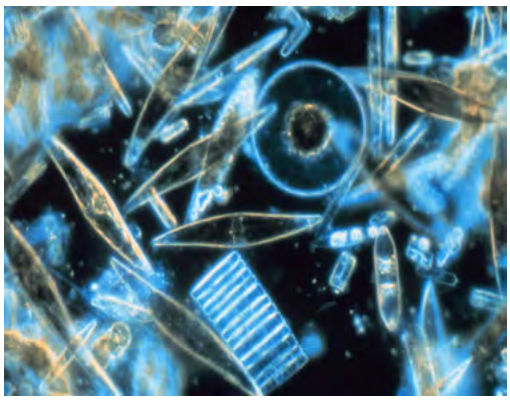


Staphylococcus aureus (yellow cells) often causes skin infections and pneumonia

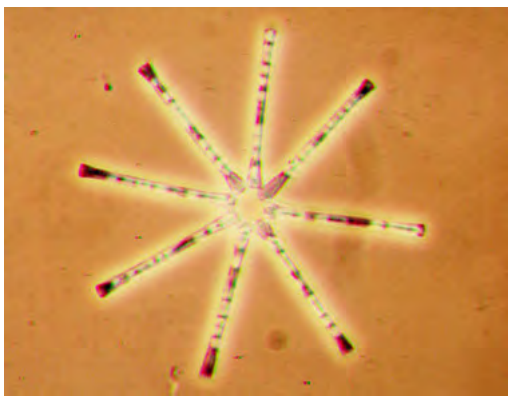
Pseudomonas aeruginosa is found in soil and water and cause infections in animals

Actinomyces bacteria which cause diseases in the mouth

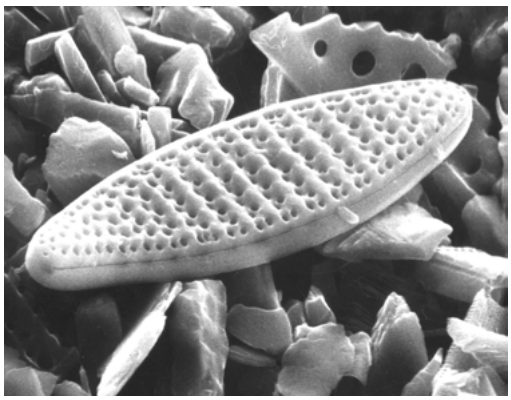
Different Protists:



Phytoplankton from the Antarctic sea



Asterionella formosa



Nitzschia kerguelensis

Different coloured amoebas

Now we will look at the amazing diversity of animals and plants on Earth, and especially in South Africa.

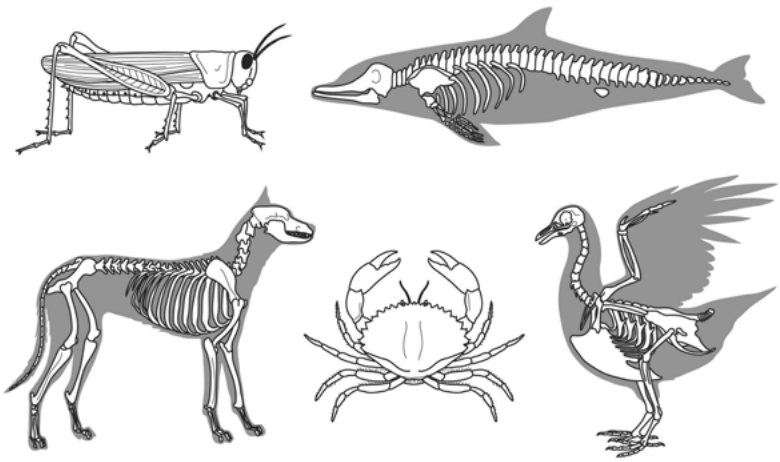
2.2 Diversity of animals

NEW WORDS

- diversity
- invertebrate
- vertebrate

Classifying animals

All the animals in the world form part of the animal kingdom.There are two distinct divisions or groups of animals within the animal kingdom: the **vertebrates** and the **invertebrates**. Can you remember what is used to classify an animal as a vertebrate or invertebrate? Look at these x-rays of animals for a clue.



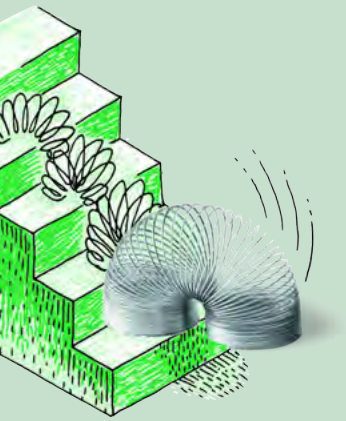
DID YOU KNOW?

Almost 98% of all the animals that have been discovered on Earth are invertebrates!

Animals that have a backbone with a hollow tube inside to hold the nerves are vertebrates. As we can see in the x-ray images of the dolphin, dog and goose, we can see the skeletons of these vertebrates. They are made of bone. We say that vertebrates have an endoskeleton.

What about the grasshopper and the crab? Why can we not see their bones? This is because invertebratesdo not have a skeleton made of bones. The grasshopper and crab have a hard shell covering on the outside of their bodies. This supports their soft bodies inside. We say they have an exoskeleton. But not all invertebrates have an exoskeleton.

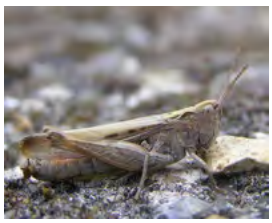
What about a jellyfish? It does not have a backbone, so it is not a vertebrate, so it must be an invertebrate. Does it have a hard, outer covering called an exoskeleton? Discuss this with your class. Make sure to take note of the third type of skeleton in your discussion.

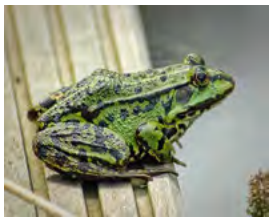


ACTIVITY: Classifying vertebrates and invertebrates

INSTRUCTIONS:

1. In the table identify the type of skeleton that each animal has and write it down beneath each picture.
2. Write down whether the animal is an invertebrate or a vertebrate.

Animal	 A grasshopper	 A bluebottle
Type of skeleton		
Vertebrate or invertebrate		
Animal	 Cape sparrow	 Butterfly
Type of skeleton		

Vertebrate or invertebrate		
Animal	 Tortoise	 Frog
Type of skeleton		
Vertebrate or invertebrate		
Animal	 Crab	 Earthworm
Type of skeleton		
Vertebrate or invertebrate		

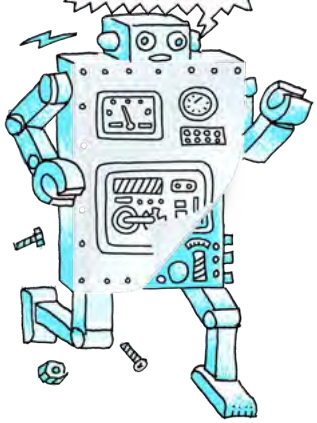
VISIT

A useful chart showing the classification system

bit.ly/178IzyU

TAKE NOTE

'Phylum' is the singular and 'phyla' is the plural use of the word.

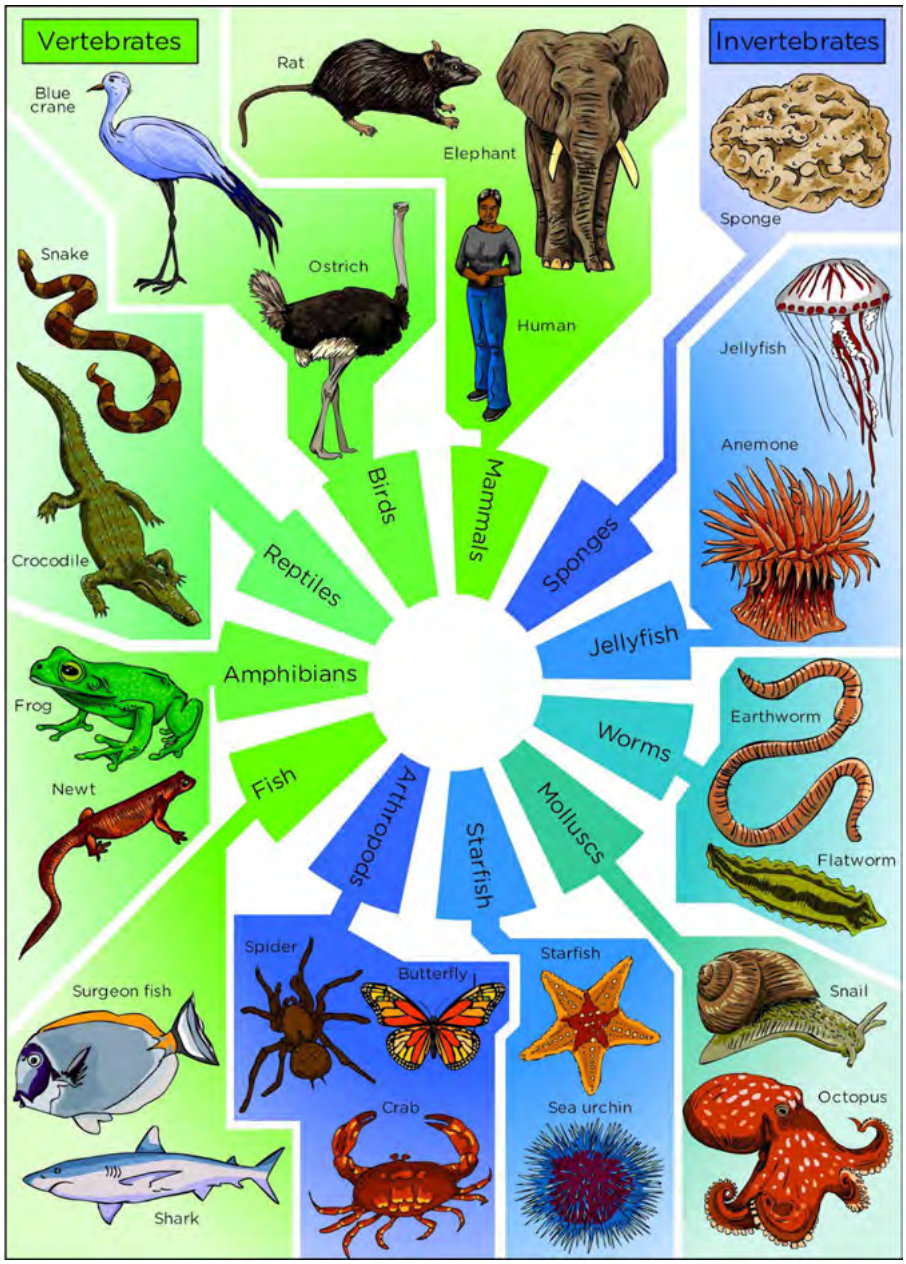


The invertebrates are divided into five phyla. The invertebrate phyla are:

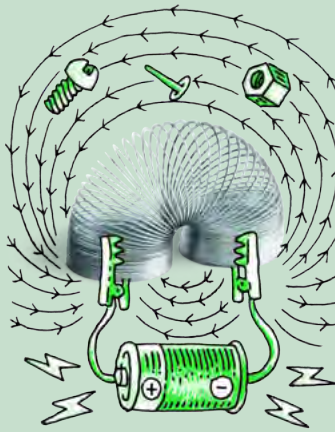
1. Sea sponges
2. Jellyfish
3. Roundworms
4. Molluscs
5. Arthropods

Vertebrates belong to the phylum Chordata. Vertebrates are subdivided into five classes.

Have a look at the following diagram which shows the different classes of vertebrates and phyla of invertebrates. Remember, all vertebrates belong to the phylum Chordata.



ACTIVITY: Identify the five classes of vertebrates



INSTRUCTIONS:

1. Study the previous chart showing vertebrates and invertebrates and identify the names of the five classes of vertebrates. Write these on the lines below.
2. Use the pictures that you previously collected from magazines to find at least 5 examples of each of these classes of animals.

QUESTIONS:

1. Identify at least one distinguishing characteristic that each class shares or has in common (that makes that class different from other classes.) Write this on the line next to the classes that you identified above.

_____

_____

_____

_____

_____

Vertebrates

NEW WORDS

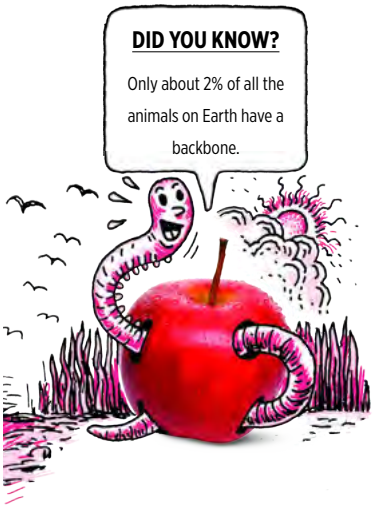
- amphibian
- cartilage
- ectothermic
- endothermic
- gill
- larva / larvae
- mammary gland

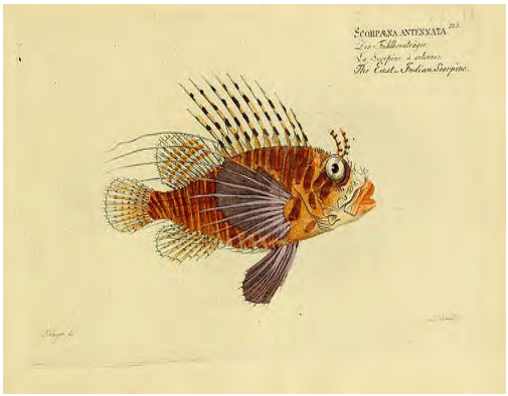
The five classes of vertebrates are:

1. Fish
2. Amphibians
3. Reptiles
4. Birds
5. Mammals

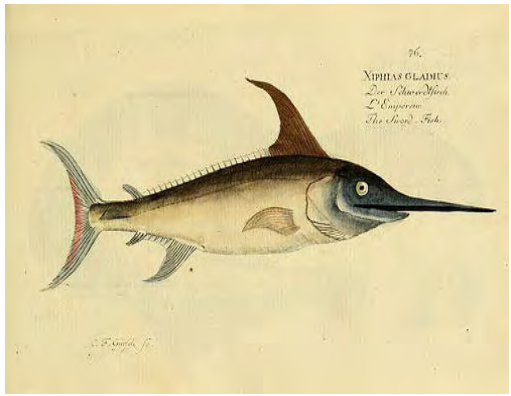
Fish

Fish come in all sorts of shapes, sizes and colours. There is huge diversity amongst fish. Have a look at some of the following drawings of different types of fish.

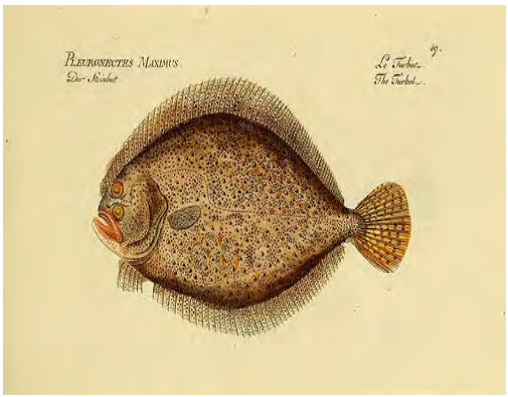




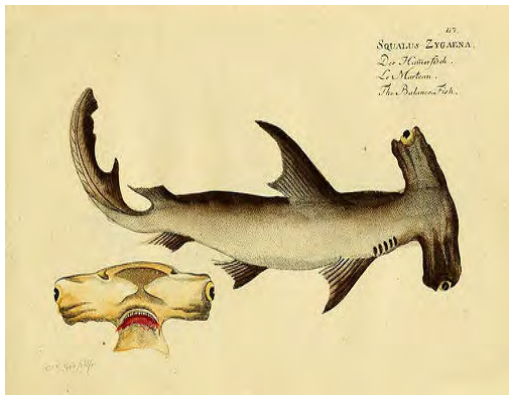
Scorpion fish



Swordfish



Sole Fish



Hammerhead shark

Puffer fish

Goldfish

ACTIVITY: Identify defining features of fish

QUESTIONS:

1. Carefully study the drawings of the fish shown previously. Although they are different shapes, sizes and colours, you should be able to identify common features to all fish. List as many of the defining features of fish as you can.

2. Some of the features that you listed might apply to other animals that are not fish. Look at your list again. Make a tick next to any of the features you listed that only apply to fish, or perhaps a combination of characteristics that only apply to fish.

When classifying fish we look closely at the material that makes up the skeleton of the fish. This leads us to divide fish into two main groups:

- **Cartilaginous fish** have skeletons made of **cartilage**.
- **Bony fish** that have skeletons made of bone.

Sharks, skates and rays are part of a group of cartilaginous fish because their skeletons are made of cartilage. These fish breathe using five to seven pairs of **gills**.

Manta ray

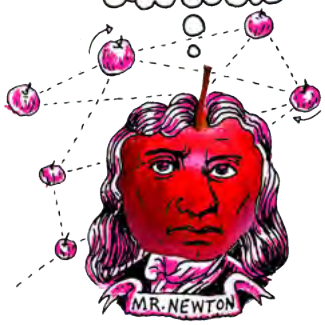
Spotted eagle ray

A whale shark surrounded by other fish

A great white shark

DID YOU KNOW?

The coelacanth was thought to be extinct for 65 million years, but was discovered in a catch of fish in 1938. Since then, more have been found along the coast of Southern Africa.



DID YOU KNOW?

A whale shark is a shark and not a whale. It is the world's largest fish and it eats only plankton.

The largest group of all vertebrates are bony fish. Bony fish have a hard, bony skeleton.

DID YOU KNOW?

The male seahorse actually becomes pregnant! The female squirts her eggs into the male's pouch and he then fertilizes them and incubates them until they are ready to hatch.

Challenge question: Is a seahorse a fish? Search books and the internet to find out and explain why we can or cannot consider it to be a fish.

A sea horse.

VISIT

Watch this video of a male seahorse giving birth

bit.ly/15eTuEw

Amphibians

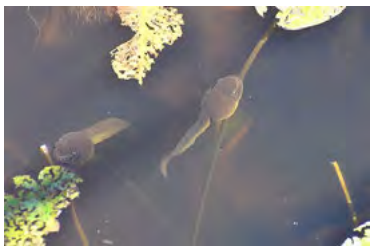
Did you know that the word amphibia comes from two Greek words, *amphi* meaning both and *bios* meaning life? So an amphibian is an animal that has 'both lives'. What does this mean?

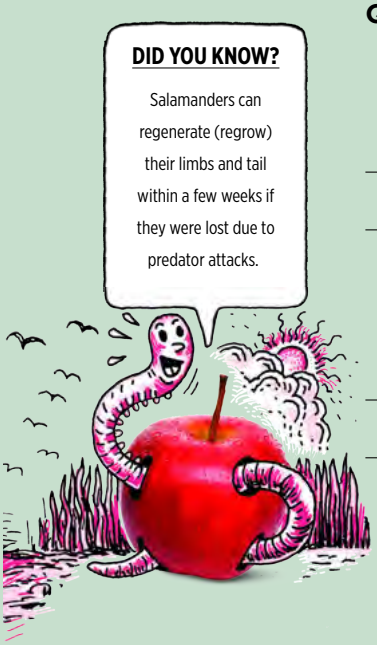
Amphibians are animals that include salamanders, newts, caecilians, frogs and toads. Let's find out what is meant by amphibians having 'both lives'.

ACTIVITY: Describing amphibians

INSTRUCTIONS:

1. Study the photos of different amphibians in the following table.
2. Answer the questions which follow.

Amphibian	Larva (young)	Adult
Frog		
Toad		
Salamander		
Newt		

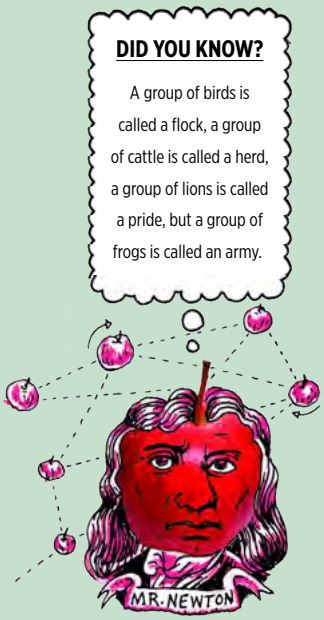


QUESTIONS:

1. What do you notice about the habitat of the young amphibians compared to the adult amphibians?

2. What do you think the larvae need to breathe underwater? What do the adult amphibians need to breathe when they are on land?

3. Can you now explain why amphibians have a name which comes from two Greek words and means 'double life' or 'both life'? Write your explanation below.



4. Amphibians are **ectothermic**. Explain how an amphibian keeps its body warm.

5. Most amphibians have a slimy, moist skin. Discuss possible reasons why they need to have this specific type of skin.

6. Look at the following image of a caecilian. There is a debate going on in a Gr. 6 class. Some learners think this animal is a worm, making it an invertebrate. Others think it is a snake, making it a vertebrate. What do you think?

A caecilian.

The caecilian is actually an amphibian! What characteristics would you test or make sure this animal displayed to explain to the Gr. 6 learners that it is not a worm. Secondly, what would you need to find out and explain to the learners to explain that it is not a reptile (a snake) but an amphibian?

7. Amphibians lay their eggs in water, like this frog. Why do you think they need to do this? Give two reasons.

A frog that has just laid its eggs

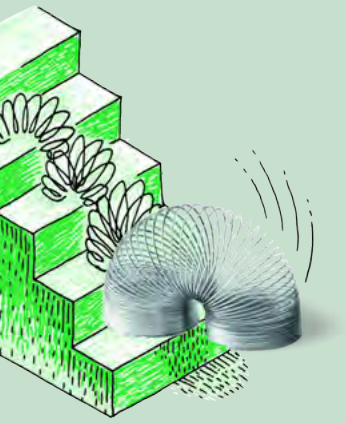
Reptiles

Reptiles have survived on Earth for millions of years. The first reptiles on earth lived 310 to 320 million years ago and included the dinosaurs.

Most reptiles live on land although some, like crocodiles, terrapins and turtles, and some snakes and lizards spend large portions of their lives in water. Reptiles are ectothermic. They cannot regulate their body heat but depend on their environment for heat.

A lizard lying in the sun to warm up

Reptiles are covered in dry scales. Reptiles reproduce by laying their eggs on dry land. The eggs are covered by a leathery or hard shell.



ACTIVITY: Reflect on reptiles

QUESTIONS:

1. Complete these sentences.
   a) Since reptiles all have a backbone they are one of the classes of _____.

_____

   b) Reptiles are ectothermic which means that _____.

_____

_____

2. Make a biological drawing with labels and a heading of the lizard lying in the sun in the previous photo.

VISIT

Learn more about the boa constrictor which keeps its eggs inside its body until they are ready to hatch

bit.ly/1331Bd1

3. We can divide reptiles into four main groups. Each of the photos in the table below shows an example of a reptile from each of these groups. Try to identify the four groups based on the animal in the photo.

Birds

The blue crane is South Africa's national bird.

DID YOU KNOW?

Turtles are only found in the sea, terrapins are found in freshwater, and tortoises do not swim around, but walk on land.

ACTIVITY: Identify characteristics of birds

INSTRUCTIONS:

1. Work in groups of three.
2. List the identifying characteristics of birds following these steps:
3. Do you remember learning about birds in previous years? Work with a different group and brainstorm identifying characteristics of birds. Study the photo of the blue crane above for some clues.
4. Use one specific colour to list the characteristics that your group can think of.
5. As you learn more about characteristics of birds add these in a different colour to help you remember the new characteristics.

QUESTIONS:

1. Birds are one of the five classes of vertebrates. Write a sentence to explain what all vertebrates have in common.

2. Just like mammals, birds are also **endothermic**. What does this tell us about their bodies?

3. What type of body covering do all birds have in common?

4. Is it accurate to say that birds have wings and can therefore fly? Explain your answer. What would be a better way to write this statement?

5. Study the pictures of these flightless birds and compare them with the flying birds in the next column. Use the pictures to write a paragraph explaining the observable differences between flightless and flying birds and why you think these characteristics help some to fly and others not.

Flightless Birds	Flying Birds
 Ostriches  Penguins	 An albatross  A hummingbird

Mammals

Lions are mammals.

A warthog is a mammal.

DID YOU KNOW?

While the larger cats (lion and leopard) prefer to hunt at night to avoid overheating, cheetah hunt in the middle of the day. There is then less chance of them losing their catch to the larger cats.

ACTIVITY: Identify characteristics of mammals

INSTRUCTIONS:

1. Work in groups of three to four.
2. You might have learnt about mammals in previous years. Work with your group to brainstorm as many identifying characteristics of mammals that you can think of. Study the diagram of the lion above for some clues.
3. List the characteristics that you can identify in the space below using one specific colour.
4. As you learn more about mammals, add what you have learnt to this list in a different colour. This will then provide a summary on mammals when you have completed the section.

Mammals are vertebrates meaning they have a backbone. Almost all mammals are endothermic. This means they are also able to maintain (keep) their body temperature at a constant level.

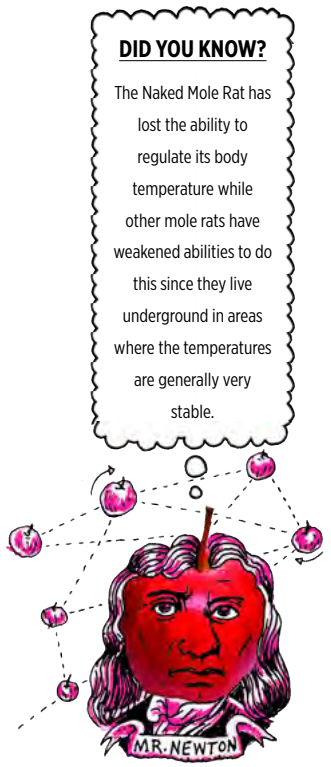
Mammals give birth to live young which are fed milk. The milk is produced by the mother's **mammary glands** (in the teats or breasts). Mammals also have hair on their bodies. This varies greatly between mammals. Mammals also have teeth that look different in different parts of the mouth.

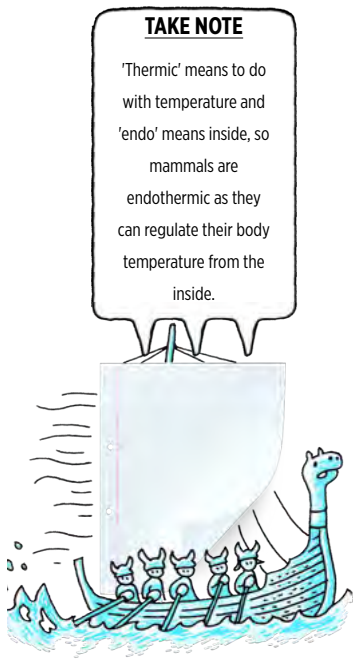
Kittens drinking milk from the mother cat.

A seal pup suckling from its mother.

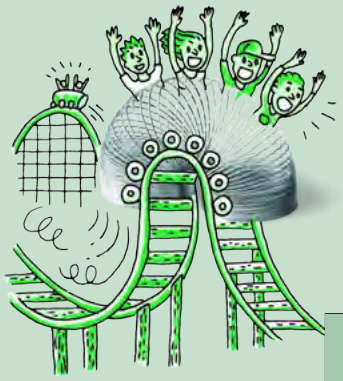
All mammals breathe using lungs. Many mammals therefore live on land. Those mammals that do live in water, like whales and dolphins, have to come to the surface of the water to breathe.

Dolphins surfacing to breathe air





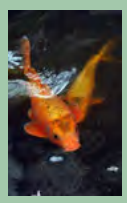
Now that we have studied the five main classes of vertebrates it is easy to compare them!



ACTIVITY: Comparing vertebrates

INSTRUCTIONS:

1. Use the table below to compare the vertebrates shown in the photos based on the features in the first column.

	Tortoise 	Chimpanzee 	Frog 	Guinea fowl 	Goldfish 
Class					
Skin covering					
How babies are born					
Habitat					
Ectothermic or Endothermic					
Distinguishing features					

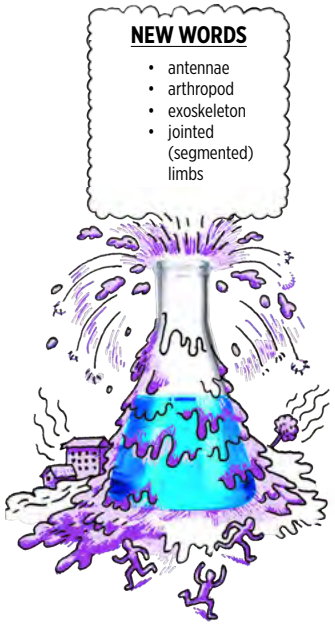
VISIT

Why are there no giant mammals? (video)

bit.ly/13gvab1

Now that we have looked at all the classes of vertebrates, let's have a look at the invertebrates.

Invertebrates



What should you look out for when you have to decide if an animal is an invertebrate?

- All invertebrates lack a backbone. They either have a hard outer shell or a fluid-filled structure that acts as a skeleton (for example jellyfish and slugs).
- All invertebrates are ectothermic.

Did you know that 97% of the animals on Earth are invertebrates? Due to the huge diversity in the invertebrates, it can sometimes make classifying them a bit tricky. The invertebrates are divided into several phyla. Some of the invertebrate phyla are:

1. Molluscs (for example snails and octopuses)
2. Arthropods (for example insects, spiders and crabs)
3. Echinoderms (for example sea urchins and starfish)
4. Cnidaria (for example jellyfish)
5. Porifera (sponges)
6. Annelids (segmented worms)
7. Platyhelminthes (flatworms)

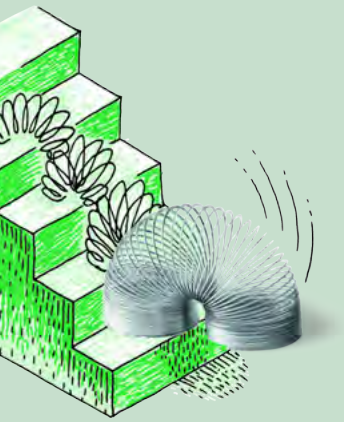
There are some other phyla too. As you can see, the invertebrates are a very large and diverse group of animals. We are mostly going to focus on the two phyla Arthropods and Molluscs.

The word arthropod comes from two greek words *arthron* meaning 'joint' and *podos* meaning 'leg', so together it means 'jointed legs'. Arthropods have an **exoskeleton** and they have jointed (segmented) limbs.

Let's now find out more about Arthropods!

Arthropods

The invertebrates that fall into the phylum arthropoda, all have a hard outer covering called an **exoskeleton**. The exoskeleton protects the animal and provides a place for its muscles to attach and function.



ACTIVITY: Classifying arthropods

INSTRUCTIONS:

1. Study the photos of different arthropods below.
2. Answer the question that follow.

A spider

A prawn

A butterfly

A scorpion

A millipede

A dung beetle

A crab

A grasshopper

A crayfish

A centipede

QUESTIONS:

1. Study the bodies of each of these animals.
   a) Describe how the bodies of the different arthropods look and if you could touch it, what do you think it would feel like?

_____

_____

   b) Do you think their bodies would be warm or cold?

_____

_____

2. Study the legs of the different arthropods.
   a) Describe how the legs of the different arthropods look in general.

_____

_____

   b) How are the legs able to bend?

_____

c) One way to classify an arthropod is to count its legs and to group these animals according to this. Count the legs on each of these arthropods and write their names in the appropriate column below to see to which group they belong.

Insects = 6 legs	Arachnids = 8 legs	Crustaceans = 10 legs	Diplopoda and Chilopoda = many legs

DID YOU KNOW?

The coconut crab (*Birgus Latro*) is the largest land-living arthropod on Earth and weighs up to 4 kg! It can crack whole coconuts with its pincers.

3. As you probably noticed, an arthropod's body is covered by a hard exoskeleton. Explain how you think an arthropod can grow and get bigger since the hard exoskeleton cannot grow with it.

4. What habitat would you say most crustaceans live in? How does this differ from the habitat of the other classes of arthropods?

5. Which class of arthropods has wings? Do all of the animals in the class have wings?

Molluscs

Molluscs are a very diverse phylum of invertebrates. They have a huge range in body shapes and sizes. Molluscs are often given a general description which is that they have internal or external shells and a single muscular 'foot'. However, there are lots of molluscs which do not strictly fit this description, such as slugs.

The group of molluscs include snails, squid, octopuses, periwinkles, abalone, mussels, oysters and other soft-bodied animals.

A reef squid

An octopus

A sea slug (nudibranch)

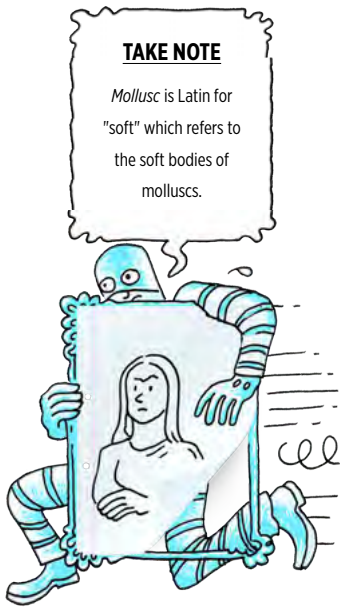
The Blue Dragon nudibranch

A cuttlefish

Limpets in a rock pool

An abalone

A garden snail



ACTIVITY: Observing molluscs

INSTRUCTIONS:

1. Carefully study the above photos of different animals that form part of the phylum mollusca.
2. Answer the following questions.

QUESTIONS:

1. Identify some characteristics that molluscs have in common.

2. Most of the molluscs shown in the photographs live in the sea. What do you think would happen if these molluscs were exposed to the air for a long time?

3. Walk through the school garden and see if you can find any garden snails. If you do, or perhaps you have seen them elsewhere before, think about their habitat. Describe the areas where you found snails.

4. If possible, collect a few snails to study in class. If you have a glass terrarium or an old aquarium, keep the snails in there, or else keep a few in large clean glass jars.

5. Carefully study their bodies and especially their long, slimy foot.
   a) What do you think the slime is used for?

   b) Describe how the snail moves.

   c) How many tentacles (**antennae**) does the snail have? What do you think these are used for?

d) What markings are on the shell? Why do you think the shell is marked in this particular way?

e) Try and see if you can find male and female snails. What conclusion can you draw from this.

6. Make a drawing of a snail. Include the following labels: hard shell, foot, head, mouth, tentacle, eyespot.

2.3 Diversity of plants

NEW WORDS

- bulb
- rhizome
- root
- seeds
- shoot
- spore
- stem
- symbiotic

In this section we will take a closer look at the organisms in the **plant kingdom**. So how do we classify plants?

Classifying plants

We can easily compare plants based on their characteristics. For example, their leaf size and shape, whether there are flowers or not and how the petals look, the length and depth of the **roots** and the type of root system, and many others.

One particularly useful way is grouping plants according to how they reproduce sexually. If we group plants based on the way that they sexually reproduce we can quickly see two distinct groups:

- Plants with **seeds**
- Seedless plants

VISIT

If you would like to join and become a research scientist yourself, visit the iSpot website

bit.ly/1beUSg3

A common fern in South Africa

The structures that produce and release spores on the underside of a fern leaf

Plants that do not produce seeds include ferns, mosses and algae. These plants produce **spores**. The spores often develop in structures found on the underside of the leaves or fronds. The spores grow into new plants.

The photo on the left shows a close-up of the underside of a fern leaf. Can you see the clusters of capsule-shaped structures that form the tiny spores?

The close-up photo on the right shows a moss sporophyte. This contains the spores of the moss plant.

DID YOU KNOW?

Ferns have been around for about 400 million years. That is even older than dinosaurs, and they are still living on Earth today.

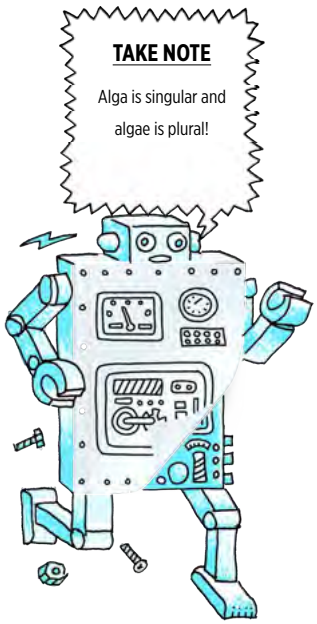
Moss growing on the forest floor

Close-up of a spore-producing moss plant

Do you know what lichen is? You often see it growing on rocks and tree trunks. Do you think lichen is a plant? Look at the photos of lichen below.

Lichen growing on a tree

Lichen growing on an old tin drum

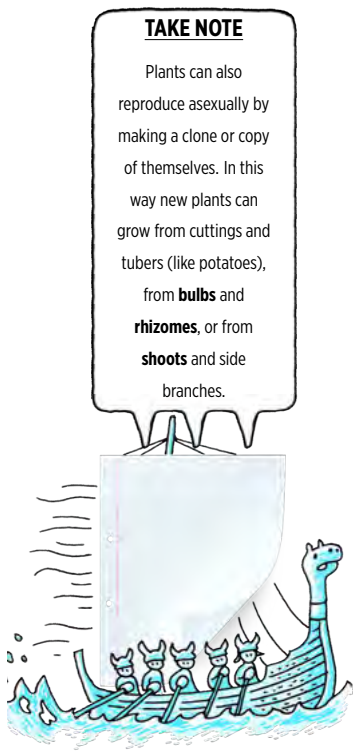


Lichen actually consist of two different organisms growing together! A fungus and a green alga grow together in a **symbiotic** relationship. The fungus absorbs water from the environment and provides the algae with an environment to grow in. The green algae photosynthesizes, providing food for the itself and the fungus. Why can the fungus not make its own food? Is the fungus a plant? Can you come up with a definition for a symbiotic relationship? Discuss this with your class and take some notes.

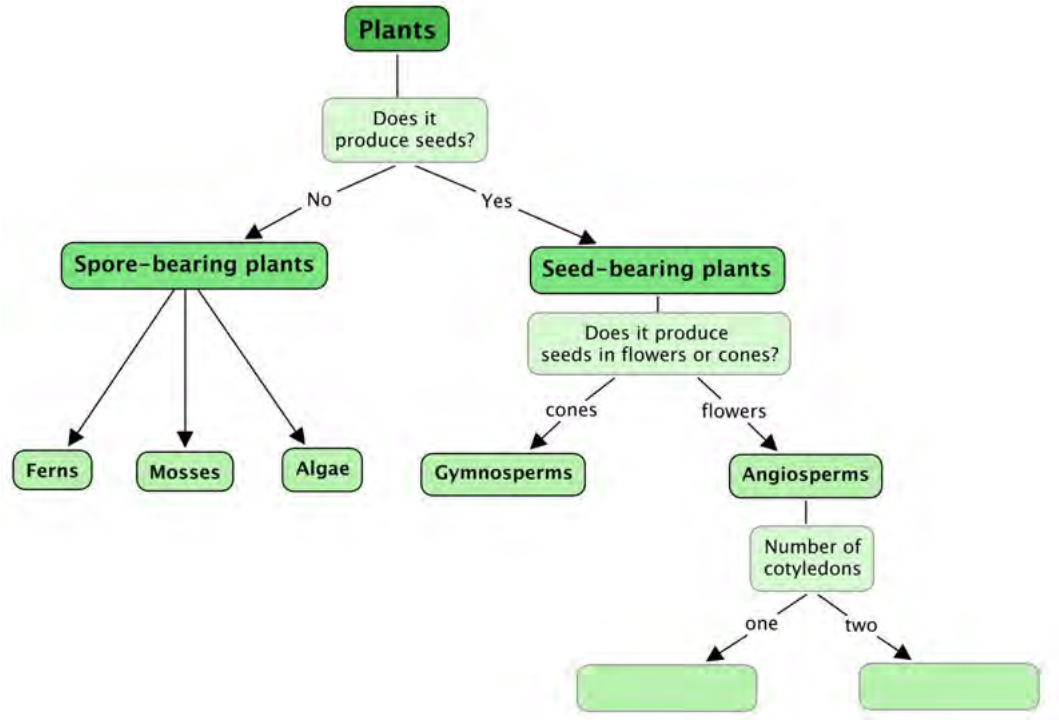
The other group of plants produces seeds. These plants can either produce seeds in flowers or they can produce seeds in cones. Most plants that you see around you, produce seeds. Plants that produce seeds in flowers are called **angiosperms** and plants that produce seeds in cones are called **gymnosperms**.

This is a gymnosperm plant as it produces seeds in cones.

This is an angiosperm plant as it produces seeds in flowers.



We can therefore classify plants as follows:



NEW WORDS

- cotyledon
- dicotyledon
- herbaceous
- leaf vein
- monocotyledon
- tap root

Come back to complete this diagram once we have learned more about angiosperms.

Seed-bearing plants

Gymnosperms

Have you ever seen a living prehistoric plant? If you thought about it, you probably have without even realising it!

In South Africa we have plants called cycads that are often referred to as 'living fossils'. Cycads grew in great numbers during the Jurassic period. They have not been around for as long as ferns and algae, but they have been on Earth for longer than all flowering plants. Flowering plants (angiosperms) evolved after gymnosperms.

VISIT

More information on cycads:

bit.ly/16CqjQu

A cycad with cones.

Cycads at Kirstenbosch Gardens in Cape Town.

Can you see the large cones in the photo of the cycad above? They are in the centre of the plant. The cones are made up of many individual seeds. Look at the following close up images of cones.

A cycad cone.

A cone from a pine tree.

The word gymnosperm means 'naked seed'. Gymnosperms are considered to have naked seeds as the seeds are not covered in a fruit, like we will see in angiosperm plants.

Another gymnosperm which is native to South Africa, and grown a lot in the Cape is the Mountain Cypress, as shown in the photo. They grow especially well at high altitudes, such as in the Cederberg Mountains.

There are several species of gymnosperms which are *not* indigenous to South Africa. What does this mean? Let's find out.

A Mountain Cypress.

ACTIVITY: Invasive plants in South Africa

INSTRUCTIONS:

1. Study the following photograph of an invasive gymnosperm plant in South Africa.
2. Answer the questions that follow.
3. You will need to do some research in books and on the internet.

Pine trees in Tokai Forest, Cape Town.

QUESTIONS :

1. Find out what it means if a plant is indigenous to South Africa. Some examples of indigenous plants in South Africa are aloes, acacia thorn trees, strelitzia flowers, rooibos and the the king protea. Write a definition below.

_____

_____

2. What is an alien species? Why do we call it invasive? An example is the Jacaranda trees with the purple flowers which are very common in Pretoria.

_____

_____

3. How do gymnosperm plants reproduce?

4. In many parts of South Africa, plantations of pine trees are regulated so that they do not impact on the biodiversity of the indigenous plants. But, there are some forests of pine trees which are not used for timber anymore. The Tokai Forest in Cape Town is one of these. Many mountain bikers and runners enjoy doing their activities in this forest. The city of Cape Town started to clear these trees in 2011 so that they could get natural, indigenous fynbos to grow again. There was an outcry from some people as they said their shady riding spot had been ruined. What are your thoughts on this? Do you think Cape Town should be cutting down these trees or not? Give reasons for your answer.

VISIT

Pretoria's Jacaranda trees are an 'alien' problem. (video)

bit.ly/16HN2ss

Let's now take a look at the other group of seed-producing plants, angiosperms.

Angiosperms

Angiosperms are flowering plants. They produce flowers which develop into seeds that can grow into new flowering plants. We will learn more about reproduction in angiosperms in the next chapter. Most of the plants that you probably see around you in the gardens are flowering plants.

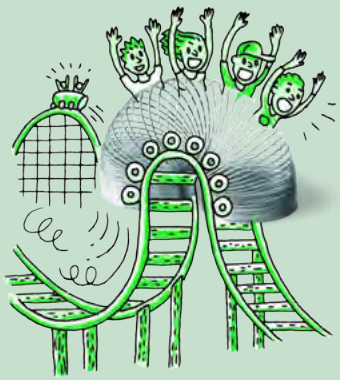
We can group flowering plants into two major groups:

- **monocotyledons**
- **dicotyledons**

All the angiosperm plants that we are studying have the following characteristics in common:

- roots
- stems
- leaves
- flowers
- fruits
- seeds

A huge thorn tree does not look anything like a maize plant, yet they are both flowering plants. They both have roots, **stems**, leaves and their flowers produce seeds. So why can we group the one as a dicotyledon and the other as a monocotyledon? Let's find out!



ACTIVITY: Discovering the differences between monocotyledons and dicotyledons

INSTRUCTIONS:

1. Study the photos of South African monocotyledons and then dicotyledons.
2. Answer the questions which follow about each group.

Monocotyledons:

Maize.

Sugar cane.

Agapanthas.

Bull rushes.

QUESTIONS:

1. Describe the leaves of the monocotyledons in the photos. How would you describe the veins in the leaves? Make a drawing to accompany your description.

2. Describe the stems. Are they woody stems or green (**herbaceous**) stems?

3. Look at the following photos of typical monocotyledonous flowers. Count how many petals are on each flower. What can you generalize about the number of petals (and other flower parts) in monocotyledonous flowers?

A disa.

Agapanthus flowers.

4. Many of the crops that we grow are monocotyledons, such as maize and sugar cane. Name two others.

Dicotyledons:

Plumbago bush.

A geranium.

Fig tree.

Protea bush.

QUESTIONS:

1. Describe the leaves of the dicotyledons in the photos. How would you describe the veins in the leaves. Make a drawing to accompany your description.

2. Describe the stems. Are they woody stems or green (herbaceous) stems?

3. Look at the following photos of typical dicotyledonous flowers. Count how many petals are on each flower. What can you generalize about the number of petals (and other flower parts) in dicotyledonous flowers?

Geranium flowers.

Plumbago flowers.

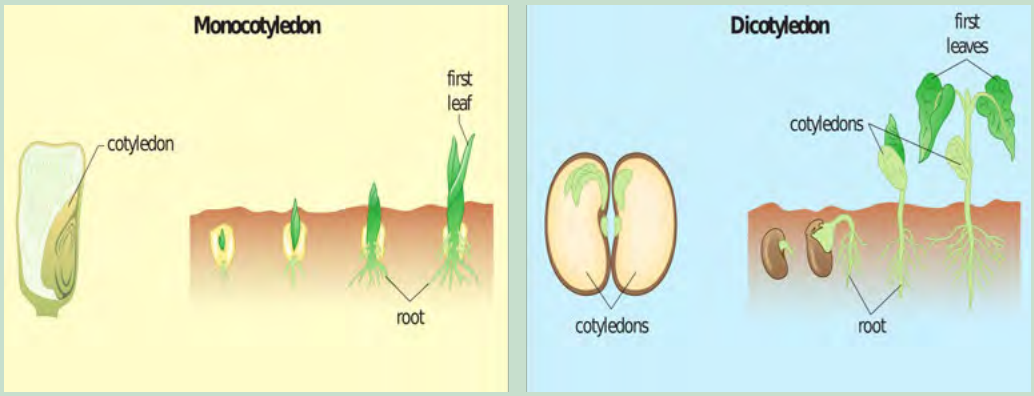
Hibiscus flower.

Hydrangea flowers.

DID YOU KNOW?

Hydrangea flowers can tell us about the soil acidity! An acidic soil (pH below 7) will normally produce blue flowers, whereas an alkaline soil (pH above 7) will produce more pink flowers.

4. Look at the following image which shows the difference between monocotyledonous seeds and dicotyledonous seeds. Monocotyledons have one **cotyledon** and dicotyledons have two cotyledons.



5. Using the information you have discovered in this activity, complete the following table to summarize the differences between monocotyledons and dicotyledons.

	Monocotyledons	**Dicotyledons**
Cotyledons		
Stems		
Flowers		

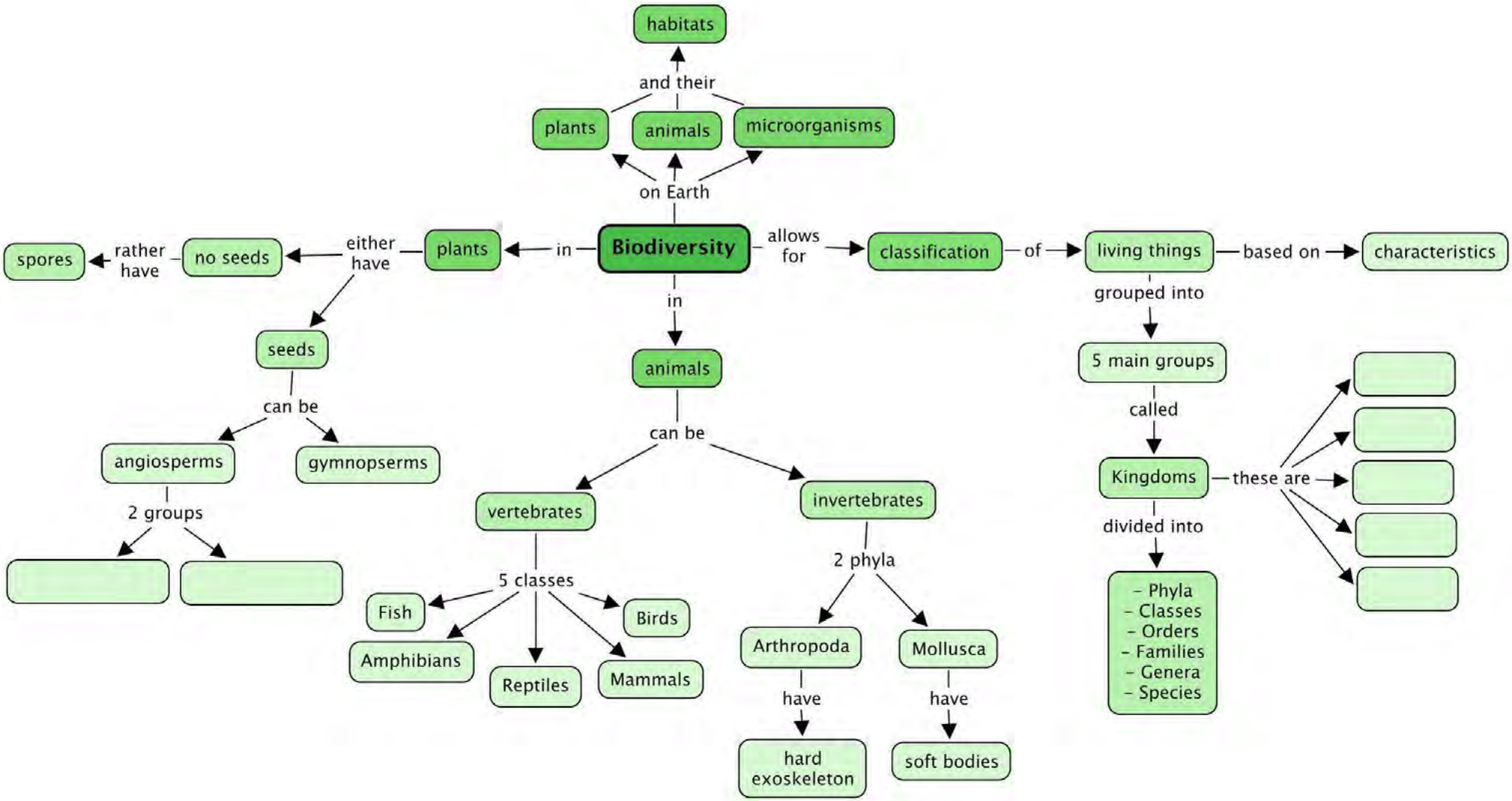
SUMMARY:

Key Concepts

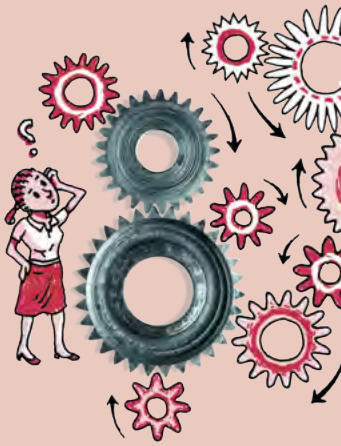
- All the plants, animals and microorganisms and their habitats make up the total biodiversity of planet Earth.
- Living organisms are sorted and classified according to their shared characteristics.
- We use a classification system that groups living organisms into five main groups or kingdoms: Bacteria, Protists, Fungi, Plants and Animals
- All living organisms have to perform the seven life processes and the way in which they perform these help us to classify them into different groups, putting plants into one group and animals into another for instance.
- We can divide a kingdom into smaller and smaller groups, in this order: phyla, classes, orders, families, genera and species.
- In the kingdom of animals, we can get two main groups of animals - this with a backbone called vertebrates, and those without a backbone called invertebrates.
- The vertebrates are divided into five groups: Mammals, Birds, Reptiles, Fish and Amphibians.
- The invertebrates make up the largest group of animals and there are many thousands of species. We also divide the invertebrates into different groups or phyla like the arthropods, molluscs, sponges and jellyfish, and many others.
- Arthropods all have a hard exoskeleton and jointed legs, such as insects, arachnids (spiders) and crustaceans (crabs).
- Molluscs have a soft body with or without a shell, such as snails and octopuses.
- In the kingdom of plants we also get two main groups: plants that produce seeds and plants that do not produce seeds but spores.
- Seedless plants produce spores - like ferns and some mosses.
- Seed producing plants can be further divided into angiosperms (seeds in fruit) and gymnosperms (seeds in cones).
- Angiosperms can be divided into monocotyledons and dicotyledons.
- Monocotyledons have seeds that only have one part or cotyledon. Their stems are herbaceous. The leaves are simple, long and narrow and their flower parts are arranged in multiples of three.
- Dicotyledons have seeds with two parts or cotyledons from which their **tap root** grows deep into the soil. Their stems can be woody or herbaceous. The leaves are varied in shape and size and have a network of **leaf veins**. Flower parts are usually arranged in multiples of four or five.

Concept Map

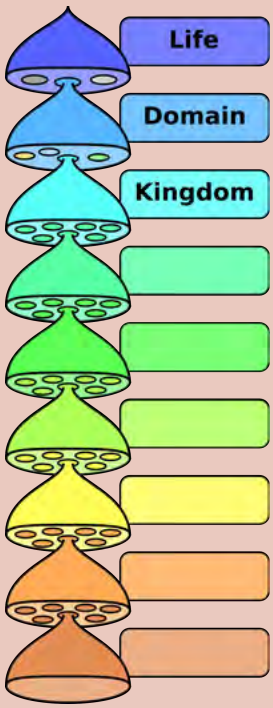
This concept map shows how the concepts in this chapter on Biodiversity link together. Complete the concept map by filling in the five Kingdoms that living things are classified into, and also giving the two major groups of angiosperm plants. Can you see how the arrows show the direction in which you must 'read' the concept map?


habitats
and their
plants
animals
microorganisms
on Earth
Biodiversity
in
plants
either have
no seeds
rather have
spores
seeds
can be
angiosperms
gymnopserms
2 groups
in
animals
can be
vertebrates
5 classes
Fish
Amphibians
Reptiles
Birds
Mammals
invertebrates
2 phyla
Arthropoda
have
hard exoskeleton
Mollusca
have
soft bodies
allows for
classification
of
living things
based on
characteristics
grouped into
5 main groups
called
Kingdoms
these are
divided into
- Phyla
- Classes
- Orders
- Families
- Genera
- Species

REVISION:



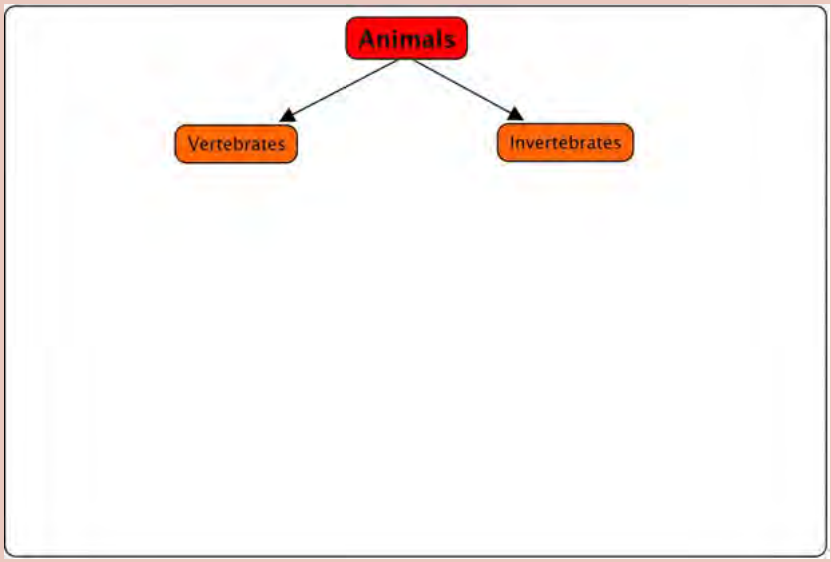
1. Use the following diagram to fill in how we classify organisms. The first 3 have been filled in as we did not discuss domains in this chapter. You will learn more about domains in later grades. [6 marks]



2. Which two levels of classification do we use to name an organism. What is the correct way to write the scientific name of an organism? [3 marks]

3. Why was Aristotle's method of classifying animals as walkers, swimmers or flyers not very effective? [2 marks]

4. Use the space on the following page to draw a classification diagram of the animal kingdom. It has been started for you. You only need to include the phyla and classes that we studied in detail. [11 marks]



5. Give one word for the following or complete the sentence required:
   a) The existence of a large number of different kinds of plant and animal species which make a balanced environment. [1 mark]

_____

   b) The animal kingdom can be divided into two main groups. [2 marks]

_____

   c) The five classes of vertebrates are: [5 marks]

_____

   d) The phylum of animals that have a hard exoskeleton. [1 mark]

_____

   e) The phylum of animals that have a soft body often protected by a shell. [1 mark]

_____

6. Write true or false next to each of the following sentences. If the sentence is false, rewrite it so that it is true. [10 marks]
   a) A small percentage of the living organisms on Earth are invertebrates.

_____

   b) Invertebrate animals do not have a backbone.

_____

   c) Spiders are examples of arthropods.

_____

d) All molluscs have exoskeletons in the form of shells.

e) Birds only have feathers as their body covering.

f) Endothermic animals need to keep very still when it is cold.

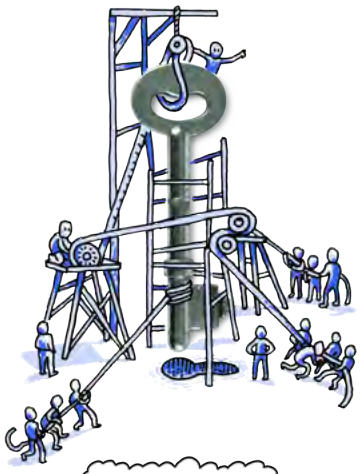
7. Look at the following sentences and underline the one that *best* describes mammals. [1 mark]
   a) Mammals are animals that breathe, move, eat, reproduce and excrete.
   b) Mammals are animals that can regulate their body temperatures.
   c) Mammals are warm blooded animals that feed their young, have special organs for breathing and a backbone.
   d) Mammals are warm blooded animals with mammary glands, a hairy body, lungs and a backbone.
   e) Mammals give birth to live young, can be found living on land and in water, and can sense their environment with well defined smell and touch senses.

8. Describe how the seeds of angiosperms differ from those produced by the cycads. [2 marks]

9. Use the following space to draw a classification diagram of plants. [10 marks]

Total [55 marks]

3 Sexual reproduction



KEY QUESTIONS:

In angiosperms

- How do plants make seeds?
- What is the role of flowers in reproduction?
- Flowers come in so many different colours, shapes and sizes. So, are there some structures that are common to all flowers?
- What is a 'pollinator'? Why are pollinators also important to humans? Is the flower on a rose the same as the flower on a sweet pea or on a daisy bush?
- Why are seeds in different shapes and sizes, or contained in fruits? Does it have something to do with the way seeds are spread to new areas?
- Does fertilisation mean the same things in plants as it does in animals?

In humans

- Why is your body starting to change?
- What is puberty and what does it mean when we "reach puberty"?
- How is it possible that we all go through puberty at different times and rates?
- What changes take place inside our bodies during puberty?
- What do our reproductive organs look like when they are mature?
- How does reproduction occur?
- What is menstruation and why does it occur once a month?
- How does a baby grow inside a woman's uterus?
- There is a lot of awareness now of HIV/AIDS and STDs, but what exactly can we learn in Natural Sciences to help us lead a safe and healthy lifestyle for the rest of our lives?

VISIT

A video on asexual reproduction

bit.ly/18dp5dE

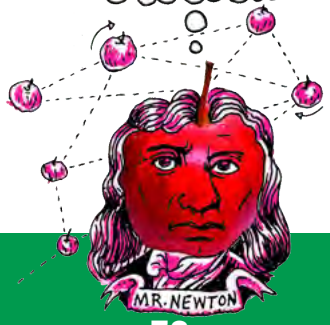
All living organisms on Earth need to be able to reproduce so that their species does not become extinct. There are two basic ways in which reproduction can take place:

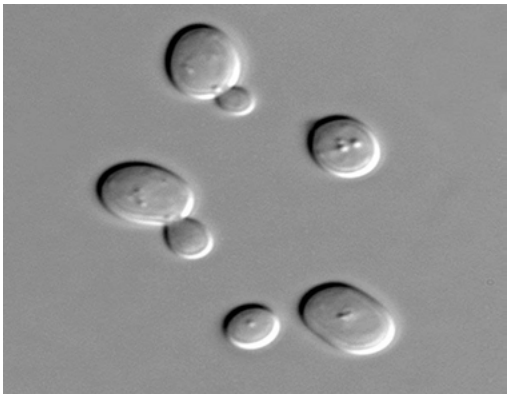
- asexual reproduction
- sexual reproduction

Asexual reproduction occurs when one parent organism makes offspring which are identical to the parent. The parent organism therefore does not need to **mate** to produce new organisms. Archaea, Bacteria, Fungi and Protists reproduce asexually. Many plants and algae reproduce asexually and also some animals, such as some species of insects, reptiles, sharks, snails and crustaceans.

DID YOU KNOW?

Some species are able to switch between asexual and sexual reproduction, depending on certain conditions, such as whether there is a mate available for sexual reproduction. Aphids are able to do this. This is called heterogamy.





These yeast cells are undergoing budding, a type of asexual reproduction. Can you see the smaller offspring 'budding' off the parent?

A mother aphid with offspring which were produced asexually or sexually, depending on the conditions.

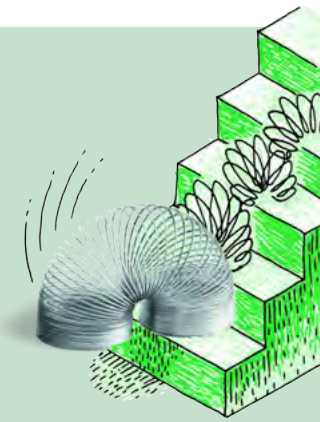
NEW WORDS

- angiosperm
- asexual reproduction
- cell
- fertilisation
- fuse
- genetic information (DNA)
- mate
- pollen
- pollination
- pollinator(s)
- sexual reproduction

In this chapter we are going to learn about **sexual reproduction** where two parent organisms mate and their **genetic information (DNA)** combines to make offspring which look similar, but they are not identical. Sexual reproduction takes place in most plants and animals. We will look at flowering plants (angiosperms) as an example of sexual reproduction in plants and at human reproduction as an example of reproduction in animals.

3.1 Reproduction in angiosperms

How do plants make new plants? In this chapter we will learn about how **angiosperm** plants reproduce. Sexual reproduction in angiosperms results in the formation of seeds. Under the right conditions, these seeds will germinate and grow into a new plant.



ACTIVITY: Growing a bean plant

MATERIALS:

- bean seed
- paper towel, toilet paper or tissue
- glass jar (or transparent plastic tub/ jar)
- water
- measuring tape or ruler

INSTRUCTIONS:

1. Place some kitchen roll, toilet paper or tissue in your transparent jar.
2. Insert the bean into the paper and place it against the side of the jar so that you can observe the changes that occur.
3. Add a little bit of water so that the paper towel is damp.
4. Place in an area which gets sunlight.
5. Add a little sprinkling of water every day to keep the paper towel damp.
6. Each day, starting on the day that you plant your seed, measure the length of the bean or height of the bean plant and record it in the following table.

Day	Height of plant (cm)	Comment/ notes
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

7. Take notes of your observations from day to day. For example, on what day did your bean start to grow roots? On what day did the stem sprout? When did you see the first leaf (or leaves)? How many were there and what did they look like?

QUESTIONS:

1. What is the term for when a seed starts to grow?

---

2. What are the requirements for a seed to grow?

---

3. Use your table of measurement to draw a graph of plant growth (height) over the 14 days of your investigation.

Now let's learn how plants make seeds. In sexual reproduction, half of the male's and half of the female's genetic material (DNA) fuses (combines) to create a new individual with the combined genetic materials of the parent plants or animals. In most animals we can usually easily identify two sexes of animals: a male or a female animal, which each have male and female parts. In angiosperms, the flowers are the sexual organs of the plant. The flowers produce male and female structures that can either be on the same plant or can be on two separate plants. Let us have a closer look at the structures of flowers.

NEW WORDS

- anther
- embryo sac
- filament
- ovary
- ovule
- peduncle
- petal(s)
- pistil (carpel)
- pollen
- receptacle
- sepal(s)
- stamen
- stigma
- style

Flower structures

Flowers are the sexual organs of angiosperms. Many plants have both the male and female reproductive organs in the same flower although some may have male and female structures on different plants all together.

Flowers come in many different shapes, sizes and colours, as in the photographs in the next activity illustrate, but there are components which can usually be identified in all flowers. These are:

- peduncle
- receptacle
- petals
- sepals
- the male structures
- the female structures

Flowers are typically set on a stem which may be long and rigid like a rose or agapanthas stem, or short and flexible like those on a petunia. The stalk or stem of a flower is called the **peduncle**.

The **receptacle** is the top part of the flower stalk where the different flower parts attach.

TAKE NOTE

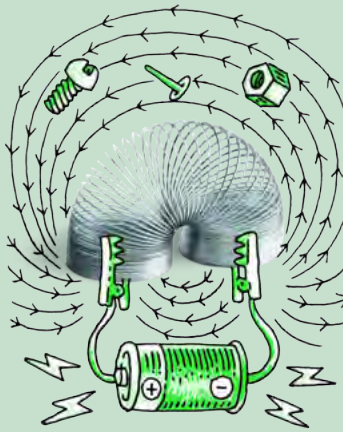
Plants can be broadly divided into gymnosperms and angiosperms. Remember that angiosperms produce flowers, and their seeds are within a fruit, whereas gymnosperms produce seeds in cones.

While the flower bud is forming, small green leaves protect and enclose the young bud. These are the **sepals**. The sepals are often green and look like small leaves, and since they are green they can also photosynthesise. Sometimes the sepals may be the same colour as the petals, like in lilies or tulips.

Flower **petals** are usually the brightly coloured parts of the flower. They attract **pollinators**, such as insects and birds and also bats and mice. We will look more at **pollination** a bit later. In some plants the petals are very small and may even be absent. This is often because these flowers depend on the wind to carry the **pollen** away and therefore do not need petals to attract animals, such as grasses.

Grass flowers.

ACTIVITY: Identify the outer structures of flowers



Rose.

Water lilies.

Petunias.

QUESTIONS:

1. What do we call the part of the stalk where the flower petals and sepals attach to the flower stalk?

_____

2. Explain why the petals on some flowers are brightly coloured while on other plants we can hardly see the petals, and sometimes they are absent altogether.

_____

_____

3. Study the photos of the different flowers above. Describe the outer structures of each of these flowers based on their peduncles (stalks) and receptacles, and their sepals and petals.

_____

DID YOU KNOW?

Sunflowers are in fact composite flowers, made up of hundreds of individual flowers working together. The 'petals' are in fact individual flowers called ray florets and the centre is made of many disc florets. Each of these has a pistil and stamens.

Rose	
Lily	
Petunias	

The structures of the flower that we have discussed here are on the outside. The reproductive structures of the flower are in the middle of the flower. Flowers can contain either male structures or female structures, or both.

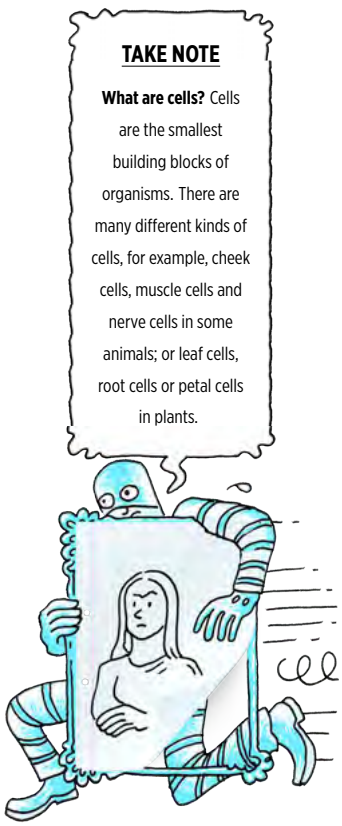
Male reproductive structures

In this section, we will be talking about sex cells. These are either male or female sex cells and only carry half the genetic material (DNA) of a typical cell. When these sex cells fuse the two halves from the male and the female organism make a new organism with the combined genetic material (DNA) from both.

The **stamen** is the male part of the flower. There are two parts to the stamen: the **anthers** and the **filaments** on which the anthers rest.

Anthers produce the pollen that contain the male reproductive sex cells. The male cells in the pollen is carried to the female sex cells and when they fuse they will create a seed which can grow into a new plant.

Filaments are stalk-like structures that support the anthers. In some flowers the filaments may be long and in others relatively short.



The male structures are clearly seen in this close up photo of a flower with the anthers covered in pollen and supported by the stalk-like filaments.

Female reproductive structures

The **pistil** is the female organ of the plant and is usually at the centre of the flower. It consists of a stigma, style and ovary. All the parts of the pistil work specifically to help the plant receive pollen, transport it and have it fertilise the **ovules** (that contain female sex cells). Ovules become seeds after **fertilisation**.

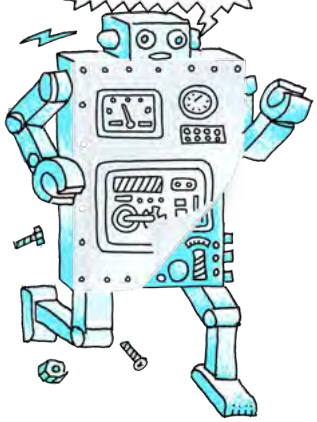
The **stigma** is the structure that receives the pollen during pollination. It is on top of a long narrow style and when it is ready to receive pollen it becomes sticky providing a place for the pollen to stick to.

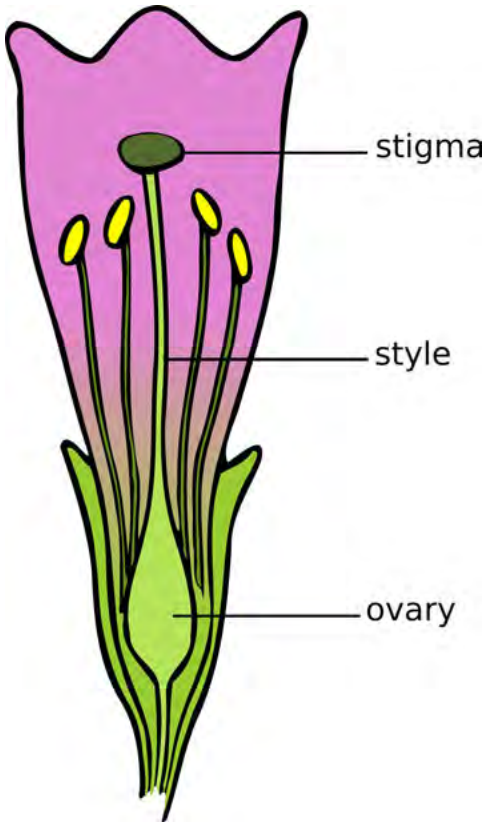
The **style** is a long tube that connects the stigma with the ovary and the ovules. The style supports the stigma and holds it in the best possible position to receive the most pollen grains. After the pollen has landed on the stigma, the pollen grows long tubes called pollen tubes down through the style from the stigma to the ovules in the ovary.

The **ovary** is the enlarged structure at the base of the pistil. It may be divided into different parts (or locules) and produces the ovules that contain the female reproductive sex cells. Within the ovule is the **embryo sac**. The embryo or tiny seed will develop in here.

TAKE NOTE

Each carpel consists of a stigma, style and ovary. Some flowers have one carpel, and some have many. Therefore in some flowers, the carpel and the pistil are the same thing, but in others, many carpels make up one pistil!





The female flowers parts making up the pistil.

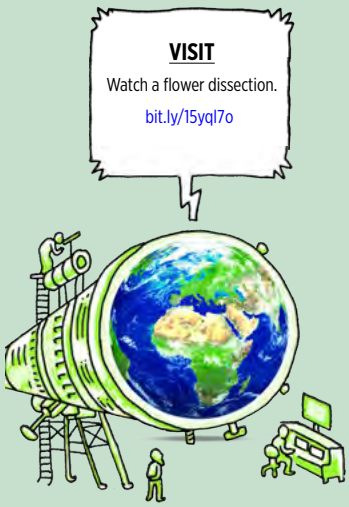
ACTIVITY: Flower dissection

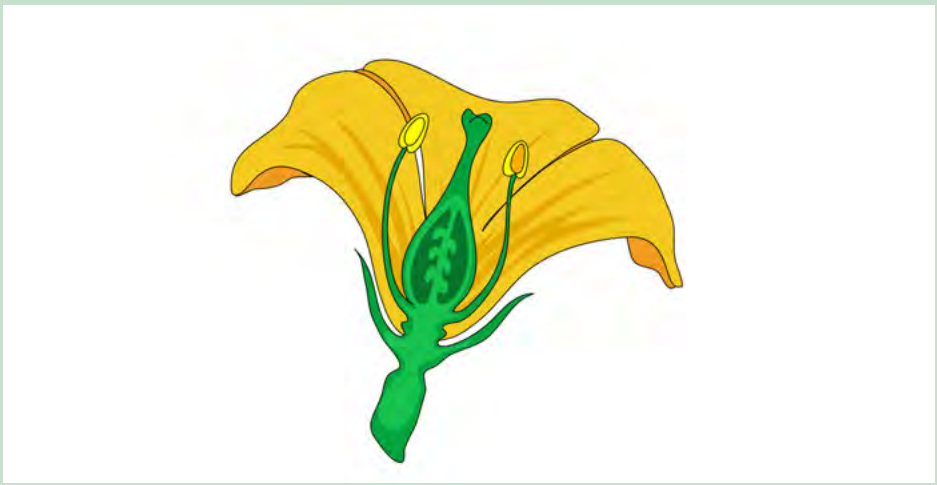
MATERIALS:

- dissecting needle
- dissecting knife
- petunia or hibiscus flowers

INSTRUCTIONS:

1. Study the following diagram of a flower. Use your understanding of the **outer structures** of a flower to add the following labels: petal, sepal, receptacle and peduncle. Once we have done the dissection, we will come back to label the inner structures.





2. Go out into your garden or explore the school grounds and surroundings and select a flower of your own to dissect. If your teacher has petunias or hibiscus flowers, dissect one of those.

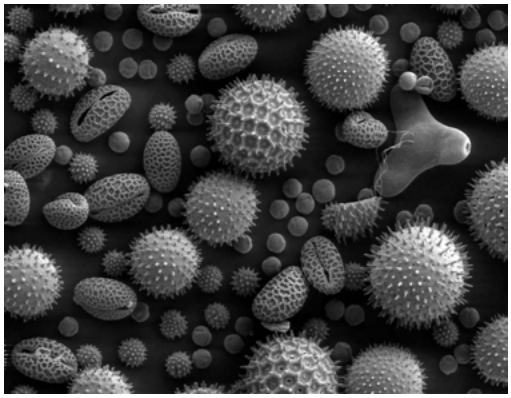
   a) First remove the outer sepals.
   b) Then remove the petals. You have now exposed the ovary.
   c) Identify the male and female structures. Label these on the diagram above.
   d) Using your dissecting knife or scalpel, cut the ovary in half.
   e) Use the dissecting needle to carefully open up the ovary. See if you can identify the ovules.
   f) Label the ovary and ovule on the above diagram.

Now that we have learnt about the structures of flowers, let us take a look at how flowers are pollinated.

Pollination

In order for a flowering plant to reproduce sexually, the male sex cells need to fuse (join) with the egg inside the ovules. The stamen produces pollen that contain the male sex cells. The pollen grains are usually very small - about the size of a speck of dust.

This person's hand is covered in millions of tiny grains of pollen.

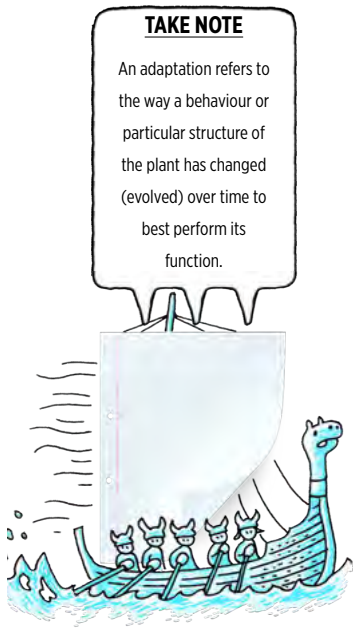


A photograph of a variety of pollen grains from different plants taken under a very strong microscope.

Pollen from the stamen needs to be transferred to the stigma of the flower, either on the same plant or another plant of the same species. This process is called **pollination**. If pollination does not occur, there will be no fertilisation and the plant will not be able to produce seeds or fruit.

Generally plants produce a large amount of pollen to maximise the chances of the pollen being transferred to as many different stigmas on as many different flowers (of the same species) as possible.

Can you identify the stamens covered in pollen and the stigma in this hibiscus flower?



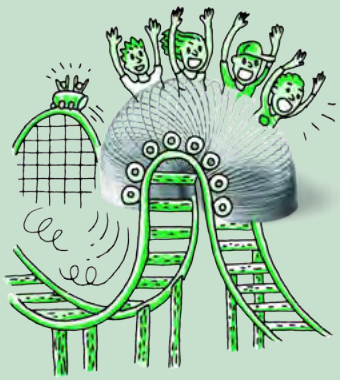
Pollination involves the pollen moving from the stamens to the stigma of the same or another flower. There are different ways that pollination of flowers can take place. For example, flowers can be pollinated with the help of the wind, water or animals. Angiosperm flowers have special adaptations which help a specific type of pollination. Let us look at some of these methods for pollination and how flowers are adapted to promote pollination.

Pollination by animals

Animals that pollinate flowers are called pollinators. These animals come to flowers to feed on the nectar produced by the flowers. As they are feeding, pollen sticks to their bodies. When they move on to the next flower to feed, some of the pollen rubs off onto the new flower parts. We call this process pollination.

Can you see this bee has been covered in pollen as it is feeding on the nectar?

Since pollinators feed on specific plants, they usually travel from flower to flower of the same species, therefore pollinating them effectively.

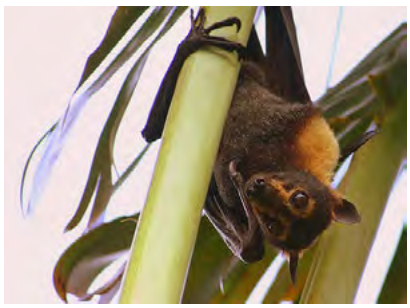


ACTIVITY: Identifying pollinators

INSTRUCTIONS:

1. There are many different types of pollinators, some of which are shown below. Identify the pollinator in each photo in the table and write the name on the line below. Answer the questions that follow.

QUESTIONS:

1. What do you notice about most of these pollinators? (Which type of animal is most common?)

---

2. What do you think these pollinators are getting from the flowers that they visit?

---

3. What do you think attracts insects to flowers? In other words, how do you think flowers are adapted to attract pollinators to them? See if you can think of three adaptations and list them below.

---

4. Flowers are also adapted so that when the pollinators visit them, they make sure the pollen rubs off onto the pollinator to be transferred to another flower. Look at the following image of a bird visiting a flower to drink nectar. How do you think this flower is adapted to make sure that it is pollinated by the bird?

A bird drinking nectar from a flower.

5. The following flower is called a Voodoo Lily. Unlike the flowers we have looked at so far which give off a sweet scent to attract pollinators, this flower gives off a really bad smell, like rotting meat or cow dung. The colour of the petals are also dark, like meat. This shows that different flowers have adapted to different pollinators.

A Voodoo Lily.

What types of pollinators do you think will pollinate this flower? Hint: Think of which insects you normally find when there is rotting food around.

DID YOU KNOW?

There is a direct relationship between the length of the tongue or beak of the main pollinator and the length of the nectar pouch in the flower! This is a very good example of natural selection at play. You will learn more about that in the last chapter of this term's work.

6. **Work in pairs for the next 4 questions.** Take a walk around your school and identify plants that you think are pollinated by pollinators. Make a drawing of at least 3 of these.

7. Identify the common names of these plants and try to find the correct scientific name.

8. Explain how each of these plants' flowers have been adapted to be pollinated by pollinators.

9. How could you easily distinguish which plants used pollinators to pollinate them?

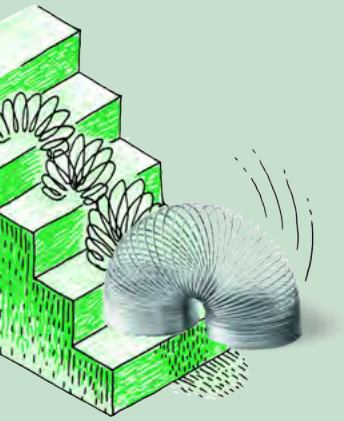
DID YOU KNOW?

Some animals can only see certain colour ranges. Although butterflies, birds (and humans) can see red, bees cannot see red colours but they can see ultraviolet (UV) rays. Some flowers especially adapt their petal colours for this to attract different insects.

Pollination by wind and water

Many flowers are pollinated by animals, as we discussed in the last section, but wind and water can also help pollination. Do you think plants that are pollinated by the wind or water need colourful, sweet-smelling flowers with nectar? Why do you think this?

There are some challenges that plants face if they rely on the wind or water for pollination. These plants have adapted to overcome these challenges so that they can be pollinated by the wind or water.



ACTIVITY: Studying the flowers of wind and water pollinated plants

INSTRUCTIONS:

1. Study the following photos of the flowers of different types of grasses that are pollinated with the help of the wind.
2. Answer the questions which follow.

In this grass plant you can see the small yellowish flowers attached to the green stem.

These white, feathery ends are the flowers of this grass.

Can you see the small, brown flowers sticking up from the maize plants? These are the male flowers of maize.

This image shows the silky female flower of the maize plant.

QUESTIONS:

1. Write a description of the flowers in the photos. Your description must show that you have observed the colour of the flowers, the size, the shape and how many there are on each plant.

2. Why do you think these flowers are not colourful like the flowers in the last activity?

3. Do you think the flowers in wind pollinated plants produce nectar? Why do you say so?

4. What types of plants are generally pollinated by the wind?

5. The flowers in these photos generally produce a huge amount of pollen. They produce much more pollen compared to the flowers pollinated by animals. Why do you think this is so? Hint: Think of the chances of a flower being pollinated by an animal which visits it to drink nectar, compared to the chances of being pollinated by pollen that is carried in the wind.

6. In animal pollinated flowers, the pollen is often sticky and clumps together. This is so that it sticks to the animal which is visiting the flower for nectar and can then be carried to the next flower. In wind pollinated flowers, the pollen is very different. The pollen is smooth and not sticky. It is also very light and small. Why do you think this is so?

7. The structures of the male and female parts in wind pollinated and animal pollinated flowers are also different. For example, in wind pollinated plants, the stamens (male structures) often have much longer filaments and the anthers hang down and can move easily. The stigmas (female structures) are also often large and look like feathers, as you can see in the photos in this activity. How do you think these adaptations of the stamen and stigma help the flowers to be pollinated by the wind?

8. Fill in the following table to compare the structures of wind pollinated plants and pollinator (animal) pollinated plants.

Structure	**Wind pollinated plants**	**Pollinator pollinated plants**
Petals		
Scent		
Nectar		
Amount of pollen		
Structure of pollen		
Anthers		
Stigma		

Plants that are pollinated with the help of water usually live in water. We say they are aquatic. When pollen is released it floats on the surface of the water. The stigmas of the receiving plant are generally close to the water surface. This is so that they can be pollinated when the pollen in the water washes up against them.

Pollinators and us

Pollinators play an extremely important role in the life cycle of flowering plants. These flowering plants include the crops that farmers grow for us to eat, such as maize and sunflowers. Since angiosperms produce a very large amount of the world's food crops, without pollinators, we would be without most of the food crops produced for us to eat.

ACTIVITY: Article from "The Earth Times"

INSTRUCTIONS:

1. Imagine it is the future - it is the year 2056!
2. Read the following article from a newspaper called "The Earth Times".
3. Answer the questions that follow.

Loss of pollinators lead to crop destruction - third year of famine

23 May 2056

The loss of pollinators in Southern Africa, specifically wild bees and butterflies, has lead to further crop failures three years in a row. Very few viable seeds remain to plant the next crop. The next crops planted might be the last ones unless another means of pollination can be found.

The entire region has been severely affected by the sudden death of large swarms of bees and butterflies in the past 5 years. Bees and butterflies, that were once so common, are almost extinct.

One group of researchers have been working to preserve the last remaining colony of bees. It was found hidden away in the mountains of the Helderberg Nature Reserve. So far they report that the colony is doing well and have added 127 new worker bees this week. It is hoped more colonies will be found in other remote mountain regions.

The researchers are still trying to identify the cause of the extinction of these insects. They think that the huge increase in air pollution and acid rain has affected the wings and flight of these insects. They are therefore not able to fly to food sources, such as the nectar of flowers, and then die.

The lead researcher, Dr Wimple, has indicated that they have wild bee larvae from other parts of the world which were frozen several years ago to preserve them. The team is now close to reintroducing these bee larvae into the remaining colony. They hope this will increase the diversity of the population. Dr Wimple's team is working closely with other similar teams around the world to find a possible solution.

The team is also looking at ways to modify the crop plants to increase how efficient they are at being pollinated by the wind, for example maize crop plants. They hope that this will increase the production of maize. They need to do this by changing the DNA of the existing crop plants. This is called genetic modification. "It's a long shot but one we hope will bear fruits" commented Dr Wimple.

Bees, and other pollinators, are dying due to air pollution.

QUESTIONS:

1. Find the following words in the article and underline them. Then look up a definition for each word and write it down. Identify whether the word is a noun, verb, adverb or adjective. Do not copy the definition word for word, but write it in your own words.

a) famine:

_____

b) failure:

_____

c) severely:

_____

d) extinct:

_____

e) preserve:

_____

f) remote:

_____

g) diversity:

h) modify:

2. Write down the title of this article.

3. What is the message that is brought across by the title and article?

4. Explain what the link is between the loss of pollinators and crop failures.

5. Which specific pollinators were lost?

6. What reason did the article provide for the loss of these pollinators?

7. Explain at least two ways in which wind pollinated plants' structures are adapted for wind pollination.

8. How do you think the researchers could modify the crops' flowers so that they are able to be pollinated more efficiently by wind?

9. Do you think the situation described in this article could happen in the future? Write a paragraph where you explain your reason why.

NEW WORDS

- disperse
- pollen tube

Fertilisation

TAKE NOTE

An ovary can contain more than one ovule. If each ovule is fertilised, then the fruit will contain more than one seed. For example, think of an apple which has a few seeds inside the fruit.

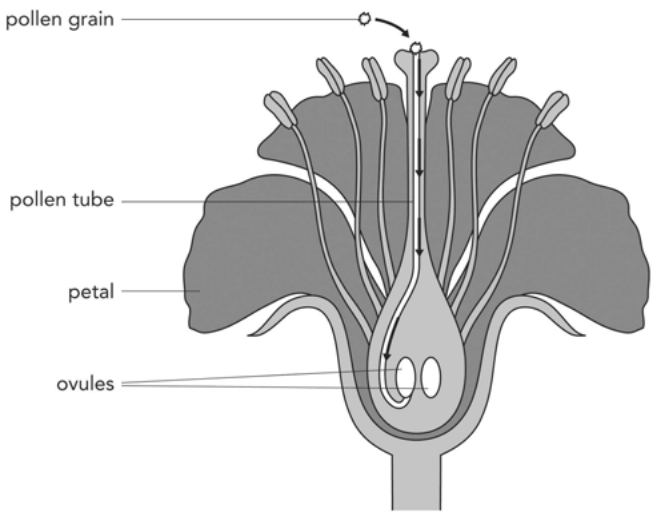
We have now looked at pollination, but what happens next? What happens after the pollen lands on the stigma of the flower?

Do you remember that the pollen grains contain the male sex cells, and the ovary contains the ovules or female sex cells. The male and female sex cells each contains only half of the genetic material (DNA) from the parent plant. After pollination, the male sex cell in the pollen grain needs to fuse with a female sex cell in the ovary to produce a fertile seed. This is called fertilisation.

In angiosperms, each pollen grain contains two male sex cells. See if you can identify the reason for this as you read through the steps for fertilisation.

The process of fertilisation in plants occurs in clearly defined steps:

1. After the pollen grain lands on the mature stigma of a flower from the same species, the pollen produces a tube.
2. This **pollen tube** starts to grow from the stigma and down the style. This transports the male sex cells to the ovules.



The pollen tube growing down the style to the ovary.

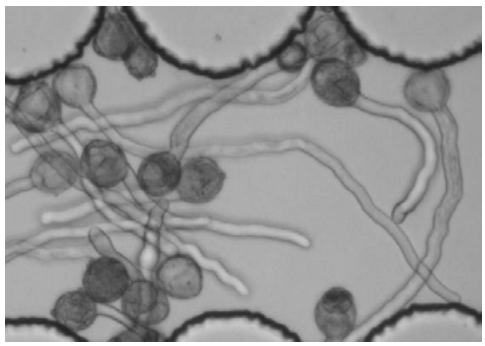
3. There is a small structure inside the ovule called the **embryo sac**. When the pollen tube bursts into the ovule, one of the male sex cells fertilises the female sex cell in the embryo sac.

VISIT

A simple animation of fertilisation.

bit.ly/17ITvt1

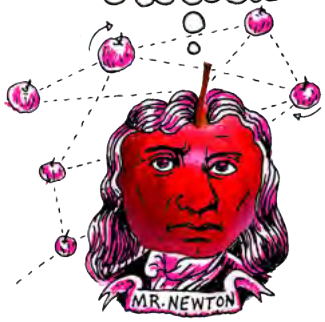
4. This fertilised egg develops into a seed.
5. The other male sex cell joins with another cell in the embryo sac to form the **endosperm**. The endosperm is the starchy food that is stored in the seed once it has ripened. Later this food is used to feed the germinating seed until it has formed leaves and can produce its own food through photosynthesis.
6. The ovary then starts to swell and enlarge, and becomes a fruit.



Can you see the pollen tubes growing here from individual pollen grains?

DID YOU KNOW?

There is a difference between fruit and vegetables! **Fruits** are the ripened ovaries of flowering plants that contain seeds, such as tomatoes and oranges. **Vegetables** are produced by other parts of the plant, like the roots, stems, and leaves, such as carrots and cabbage.



After fertilisation, the ovule inside the ovary starts to develop into a seed and the ovary wall becomes the rest of the fruit. There is huge variety in the types of seeds and fruit in the world.

This is one seed from the Coco de Mer plant and it has been cut in half.

Seeds from different orchid species. They are really small - like dust particles.

DID YOU KNOW?

The Coco de Mer seed is larger than the size of the human head!

Think about all the different fruits that you can buy in the shops - there are many different shapes, sizes and colours!

There are many colours, shapes and sizes of fruit!

NEW WORDS

- gravity

So why do plants have so many different kinds of seeds and fruit? This is because the seeds need to be spread to other areas to grow into a new plant. The shapes and structures of seeds help with this, and so too does the fruit. We say the fruit and seeds are **dispersed**. Let's look at some ways that seeds can be dispersed.

Seed dispersal

Plants use different methods to disperse their seeds as far from the parent plant as possible. Why do you think seeds need to be dispersed? Discuss this with your teacher and your class and take some notes.

VISIT

Interactive website on the life cycle of plants

bit.ly/15R4ZYX

Different plants have different ways of dispersing the seeds and fruit. Let's have a look at some of these.

Gravity: Fruit can fall off a tree and roll as far as possible from the parent tree. When the fruit has fallen it can then be taken further from the parent plant by water, by rolling along the ground or by animals.

Animals: Animals may eat the fruit from the plant or the fallen fruit, and carry the seeds in their digestive systems. The seeds have a tough outer covering so that they are not digested by the animal. Some seeds also have spiky structures that can stick to the fur of animals. They are then carried along as the animal walks and drop off later.

Many wild animals love to eat the fruit from the marula tree, such as this elephant, which has pushed the tree over to get to the fruit. The seeds are dispersed later far away in the elephant's dung.

DID YOU KNOW?

The tiny hooks on seeds and burrs that stick to fur inspired the design of Velcro. One part of Velcro tape hooks into the other part of the Velcro tape just like seeds hook into fur.

Explosive force: In some plants their seed capsules mature and then 'explode', shooting the small, light seeds far away from the parent plant.

The seed pods of jewelweed (shown on the left) explode when they are touched (shown on the right) and shoot out the seeds to disperse them.

DID YOU KNOW?

The Sandbox tree that grows in the Amazon Rainforest can fling its seeds anything from 45 to 100 m away at speeds of up to 252 km/h!

Wind: Wind dispersal requires very light, small seeds that can be carried on the wind. Some seeds have 'wings' like dandelion seeds that can be carried across great distances by the wind.

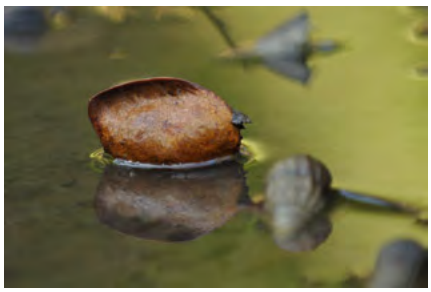
Dandelion seeds are dispersed by the wind.

VISIT

Video showing how ripe yellow woodsorrel pods explode to release their seeds

bit.ly/14Apbii

Water: Plants that grow in or near water use the water to disperse their seeds. Mangrove seeds start to germinate while still on the parent plant, then drop into the ocean and wait until the sea washes them onto a shore where they can continue germinating and growing.



A mangrove seed floating in the water.

VISIT

Review all of the different ways that plants can disperse their seeds

bit.ly/1bf1nzm

Do you remember how we spoke about the different flower structures and how they are adapted for pollination by either animals or wind or water? In the same way, the seeds and fruit are adapted for their method of dispersal.

ACTIVITY: Studying different kinds of seeds

INSTRUCTIONS:

1. Look at the following table which contains different kinds of seeds. Each one is dispersed in a different way.
2. In the second column, state how the seed or seeds are dispersed (for example, by an animal, by the wind, by water etc.)
3. In the third column, write a couple sentences describing how you think this seed is adapted for dispersal. You need to think about what would most help this seed to be dispersed.

Seed	How is it dispersed?	What adaptations does the seed or plant have for dispersal?
		
		
		

We have now finished looking at how angiosperm plants reproduce. We are now going to look at how animals reproduce. Specifically, we are going to look at how humans reproduce so that we can learn about our own bodies and how they function.

3.2 Human reproduction

If you look around at your Gr. 7 classmates, you will probably notice that your friends, and you, have changed quite a bit since you started Gr. 1. Apart from growing taller, changing hairstyles or changing the way you dress, your bodies are changing and growing up. We say you are **maturing**.

Understanding the changes that occur in your body and more specifically understanding why they occur, will help you to manage and cope in the next few years until you become a young adult.

Why do humans need to reproduce?

Humans need to reproduce to have children to continue the existence of our species. As with angiosperm plants, humans reproduce sexually. This means that human reproduction requires a male and a female and a new human being is formed by combining the genetic material (DNA) from the parents. The child will have half its genetic material (DNA) from its mother and half from its father. In order for this to happen, the **sperm** (from the male) has to combine with the **egg cell** (from the female) to produce a baby. Our sexual organs are adapted for these functions.

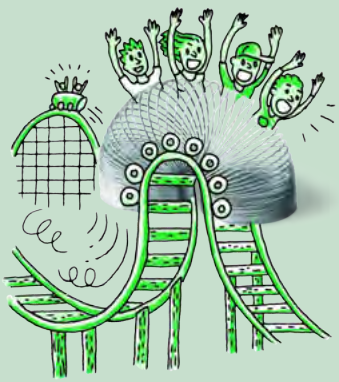
Our sexual organs need to reach maturity. This takes place during a stage in our life called **puberty**.

Puberty

When a boy or girl reaches a certain point of growth and development, the sexual organs in the body also start to mature. Girls and boys do not, generally, go through puberty at exactly the same time:

- Girls go through puberty between 10/11 - 14/15 years of age
- Boys go through puberty between 12/13 - 15/16 years of age

During puberty, you will experience different physical and emotional changes as your body develops towards sexual maturity and adulthood. Let's take a look at some of these changes that take place during puberty.



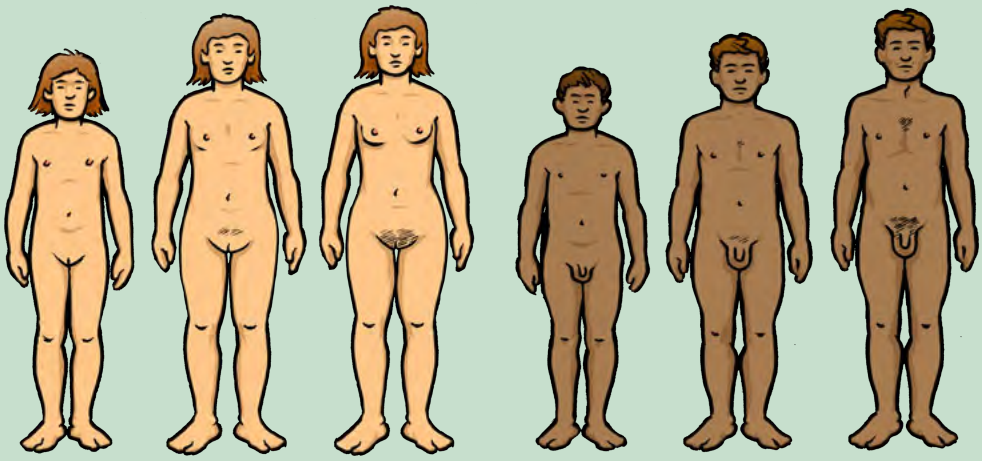
ACTIVITY: What happens during puberty?

INSTRUCTIONS:

1. Study the images above of a girl at 10, 12 and 17, and of a boy at 10, 12 and 17.

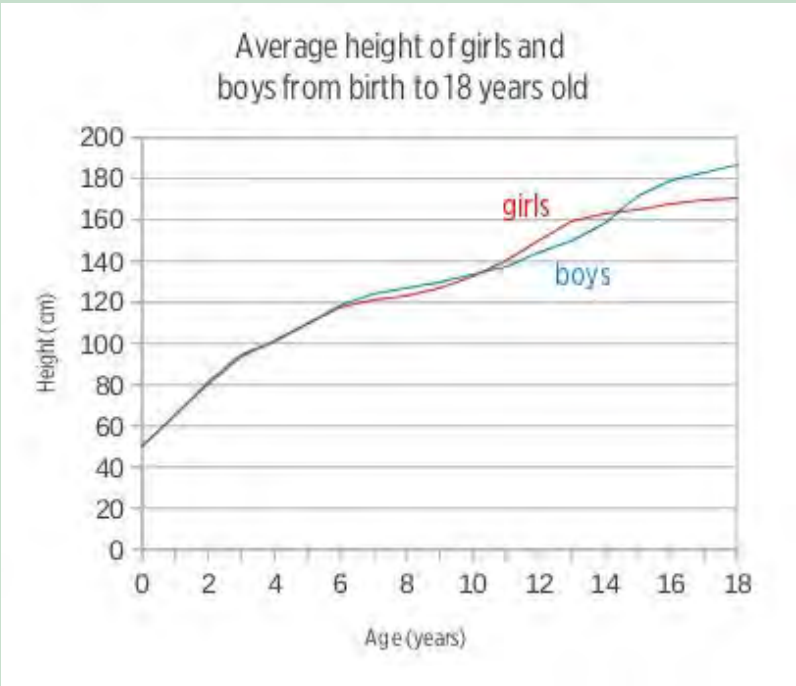
QUESTIONS:

1. Identify the changes that both go through during puberty and fill these into the table.



Changes in the girl	Changes in the boy

2. Study the following graph and answer the questions that follow.



What type of graph is this?

3. What information is this graph providing?

4. In a graph, there are two variables. The independent variable is placed along the horizontal x-axis. The dependent variable is the variable that changes according to the independent variable. It goes along the vertical y-axis. Identify the independent variable and the dependent variable that was used in this study based on the graph.

5. What is the unit of measurement that height is recorded in? What is the unit of measurement for age?

6. Explain in words what you think this graph is telling us about how boys and girls grow from 0 to 18 years old. Compare the two different lines for boys and girls and see what you can tell from the average heights as they grow older. Answer the following questions to help you interpret this graph.

   a) There are two lines on this graph. What does each line represent? Use the colours in your answer.

   b) Why are the graph lines for boys and girls overlapping from 0 to 6 years old? What does this tell us about the height of boys and girls up until 6 years old?

   c) After 6 years old, and until 10 years old, the graph lines for boys and girls split. Which line is on top? What does this tell you?

   d) At what age are boys and girls on average the same height again? How can you tell this from the graph?

e) At age 18, are boys or girls generally taller? What is the average height of boys and of girls at 18 years old? Read this off the graph.

7. A growth spurt is when children grow quite rapidly over the years, faster than over other years. Answer the following questions to help you understand this.
   a) What can you use to identify a growth spurt in the graph? Hint: A growth spurt means that the boys' and girls' height is increasing faster than at other times.

   b) On the graph, we can see that there is a growth spurt for girls and a growth spurt for boys. Do the growth spurts take place at the same age for boys and girls?

   c) At what ages do the growth spurts take place for boys and girls?

   d) Why do you think these growth spurts took place when they did? Hint: Think back to the ages of puberty for boys and girls and how they differ.

8. Make an X on the graph to indicate where you are in this process according to your age.
9. Using the data on the graph, what changes in your height can you expect to experience if you were to follow the typical growth trend?

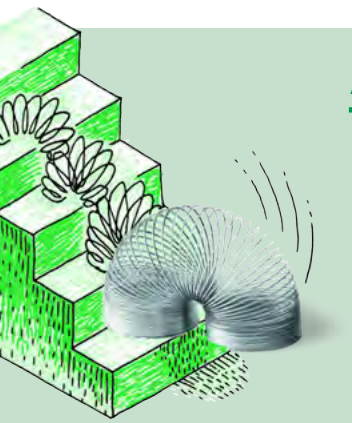
10. Based on your family history and the height of other members of your family, predict whether you will 'follow the curve' or whether you will be shorter or taller than the average person your age?

The following table summarises some of the physical changes that occur during puberty.

Physical changes in girls during puberty	Physical changes in boys during puberty
• The **sexual organs** (vagina, uterus and ovaries) start to mature. • **Pubic hair** starts to grow on the genitals. • **Menstruation and fertility**: girls have their first menstrual bleeding. **Menstruation** is a sign that the ovaries have started secreting **hormones** and releasing eggs, and is therefore a sign that the girl is now fertile (able to fall pregnant). • **Body shape**: changes occur, such as the waist becomes more defined and hips widen (to make space for childbirth). There is an increase in body fat. • **Breasts** start to develop • **Body odour** is typically part of puberty as the skin produces more oils and the smell of sweat changes. • **Acne and pimples** can occur due to changes in hormones and increased oil secretion from the skin.	• The **sexual organs** (testicles and penis)start to mature. • **Pubic hair** starts to grow on the genitals. • **Fertility**: the testicles start to produce sperm that can fertilise a female egg during sexual intercourse. • **Body shape:** changes occur as the bones and muscle increase to give the young man a stronger, more muscular look. • **Voice changes** occur becoming deeper and lower. • **Body odour is** typically part of puberty as the skin produces more oils and the smell of sweat changes. • **Acne and pimples** can occur due to changes in hormones and increased oil secretion from the skin.

During puberty, many young people have commented that their emotions are like a roller-coaster. This time in your lives is not only about growing up and maturing physically, but also emotionally.

Many events are taking place in your life, so let's draw a timeline to show this!



ACTIVITY: Draw a timeline of your life

A timeline shows us a representation of how time passes and the events which take place.

INSTRUCTIONS:

1. Draw a personal timeline of your life so far.
2. You can include photos and pictures.
3. You can possibly include:

4. Your birth - where and when
5. Your first tooth, first word, first first step that you took, etc
6. Your different birthdays - perhaps you have some photos you can stick on for some of your birthdays.
7. Your first day at school, playing a team sport, on stage as a performer, etc
8. Celebrations and memorable events in your life.
9. Locate puberty on your timeline.

Let us now take a closer look at the male and female reproductive organs that mature during puberty.

Human reproductive organs

NEW WORDS

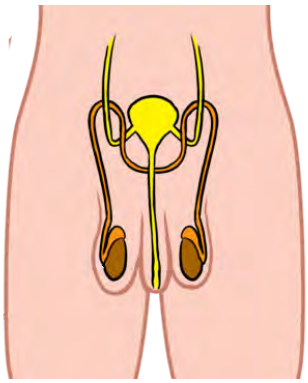
- fallopian tube (oviduct)
- ovary (ovaries)
- ovulation
- scrotum
- testes
- uterus
- vagina

Puberty is a time when the human reproductive organs start to develop, maturing about 5 - 6 years after puberty started.

In males, the reproductive organs include the penis and two **testes** hanging in a pouch or bag of skin called the **scrotum**.

- At the start of puberty the scrotum starts to grow larger and pubic hair starts to appear. The penis also grows bigger.
- Inside the scrotum, the testes mature and start to produce sperm.

When the male reproductive organs are mature in an adult, they will look as they do in the following diagram:



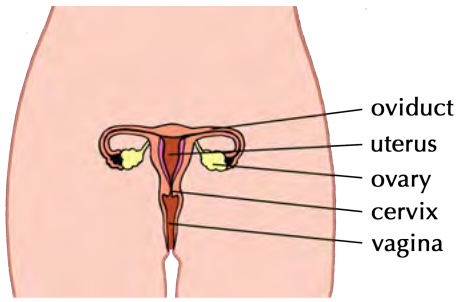
The female reproductive organs include the **vagina**, **uterus**, two **fallopian tubes** (**oviducts**) and two ovaries.

- Inside the girl's body the uterus becomes longer and the lining of the uterus becomes thicker.
- When a girl is born she already carries millions of eggs (also called ova) in two organs called the ovaries. During puberty, the ovaries mature, and start to release one mature egg each month. This is called **ovulation**.
- Two tubes connect the uterus with the ovaries - these are called the fallopian tubes or the oviducts.

When the female reproductive organs are mature in an adult, they will look as they do in the following diagram:

NEW WORDS

- conception
- ejaculate
- sexual intercourse
- umbilical cord



We now know more about the male and female sexual organs and how these organs mature during puberty. Let's take a closer look at human reproduction and the different stages.

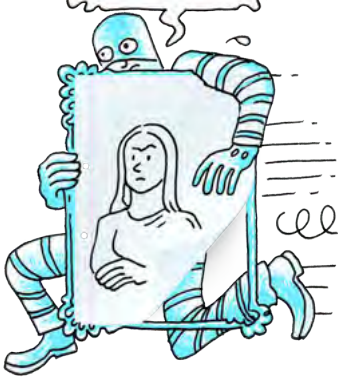
Different stages in human reproduction

Although you are not ready for the responsibility of having a baby and parenthood, your body starts to prepare itself for reproduction during puberty. The main purpose of the human reproductive organs is to produce a mature sperm or egg that can fuse and create a new human baby.

Ovulation

TAKE NOTE

You are 100% unique - there is no one like you on Earth!

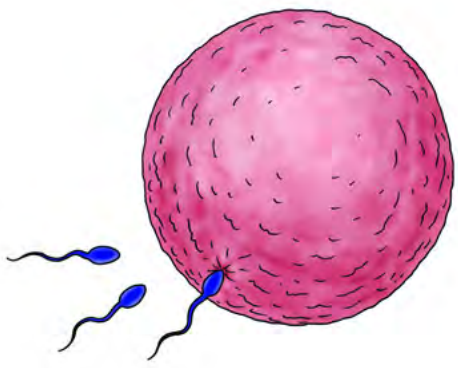


Once a month, one of the ovaries in a girl or woman's body will release a mature egg into the fallopian tube (oviduct). From here it moves to the uterus. During this time the uterus develops a thick lining of blood in preparation for the possible arrival of a fertilised egg.

Fertilisation and pregnancy

In order for a baby to develop in the mother's uterus, the egg needs to be fertilised. During **sexual intercourse**, the male **ejaculates** (releases) millions of sperm into the woman's vagina. From the vagina, the sperm travel into the uterus and up into the oviducts and to the egg cell.

The sperm reach the egg cell, and only one of them enters through the outer layer of the egg cell. The layer then hardens and no other sperm are allowed to enter. This moment, when the male sperm and the female egg cell fuse is referred to as the moment of **conception**, or **fertilisation**, and this leads to pregnancy as the baby starts to develop.



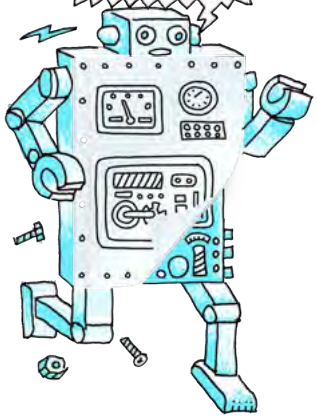
Only one sperm will fertilise the egg cell. The other millions will not be able to enter.

Once the egg cell is fertilised, it continues its journey to the uterus. When it arrives in the uterus, it is safely attached in the thick lining of the uterus. The foetus starts to grow and develop. An **umbilical cord** grows between the foetus and the uterus. A placenta forms to supply food and oxygen to the developing baby and to remove waste. The developing foetus receives food and oxygen from the mother through the placenta and umbilical cord.

A baby developing inside the mother's uterus. Can you see the umbilical cord?

TAKE NOTE

If the mother consumes drugs and alcohol while she is pregnant, these harmful substances will also pass through the placenta to the baby. They can cause serious damage to the baby. For example, if a pregnant mother drinks alcohol, the baby can develop Foetal Alcohol Syndrome (FAS).



At the end of pregnancy, the mother gives birth to the baby through the vagina. Sometimes there are complications and the doctors perform a Caesarean section. this is a surgical procedure where a cut is made in the mother's abdomen and the baby is removed.

As we have seen, if the egg is fertilised after sexual intercourse, the mother falls pregnant. But what happens to the egg if it is not fertilised?

Menstruation

After ovulation, if the egg in the oviduct does not fuse with a sperm and fertilisation does not take place, then the egg cell will still travel down to the uterus. But instead of implanting into the uterine wall, the unfertilised egg cell will be discarded through the vagina, together with the thick blood-rich uterus lining that had developed in case of fertilisation. This is called menstruation.

Do you know what a myth is? A myth is a story that may or may not be true. Often, myths are quite old stories that are passed down from one generation to the next. Myths are often told and people believe them even when there is no proof that they are actually true.

One such Greek myth is about a lady called Medusa. She had hair made of real snakes and could turn anyone into stone if they looked directly at her. One day, the hero Perseus fought her and rather looked at her reflection in his shield. He was protected from her deathly stare and managed to cut off her head and kill her.

Do you think the myth about Medusa is true?

There are many myths about menstruation and sex which are told by people in our society. A lot of these myths are not based on proof. Now that you know more about human reproduction, you need to decide if these stories and myths are true or not. Let's discuss this some more.

ACTIVITY: Conduct a survey

INSTRUCTIONS:

1. Read some of the following comments people have made about menstruation and sex.
2. As a homework assignment, read these to at least five separate members of your family and friends.
3. Make a small cross if the person thinks it is not true and tick if they think it is true or correct.

Myth	Responses (tick or cross)
"Women who are menstruating are dirty and unclean."	
"During your period you should never have cold food or walk with bare feet. If you get cold your period will be worse."	
"Exercise is bad for you when you menstruate."	

Myth	Responses (tick or cross)
"Don't ever swim when you are having a period!"	
"Virgins cannot use tampons - they will lose their virginity."	
"It is unhealthy to have sex at the time of the month when you are menstruating."	
"You cannot fall pregnant during your period."	
"You cannot fall pregnant or make someone pregnant if you have sex in water."	
"Women are always moody and irrational during menstruation."	
"Drinking and drugs make sex more fun."	
"If you have a shower after sex, you will not fall pregnant."	
"You cannot fall pregnant if it is your first time."	
"Everyone is having sex."	

QUESTIONS AND DISCUSSION:

1. How many people in the homework survey believed that the comments were in fact true?

Most believed they were true	About half believed they were true and the other half believed they were not.	None believed they were true

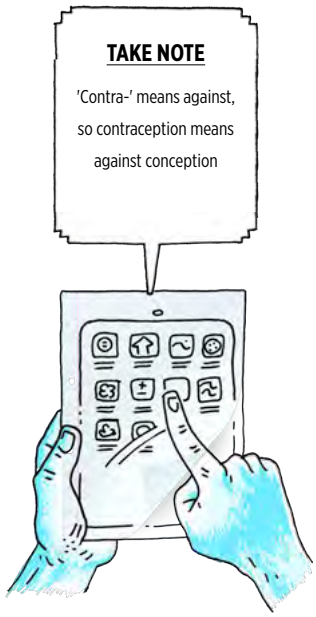
2. Discuss with your class which of the comments were most widely believed to be true by the people you surveyed. Take some notes on the following lines.

3. Which of these comments had the strongest reaction from the people you surveyed? (Either positive or negative reaction.) Discuss their reactions with your class. Take some notes on the following lines.

4. Did anyone laugh at any of the comments? Which ones? Did they tell you why they laughed? Share this with the class.

5. Which of these statements do you think are true? Discuss this with your class and take some notes on the following lines.

Ways to prevent pregnancy and STDs



As we discussed above, your body prepares itself to reproduce during puberty. However, you are in control of your body and can make the decision when you are ready to become a parent and to fall pregnant.

If you decide to become sexually active, it is important to think very carefully of two risks involved in sexual activity:

1. Pregnancy
2. Being infected by a Sexually Transmitted Disease (STD) like HIV/AIDS, Herpes or Syphilis.

There are different things that you can do to prevent pregnancy.

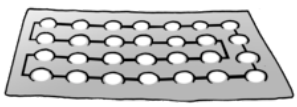
Contraceptives

To avoid falling pregnant, you can use **contraceptives**. There are different contraceptives available today. They prevent the sperm from reaching the egg and thus prevent fertilisation from taking place. Or else, they can prevent the fertilised egg from implanting in the uterus wall.

Male condoms are rubbery sheaths that are placed over a man's erect penis before sex, and are worn during sexual intercourse to prevent the sperm from entering the woman's vagina. Condoms also help to prevent the spread of STDs.

Female condoms also prevent the sperm from reaching the egg. However these are placed in a woman's vagina to act as a barrier to the sperm, and are much less commonly used.

Oral contraceptive pills are used by many women today. Many of these prevent ovulation. Pills need to be taken at the same time every day, otherwise they are not effective. If the woman has an infection with a high temperature, or is on antibiotics, this may also reduce the pill's effectiveness. While the pill is excellent at preventing pregnancy, it offers NO protection against STDs.

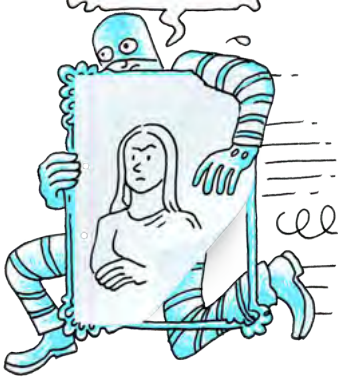


Sexually Transmitted Diseases (STDs)

There are various very dangerous and harmful diseases that are spread from one person to another during sexual intercourse. Some of these are life-threatening, like the Human Immunodeficiency Virus (HIV), while others cause very painful and long-term symptoms.

TAKE NOTE

If you have been a victim of sexual abuse you can receive guidance and help by contacting Lifeline at 0800 150 150. The Lifeline website for victims of sexual abuse can be found at http://www.lifeline.co.za/need-support/rape/.



You can prevent yourself from being infected with an STD by doing the following:

- Get the facts: Make sure you know up-to-date information about STDs and how they are spread, their symptoms and how you can protect yourself during sexual intercourse.
- Take control of your sex life: The more sexual partners you have, the higher your risk will be of contracting an STD.
- Be faithful: If you or your partner has sex with someone else you risk infecting the other person with the STD.
- Using condoms significantly reduces the risk of contracting STDs.

It is your decision whether you want to participate in sexual intercourse with a romantic partner or not. There are two very important points to remember here:

1. No one, no matter who they are, has the right to force you or pressure you to have sex with them or with anyone else. Therefore you are the only one who should be permitted to decide when you are ready to have a sexual relationship.
2. If you decide to have sex, you should do so in a responsible manner. This includes protecting yourself against possible pregnancy and against any STD infection.

ACTIVITY: Write a letter

So often we make promises to other people and work very hard to keep them, but when we make promises to ourselves we often neglect to honour these.

Write a letter to yourself in which you explain what you want to do with regards to sexual activity. Do you want to engage in sex or do you want to wait until you are older? Explain why you made this decision.

Then add to your letter what you promise yourself that you will do to protect yourself from contracting an STD or from a pregnancy before you are ready to be a parent. Explain how you see yourself practising responsible choices regarding sex.

Put your letter in a safe place at home where you can often see it to remind yourself of your promise to yourself. Remember this is a private letter and you can choose whether you want to show it to anyone else or not.

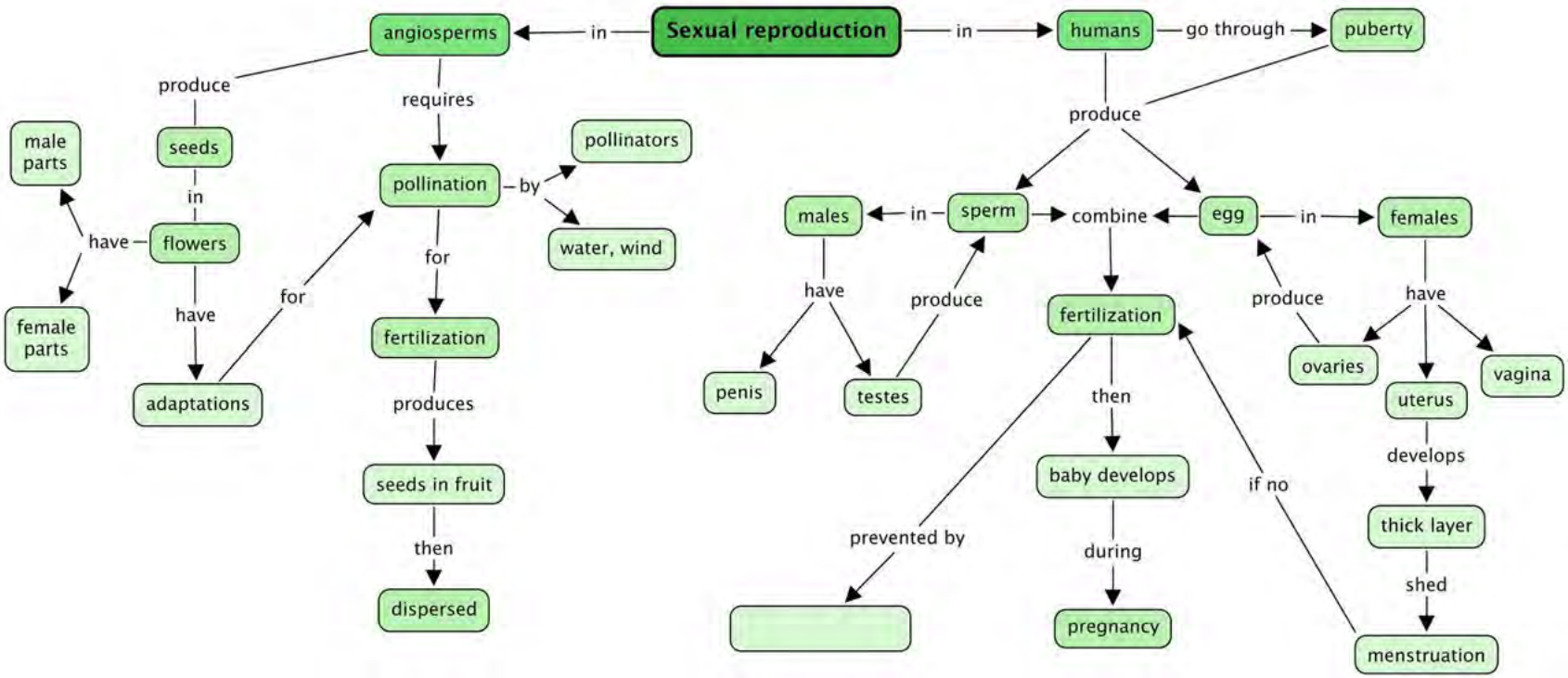
SUMMARY:

Key Concepts

- Sexual reproduction occurs when a sperm and an egg from two people combine to make offspring which look similar but not identical to the parents.
- In angiosperm plants, seeds are produced in the flowers.
- The male structures of flowers are the anthers and filaments, making up the stamens.
- The female structures of a flower are the stigma, style and ovary, forming the pistil.
- Pollination occurs when pollen is transferred from the anther of one flower to the stigma of another flower of the same species.
- Pollination is assisted by animals (pollinators), the wind and/ or water.
- Pollinators play an important role in the production of crops for humans.
- The pollen grows a pollen tube down the style to deliver the pollen nucleus to the ovules in the ovary.
- The fertilised ovules become seeds and the ovary may swell to form a fruit.
- Seeds are dispersed in various ways by animals, the wind, water and explosive force.
- In humans the main purpose of reproduction is for the sperm and egg to fuse and develop into a baby during pregnancy.
- Puberty is the stage in the human life cycle when sexual organs mature for reproduction.
- During puberty, boys and girls experience physical and emotional changes.
- The male reproductive organs include the penis and testes that produce sperm.
- The female reproductive organs include the vagina, uterus, oviducts and the ovaries.
- The ovaries produce one mature egg each month during ovulation which is then transported to the oviduct.
- If sexual intercourse takes place, the sperm travel to the egg and one will fuse with it in the process of fertilisation.
- The fertilised egg then moves to the uterus, is embedded in the lining of the uterus and grows for approximately 9 months before the baby is born.
- If fertilisation does not take place the egg moves to the uterus from where it is discarded in the vagina. The uterus lining is broken up and discarded through the vagina during menstruation.
- Pregnancy and STDs can be prevented mostly by wearing a male condom.

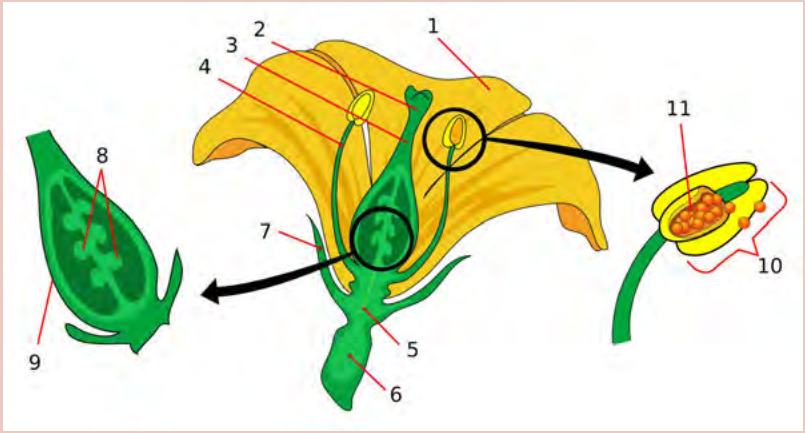
Concept Map

Study the concept map below. Does it make sense to you? Are you starting to see what concept maps do? To complete the concept map below, fill in the blank spot. Look at the concept it is linked to in order to find the answer: 'In humans, fertilisation is prevented by .....'


Sexual reproduction
angiosperms
in
humans
go through
puberty
produce
seeds
in
flowers
have
male parts
female parts
have
adaptations
for
requires
pollination
by
pollinators
water, wind
for
fertilization
produces
seeds in fruit
then
dispersed
produce
males
in
sperm
combine
egg
in
females
have
penis
testes
produce
fertilization
prevented by
then
baby develops
during
pregnancy
if no
produce
ovaries
have
uterus
vagina
develops
thick layer
shed
menstruation

REVISION:

1. Study the following diagram of a flower and the reproductive parts. Provide labels for numbers 1-12. [12 marks]



1:	7:
2:	8:
3:	9:
4:	10:
5:	11:
6:	4 and 10:

2. Describe the function of the following structures: [5 marks]

Structure	Function
petal	
ovules	
pollen grains	
filament	
receptacle	

3. Look at the following image of a bat busy drinking nectar from the flower. How is this flower adapted for pollination by the bat? [3 marks]

A bat drinking nectar.

4. Look at the following image of the seed. How do you think this seed is dispersed? How is this seed adapted for this kind of dispersal? [3 marks]

A seed.

5. A Gr. 7 learner was trying to explain the process of the human reproduction cycle, but they muddled up the order of the cycle. Write numbers 1 - 6 to place their sentences below into the correct order. [3 marks]

_____ The sperm arrive in the oviduct.
_____ During sexual intercourse, the sperm is propelled from the penis.
_____ One sperm enters the outer cover of the egg to fertilise it.
_____ The fertilised egg is implanted in the uterine lining.
_____ The sperm travel from the vagina, through the uterus to the oviduct.
_____ The egg is released from the ovaries and travels along the oviduct.

6. Explain the difference between ovulation and menstruation. [2 marks]

7. Once an egg is fertilised, where is it implanted or embedded? [1 mark]

8. The reproductive organs are structured in a very specific way - to make fertilisation and pregnancy possible. Explain the function of each of these structures in the male and female bodies. [12 marks]

Reproductive organs	**Their function**
Ovaries	
Oviducts	
Uterus	
Vagina	
Penis	
Testes	

9. During puberty the penis and testes develop and mature to fulfil their function in reproduction. Explain what changes occur and why these changes are necessary. [2 marks]

10. Explain what changes occur inside the ovaries of a girl during puberty and why these changes are important for reproduction. [2 marks]

11. A Gr. 7 learner was asked to define the terms puberty, menstruation, fertilisation, pregnancy and conception. First **evaluate** how well they defined each of these terms and then **correct or improve** their definitions in each case. [10 marks]

Term and definition	**Evaluation**	**Improvement**
Puberty: when you grow up.		
Menstruation: when a girl bleeds.		
Fertilisation: when you put stuff into the garden to make it grow better.		
Pregnancy: when the mom's stomach grows and a baby pops out.		
Conception: when the baby starts to come alive.		

Total [55 marks]

4 Variation

KEY QUESTIONS:

- Are all dogs part of the same species if there are so many different sizes, shapes and colours?
- What about humans? What does it mean that we have different skin colours, heights and other differences if we are all part of *Homo sapiens*?
- What does variation mean?
- What causes variation?
- Why is it important that we study variation?

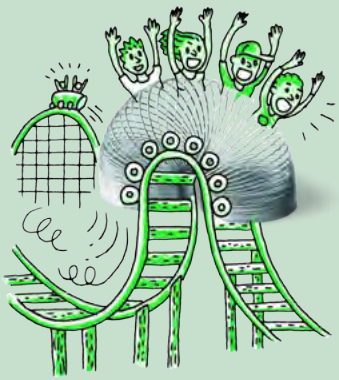
4.1 Variation within a species

In the last chapters we looked at how to classify organisms on Earth. Do you remember what the classification levels are? What is the smallest group in the classification system?

A species is a group of organisms that can interbreed with each other to produce fertile offspring. In this section you will learn why the ability to create a fertile offspring is the single most defining characteristic of a species.

Wherever organisms in a species live, they need to survive in those conditions. We say they are adapted to their environment. Those individuals of a species, which have characteristics that make them more successful at surviving, will reproduce more and pass on their characteristics to their offspring. However, environments change over periods of time. This means that the species needs to constantly change over time to better survive the conditions of their changing habitat. If the organisms do not adapt to their environment, they may not survive, and the species will die out. But how do species adapt? Does it happen quickly or over a long time?

What does variation mean when we use it in Natural Sciences? Let's take a look at some animals with which we are all familiar to find out what variation means.



ACTIVITY: Small, big, long-haired, short-haired, black, white, brown or spotty?!

Do you have a dog, or have you seen some dogs in your neighbourhood? Think of those dogs, and use the following image to answer the questions.

QUESTIONS:

1. What kingdom of animals do dogs belong to?

_____

2. What phylum do dogs belong to? Why do you say so? Give a reason for your answer.

3. What class do dogs belong to? Give three reasons why you would classify dogs in this class.

4. Look at the dogs in the above picture and write down some common characteristics of the animals.

5. Do you think these dogs are part of the same species? How would you know? Discuss this with your class and teacher.

6. Although these dogs share many characteristics, there are many differences between them. What are some of these differences?

7. Another example of variation is horses. Horses all belong to the same species as they can mate and produce offspring which are fertile. This means their offspring are able to reproduce. But there are many different colours and sizes of horses.

A white horse with a brown foal.

Horses and ponies are from the same species. But what about donkeys?

If a horse and a donkey mate, they are able to produce offspring, but the offspring are infertile. They are called mules or hinnies. Do you think donkeys and horses are the same species? Give a reason for your answer.

A donkey

All living organisms that reproduce sexually produce offspring that are different from the parent organisms. Remember that we learnt about sexual reproduction in angiosperms and humans in the last chapter. This allows the new organisms to be different to other organisms within the same species. We call this difference **variation**. As we saw in the last activity, all dogs on Earth are actually the same species, as well as horses, but there are huge differences between all the individuals. We say there is variation.

Three kittens from the same litter but they all look different!

Even animals from the same litter or children from the same parents have differences. Take a look at the kittens in the box below. They are all from the same litter so they share the same parents, but they all look different.

All humans on Earth are from the same species, and yet there is huge variation among us. Look at the following photos of people from around the world.

A Tibetan girl.

A Swedish man.

A schoolgirl in Congo.

An Indian lady.

A Cambodian boy.

A Dutch girl.

A Masai warrior in Kenya.

A Chinese soldier.

An English boy.

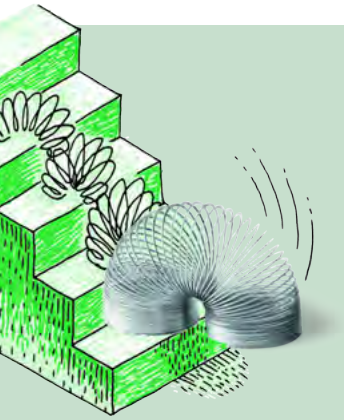
An Iranian woman.

An Ethiopian man.

A Peruvian woman.

Humans are all one species. Do you remember what the species name is for humans?

South Africa is an amazing example of diversity amongst our people. Just have a look at your class and how much variation there is between all of you in one class. Some learners may be tall and others may be shorter, some have dark hair, some have blonde or brown hair, and there is a range of skin colours in South Africa. Since you are all from the same species this is another example of variation. Let's have a look at how your class varies in height.



ACTIVITY: The height of learners in your class

MATERIALS:

- 2 m measuring tape
- pencil, table drawn on scrap paper and clipboard to work on

INSTRUCTIONS:

1. Attach a measuring tape or similar apparatus to a wall in your class.
2. Learners who are having their length measured must be barefoot and must place their heels against the wall, standing up straight against the wall.
3. Learners who are taking the measurement must stand on a chair and place a ruler or pencil horizontally on the person's head (and flatten the hair) when taking the measurement.
4. Another learner should record the name and height of each learner.
5. Use this method to record the height of each learner in the class.
6. Draw a table to record the measurements.
7. Represent these results on a bar graph in the space provided.

Use the following space to record the heights of learners in your class in a table.

Now use this information to draw a graph to represent the information. You will need to draw a bar graph. Think about what must go along the horizontal x-axis and what must go along the vertical y-axis. Remember, the x-axis is for the independent variables and the y-axis is the dependent variable. Give your graph a heading.

TAKE NOTE

Do you remember how to calculate an average? You need to add up all the individual measurements, then divide by the number of learners you have measured.

QUESTIONS:

1. Who is the tallest and who is the shortest in your class?

---

2. What is the average height of all the learners in your class? Use the following space to show your working for this calculation.

3. What is the average height of the boys and what is the average height of the girls? Use the space to show your working.

4. As a homework activity, measure the heights of some of the adult members in your family. Record these heights in the following space to discuss with your class the next day.

5. Discuss these results with your class.
   a) Do the shorter people in your class also have shorter family members and do the taller people in your class also have taller family members?
   b) Is there a correlation (relationship) between the heights of learners in your class and the adults in their family?
   c) What other similarities are there between family members?
   d) Write down some notes from your class discussion below.

We have now seen that there is huge variation between all the people on Earth, and even in your class. But, there are also lots of similarities, especially between family members, such as height and skin colour. These characteristics (or traits) are passed down from one generation to the next in a family. We say they are inherited traits. Let's look at this a bit more.

4.2 Inheritance in humans

We say that certain traits are passed down from generation to generation over many years, from parent organisms to their offspring. This is called **inheritance**.

There are some traits which are very easy to see how they are inherited, such as skin colour or height. Did you know that some people are able to wink with one eye but not with both? Or that others can only see some colours but not all the colours - this is called colour blindness. Let's find out a bit more about some of these inherited traits.

ACTIVITY: What is your inheritance?

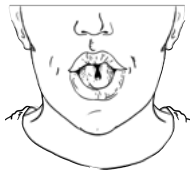
1. Think about your most recent family event or family photo. Is there something that you all have in common? It can be something about your physical appearance, or your behaviour or something that you can each do. Discuss any inherited traits or characteristics that get passed down from generation to generation in your family.
2. One of the very interesting inherited traits is the ability to roll your tongue.

Can you roll your tongue?

Can you roll your tongue? Can your family members roll their tongues?

---

3. There are many other traits and abilities that are inherited from our parents, that they inherited from their parents, which they inherited from their parents and so on. Below is a table detailing some of these traits.
4. Count how many people in your class can do each or have each of these traits or characteristics.
5. Record the number of learners in your class who have each characteristic.
6. Calculate the percentage of learners that have this characteristic.

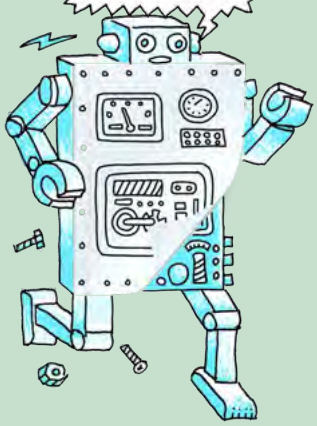
Characteristic	Illustration	Number of learners with the characteristic	Percentage of learners with the characteristic
Tongue rolling			
Thumb shape	 	Hitchhiker thumb: Straight thumb:	
Dominant hand	 	Right-handed: Left-handed:	
Attachment of earlobe	 	Attached earlobe: Unattached earlobe:	
Dimples			

Second toe length		Longer second toe:	
Vulcan sign			

When you have collected all the data and have worked out the percentage of learners that have a certain trait, draw a bar graph in the space provided. Remember to label your graph and to give it a heading.

TAKE NOTE

We can use the word **inheritance** in different ways. When someone dies they may leave an inheritance of money, a home, car or other physical belongings to their children or other people. In Science, inheritance is how parents pass on traits or characteristics to their children.



VISIT

Watch a video that explains how natural selection works bit.ly/17zOR9R .

Afterwards, experiment with natural selection by controlling the environment and causing changes in rabbits. (simulation)

bit.ly/15zeea9

How does variation in a species help it to survive?

Natural selection

Have you ever heard the saying: "survival of the fittest or strongest"? This refers to the way in which the organisms are able to survive in their environments because they have adapted the best or they have certain characteristics which allow them to survive better than others.

Survival refers to the characteristics that allow the members of a species to thrive and reproduce successfully so their advantageous characteristics are passed on successfully. Thus over generations the entire species can survive as the majority of its members happen to have inherited the advantageous characteristics.

For example, imagine some impala in one group in a game reserve started to develop a characteristic, which was passed down from the parents to the offspring, allowing them to run faster for longer. The impala in this group can then run faster than the impala in another group. Over time, the faster impala will be able to escape the predators such as cheetahs and lions more often and so they will live long enough to reproduce and raise their offspring successfully. They will therefore pass on the swift running characteristic. The slower impala will get caught more often and so they will not survive to produce offspring. The slower impala are slowly removed over time. The characteristic making some of the impala faster allows those impala to survive and pass this trait on to their offspring. This is the principle of **natural selection**.

Let's look at a famous and interesting example of how variation in the peppered moth allowed for natural selection.

ACTIVITY: Natural selection in the peppered moth

INSTRUCTIONS:

1. Read the following information about the peppered moth.
2. Answer the questions that follow.

The peppered moth's story of evasion

The peppered moth has been studied in a lot of detail over the past 200 years as it has a very interesting evolution over a short time period. Originally, most of the peppered moths were a light, speckled colour, as you can see in the top moth in the image.

This colouring allowed the moths to be camouflaged when they rested upon the light-coloured trees and lichens in their habitat. However, not all the peppered moths were this light colour. There was some variation and there were a few which were a much darker, grey colour. They could not camouflage themselves as well as the light coloured one. The darker coloured moth is shown below the lighter coloured moth.

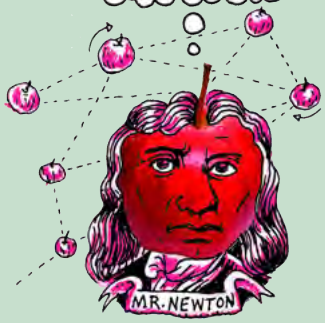
The light and dark variation in the peppered moth.

During the Industrial Revolution in England, there was a huge increase in the number of factories. These factories mainly burnt coal as an energy source, which increased the amount of pollution and soot in the air. The pollution caused the lichen on the trees to die off. The soot coated the trees in the peppered moths' habitat. These trees now did not have any lichen and they were a dark grey colour because of the soot covering them.

The light coloured moths were therefore not camouflaged anymore and could be seen easily by predators when they rested on the trees. As a result, more of the light-coloured moths were eaten by birds and didn't have a chance to mate and lay eggs. Therefore the number of light-coloured moths decreased. In comparison, the few moths that were a dark grey colour were now at an advantage as they were now the same colour as the soot covered trees and could hide. These darker-coloured moths could therefore go on to have more offspring. Over time, this resulted in more and more of the moths being dark-coloured.

DID YOU KNOW?

The location of this fabulous example of natural selection was the city of Manchester in England. The first observation of a dark black peppered moth occurred in 1848. However, by 1895 98% of peppered moths in the city were dark!



QUESTIONS:

1. When the moths land on the trees and they are camouflaged, what are they hiding from?

_____

2. Why do you think there were only originally a few of the dark coloured moths, and there were lots of light-coloured moths?

_____

_____

3. Why do you think the dark grey moths started to increase over time after the Industrial Revolution?

_____

_____

VISIT

Play the evolution game and hunt for peppered moths!

bit.ly/178YdKJ

4. Since the Industrial Revolution, the numbers of light-coloured moths have started to increase again due to improved environmental standards. Why do you think this is?

_____

_____

_____

VISIT

10 reasons to love science (video)

bit.ly/1bf3K5r

We have now looked at how variation within a species helps it to adapt to its changing environment and therefore survive. But, these changes do not happen quickly. Although small changes can happen within a few generations, big changes take a very, very long to happen over thousands of years.

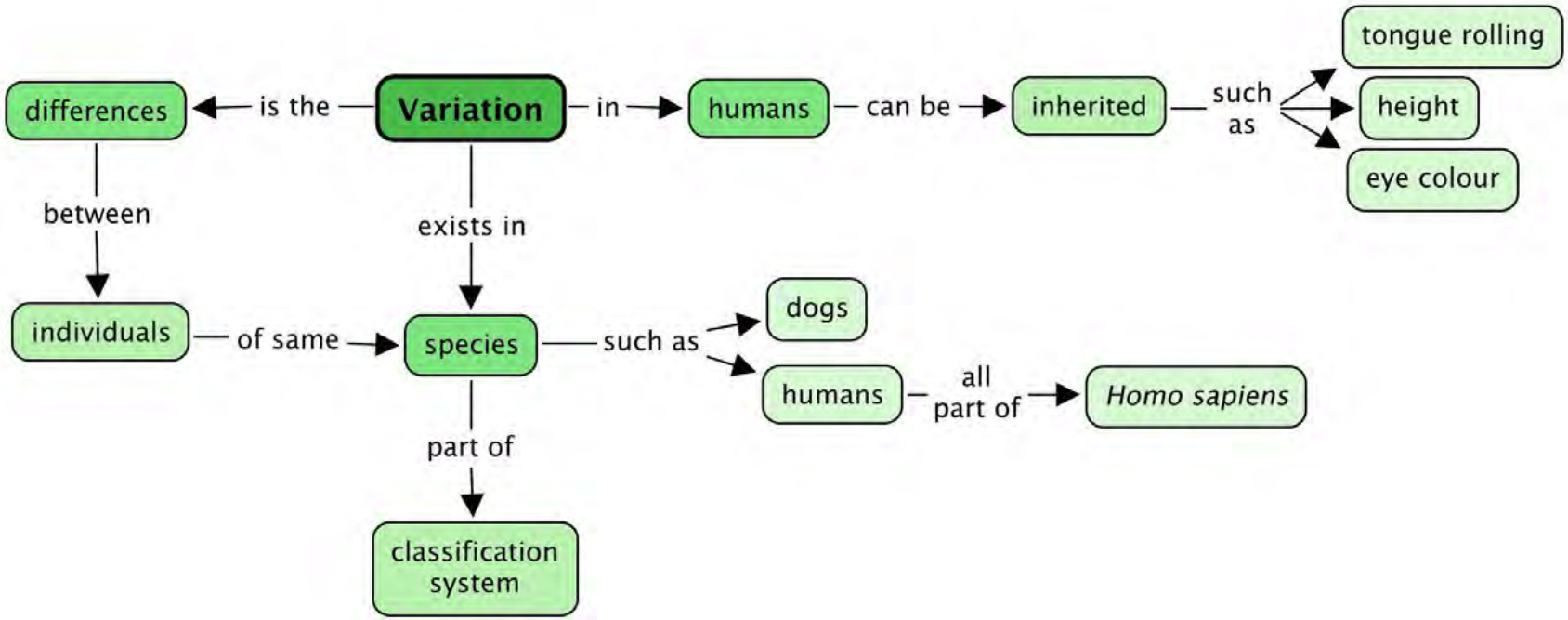
SUMMARY:

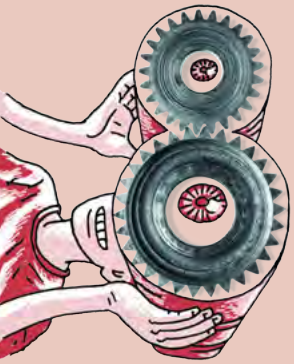
Key Concepts

- A species is a category within the classification system.
- Living organisms of the same type belong to the same species.
- Organisms from the same species can reproduce sexually and produce offspring that are fertile and can reproduce.
- People belong to the species *Homo sapiens*.
- Variation is the difference between individuals from the same species.
- This variation can be inherited from one generation to the next.
- The individuals that are better suited (adapted) to their environment will survive to reproduce. This is called natural selection.
- Small changes can take place in a species over shorter periods, like from one generation to the next.
- Over very long periods these small changes can accumulate so that big changes occur over time.

Concept Map

This was a short section and so we have a smaller concept map than in the previous sections.


Variation
is the
differences
between
individuals
of same
exists in
species
such as
dogs
humans
all
part of
Homo sapiens
part of
classification system
in
humans
can be
inherited
such as
tongue rolling
height
eye colour



REVISION:

1. Are dobermans, terriers and bulldogs from the same species? Give a reason for your answer. [2 marks]

2. A new breed of cat has been developed, called the munchkin cat. Breeders specifically tried to breed a cat with very short front legs. Explain how you think they achieved this. [2 marks]

3. Predict whether you think munchkin cats would be able to hunt as well as other cats with normal length front legs. [2 marks]

4. Do you think it is correct for humans to breed animals in this way? Explain your answer. [2 marks]

5. Explain in your own words what you understand by the term "inherited characteristics". [2 marks]

6. Why do you think it takes a long time for a species to adapt and change to its changing environment? [2 marks]

Total [12 marks]

Curious? Use your imagination and show what this key can be.

GLOSSARY

abiotic:	non-living elements of the environment such as soil, water and air
adapt / adapted:	to change the way that something looks or the way something is done based on the surroundings / environment
amphibian:	any of a class of vertebrate animals that live on land and in water at different times in its life-cycle, are ectothermic and have a naked skin, and that the larvae hatch in water and has gills, which later transforms into the adult that breathes with lungs
angiosperm:	a plant that has flowers and produces seeds that are enclosed in a fruit
antenna (antennae):	one of two long thin parts on the head of some arthropods (like insects and crustaceans) used for touch, smell and taste
anther:	the part of the male sex organ of a plant that contains the pollen
aquatic:	being in or near water
arthropod:	any of a large group of animals with a hard body, no backbone and legs that are divided into sections
asexual reproduction:	reproduction of plants and fungi that doesn't require male and female sex cells to fuse in order to make a new organism
atmosphere:	the layers of gas that surround the Earth
biosphere:	the parts of the Earth's surface, water and atmosphere in which life can exist (and where plants, animals and organisms can live)
bulb:	a type of underground stem with one or more buds that are covered by leaves or scales - like onions and tulips
cartilage:	strong, flexible tissue similar to bone
cell:	the smallest structural unit or building block of life that can sustain the seven life processes
cellular respiration:	the process in living organisms by which oxygen is used to release energy from food and carbon dioxide is given off as a by-product
characteristic:	a typical feature or quality that makes one thing different from another
class:	the major taxonomic rank below phylum and above order that includes groups of vertebrate animals such as fishes, amphibians, reptiles, birds and mammals, and the invertebrate groups such as insects and arachnids
classify:	a systematic grouping of objects, items or organisms based on characteristics, relationships and processes
component:	one of the parts that something is made of

conception:	moment of fertilisation when the male sperm and the female egg cell fuse and a new individual is formed
cotyledon:	the seed leaf that is involved in the storage or absorption of food reserves
depend / dependent:	to need something or somebody to do their part in providing a shelter, food, air, etc. for an organism's survival
dependent variable:	the variable of interest that is measured to get the results
dicotyledon:	a plant that has a seed with two cotyledons, nodes and internodes on its stem, a tap root and generally leaves on small stalks called petioles; the leaves have a net-type leaf vein
disperse:	spread over a wide area
diversity:	the number and variety of species present in an area and the location of their different habitats
ectothermic:	relating to animals that have a blood temperature that changes if the temperature of their surroundings change
ejaculate:	when a male releases sperm from the penis
embryo sac:	structure within the ovule that contains the egg cell; contains the newly developing plant and endosperm after fertilisation
endothermic:	relating to animals that have a blood temperature that does not change if the temperature of their surroundings change
environment:	the external surroundings, conditions, resources, stimuli, etc. in which an organisms lives and interacts
exoskeleton:	the hard outer covering that protects the body of certain arthropods
fair test:	an experiment where only one independent variable is changed each time the experiment is repeated
fallopian tube (oviduct):	a tube lying close to each ovary that receives the mature ova (egg) and transports it to the uterus
favourable:	good, suitable or acceptable
fertilisation:	the process when a male sex cell fuses with a female sex cell to make a new, unique individual with half the genetic material from the male and half from the female parent organisms
filament:	the stalk-like structure of the stamen that holds and supports the anther
fuse:	to join or blend to form a single entity
genetic information (DNA):	the inherited information coded into the cell that determines what type of cell it is and what it needs to do
gill:	the organ in fish and other water-breathing animals that allows them to breathe underwater

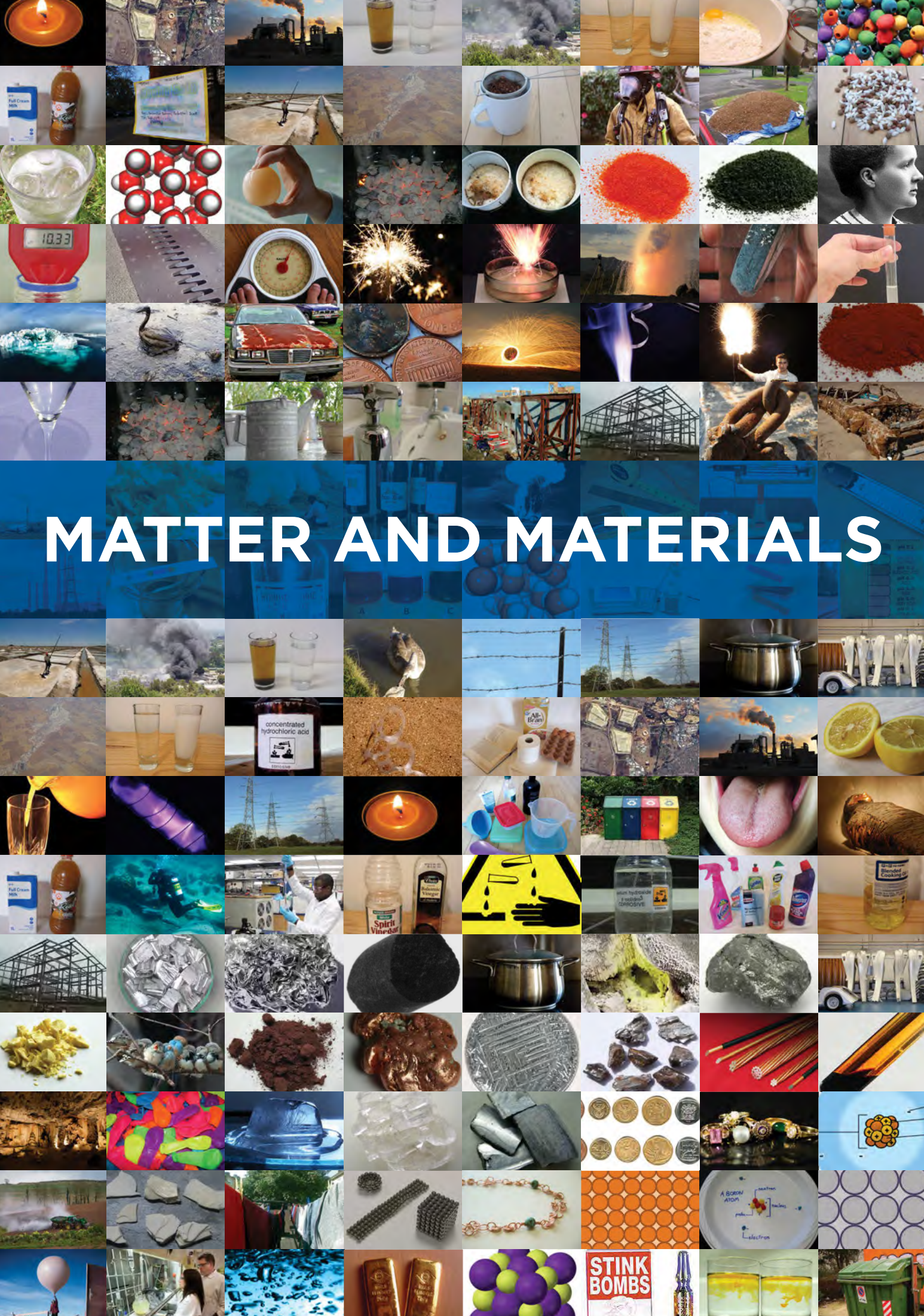
gravity:	the force that attracts a body towards the centre of the Earth or towards any other physical body having mass
habitat:	the natural place where a plant or animal lives
herbaceous:	a plant that has a non-woody stem and which normally dies at the end of the growing season
hormone:	chemical messengers that travel in the bloodstream to tissues and organs to affect many different reactions in the body.
hydrosphere:	the water on the Earth's surface, including the oceans, seas, lakes, rivers and dams
hypothesis / hypotheses:	a statement that is an educated guess about the outcome of the experiment; an idea that is suggested as the possible explanation for something that has not yet been proved to be true or correct
independent variable:	those variables that will be changed one at a time to see what effect they will cause in the dependent variable; variables that are under the control of the investigator
inheritance:	something that is passed on genetically from one generation to another
invertebrate:	an animal without a line of bones (backbone) going down its back
jointed (segmented) limbs:	separate parts of the leg is covered in a hard exoskeleton with clear joints between them
kingdom:	refers to five major divisions of living organisms; plants, animals, fungi, protists and bacteria that is in turn composed of smaller groups called phyla
larva / larvae:	a stage in the development of insects and other animals where it has come out of the egg and is mainly concerned with consuming food
leaf vein:	little tubes that branch throughout a leaf carrying water and dissolved substances
lithosphere:	the crust or outer part of the Earth
mammary gland:	milk producing glands in female mammals
marine:	of or relating to the sea
mate:	come together for breeding, copulating
matter:	the physical substances from which all things are made, such as rocks, soil, air, water, plants and animals
maturing:	to become physically mature and fully developed
menstruation:	a recurring monthly event where the lining of the uterus breaks down and is discharged as menstrual blood
microorganism:	an organism that is too small to see without a microscope
monocotyledon:	a plant that has a seed with one cotyledon, adventitious, generally shallow roots and leaves that forms sheaths around the stem; the leaves have a parallel leaf vein

natural selection:	a process in which organisms with more suitable features survive and reproduce more successfully in a particular environment, resulting in more offspring that carry the same traits
order:	a taxonomic rank below class and above family that classifies organisms based on specific characteristics, such as diet and tooth structure, such as herbivores, carnivores and primates
organic:	produced by or formed from living organisms
organism:	an individual living thing that can react to stimuli, reproduce, grow, etc, such as a bacterium, protist, fungus, plant or animal
ovary:	the female reproductive organ in which the female sex hormones oestrogen and progesterone as well as female sex cells (ova) are produced and stored; in a flower it is the thickened part at the base of the flower that contains the ovules
ovule:	the part of the ovary of the flower that contains the female sex cell and that becomes the seed after fertilisation
ovulating:	when a mature egg (ova) is ready and gets released (and is in the right place) for fertilisation to take place
peduncle:	the stalk or stem of a flower
penis:	the male sex organ for the transfer of sperm cells to the female
petal(s):	each of the modified leaf sections of a flower that are typically coloured to attract animals
photosynthesis:	the process by which green plants (and some bacteria) use energy from light to turn carbon dioxide and water into food and oxygen
phyla:	a taxonomic rank in biological classification that is below kingdom and above class, that divides organisms according to major body similarities, such as chordates, molluscs and arthropods
pistil (carpel):	the female organs of a flower containing the stigma, style and ovary
pollen:	a fine powdery substance that is often yellow and contains the male sex cells
pollen tube:	a hollow tube that develops from a pollen grain and grows into the stigma and down the style to deliver the male sex cells to the ovary of the flower
pollination:	the transference of pollen from the anther of one flower to the stigma of another flower of the same species
pollinator(s):	an agent that carries pollen from one flower to another (bees, butterflies, birds or the wind for instance)
puberty:	the period between childhood and adulthood when the sex organs mature causing changes in the body that prepare the body to be able to reproduce
receptacle:	the place where a flower is attached to the peduncle (stalk or stem)

requirement:	something that you need or must have
respire:	to take oxygen into the body and release carbon dioxide; to breathe
rhizome:	a horizontal stem underground that has both roots and shoots
roots:	the part of a plant that is (mostly) underground and responsible for anchoring the plant, and for absorbing water and minerals from the soil
scientific method:	a set way of doing / conducting a scientific investigation allowing you to gain new knowledge by collecting measurable evidence based on observation, measurement and experiment based on the formulation, testing and changing of the hypotheses
scrotum:	the external sac of skin that encloses the testes in males
seeds:	the reproductive organ formed in gymnosperms and angiosperms from which a new plant can grow; it is usually covered by a protective coat and also contains food reserves for the young plant
sepal(s):	small green leaves that protect the developing bud
sexual intercourse:	when the male sperm is introduced into a woman's body
sexual reproduction:	the process of producing new individuals of a species by fusing the genes of two individuals
shoot:	a young branch that sprouts from the main stem of a plant
sperm:	the male sex cell produced by the testes
spore:	the reproductive cell of mosses and ferns (and other organisms) that under the right conditions can develop into a new individual fern or moss
stamen:	the male reproductive organ of a flower containing the filament and anther
stem:	the long thin part of a plant that rises from the ground and from which smaller branches can grow; it supports the leaves, flowers and fruit
stigma:	the sticky tip of a flower pistil where the pollen is deposited during pollination
style:	the stalk-like slender part of the pistil joining the stigma and the ovary, and holding the stigma in a favourable position to receive pollen; the pollen tube grows through the style to deliver the male sex cells to the ovules
sustain:	to keep things alive or healthy
symbiotic:	a type of relationship between organisms in which one or both organisms benefit
tap root:	the main root of a plant that grows deep into the soil of a plant that has a single, dominant main stem
testes:	sperm producing glands of the male body
umbilical cord:	the cord- or tube-like structure that connects the foetus from its abdomen with the placenta of the mother; it transports nourishment and oxygen to the foetus and removes waste

uterus:	the hollow muscular organ in the pelvic area of female mammals in which the fertilised egg implants and develops (also known as the womb)
vagina:	an elastic muscular tube or canal that connects the neck of the uterus (cervix) with the external sexual opening
variables:	any factor that can affect the outcome of the investigation and can be measured, controlled or varied in some way
variation:	differences between living organisms of the same species
vertebrate:	an animal that has a backbone (spine) that holds the nerve or spinal column


Spirit Vinegar
concentrated hydrochloric acid
A BORON ATOM
STINK BOMBS
HYDROCHLORIC ACID 60%
A
B
C



MATTER AND MATERIALS

1 Properties of materials

KEY QUESTIONS:

- Which properties are important when choosing a material for a particular use?
- How can we measure the strength of a material?
- What does it mean when a liquid boils?
- How can we explain the term 'boiling point'?
- How can we explain the term 'melting point'?
- Why should we always think about the impact on the environment when we manufacture or use a particular material?

We learnt in Gr. 5 that the properties of a material determine what it can be used for. Can you remember what *properties* are?

1.1 Physical properties of materials

NEW WORDS

- property
- durable
- ductile
- malleable
- flexible
- mould

What are properties and why are they important?

You may remember that properties are distinctive characteristics that describe an object or material. For instance, we can describe a metal by saying that it is strong and **durable**. A metal is is also **malleable**. This **property**, malleability, means that a metal can be formed into sheets which can be used for a variety of different purposes. For example, metal sheets can be used as roof panels for a house, or to press body panels for a car.

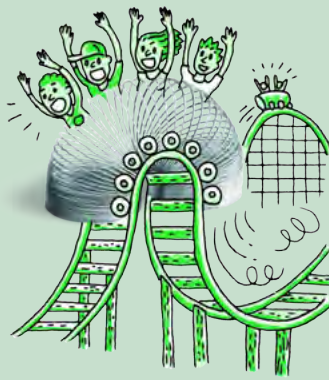
The walls and roof of this house are made of sheets of corrugated metal.

Can you see some parts of a car hanging up inside a car factory? These are made of sheets of metal.

What other properties of metals do you remember? Discuss this as a class.

Let's do a warm-up activity to get us thinking about materials and their properties.

ACTIVITY: Thinking about materials and their properties



INSTRUCTIONS:

1. Complete the following table by adding the names of different materials that have the properties listed.

Property	Materials
Strong	
Flexible	
Conducts electricity	
Conducts heat	

QUESTIONS:

1. What does it mean when a material is flexible?

2. Suggest three possible uses of flexible materials?

3. Suggest three possible uses of a material that is a good conductor of electricity.

4. Suggest three possible uses of a material that is a good conductor of heat.

_____

_____

_____

5. Which of the above properties would be important if you were choosing a material for making cookware (cooking pots)?

_____

_____

_____

_____

_____

A metal pot.

6. Which of the above properties would be important if you were choosing a material for making the wires used for distribution of electricity (shown in the adjacent photo)?

_____

_____

_____

_____

_____

These electrical wires carried by pylons are made of metal.

7. Which of the above properties would be important if you were choosing a material to make a barbed wire fence?

_____

_____

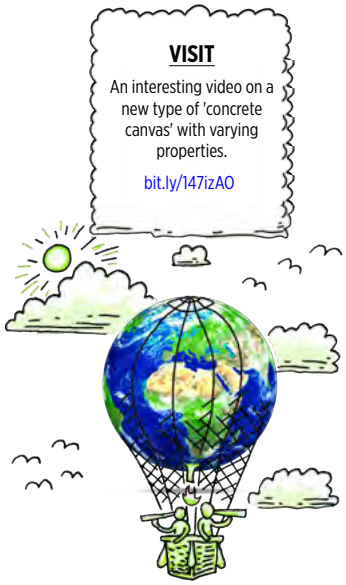
_____

_____

_____

A barbed wire fence.

We can think of certain properties of materials in terms of advantages and disadvantages. Do you know what those are? Let's find out.



Advantages versus disadvantages

We have seen that strength and durability are desirable properties in some materials. We want things to be strong and to last long. Let's think of an example.

Why would plastic shopping bags need to be strong?

_____

_____

A black, plastic shopping bag.

Why would plastic shopping bags need to be durable?

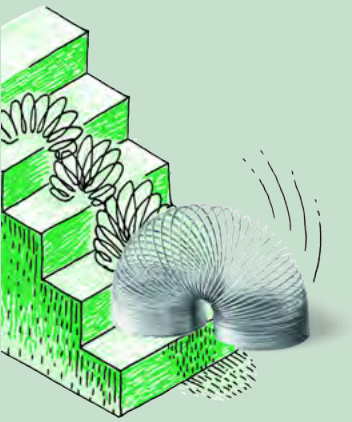
_____

We call the desirable properties of materials advantages. Disadvantages are unfavourable features, as can be seen in the images of plastic in the environment.

A goose about to eat a plastic bag in a river.

These plastic rings from soft drink packaging are very dangerous in the wild as they can entangle an animal's neck.

The following activity has another example of advantages versus disadvantages.



ACTIVITY: Advantages versus disadvantages

Can you imagine a car made of solid gold? A car like this would be very valuable!

INSTRUCTIONS:

1. Look at the image of a gold car then answer the questions that follow.
2. Discuss some of the questions with your classmates before writing down your answers.

QUESTIONS:

1. What are your feelings about the golden car in the picture?

2. What are the advantages of having a car made of gold?

3. Do you think a golden car would be very strong? Would it perhaps be safer in the event of an accident?

4. What are the disadvantages of a car made of gold?

We always have to weigh up the advantages against the disadvantages when we choose materials for a particular job.

How would you test how strong a material is? Let's imagine you have different types of paper. How would you test which paper is the strongest? Discuss this as a class and write some notes on the lines provided.

The strength of paper is important because we use paper for many different things.

All these objects are made from different types of paper with different properties that suit the function of the object.

In the next activity we are going to investigate the tearing strength of different types of paper.

INVESTIGATION: Which type of paper is the strongest?

AIM: To compare the tearing strengths of different types of paper.

HYPOTHESIS:

When you write a hypothesis, you must state what you think will happen in your investigation.

MATERIALS AND APPARATUS:

- strips of different types of paper (20cm x 5cm)
- hole puncher
- strong paper clips
- yoghurt tub
- marbles
- string
- hand lens (optional)

METHOD:

1. Punch a hole at both ends of each paper strip. This is so that you can test the paper twice on each side. Make sure that the holes are in the middle, and also at the same distance from the end of each strip. This will make it a fair test.
2. Form the paper clip into an S-shape and hang it from the hole in the paper.
3. Make a handle for the yoghurt tub, using the string.
4. Hang the yoghurt tub from the paper clip and hold it in your hand.
5. Add marbles one-by-one to the yoghurt tub until the paper tears. Count the number of marbles in the tub. (Tip: Place the marbles very gently into the yoghurt tub or the shock of dropping them in might tear the paper).
6. Repeat steps 1 - 5 using the other end of the strip and count the marbles again. Take the average of the number of marbles.
7. Repeat this using the other strips of paper, doing each twice and taking the averages.
8. If each marble has a mass of 5 grams, work out the mass in grams that was needed to tear each strip of paper and write the number in the final column of your table.
9. If you have time, you can also test different kinds of materials, such as a plastic shopping bag, aluminium foil or plastic wrap.

Tip: To calculate the **average** of a set of numbers, you add all the numbers together and then divide by how many numbers there were in the set.

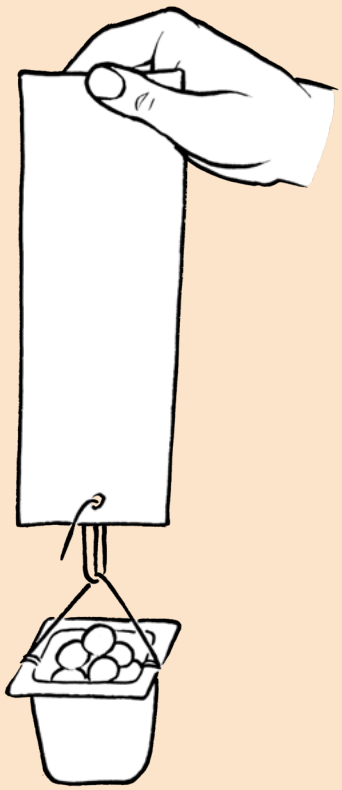
In this investigation, you will add the number of marbles together for each time you tested the paper strength (this was twice for each strip of paper) and then divide by 2 to calculate the average number of marbles that each piece of paper can hold before it tears.

For example, if you had 5 marbles in the first attempt, and 3 marbles in the second attempt, the average will be calculated as follows:

5 + 3 = 8 marbles

8 ÷ 2 = 4 marbles on average

Therefore, the paper type could hold an average of 4 marbles.



RESULTS AND OBSERVATIONS:

Record your results in the table.

Type of paper	Number of marbles (Trial 1)	Number of marbles (Trial 2)	Average number of marbles	Mass of the marbles

Now answer the following questions:

1. Look carefully at the surface of one of the paper strips. Now look carefully at the torn edge. Can you see anything special? Describe what you think the paper is made of.

2. Which paper is the strongest?

3. Which paper is the weakest?

4. Arrange the different types of paper *in order of increasing tearing strength*. (That means from weakest to strongest.)

ANALYSIS AND EVALUATION:

Let's now analyse and think about the results of the investigation.

1. What do you think causes one paper to be stronger than another?

2. How would you modify the investigation to test the strength of different types of plastic?

3. What did you do to ensure fair testing?

4. How would you modify the investigation to test the flexibility of different types of materials?

5. Why did you repeat the experiment for the same type of paper?

CONCLUSION:

What can you conclude from this investigation?

Strength, **flexibility** (the ability to flex or bend), electrical conductivity and heat conductivity are important properties of materials that we learnt about in Gr. 5 and have revised again here.

Can you think of materials that are both strong and flexible? Most people will immediately think of plastics! Most plastics can easily be melted and **moulded** into different shapes for different purposes. Why do you think plastics can be 'melted and moulded' with ease?

All of these items are made of plastic in different shapes, sizes and colours.

We are going to learn about two new properties of materials, namely boiling point and melting point.

NEW WORDS

- temperature
- thermometer
- heat
- melting point
- boiling point

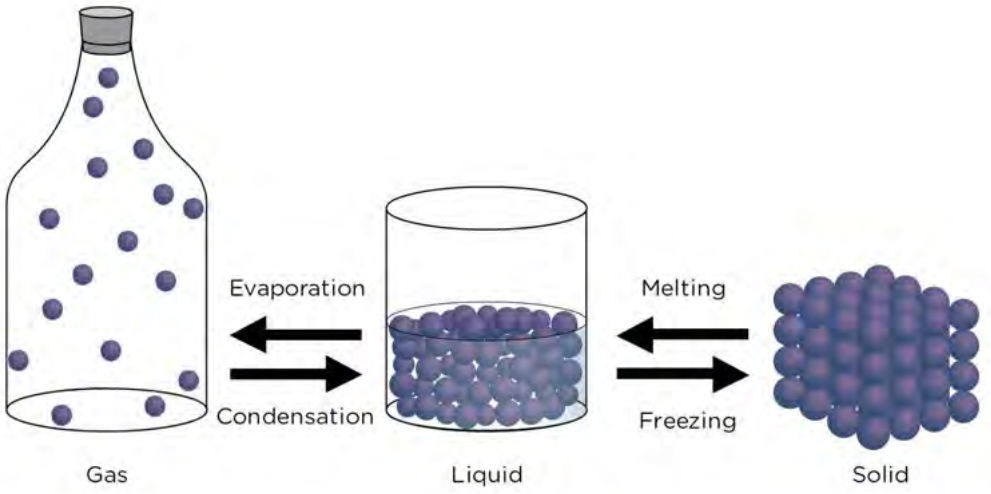
First, let's check if everyone knows that there is a difference between the words heat and temperature. The two words, heat and temperature, are connected but they do not mean the same thing:

- **Heat** is the transfer of energy from one object to another. This happens because of the difference in temperature between the two objects. The transfer of energy will be from the hotter object to the cooler object until they are the same temperature. You cannot measure heat directly, but you can detect its effect on a substance. Changes in heat can usually be detected as changes in temperature.
- **Temperature** is used to describe how hot or cold something is. Temperature can be measured directly with a thermometer.

Adding heat energy usually results in a temperature rise, so people often confuse heat and temperature. But they are not the same thing! We will look more at heating as a transfer of energy next term in Energy and Change.

Boiling and melting points

Do you remember learning about the state changes in previous grades? We will be focusing on boiling and melting in this section. Have a look at the following diagram to refresh your memories about the different changes of state between solids, liquids and gases.



1. Melting is when a solid changes into a liquid. Look at this photo of a candle burning. What is happening to the wax around the flame?

_____

2. Discuss with your partner why you think this is happening to the wax. Write your answer below.

_____

_____

_____

_____

A burning candle.

As you can see in the previous diagram, a liquid can change into a gas by evaporation. For example if you leave a saucer of water out in the sun, the water will evaporate. Evaporation can take place at any temperature. But, in boiling, the liquid needs to be heated to reach its **boiling point**. Bubbles of water vapour then form in the liquid and rise up.

Can you think of at least three different ways to boil water? Discuss this with your class and write your answer down.

_____

_____

_____

What would happen if you tried to put the kettle into the microwave or on the stove? We will soon find out!

ACTIVITY: Boiling and melting

Look carefully at the picture. It looks as if something has gone wrong here!

QUESTIONS:

1. Write a short story to explain what you think happened to the kettle in the picture.

2. Why do you think the person made the mistake of heating the kettle on the stove?

3. Do you think plastic is a good choice of material for making a whole cooking pot? Why do you say so?

4. Why does a plastic kettle not melt when we boil water in it?

5. Sometimes, just the handles of the cooking pot are made from plastic or wood. Why do you think this is so?

TAKE NOTE

The mercury inside these kinds of thermometers is toxic and dangerous so they must be handled with care.

At what temperature does water boil? We are going to do an investigation to find out! Since we have to make temperature measurements in the investigation, we are going to first check if everyone knows how temperature is measured.

Have you ever been so sick that you had a fever? Have you ever had your temperature taken?

Perhaps you have had your temperature taken with a **thermometer**. A thermometer can be used to find out how hot or cold something is. A thermometer is an instrument for measuring temperature.

This is a thermometer used to take your temperature when you have a fever.

Let's now investigate boiling and melting.

INVESTIGATION: What is the boiling point of water?

AIM: To observe boiling and to determine the boiling point of water.

HYPOTHESIS:

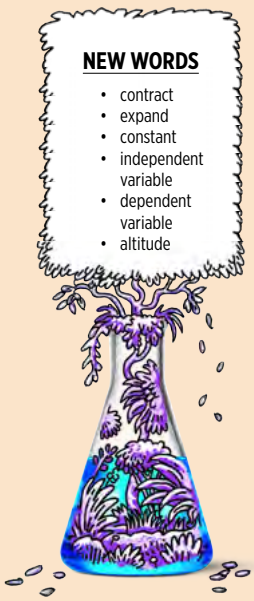
What is your hypothesis for this investigation?

_____

_____

NEW WORDS

- contract
- expand
- constant
- independent variable
- dependent variable
- altitude



MATERIALS AND APPARATUS:

- glass beakers x 2 (or small pot)
- Bunsen burner (or stove plate)
- tripod with gauze
- tap water
- thermometer
- funnel
- ice blocks

Before you start, discuss the following questions in your group:

1. Discuss what you know about gases, liquids and solids; the three states of matter. Write down your ideas from your discussion.

_____

_____

2. What needs to happen to water to make it freeze?

3. What needs to happen to water to make it boil?

4. How do we measure temperature?

5. Can you remember the boiling point and freezing/melting point of water? If you can, write them in the space below.

6. Let's make some predictions. Read the two statements below, and indicate whether you AGREE, DISAGREE or are NOT SURE, by drawing a cross in the matching column:

Statement	AGREE	DISAGREE	NOT SURE
Water can get hotter than 100°C.			
Water always freezes at 0°C.			

Safety precautions

- Your teacher will demonstrate how to handle the Bunsen burner safely.
- Remember that boiling water can cause painful burns.
- The thermometer is made of very thin glass. Hold it gently, and do not use it to stir the water. Be careful not to drop it or bump it against the bottom or sides of the beaker.

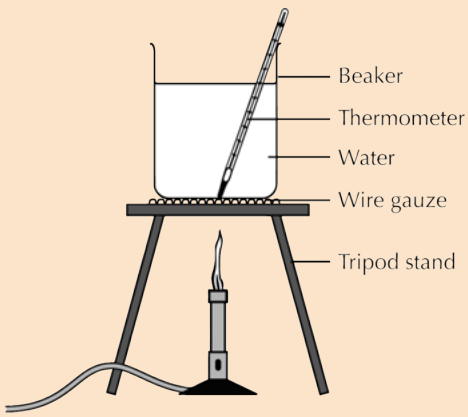
VISIT

This video shows you how to use a laboratory thermometer.

bit.ly/16ww1kU

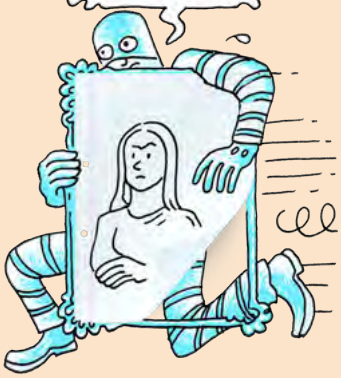
METHOD:

1. Set up your apparatus as shown in the image. Remember that when you want to take the temperature, the thermometer must not be touching the sides.
2. Take a measurement of the water temperature before you start heating the water. This will be your measurement at time 0.



TAKE NOTE

Perhaps you measured the boiling point of the water as slightly less than 100°C. This does not mean that your measurements were incorrect. The boiling point of water depends on the atmospheric pressure. At sea level (close to the ocean) water boils at 100°C. Water boils at a lower temperature at higher **altitudes** (for example, on a mountain) because the air pressure is less.



3. Light the burner and heat the water.
4. Measure the temperature of the water at regular intervals. Record the temperature in the table provided.
5. After a while you will notice that the temperature of the water becomes **constant** (this is when the temperature stops going up). Continue to take the temperature three more times (once every three minutes) after this happens. What do you notice about the water?

_____

_____

RESULTS AND OBSERVATIONS:

Record your results in the table.

Elapsed time (minutes)	Temperature of the water (°C)
0	

VISIT

Water can boil at room temperature, inside a vacuum

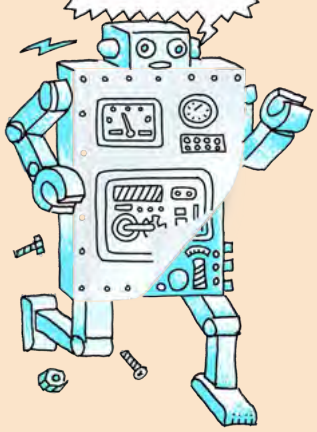
bit.ly/16ww3cp

We are now going to draw a graph of the results recorded in the table. Here are some guidelines for drawing the graph:

1. The title of your graph should be: **Determining the boiling point of water**.
2. The independent variable should be 'Time'. Label the axis, and use minutes as units. Remember that the **independent variable** should always be drawn on the horizontal axis of your graph, or the x-axis.
3. The dependent variable should be 'Temperature'. Label the axis, and use degrees Celsius (°C) as units. The **dependent variable** should always be drawn on the vertical axis of your graph; this is the y-axis.
4. Plot the data on a line graph using the graph paper - each data point must be marked with a small, neat cross.

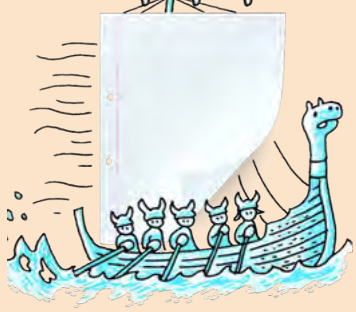
TAKE NOTE

The boiling point of water also depends on the purity of the water. Water which contains impurities (such as salt or sugar) boils at a higher temperature than pure water. This is why orange juice or apple juice will boil at temperatures slightly above 100°C.



TAKE NOTE

Different thermometers from different batches might also give slightly different readings. This is because they might have been calibrated differently.



ANALYSIS:

1. What did you see when the water started to boil?

2. What do you think happened to the water when it boiled?

3. Describe the shape of your graph. Is it a straight line?

4. How did the temperature of the water change over time?

5. How does the shape of the graph show the way the temperature changed over time?

6. What happened to the temperature of the water when it started to boil?

7. How long did it take for the water to start boiling?

8. At what temperature did the water boil?

9. What do we call the temperature at which the water boils? Indicate this temperature on your graph.

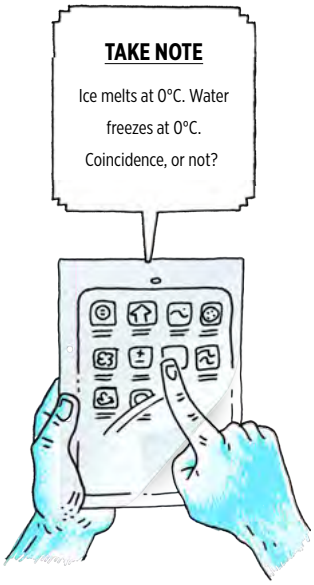
10. Suppose we used a Bunsen burner with a bigger flame.
    a) Do you think the water would boil at a temperature that is higher, lower or the same as the boiling point you just measured? Why do you say so?

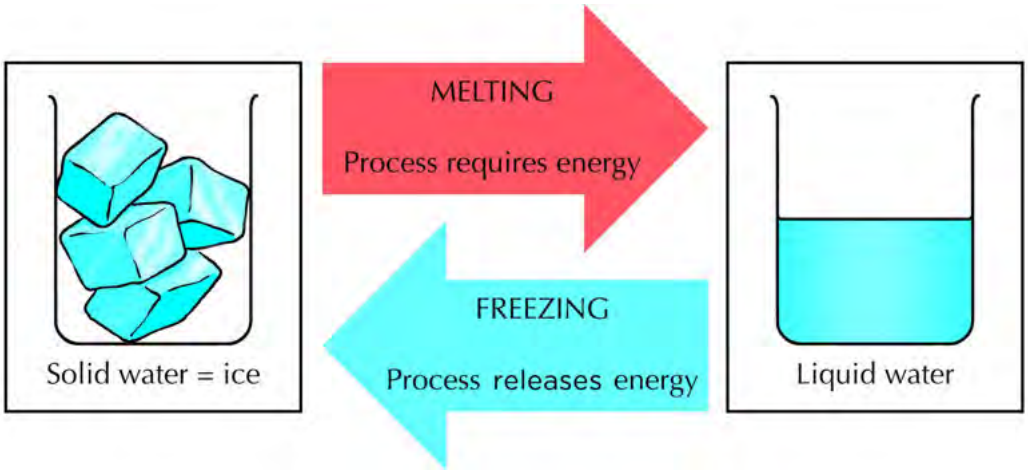
    b) Do you think the time required for the water to boil would be longer, shorter or the same? Why do you say so?

CONCLUSION:

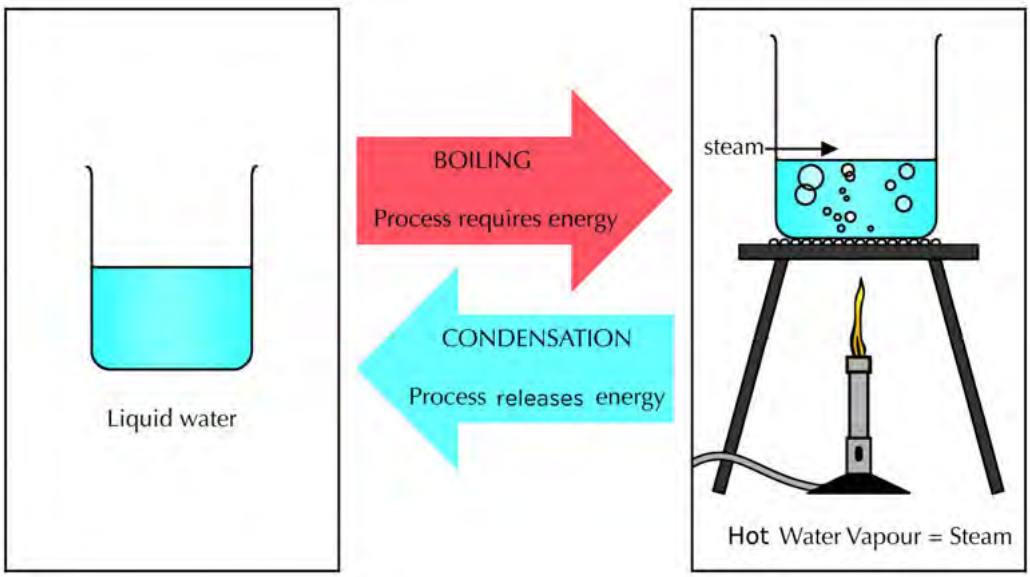
Write a conclusion for this investigation. When writing a conclusion, you must go back to look at your initial aim.

We will learn more about changes of state in Gr. 8 Matter and Materials. In order to melt ice, we need to add energy to it to raise the temperature to **melting point**. However, if we want to freeze water, we need to remove (take out) energy from it until the temperature decreases to freezing point.

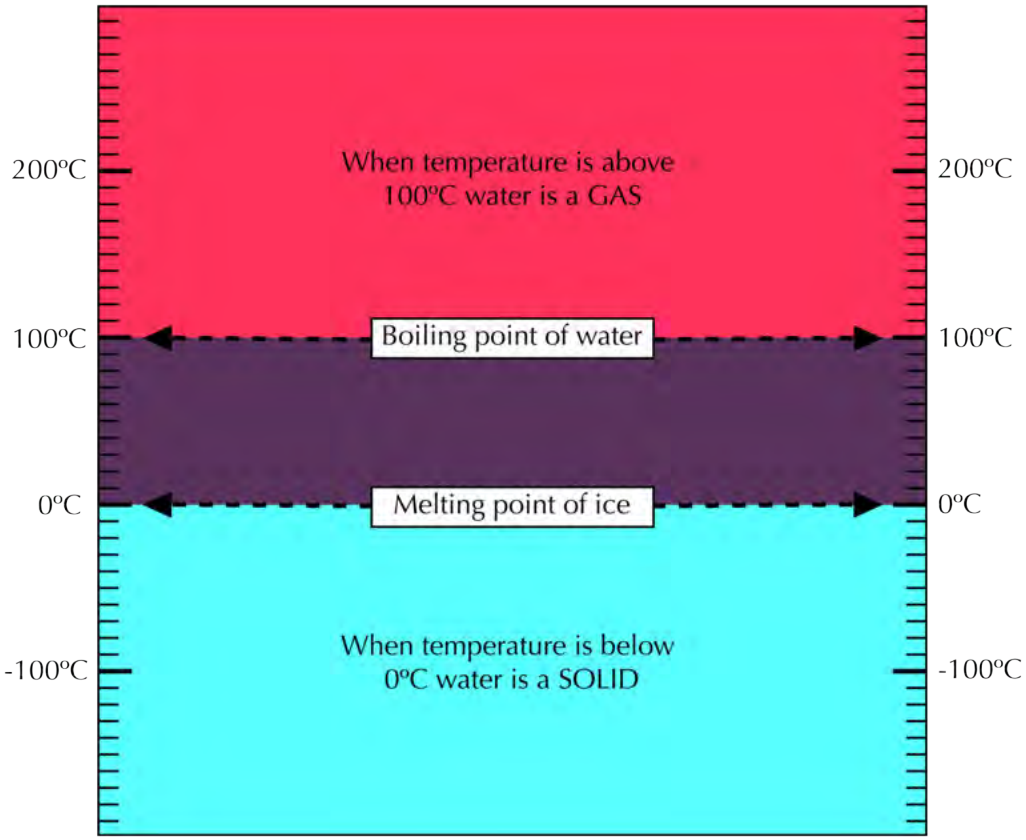




Does boiling have a reverse process? Boiling is when liquid water changes to water vapour or steam. The reverse process, when steam turns back to water, is called condensation. In order to boil water, we need to add energy to it. But if we want to condense the water vapour, we need to cool it down (take energy out of it).



The following diagram summarises what we have learnt so far.



Do all liquids boil at 100°C? No, of course not! Not all substances melt at 0°C either.

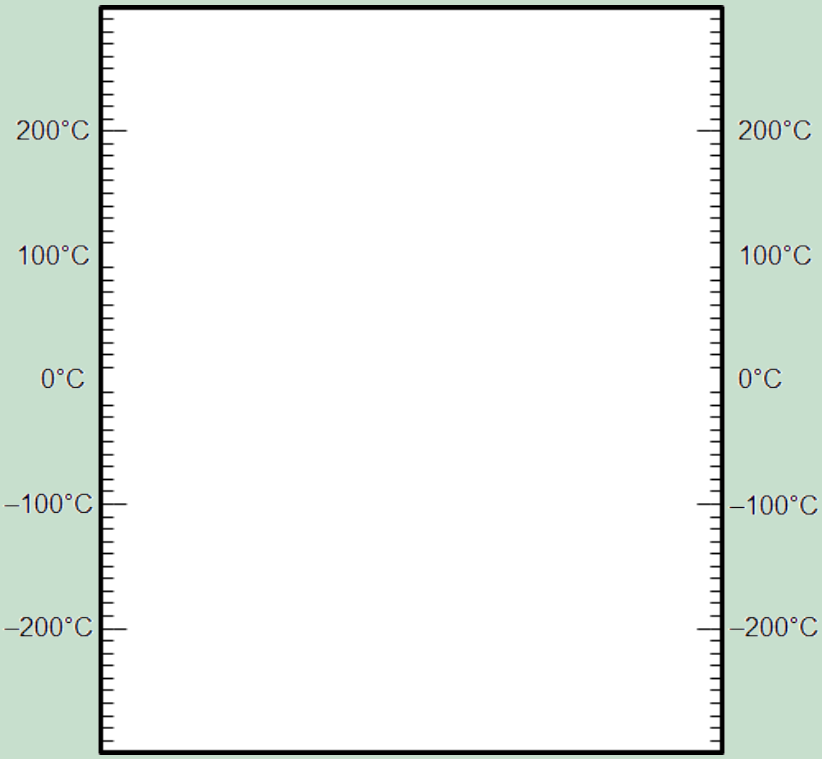
Can you think of a few substances that are solids at low temperatures, but have low melting points? (Think of things that melt easily when it is hot outside. Ice cream is an example.)

In the next activity we are going to explore the boiling and melting points of a few substances other than water.

ACTIVITY: Boiling and melting points of other substances

INSTRUCTIONS:

1. Place the boiling and melting points of the substances listed below on the blank template provided and then answer the questions.
2. The boiling point of nitrogen is - 200°C. Draw a green line at this temperature on the diagram and label it 'Boiling point of nitrogen'.
3. The boiling point of ethanol is 78°C. Draw a red line at this temperature on the diagram and label it 'Boiling point of ethanol'.
4. Now draw a blue line at the boiling point of water and also label this line.
5. What is room temperature? Draw a black line at this temperature and label it.



QUESTIONS:

1. What state would nitrogen be in at room temperature? Why do you say so?

2. Suppose you mix some water and some ethanol. They are mixed but they have not changed into something else. The mixture is at room temperature to begin with. Now suppose you start heating the mixture. What temperature would be reached first: 78°C or 100°C?

3. What do you think will happen when the mixture reaches a temperature of 78°C? Do you think the ethanol will start to boil?

4. Will the water boil at the same time?

VISIT

Play an interactive game based on the melting points of solids.

bit.ly/16ww5RR

So far we have seen that materials have different properties such as their strength, their flexibility and their melting and boiling points. These properties determine how these different materials are used.

We also briefly mentioned how some materials can conduct heat better than others. This is called heat conductivity. Think of some objects which you want to be able to conduct heat well and what material they should be made of. Write some of your ideas down.

Why do you think you put a jersey on when you are cold? What can we say about the wool that the jersey is made from in terms of heat conductivity?

NEW WORDS

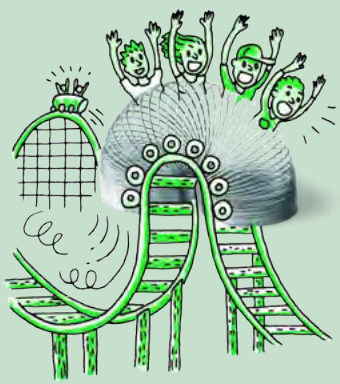
- impact
- concern
- environmental concerns

We will learn more about heat transfer later in the year. Another property of materials is how well they can conduct electricity. This is called electrical conductivity. We will look more at how different materials can be used as electrical insulators (meaning they do not conduct electricity well), later in the year.

1.2 Impact on the environment

Earlier, we saw how some of the properties of materials may be advantages under certain circumstances, but can become disadvantages under a different set of circumstances, such as plastics and other materials which, if they end up in nature, can have serious consequences and cause harm to other animals. Every process used to produce materials for our benefit has an **impact** on the environment. Some processes have a small impact and others have a large impact.

We have already seen how the use of materials, such as plastics and paper, has a negative impact on our environment, but what about their production?



ACTIVITY: Environmental impact of material production

INSTRUCTIONS:

1. Look at the pictures and answer the questions that follow about the production of different materials in South Africa.
2. You will need to do some extra research for this activity. Some information about each of the processes has been provided, but you will need to research them in more detail and answer the questions that follow.

Mining:

Mining in South Africa has been one of the main reasons for our development. South Africa is still one of the top gold mining countries in the world. We also mine and produce other metals such as chromium, platinum, as well as coal and iron ore. Although this is hugely beneficial for the economy, it has devastating effects on the environment.

VISIT

What is fracking? (An article)
bit.ly/16BKP3A
Learn more about fracking in South Africa. (An article)
bit.ly/13IJ1Yw

1. This huge hole is actually a diamond mine about 40 km outside of Pretoria. What effects do you think this has had on the environment?

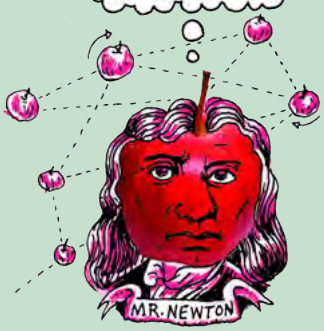
The Premier Diamond Mine outside of Pretoria.

2. In this photograph, the 2010 World Cup Soccer Stadium can be seen in the centre. In the top left are huge areas called slag piles. These are huge piles of crushed rock left over from decades of gold mining. What impact do you think this has on this area?

An aerial view of the Soccer City Stadium and surrounding area.

DID YOU KNOW?

A major **environmental concern** at the moment is the proposal to start fracking in the Karoo. Fracking is a process where water is injected at very high pressures into small fractures in underground rock to crack it further and release gas and oil which are used as fuels.



3. Coal mining in South Africa also has a major impact on the environment. Not only the mining, but the use of coal in power stations has negative impacts. What are some of these?

Paper making:

Can you imagine your world without paper? Probably not! We use it every day of our lives. South Africa has a big paper-making industry. Although paper is important in our lives today, the production has negative impacts on the environment.

A tree plantation for paper.

A paper-making factory.

1. Huge areas of land are used to plant the trees that are then harvested to make pulp and then paper. What impact do you think this has on the environment? Hint: Also think about what you learnt about in Life and Living about biodiversity.

2. Look at the photo of the paper-making factory. What effects does this have on the environment?

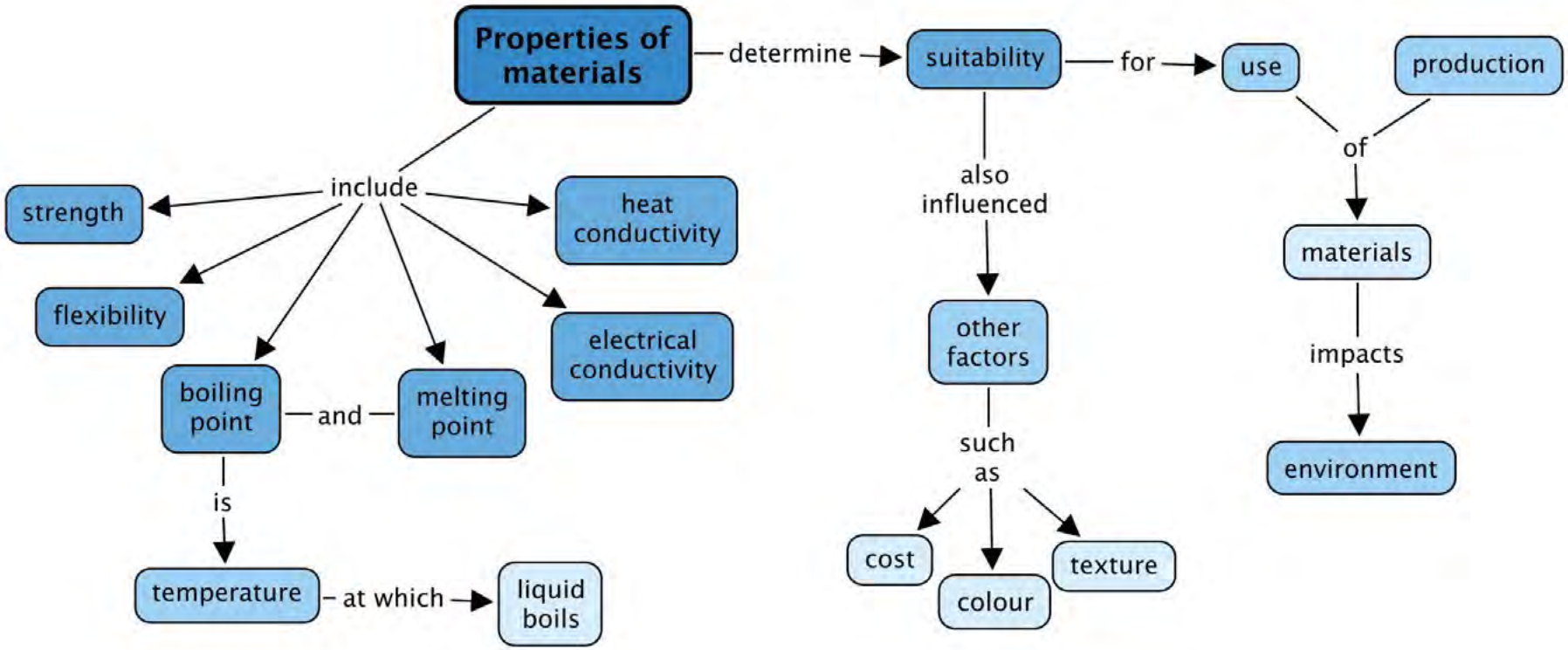
SUMMARY:

Key Concepts

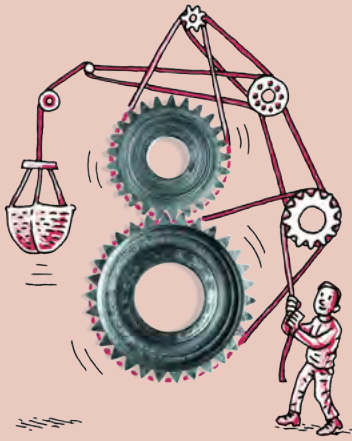
- The properties of a material determine the purposes for which it can be used.
- Some of the properties of materials include strength, flexibility, heat and electrical conductivity and they have specific boiling and melting points.
- Boiling point is the temperature at which a liquid boils.
- Melting point is the temperature at which a solid melts.
- The suitability of a material for a certain use is also influenced by other factors such as its cost, its colour and its texture.
- The ways we use materials and the processes we use to produce them always have an impact on the environment.

Concept Map

On the following page is a concept map for what we have learnt about the properties of materials. We discussed several properties of materials in this chapter. Can you see how we can summarise a lot of information onto one page?


Properties of materials
determine
suitability
for
use
production
of
materials
impacts
environment
include
strength
heat conductivity
flexibility
electrical conductivity
boiling point
and
melting point
is
temperature
at which
liquid boils
also influenced
other factors
such as
cost
colour
texture

REVISION:



1. Below are a number of short sentences. In each case, you must complete the sentence by filling in the missing words. Write the whole sentences out on the lines provided. Fill in the missing word. [8 x 1 mark each = 8 marks]
   a) The set of characteristics that describe a material are called the _____ of that material.

_____

_____

   b) Materials that can be hammered into thin sheets are called _____. (Metals have this property.)

_____

   c) Materials that can be bent are called _____. (Some plastics have this property.)

_____

   d) The boiling point of a material is the _____ at which the liquid state of that material turns into a gas.

_____

_____

   e) When we want to measure temperature we use a _____.

_____

   f) The boiling point of water at sea level is _____.

_____

   g) A material that conducts heat well is said to have a high _____.

_____

   h) If you want to create a circuit for a bulb, the material that you use in the circuit to connect the battery to the bulb must have a high _____.

_____

_____

2. State whether each of the following statements is TRUE or FALSE. If you think a statement is FALSE, you have to write a TRUE statement in its place. [4 x 2 marks each = 8 marks]

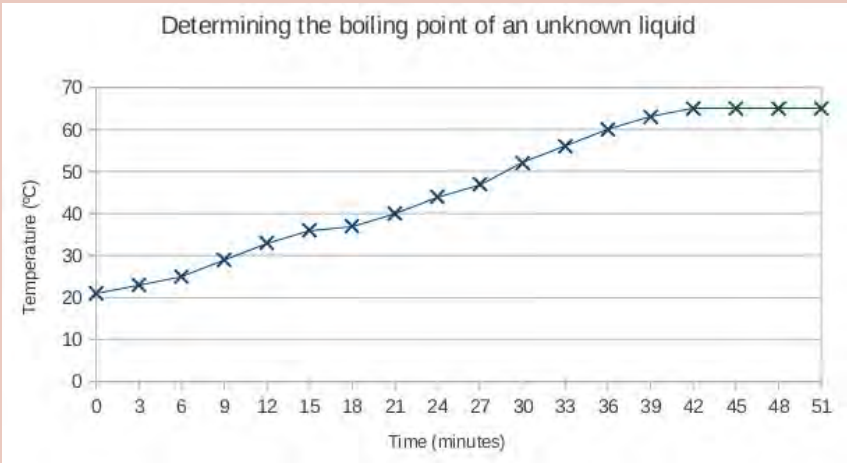
a) All liquids boil at 100°C.

b) Water always boils at 100°C.

c) Any given material will melt and freeze at the same temperature.

d) When water is boiled over a bigger flame, it will boil at a higher temperature.

3. A scientist wants to determine the boiling point of an unknown liquid. She places the unknown liquid in a beaker and carefully heats it on a hot plate. The scientist measures the temperature of the liquid at regular time intervals (every 3 minutes). Afterwards, she draws the the following graph:



a) At what temperature does the unknown liquid boil? Show this temperature on the graph. [2 marks]

b) How long does it take for the unknown liquid to start boiling? [1 mark]

c) The scientist suspects that the unknown liquid is one of the substances on the following list. Use the list to identify the unknown liquid. Say *why* you think it is this substance. [2 marks]

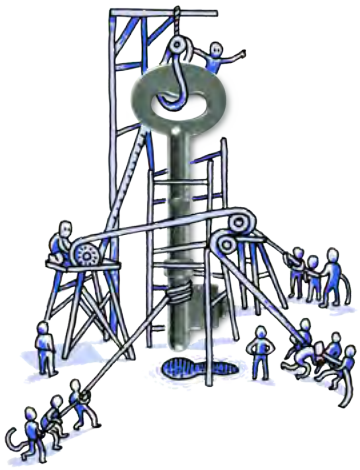
Substance	**Boiling point (°C)**
Acetone	56
Methanol	65
Ethanol	78
Isopropanol	83
Water	100

d) What was the temperature of the unknown liquid at the start of the experiment? [1 mark]

Total [22 marks]

Draw and discover the possibilities of what a slinky can be.

2 Separating mixtures



KEY QUESTIONS:

- How can we explain the term 'mixture'?
- What types of materials can be mixed?
- What methods can be used to separate a mixture into its original components?
- Which factors are important when choosing a method for separating a mixture into its components?
- Which materials can be recycled?
- Who is responsible for the disposal of waste materials?
- What are the negative consequences of poor waste management?

2.1 Mixtures

NEW WORDS

- mixture
- suspension
- opaque
- solution
- clear

What does it mean to *mix* something? Can you mime an explanation (that means you have to explain without saying a single word!)

Is it possible to mix water? Discuss this with your class.

One substance alone cannot be a mixture. A **mixture** is made up of two or more different substances.

A mixture can contain solids, liquids and/or gases. The components in a mixture are not chemically joined; they are just mixed. That means we do not need to use chemical reactions to separate them. Mixtures can be separated using physical methods alone and that is what this chapter is all about: how to separate mixtures.

There are many different kinds of mixtures. Before we learn how to separate them, it is worth looking at all the different kinds of mixtures briefly.

Different kinds of mixtures

A mixture of a solid and a solid

Soil is a mixture of different components.

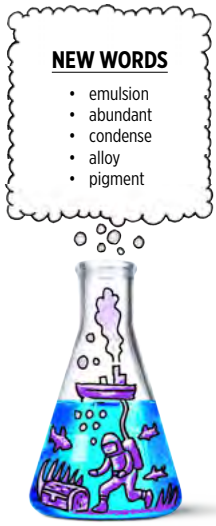
Can you think of an example of a mixture of a solid and a solid? Soil is an example of a mixture of solids. What are the substances found in soil?

_____

_____

_____

A mixture of a solid and a liquid



What happens when clay or sand is mixed with water? Would you be able to see through a mixture of clay and water?

Can you see the difference between an opaque suspension of sand and clay in water (on the left) and a clear solution of sugar in water on the right?

The mixture of clay or sand with water is muddy. The small clay particles become suspended in the water. This kind of mixture is called a **suspension**. Suspensions are **opaque**; that means they are cloudy and we cannot see through them very well. What happens when sugar is mixed with water? Does the mixture become muddy? Why not? The sugar dissolves in the water and the mixture is called a **solution**. Solutions are **clear**; that means we can see through them.

A mixture of a solid and a gas

The black smoke from a burning building.

Have you ever seen smoke from a fire? What is the smoke made of? Do you think it is a mixture?

A mixture of a liquid and a liquid

Milk is not a single substance, but actually a mixture of two liquids! The one liquid component in milk is water, and the other is fatty oil. The reason milk is opaque is that tiny droplets of the oil is suspended in the water. Can you remember what a mixture is called when a solid is suspended in liquid?

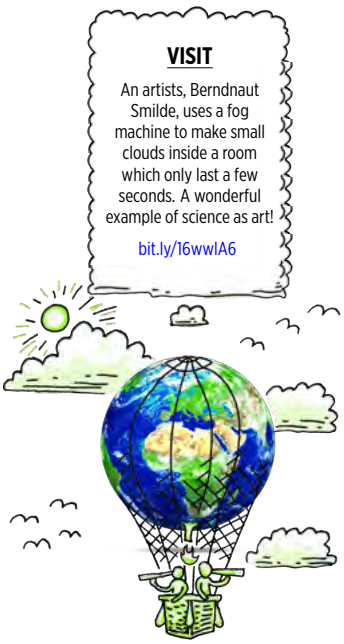
When some liquids are suspended in liquid, we call the mixture an **emulsion**. Like suspensions, emulsions tend to be opaque.

A clear, transparent solution on the left and an opaque emulsion on the right

Are all liquid-liquid mixtures emulsions? (One way to recognise an emulsion is that it is opaque). Are all liquid-liquid mixtures opaque? Can you think of a liquid-liquid mixture that is not an emulsion? Discuss this with your class and give an answer below.

A mixture of vinegar and water is clear, and that is a clue that the mixture is a **solution**.

Solutions are special kinds of mixtures in which the particles are *so well mixed* that they are not separated from each other. We cannot make out separate substances anymore - everything looks the same when we look with the naked eye.



A mixture of a gas and a gas

We learnt in Gr. 6 Matter and Materials that the particles of gases are far apart. This means that gases can mix very easily, because it is easy for their particles to move in amongst each other. The air we breathe is not a single gas but actually a mixture of gases! Do you know what the two most **abundant** components are?

A mixture of a liquid and a gas

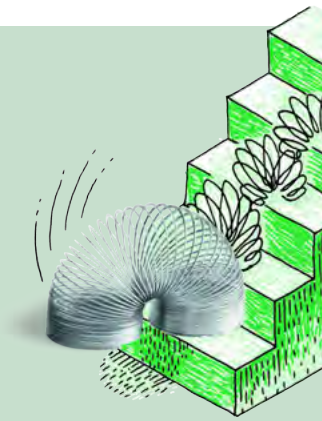
Do you remember that we discussed boiling in the previous chapter (Properties of Materials)? What happens to a liquid when it boils?

Can you see the water vapour in the picture of a boiling kettle? Point to it with your finger. Discuss this with your teacher and classmates and when you have agreed on an answer, draw an arrow onto the picture to indicate the water vapour.

Can we see most gases? Why do you think so?

Clouds and fog or mist are all examples of tiny water droplets suspended in air.

We have learnt that mixtures can be made of substances in the same state or in different states. The following activity will help us apply our new knowledge about mixtures to more examples.



ACTIVITY: Types of mixtures

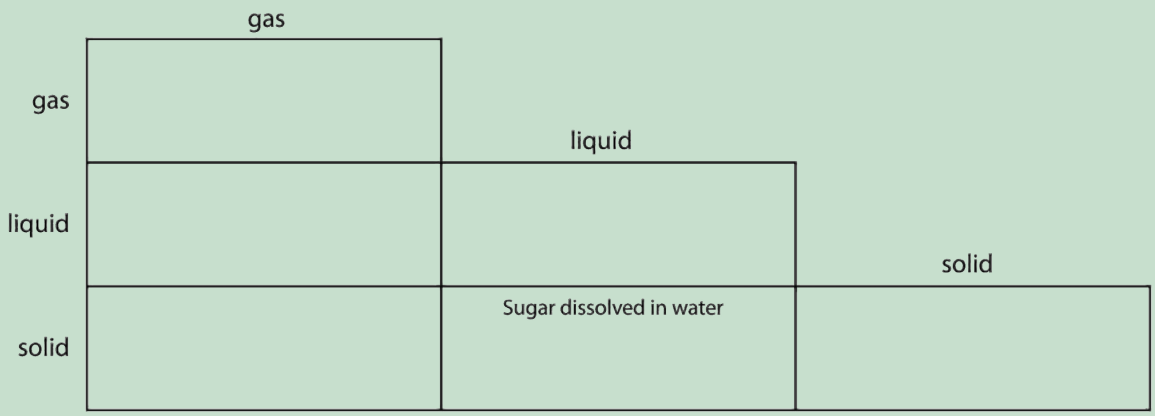
INSTRUCTIONS:

1. Look at the list of mixtures. Discuss in your group, or with your partner, what each mixture consists of.
2. Identify the type of substances (solid, liquid or gas) that are mixed in each of the examples on the list.
3. Write the name of each example in the appropriate block on the diagram.

Mixtures:

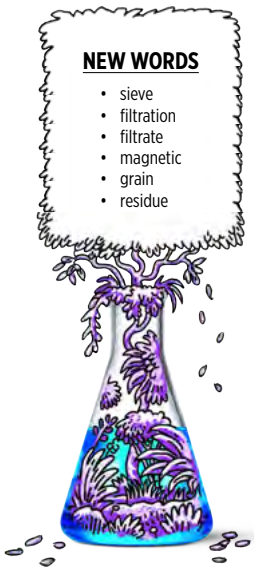
- air
- smoke
- hair oil (emulsion of oil and water)
- clear fruit juice (eg. apple juice)
- cloudy apple juice
- salty water
- **alloys** such as brass (used for coins) and stainless steel (used for rust-resistant metal items)
- foam plastic (like the material used for making mattresses and pillows)
- spray deodorant
- air freshener (aerosol type)
- paint
- dust cloud
- soil

For instance, sugar dissolved in water would go in the middle block of the bottom row, to show that it is a solid (sugar) mixed with a liquid (water).



Why do we make mixtures? Mixtures have many uses: perhaps we are mixing ingredients to bake a cake, or mixing metals to make a really strong alloy.

A cake is a mixture of ingredients, including flour, eggs and milk.



Many things around us occur naturally as mixtures: salty sea water, moist air, soil, compost, rocks (mixture of minerals) to name a few. Many mixtures are man made, for instance; Coca Cola, paint, salad dressing and so forth.

Mixtures are very useful. However, sometimes we need to separate mixtures into their components. Remember that the substances in a mixture have not combined chemically. They have not turned into new substances, but are still the same substances as before - they have just been physically combined. That is why we can use physical methods to separate them again.

2.2 Methods of physical separation

Now that we know about the different kinds of mixtures that are possible, we are going to learn about some ways of separating them.

How do we separate mixtures?

Suppose you were given a basket of apples and oranges. How would you sort them? You would probably pick out all the oranges from the apples by hand. The same method may not be suitable for all mixtures. You would probably not consider sorting sugar and sand **grains** by hand. Why not?

_____

Let us look at some of the most commonly used methods of physical separation.

Hand sorting

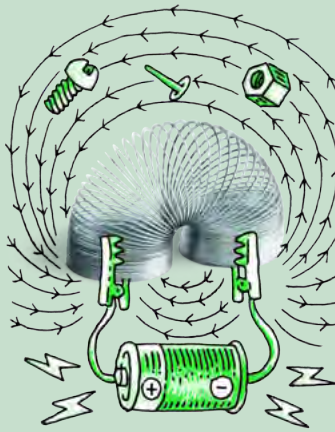
A mixture of different coloured beads.

How would you separate the mixture of beads in the adjacent picture into the different colours?

_____

_____

_____



ACTIVITY: Thinking about hand sorting

1. Would hand sorting also be a practical way to sort out the mixture of rice and lentil beans in the picture below?

A mixture of rice and lentils

2. Would hand sorting be a practical way to sort the pebbles out of a large pile of sand?

3. Besides what we discussed in the chapter, think of at least three other examples of mixtures that could be hand sorted.

4. When is hand sorting a good method for separating the components in a mixture?

Sieving

Can you think of a practical way to sort stones or pebbles from sand? Do you think picking the pebbles out by hand would work?

How would you separate the pebbles from the sand in this pile?

When we have large quantities of materials to sort and the different particles have different sizes, we can **sieve** the mixture. The smaller particles will fall through the openings in the sieve, while the larger particles stay behind.

TAKE NOTE

The clear liquid that has passed through the filter paper is called the **filtrate** and the particles that are left behind on the filter paper is called the **residue**

Filtration

Muddy water is poured through a funnel lined with filter paper to remove the small sand and clay particles.

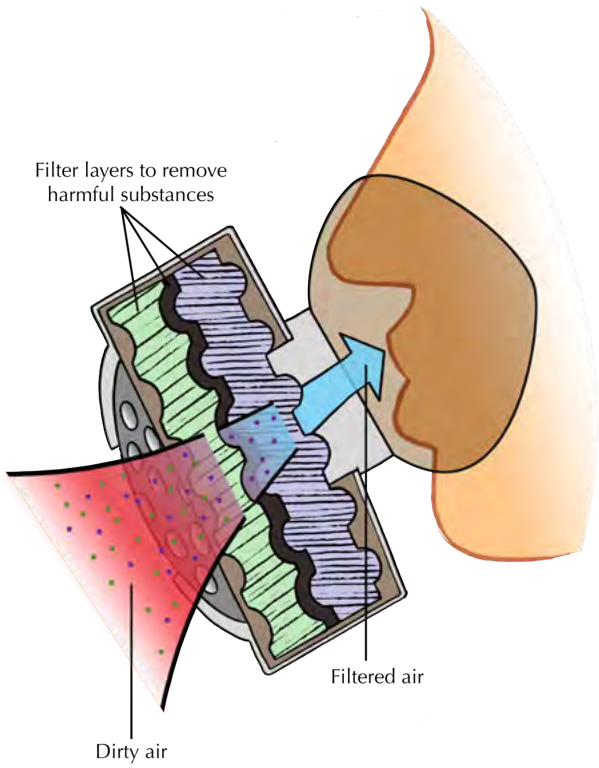
When the particles in a mixture are too small to be caught by a sieve and when the components of the mixture are in different states, we can separate them by **filtration** using a filter.

What type of mixture is the muddy water in the glass an example of?

A firefighter wears a mask to filter out the smoke.

Have you ever noticed how, when people have to work in dusty or smoky environments, they wear dust masks or smoke masks? Why do you think that is necessary?

The following diagram shows how a gas mask works. Layers of very fine filters trap harmful substances and dust or smoke particles, so that only clean air is let through.



A smoke mask consists of filter layers which clean the dirty air before it is breathed into the body.

ACTIVITY: Thinking about sieving and filtering

1. Besides what we discussed in the chapter, think of at least three other mixtures that could be sieved, and write them in the space below.

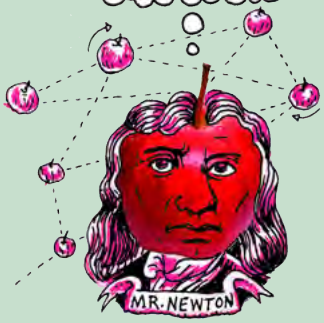
2. When is sieving a good method for separating the components in a mixture?

3. Nowadays most people use tea bags to make tea, but there was a time when people brewed tea from leaves and then poured the tea through a sieve into the cup. Why do you think they did this?

Tea leaves and bits have collected in the sieve after pouring the tea into the cup.

DID YOU KNOW?

In ancient cultures, grain and chaff was separated by a process called winnowing. They would throw the mixture into the air and the wind would blow away the lighter chaff, but not the heavier grain.



4. Sometimes the particles that we want to remove from a mixture are so small that they will pass easily through a sieve (think of the example of the muddy water from before). Can you think of a way to overcome this?

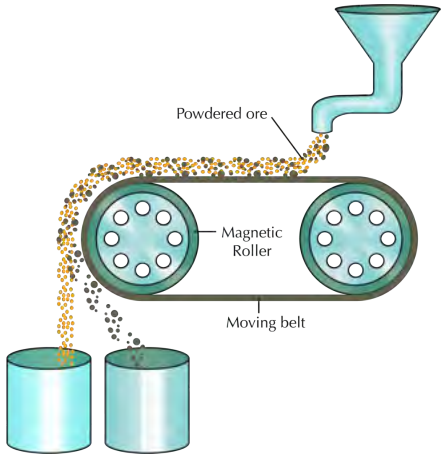
5. Besides what we discussed in the chapter, think of at least three other mixtures that could be filtered, and list them below.

6. When is filtering a good method for separating the components in a mixture?

Can you remember the activity from Gr. 6 when Tom used magnetism to separate different kinds of metals at his uncle's junk yard? The **magnetic** properties of the metals allowed them to be separated in this way.

Magnetic separation

The following diagram shows how magnetic separation can be used to separate a mixture of components. In the example, mineral ore that contains two compounds (one magnetic, and the other non-magnetic) is being separated. The ore grains are fed onto a revolving belt. The roller on the end of the belt is magnetic. This means that all the magnetic grains in the ore will stick to the belt when it goes around the roller, while the non-magnetic grains will fall off the end. As soon as the magnetic grains move past the magnetic roller, they will also fall down.



In the above diagram, what colour are the non-magnetic grains and into which container do they fall? Label this on the diagram. What colour are the magnetic grains and which container do they fall into?

ACTIVITY: Thinking about magnetic separation

1. Besides what we discussed in the chapter, can you think of two other mixtures that could be separated magnetically? Write them in the space provided.

2. When is magnetic separation suitable for separating the components in a mixture?

How can we separate the components in a solution? Let's find out.

Separating solutions

The substances in a solution are mixed on the level of individual particles. In a sugar and water solution, the sugar particles and the water particles are mixed so well that we could not distinguish them with the naked eye. You might think that mixtures that are so 'well-mixed' are impossible to separate! But as we shall soon see, this is not true.

NEW WORDS

- evaporation
- condensation
- distillation
- still
- chromatography
- chromatogram
- solute
- solvent

Separation by evaporation

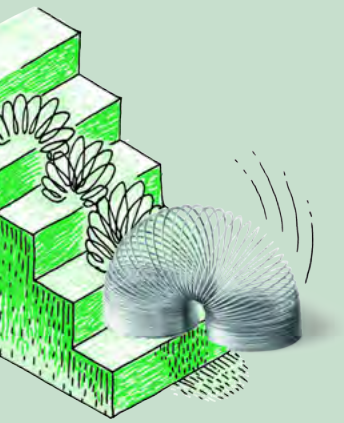
Do you know where most of the salt that we use in South Africa comes from? South Africa gets it salt from inland salt pans, coastal salt pans and seawater. A salt pan is a shallow dam in the ground where salt water **evaporates** to leave a layer of dry salt.

An aerial view of salt pans.

Salt pans in India. A man is busy collecting the dried salt to be packaged and sold.

When sea water is allowed to stand in shallow pans, the water gets heated by sunlight and slowly turns into water vapour, through evaporation. Once the water has evaporated completely, the solid salt is left behind.

Do you think this is a good method for separating salt from water? Do you think it would work for a sugar and water solution?



ACTIVITY: What if we want to keep both the water and the salt?

QUESTIONS:

1. Do you think separation by evaporation would be a good method to separate a salt-water-solution if you wanted to keep both the salt and the water? Why do you say so?

2. Can you think of a way to modify the method so that the water that evaporates is not lost? Perhaps the following diagram will help you to formulate a plan. Write an explanation.

3. What is happening in the kettle?

4. Can you say what change in state is happening inside the kettle? What is the process called?

5. What change of state is occurring on the cold surface of the metal plate? What is the process called? (Hint: the change of state from gas to liquid was covered in the previous chapter, under *Physical properties of materials*.)

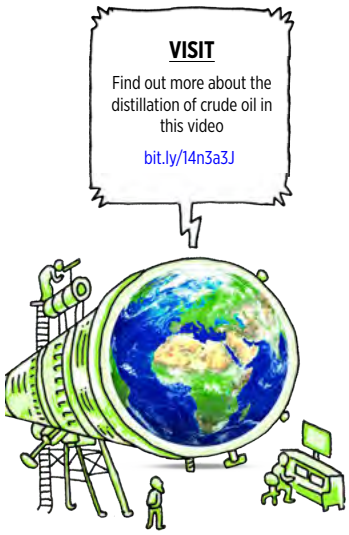
6. Does the salt evaporate with the water? How would you find out?

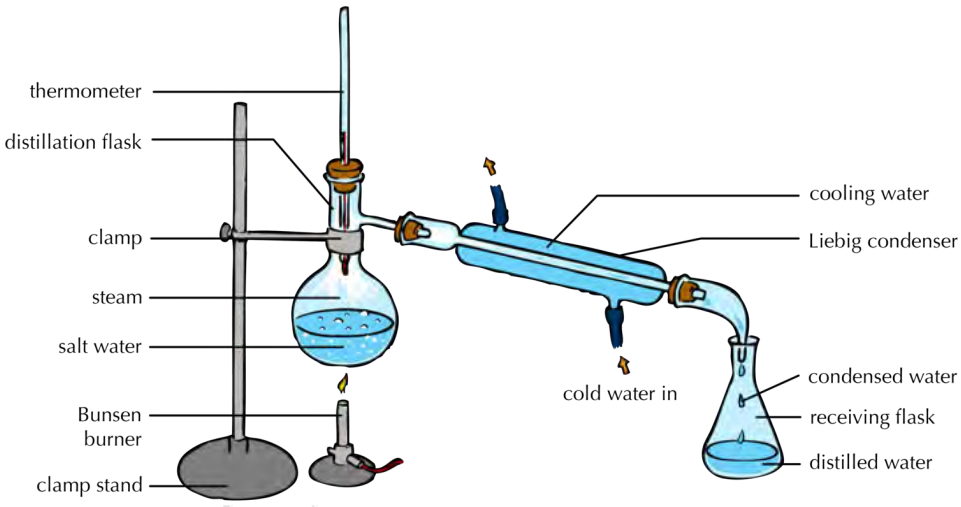
7. What can you tell about the purity of the water after it has evaporated and condensed?

The water that is lost through evaporation can be **condensed** on a cold surface. The cold metal plate will do the job, but it would be difficult to recover all the condensed water, because it will be dripping off the surface of the plate in many different places. Scientists have a solution for that problem: they use a special technique to separate mixtures like these without losing any of the components. The technique is called **distillation**.

Distillation

Distillation is the separation of one substance from another by evaporation followed by condensation. The apparatus used in this technique is called a **still**.





Experimental setup for distillation

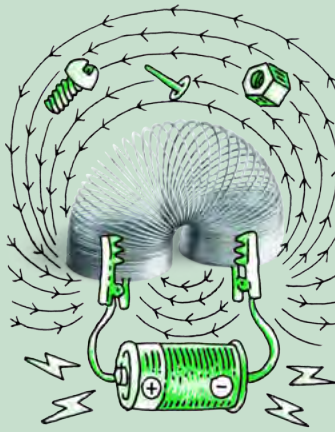
Suppose we want to separate the water and salt in seawater. We would place the seawater in the round flask on the left of the picture (in the distillation flask). We would then boil the seawater to produce water vapour, or steam. The salt would not evaporate with the water, because only the water evaporates. The water vapour rises through the top of the flask and passes into the Liebig condenser.

Two Liebig condensers which are used in the distillation process

The Liebig condenser consists of a glass tube within a larger glass tube. The condenser is designed in such a way that cold water can flow through the space between the tubes. This cools the surface of the inner tube. The water vapour condenses against this cold surface and flows into the receiving flask. Since the salt has not evaporated, it stays behind in the distillation flask.

Distillation is also the best way to separate two liquids that have different boiling points, like water and ethanol for example. Let us have a look.

ACTIVITY: How can we separate two liquids with different boiling points?



QUESTIONS:

1. Can you remember the temperature at which water boils? Write it down below.

2. What is this temperature called?

3. Ethanol boils at a temperature lower than the boiling point of water, namely 78°C. Suppose you mix some water and some ethanol. The mixture is at room temperature to begin with. Now suppose you start heating the mixture. What temperature would be reached first: 78°C or 100°C?

4. What do you think will happen when the mixture reaches a temperature of 78°C? Do you think the ethanol will start to boil?

5. Will the water boil at the same time?

DID YOU KNOW?

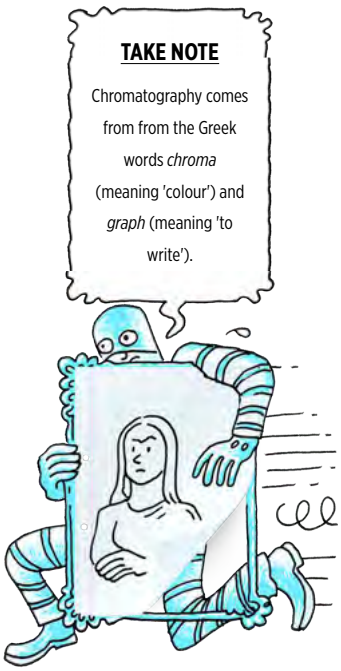
Crude oil is separated into different components using distillation. The components are evaporated, starting with lighter fuel (which has the lowest boiling point), then jet fuel, then petroleum, then motor car oil, until only tar is left. We call the separated components fractions, and the process, fractional distillation.

We can use the same distillation method that we used for separating seawater, to separate the two liquids. The principle is exactly the same, except that we will distill the mixture more than once. Here is how it works:

The mixture of the two liquids is placed in the distillation flask and heated to the lowest boiling point. In the case of an ethanol/water mixture, that temperature would be the boiling point of ethanol, namely 78°C. All of the liquid with that boiling point will evaporate, condense in the Liebig condenser, and pass into the receiving flask. The liquid with the higher boiling point will remain in the distillation flask. Suppose it contains a third substance that we want to separate. How would you do this?

There is one more separation technique for us to explore. Have you noticed how ink on paper will sometimes 'run' when it gets wet?

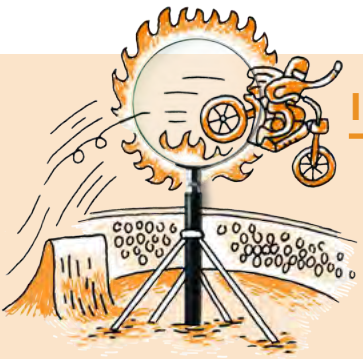
Can you see how the ink on this sign has run after being wet, probably by the rain?



Most inks are a mixture of different pigments, blended to give them just the right colour. A **pigment** is a chemical that gives colour to materials. When a mixture contains colourful compounds, it is often possible to separate the different components using a separating method called chromatography. Let's have a look at this next.

Chromatography

Chromatography is a method for separating coloured substances into individual pigments. We are going to explore this in the next investigation.



INVESTIGATION: Is black ink really black?

AIM: To separate the pigment components in ink using different liquids.

HYPOTHESIS:

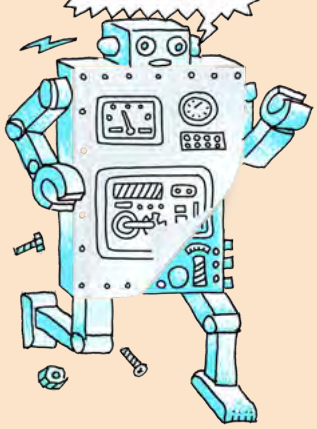
What do you propose the answer to our investigative question is? This is your hypothesis.

MATERIALS AND APPARATUS:

- absorbent paper cut into strips approximately 3 cm wide and 12 cm long
- clear drinking glass or beaker
- assorted black pens and markers
- tap water
- pencil
- paper clip or clothes peg
- filter paper
- dropper
- variety of liquid solvents (ammonia, surgical spirits, methylated spirits, and nail polish remover)

TAKE NOTE

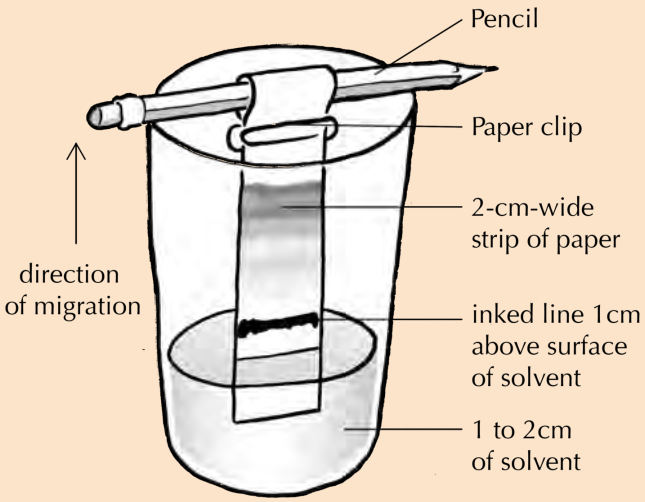
A **solvent** is a substance that dissolves a **solute**, resulting in a solution. A solvent is usually a liquid, but can also be a solid or a gas.



METHOD:

To make a strip chromatogram

1. Use a black pen or marker to draw a line across one end of the paper strip, 2 cm from the end.
2. Pour tap water into the beaker to a depth of approximately 1 cm.
3. Wrap the unmarked end of the paper strip around the pencil and secure it in place with a paper clip.
4. Before putting it into the glass, adjust the strip of paper so that the height of the inked line is approximately 1 cm above the surface of the liquid by holding it against the outside of the beaker.
5. Lower the strip into the glass and rest the pencil across the top of the glass as shown in the diagram. The end of the strip should be in the water, but the inked line should be above the surface of the water.
6. Allow the liquid to soak up into the paper, rising through the inked line.



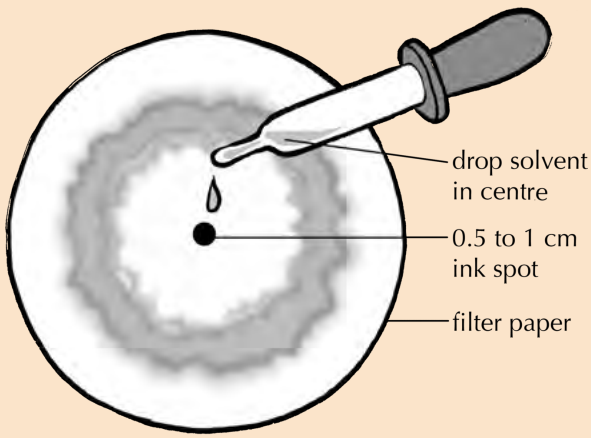
VISIT

Pen colour science.
bit.ly/13Py29D

7. When the migrating pigments approach the top of the strip, near the paper clip, remove the paper strip and allow it to dry on a flat, non-porous surface.
8. Make a similar strip chromatogram for each of the black pens you have collected.
9. Compare the chromatograms. Are they the same or are they different?
10. When you have finished comparing your chromatogram with those of the rest of the class, you can either stick your chromatogram in the following space, or draw a picture of it in the space.

To make a circular chromatogram

1. Lay a large round piece of filter paper on a smooth non-absorbent surface, like the surface of your desk, for instance.
2. Use one of the coloured pens to make a 0.5 to 1 cm ink spot in the centre of the disk.
3. Lay the paper disk flat over the top of a beaker.
4. Place a drop of water in the centre of the ink spot.
5. Add another drop of water every minute or so to make the chromatogram spread toward the edges of the paper disk.



6. Repeat the experiment with one of the other solvents (ammonia, alcohol or nail polish remover).

OBSERVATIONS:

1. Do the two chromatograms look the same or different? If they look different, and you have used the same pen, why do you think that is?

2. Which colour pigments were you able to observe?

3. Draw pictures of your chromatograms in the space below.

CONCLUSION:

1. What can you conclude about the pigments that make up black ink?

_____

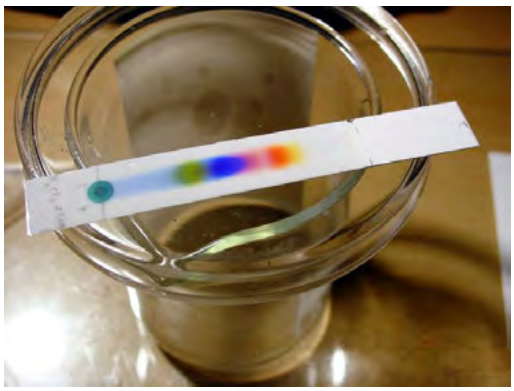
_____

A closer look at how this works:

In paper chromatography, liquid is drawn through the paper fibers. But, why do the pigments in the ink separate into bands of different colours?

The pigments in the ink are carried along by the liquid, but because they are different compounds, they get carried upward at different speeds. This causes them to appear as bands of different colours on the chromatogram.

Look at the picture of the chromatogram on the following page.



An example of a strip chromatogram

1. Which colour pigment is moving up the paper at the fastest speed? Why do you say so?

2. Which colour pigment is moving up the paper at the slowest speed?

Why are the different pigments carried at different speeds?

Pigments migrate at different speeds because of differences in their properties: large pigment particles tend to move more slowly. Furthermore, particles that dissolve well in the liquid will tend to stay in the liquid and be carried to the top quickly, while particles that bind well to the paper will tend to move more slowly.

Now that we have learnt about some of the different ways in which mixtures can be separated, we are going to apply what we know to separate a mixture made of many components.

ACTIVITY: Separating a complex mixture

Imagine you are a member of a team of scientists working together in a laboratory. Your team has been given an important job. You have been given a beaker that contains a mixture of substances to separate.

The mixture contains the following components:

- sand
- iron filings
- salt
- ethanol
- water

Your job is to design a procedure for separating the mixture into its individual components. How would you do that? Your procedure should be summarised in the form of a flow chart.

Before you start, imagine what the mixture would look like. Draw a picture of the a clear container and the different contents in the mixture in the space.

To help you design your procedure, here are a few guiding questions and a template for your flow chart:

1. What is the physical state (solid, liquid or gas) of each of the components in the mixture? Fill these into the table.

Component (substance)	State (solid liquid or gas)	Dissolved or undissolved?

2. Name the solids that will not dissolve in the mixture. These are the undissolved solids.

---

3. Name the dissolved solids in the mixture.

---

4. What would be the best method for separating the undissolved solids from the liquids in the mixture? Write the name of this method in the block numbered 1 of the flowchart below.
5. Write the names of the undissolved solids in block 2 of the flowchart.
6. What remains after the undissolved solids have been removed from the mixture? Write the names of these compounds in block 3.
7. How could we separate the undissolved solids? (Hint: look at the flow chart for some ideas.) Write the name of this process in block 4.
8. Write the names of the two undissolved solids in blocks 6 and 7.

9. How could we separate the liquids from the dissolved solid? We could evaporate them, but then they would be lost. What other option is available if we want to separate the components in a solution? Write the name of this process in block 5.
10. Which liquid would be distilled first? (Hint: which liquid has the lowest boiling point?) Write the name of this liquid in block 8.
11. What remains in the solution when the first liquid is removed? Write the names of these components in block 9.
12. How can we separate the liquid from the dissolved solid? (Hint: this process is the same as the one in block 7.) Write the name of the process in block 10.
13. Write the names of the final two components in blocks 11 and 12.

VISIT

Summary of separating mixtures in short slideshows

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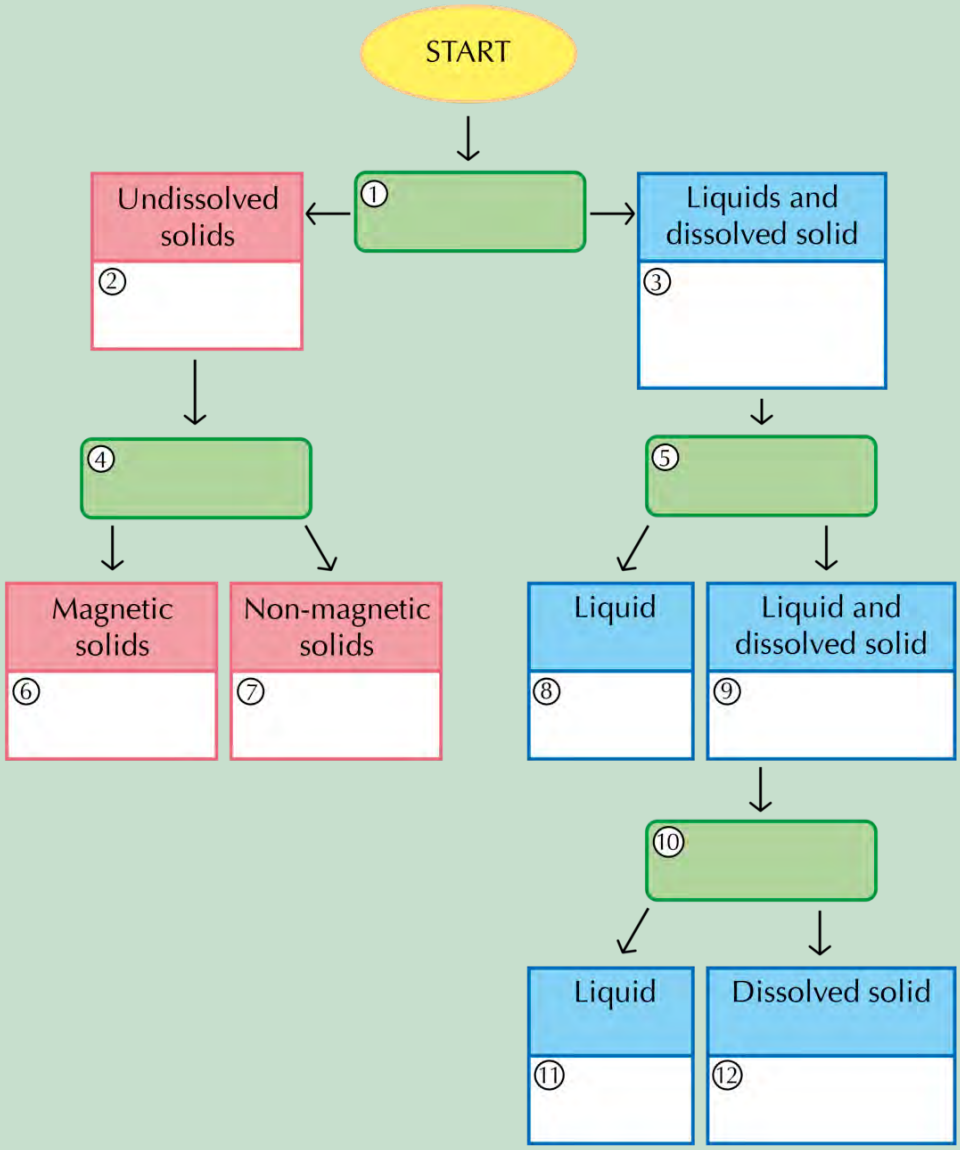
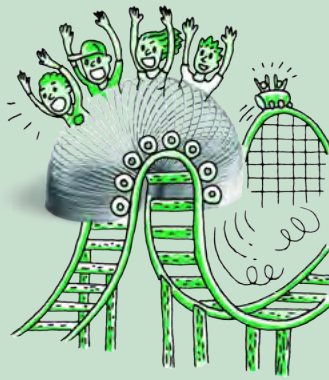


So far, we have been discussing materials, their properties, how to mix them and how to separate them if they are mixed. The final section of this chapter deals with waste materials and what we can do to reduce their impact on the environment.

2.3 Sorting and recycling materials

Over time, some of our things get old and break and we need to throw them away. When we buy food or other items, the packaging used for wrapping these items is also thrown away. But what does 'away' mean? Does it mean these waste items just disappear? Where do you think our rubbish goes once we 'throw it away'?



ACTIVITY: What happens when we throw things away?

INSTRUCTIONS:

1. Work in groups of 3 to 4.
2. In your group, spend 5 minutes discussing the posters and what you think they mean.

QUESTIONS:

1. Write a paragraph to explain the messages on the posters. What do you think they mean?

2. Do you think it is possible to stop throwing things away altogether?

3. Can you suggest ways to reduce the amount of trash that is thrown away in your home?

How is household waste managed by local authorities?

In some suburbs, recycling is actively encouraged and special transparent recycling bags are provided for this purpose. Do you have recycling in your community? Is the recyclable waste collected from your home or do you have to drop it off at a container or a depot? Did you know that some people even make money selling recyclable waste that they collect?

Do you know which materials from household waste can be recycled? What are the four main categories?

Have you seen colourful bins similar to these around your school or in shopping areas? They are for recycling.

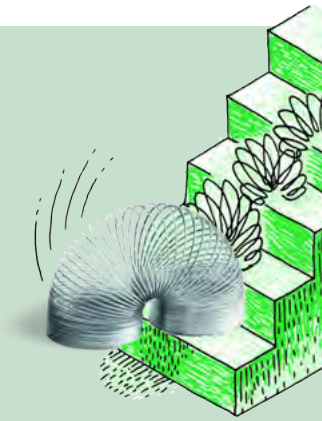
If you ever need to dispose of objects, like batteries and fluorescent light bulbs that contain harmful substances, be sure to use the correct recycling bin.

Careers in chemistry

Do you know what chemists do? Let's discover the possibilities of chemistry!

Chemists study various chemical elements and compounds, their properties and how they react with each other. We will learn about elements and compounds in the next chapter. Chemists are also responsible for developing new materials with specific properties; such as new medicines; innovative materials for building buildings and other structures; materials that could be used for making fuels from renewable sources and many others.

If you study chemistry after you have finished school, you can work as a researcher, a laboratory technician, a science teacher and many other important and stimulating jobs! Be curious and discover the possibilities! Science can help us solve problems in the world around us.



ACTIVITY: Careers research task

INSTRUCTIONS:

1. Below is a list of different careers that all use chemistry in some way. Have a look through the list and then select one that you find most interesting.
2. Do an internet search to find out the career involves.
3. Write a short description of this career. Find out what level of chemistry you will need for this particular career.
4. There are many other careers besides the ones listed here which use chemistry in some way, so if you know of something else which is not listed here and it interests you, follow your curiosity and discover the possibilities!

Some careers involving chemistry:

- Chemical education/teaching
- Chemistry researcher
- Environmental chemistry
- Mining industry
- Oil and petroleum industry
- Pharmaceuticals and drug discovery
- Space exploration
- Waste management

VISIT

A useful site to find out more about some chemistry-related careers.

bit.ly/19cXkqe

Your descriptions of the career you are interested in:

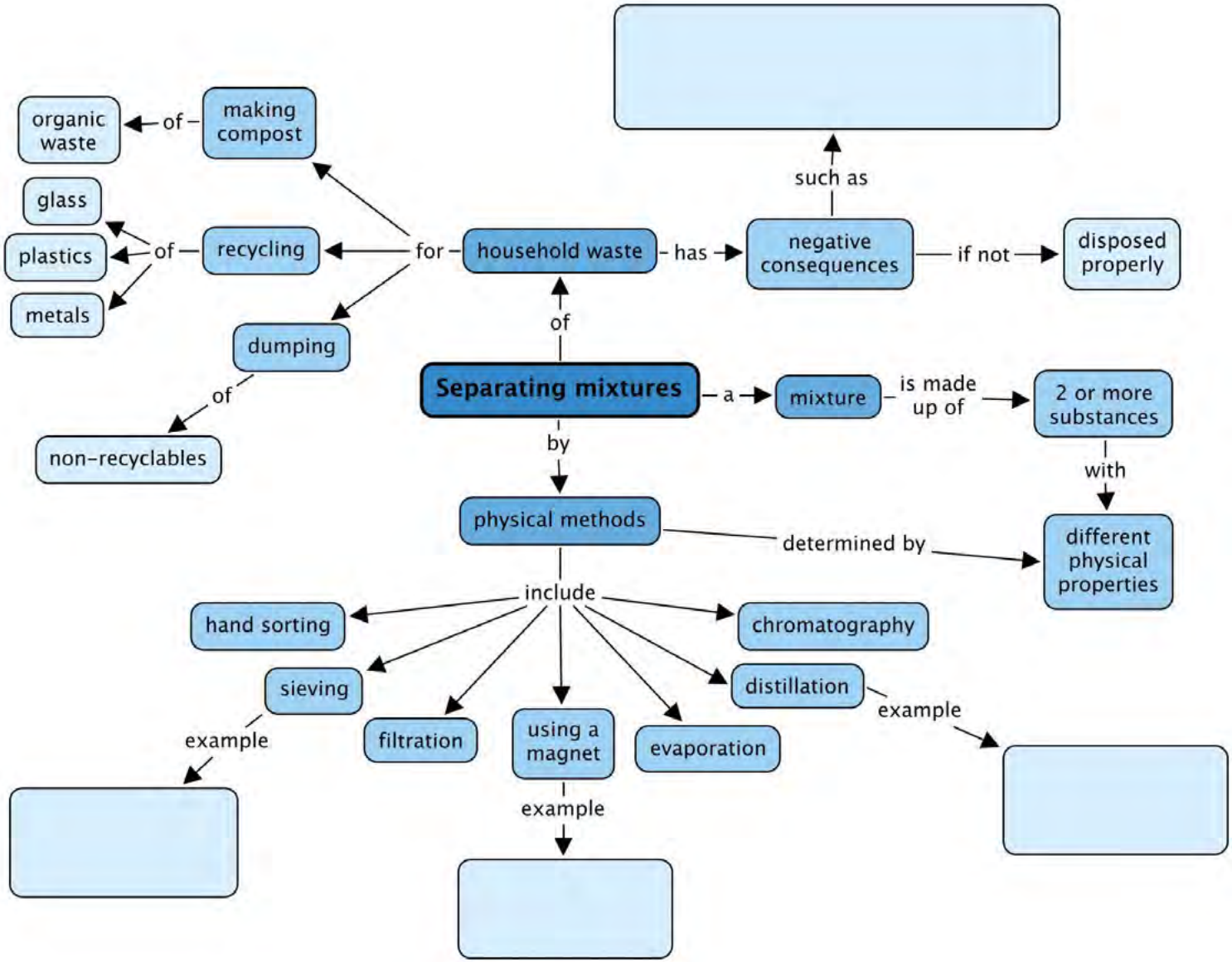
SUMMARY:

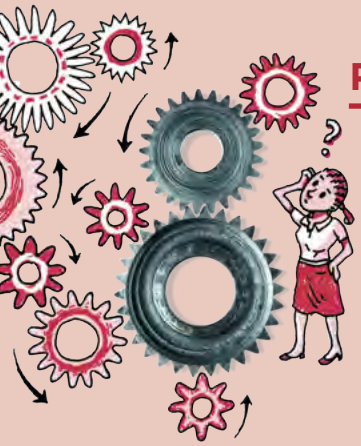
Key Concepts

- A mixture consists of two or more components that have different physical properties.
- The components in a mixture are not chemically joined; they do not change their chemical identities and they retain their physical properties as well.
- When we want to separate a mixture, we can use the differences in the physical properties of the components of the mixture to separate the components from each other.
- Hand sorting is a suitable separation method for a mixture that contains a relatively small number of large items.
- Sieving is a suitable separation method when the pieces to be separated are sized differently.
- Filtration is a good method for separating an undissolved solid from a liquid.
- Components with different magnetic properties can be separated using magnetic separation.
- Evaporation is a suitable separation method for removing a liquid from a solid.
- Distillation is a suitable method for separating two liquids with different boiling points.
- Chromatography is a good method for separating coloured pigments from each other.
- Waste disposal should be managed in a responsible way so that the negative impact on the environment is as small as possible.
- Metals, plastics, paper and glass can be recycled.
- Organic waste can be turned into compost.
- Responsible waste disposal is everyone's responsibility, but it is usually managed by the local authorities, who have systems for sorting and recycling waste.
- Poor waste management leads to negative consequences for humans, animals and the environment. Some of these are:
  - pollution of the soil, water resources and the environment;
  - health hazards and the spread of disease;
  - blockage of sewers and drainage systems;
  - land wasted when it is used to dump or bury garbage (landfills); and
  - materials and other resources wasted when they could have been recycled.

Concept Map

We looked at physical methods to separate mixtures and these are shown in the concept map. Give an example of the types of mixtures you could separate using three of these methods. What negative consequences does human waste have on the environment? Fill these in the concept map.

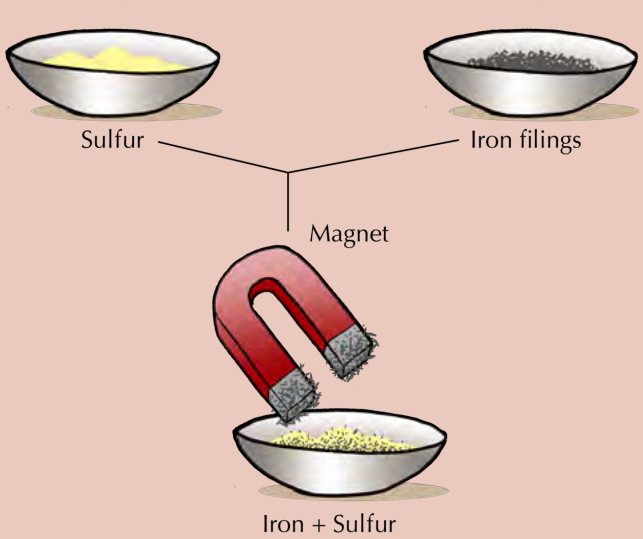

Separating mixtures
by
physical methods
include
hand sorting
sieving
example
filtration
using a magnet
example
evaporation
distillation
example
chromatography
determined by
different physical properties
of
household waste
for
making compost
of
organic waste
recycling
of
glass
plastics
metals
dumping
of
non-recyclables
has
negative consequences
such as
if not
disposed properly
a
mixture
is made up of
2 or more substances
with



REVISION:

1. Two important words have been left out of the following paragraph. The missing words are **chemical** and **physical**. Rewrite the sentences and fill in the missing words in the paragraph by placing each one in the correct position:
   The components in a mixture have not undergone any _____ changes. They still have the same properties they had before they were mixed. That is why mixtures can be separated using _____ methods. [1 mark]

2. In the diagram below, iron filings and sulfur have been mixed. Write a short paragraph (2 sentences) to explain how the mixture can be separated using magnetic separation. [2 marks]

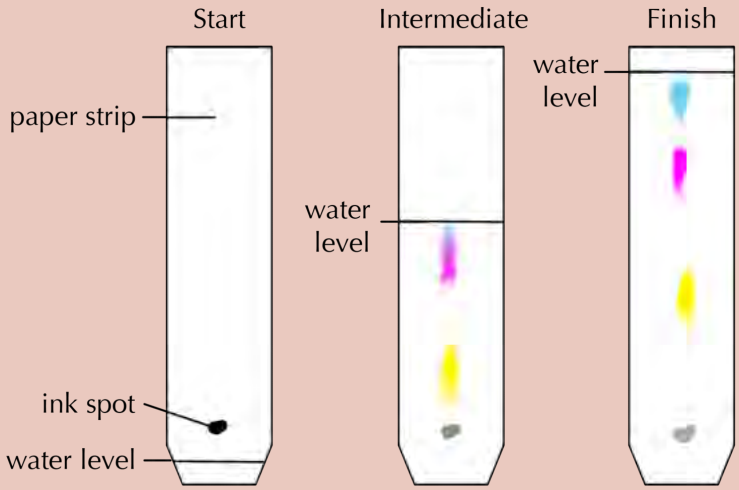


3. A vacuum cleaner creates a suspension of dust in air as it sucks up the dust on the floor. Clean air comes out of the vacuum cleaner. How does the vacuum cleaner separate the dust from the air? [2 marks]

4. Write a short paragraph (3 sentences) to explain how salt is produced from seawater. [3 marks]

5. Choose the correct word to complete the sentence from the following list: colours; boiling points, tastes. Write the word below.
Suppose we want to separate two liquids using distillation as separation method. This will only be possible if the two liquids have different... [1 mark]

6. The diagram below shows a strip chromatogram that is being prepared from a spot of black ink. The strip on the left shows the chromatogram at the start of the experiment, the strip in the middle shows the chromatogram halfway through the experiment, and the strip on the right shows the chromatogram at the end of the experiment.



a) How many different pigments does the black ink consist of? Explain your answer. [1 mark]

b) Which pigment is moving up the paper at the fastest speed? Arrange the pigments in order of increasing speed of movement. [2 marks]

7. The table below contains a list of mixtures. In the right hand column, next to each mixture, write the **best** method for separating the mixture into its components. [8 marks]

Mixture	**Separation method**
Salt and water	
Sand and iron filings	
Sand and water	
Colour pigments in ink	
Stones and sand	
Ethanol and water	
Oranges and apples	
Sugar and iron filings	

8. Name the 4 classes of materials that can be recycled. [4 marks]

_____

_____

_____

_____

9. Write a sentence to say how you would dispose of each of the following non-recyclable materials: vegetable peels; old running shoes; expired medicine. [3 marks]

_____

_____

_____

_____

TOTAL: 27 marks

Are these just cogs? Be curious! What else could they be?

3 Acids, bases and neutral substances

KEY QUESTIONS:

- Which tastes can we sense with our tongues?
- How does our sense of taste ensure our survival?
- What are the unique properties of:
  - acids;
  - bases;
  - neutral substances?
- Which household substances are (or contain):
  - acids;
  - bases;
  - neutral substances?
- How can we tell if something is an acid, a base or a neutral substance?

NEW WORDS

- flavour
- sense
- taste buds
- chemoreceptor
- savoury
- instinct
- tongue map

What do you know about acids? Would you touch an acid? Have you ever tasted an acid? Do you think it is possible to taste an acid without burning your tongue? What do you think it would feel like when an acid burned your tongue?

Before we talk more about acids, let us first examine the human tongue. It is a most fascinating organ, and plays an important role in our sense of taste.

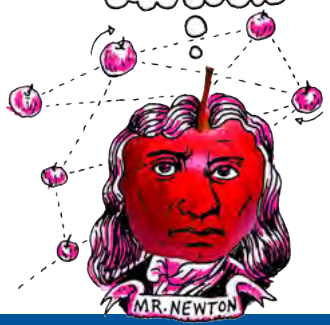
3.1 Tastes of substances

What is your favourite food? What do you like most about your favourite food? You will probably say that you just LOVE the taste of it! The taste of our favourite foods make us feel good. How do we taste our food?

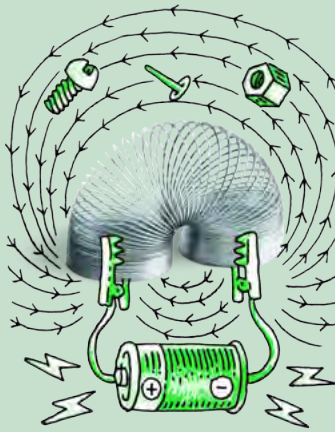
We taste food with tiny structures on our tongues!

DID YOU KNOW?

Insects have the most highly developed sense of taste. They have taste organs on their feet, antennae, and mouthparts.



Look in the mirror, and stick out your tongue. Look for small, round bumps. These are called **papillae**. Most of them contain **taste buds**. The taste buds are very small structures which have sensitive hairs. The chemicals in the food that you eat dissolve into your saliva in solution. The chemicals then stimulate the tiny hairs within the tastebuds and turn these signals into impulses. These impulses travel to the brain allowing us to experience the sensation of taste.



ACTIVITY: Have a look at your own tongue

MATERIALS:

- mirror
- pencil
- sugar water
- lemon juice

INSTRUCTIONS:

1. Look in the mirror at your tongue.
2. Stick it out as far you can and try to see the papillae. Are they larger in some areas?

Have you tasted a lemon before?

Close your eyes and imagine biting into a slice of lemon. Can you describe the experience? What does the lemon taste like? Sweet, sour, salty or bitter?

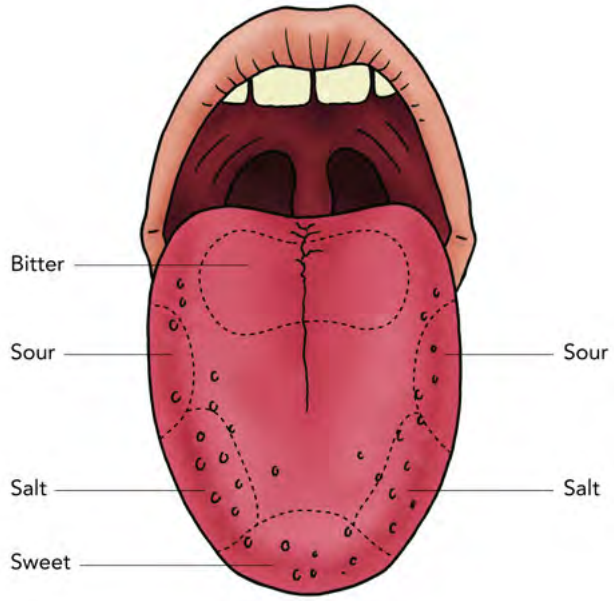
If you have sugar solution and lemon juice available in the class, taste these different substances. See if you can identify *where* on your tongue you taste the two different tastes.

DID YOU KNOW?

We have more than 10 000 taste buds in our mouth. You even have taste buds on the roof of your mouth.

Your tongue can only sense four flavours

You can only sense four different tastes with your tongue. Can you name them?



The tongue map.

TAKE NOTE

A flavour is a combination of tastes and smells.

The four main tastes that are most common, are sweet, sour, salt and bitter. These tastes combine to make up the different flavours of our foods.

How would you classify the taste of apples? Sweet or sour? Bitter? Perhaps a combination?

Many people really enjoy the sour-salty taste of salt and vinegar chips!

DID YOU KNOW?

Almond nuts can be sweet or bitter, depending on the type of tree they come from. The sweet almonds (which we eat) do not contain poisonous chemicals. Bitter almonds from another tree species contain chemicals which are toxic to humans.

There is a good reason for why we like certain tastes, but not others.

Our sense of taste protects us

Just as we like and seek out foods that taste good, our bodies have also been programmed to avoid food with strong bitter or sour tastes. This helps to protect us against poisons, which often have a strong bitter taste. 'Bitter' is also the basic taste that our tongues are most sensitive to. Spoiled food often tastes sour and it may also have a bad smell. Our instinct will be to avoid it, which will protect us from becoming ill from ingesting the organisms that have spoiled the food.

Sweet almonds, such as these, are edible as they do not contain toxic chemicals, unlike the wild bitter almonds.

Cocoa beans come from cocoa pods. Chocolate is made from cocoa, but cocoa is very bitter. Lots of sugar is added to chocolate to make it sweet.

TAKE NOTE

When we want to say something has the properties of an acid, we use the adjective acidic. When we want to say something has the properties of a base, we use the adjective basic.

Soon the link between the tongue and chemical substances will become clear.

3.2 Properties of acids, bases and neutral substances

In the previous section you had to imagine what it would feel like if an acid burned your tongue. In the next section we are going to learn more about acids. We will learn that they taste sour (and also why it is not a good idea to taste them!).

We will also learn about other substances that have a special relationship with acids. They are called bases. Finally, we will also learn about substances that are neither acids or bases, but neutral substances.

NEW WORDS

- corrosive
- acid
- chemical formula
- essential
- immune system
- ascorbic acid
- citric acid
- formic acid

Acids

Do you know the names of any acids? Think about this as a class and make a list of all the acid names you have heard.

There are many different acids. You might have already tasted an acid in class. Was it the sugar water or the lemon juice?

Do you like sour sweets, such as sour worms? The sour taste comes from fumaric acid. Fumaric acid is a natural acid with a sour taste, that is often added to foods.

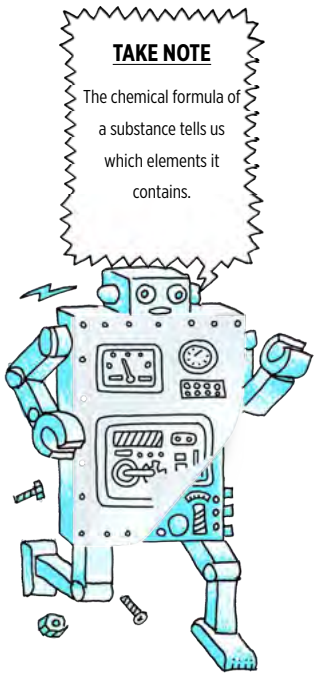
The juice of lemons is rich in ascorbic acid (vitamin C) and citric acid, which makes it taste sour.

All acids taste sour. Does this mean that all acids are safe to taste? Definitely NOT! Next, we will learn which acids should not be tasted under any circumstances.

Laboratory acids

Concentrated hydrochloric acid is very corrosive and dangerous.

Some acids are very dangerous and must be handled carefully. These acids are **corrosive**. They can cause serious burns on your skin. Scientists always wear protective clothing when handling these acids. It would be very dangerous to taste them. These acids are most often found and used in laboratories and certain industrial processes. We will refer to them as laboratory acids.



This scientist is handling an acid. Can you see he is wearing protective clothing, gloves and safety glasses?

Look out for this label on bottles which contain corrosive substances, such as strong acids.

Name of the acid	Formula of the acid
hydrochloric acid	HCl
nitric acid	HNO_3
sulfuric acid	H_2SO_4

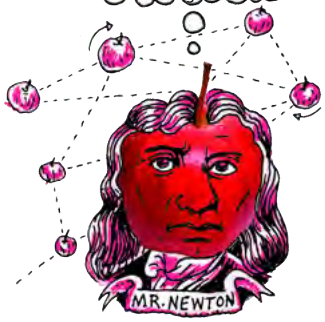
The above table contains the names and **chemical formulae** of the three most common laboratory acids. Even though you have not learnt how to write chemical formulae yet, we have included them here. You should handle containers with these formulae printed on them with care.

There are many other laboratory acids that we have not listed. These are only the most common ones.

Other acids in the foods we eat are not dangerous. In fact, some are even vital for our health and well-being. Let's now have a look at acids that are safe to handle.

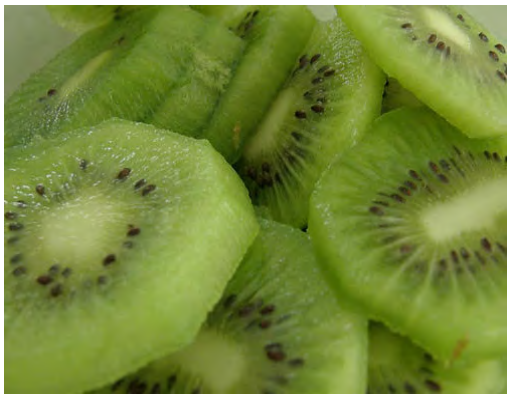
DID YOU KNOW?

You have a laboratory acid inside your body?! Your stomach contains hydrochloric acid (HCl). HCl helps break down the food for digestion. Your stomach has a very mucous lining which helps protect it from the strong acid.



Natural and household acids

Not all acids are dangerous. One such acid is called ascorbic acid, or vitamin C. Vitamin C helps our immune system. Which foods contain vitamin C? Have a look at the pictures.



Kiwi fruit.

Strawberries.

Broccoli.

Bell peppers.

DID YOU KNOW?

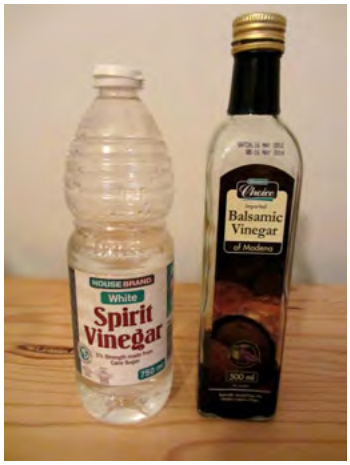
Most people associate oranges with a high vitamin C content, but there are other foods which are much higher in vitamin C. These include chillies, guavas, strawberries, bell peppers, broccoli, kiwi fruits and papaya.

We will call the acids that we find in food natural acids. Many of these natural acids are found in the kitchen. For this reason they are also sometimes called household acids.

DID YOU KNOW?

Formic acid is what gives ants their sting when they bite. 'Formic' comes from the Latin word for ant 'formica'.

One very well-known household acid is acetic acid. Vinegar is a mixture of a small amount of acetic acid dissolved in water. So vinegar is a solution of acetic acid in water.



Spirit vinegar and balsamic vinegar.

ACTIVITY: True or false?

INSTRUCTIONS:

- Let's briefly revise some of the concepts we have learnt so far.
- Below are some statements. You need to state whether they are true or false. If they are false, explain why.

True or false?

1. We can sense three tastes with our tongues.

_____

2. Acids taste sour.

_____

3. If we want to know if something is an acid, we can just taste it.

_____

4. All acids are dangerous.

_____

5. Vinegar is a mixture of a small amount of acetic acid dissolved in water.

_____

6. Laboratory acids must be handled with care and using protective clothing.

7. The following symbol means you can wash your hands using this substance.

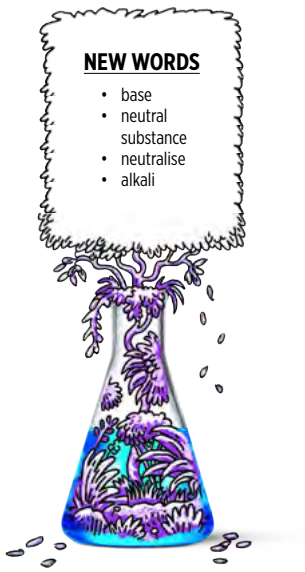
8. Formic acid is commonly referred to as Vitamin C.

9. Oranges are the food which contain the highest amount of ascorbic acid.

Do you think that it would be possible for acids to lose their strength? There is one class of compounds that can make acids lose their strength. These compounds are called bases.

Bases

Bases can **neutralise** acids and vice versa. What does it mean to neutralise something?

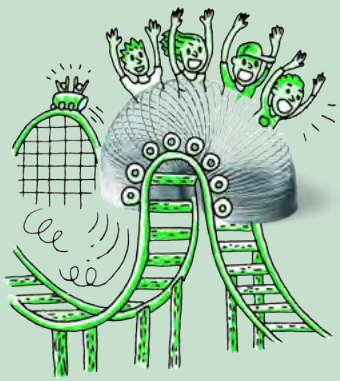


Bases and acids have chemical properties that are the opposite of each other. We can think of bases as the chemical opposite of acids.

As with acids, there are some bases that are extremely dangerous. The same hazard symbol that is used to warn people of the dangers of acids, is also used for these bases. Strong bases react corrosively with other materials and can burn your skin. They must be handled carefully and always while wearing appropriate protective clothing, such as lab coats, gloves and safety glasses.

Sodium hydroxide is a strong base used in laboratories. Do you see the yellow corrosive warning symbol?

Other bases are mild enough to be used as cleaning materials in and around the home. This does not mean that they are completely harmless. It just means that they have been mixed with other substances so that they are not so corrosive.



ACTIVITY: Acids and bases in our homes

1. All of the products in the picture below contain bases. Which of the products do you recognise? Write their names and what they are used for in the table.

Some household products which are bases.

Product	What is it used for?

2. Next, your teacher will let you come up to feel different substances which are either bases or acids. All of these substances are safe to touch. Take note of how they feel between your fingers and then come back to fill in the table.

Substance	How did it feel between the fingers?	Is it an acid or a base?

QUESTIONS:

1. What can you conclude about how bases feel?

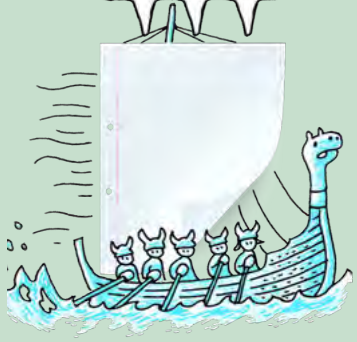
2. What can you conclude about how acids feel?

3. What did your teacher have to do to the dry washing powder before you could feel it in the bowl? Do you know what we call the solution which forms? If so, write it down, otherwise your teacher will help you.

4. Although we have spoken about acids and bases as being chemical opposites, what property do many of them have in common?

TAKE NOTE

When an acid and a base are mixed together in the **correct ratio**, they will neutralise each other. This means that the solution made up of the acid and the base becomes something that is neither an acid nor a base, but neutral. In the process, both the acid and the base will lose their unique characteristics.



TAKE NOTE

Bases that can dissolve in water are called **alkalis**. For this reason, the terms base and alkali are sometimes considered to have the same meaning. (Words that have the same meaning are called synonyms.)

Finally, there is a class of substances that are neither acids nor bases. They are called **neutral** substances. We will explore them next.

Neutral substances

We have learnt that when an acid and a base are mixed (in the right amounts), they will neutralise each other. That means that, together, they will change into something that is neither an acid nor a base. So the acid will lose its properties and so will the base. And the new substance that forms from the two substances will be neither an acid nor a base. We call it a neutral substance.

Some neutral substances are formed when an acid is mixed with a base and a neutralisation reaction occurs. Other substances are neutral to begin with. They are not the product of a neutralisation reaction. The neutral substances that are the most well known are: water, table salt, sugar solution and cooking oil.

Cooking oil is a neutral substance.

TAKE NOTE

To indicate means to show.

We have learnt about three classes of substances: acids, bases and neutral substances. But, we cannot tell whether a substance is an acid, base, or a neutral substance, just by looking at it. We know that acids taste sour, but we have also learnt that it is never a good idea to taste chemicals.

Let's imagine we have an unknown substance. It is colourless and looks just like water. It is also odourless (that means it has no smell). There are no physical signs to show whether it is acidic, basic, or neutral. How can we tell what it is?

3.3 Acid-base indicators

NEW WORDS

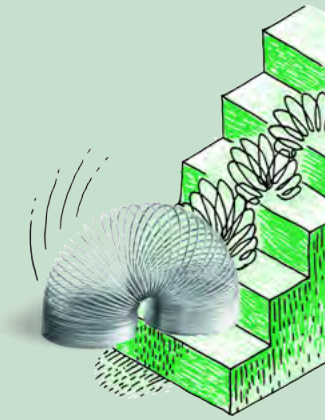
- indicator
- litmus

What do the indicators on a car do?

Acids and bases can change the colour of some substances. In the next activity, we are going to investigate a substance that changes colour when we mix it with an acid or a base.

Have you ever eaten red cabbage? It is not only tasty, but also very healthy. We are going to see how red cabbage juice changes when we mix it with different substances.

ACTIVITY: Preparing and testing red cabbage juice with acid and base



MATERIALS:

- one large, red cabbage
- pot with water for boiling
- hot plate (or stove)
- strainer
- sharp knife
- container for red cabbage juice (ice cream tub or large yoghurt tub will work well)
- white plate
- vinegar
- baking soda solution

INSTRUCTIONS:

Prepare the cabbage juice:

1. Cut the cabbage into thin slices and place it in the pot.

2. Add just enough water to cover the cabbage slices.
3. Boil it over low heat for approximately 30 minutes, adding water to keep the cabbage covered if necessary.

4. Remove the pot from the heat and let it cool completely.
5. Strain the juice off the cabbage slices into the ice cream tub. The boiled cabbage slices can be eaten (or placed in the compost).

VISIT

This website has a list of other household products that will also change colour when mixed with acids or bases. Make sure you ask your parents if you may experiment before you start!

bit.ly/195o6gF

6. If kept in the fridge the red cabbage juice will last about 3 days.

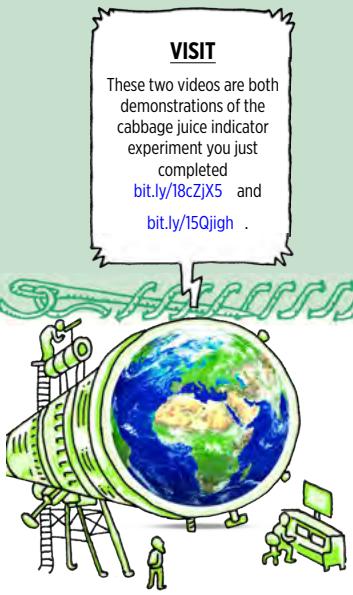
Test the cabbage juice indicator

1. Carefully place three large drops of the cabbage juice on a smooth, white surface (a white plate or tile will work well).
2. Pour a few drops of vinegar into one of the drops of cabbage juice. What do you see?

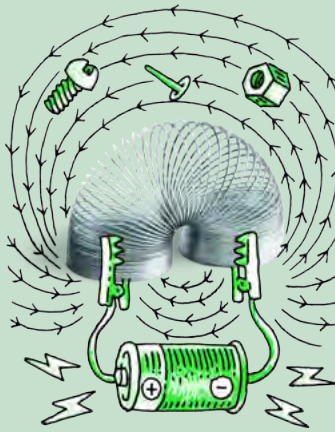
---

3. Pour a few drops of baking soda solution into one of the remaining drops of cabbage juice. What do you see?

Red cabbage juice mixed with baking soda (left) and with vinegar (right). The blue drop at the top is the unmixed juice.



In the next activity we are going to preserve the red cabbage juice by absorbing it on some filter paper, and drying it, so that we can use it later.



ACTIVITY: Making red cabbage indicator paper

MATERIALS:

- pieces of absorbent paper
- red cabbage juice from the previous activity in a container
- scissors
- container

INSTRUCTIONS:

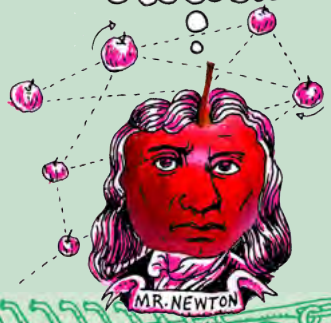
1. Place the absorbent paper in the cabbage juice.

2. After 30 minutes, remove the paper and leave it in a warm place to dry.
3. When the paper has completely dried, cut it into strips (approximately 1 cm wide). You can keep the strips for a long time if you store them in a dry place.

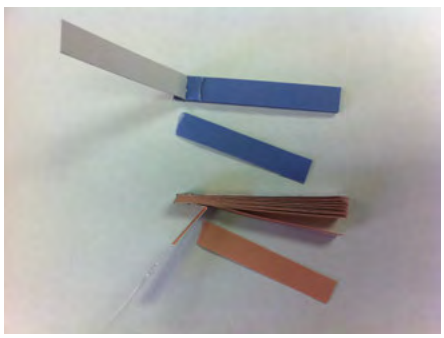
We will use the red cabbage paper strips later, as part of an investigation.

DID YOU KNOW?

Litmus is a coloured substance that comes from the pigments of a living organism called *lichen*. Pigments are coloured substances found in nature.



Some other substances also change colour when an acid or a base is added to them. By changing their colour, they show that they have reacted with an acid or a base. That is why we call them **acid-base indicators**.The most well-known acid-base indicator is a substance called **litmus.**

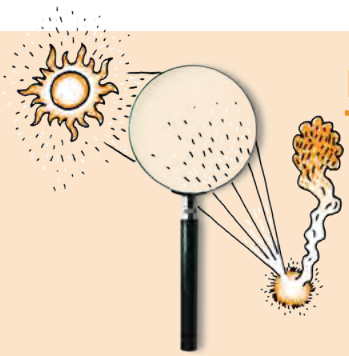


Blue and red litmus paper.

Litmus comes from pigments in the lichen which are found growing in many different places, mostly on rocks.

Litmus solution is most commonly soaked into paper, the paper is then dried and cut into strips we then call "litmus paper". It is just like the red cabbage paper we made earlier. Litmus paper is available in two colours: blue and red.

How does litmus paper indicate whether a substance is an acid or a base? In the next activity, we will investigate how litmus responds to some household acids and bases.



INVESTIGATION: How does litmus respond to acids and bases?

AIM: To determine how litmus responds to some household acids and bases.

HYPOTHESIS: What is your hypothesis for this investigation?

_____

_____

MATERIALS AND APPARATUS:

- small containers (test tubes or yoghurt tubs) filled with the following substances:
  - water
  - soda water
  - vinegar
  - lemon juice
  - sugar water (1 tablespoon dissolved in a cup of water)
  - baking soda (1 tablespoon dissolved in a cup of water)
  - Handy Andy (1 tablespoon dissolved in a cup of water)
  - aspirin (Disprin) (1 tablet in 2 tablespoons of water)
  - dishwashing liquid (1 teaspoon dissolved in a cup of water)
  - any other substances commonly used at home that are not dangerous
- litmus paper (blue and red)
- glass or plastic rods (plastic teaspoons will also work well).

METHOD:

1. Cut a small piece (1 cm long) of blue and red litmus for each substance that you will be testing.
2. Use the plastic teaspoon or rod to place just 1 drop of water on the blue litmus. Do the same with a piece of red litmus.
3. Did the blue litmus change colour? Did the red litmus change colour? Write the new colours in your table, in the appropriate place.
4. Repeat the procedure to test all the substances you have been given. You must rinse the teaspoon or rod with water in between substances.
5. Save all your test substances, because you will need them for another investigation later.

RESULTS AND OBSERVATIONS:

Record your observations in the table. If you did not use some of these substances, cross them out and write headings for your substances in the empty rows.

Substance	Colour with blue litmus	Colour with red litmus
Water		
Soda water		
Vinegar		
Lemon juice		
Sugar water		
Baking soda		
Handy Andy		
Aspirin		
Dishwashing liquid		

ANALYSIS:

Let us now have a look at our observations to see what we can conclude.

1. How does the litmus paper indicate when a substance is an acid?

2. Which of the substances you tested are acids?

3. How does the litmus paper indicate when a substance is a base?

4. Which of the substances you tested are bases?

5. How would you describe a neutral substance?

6. How does the litmus paper indicate when a substance is neutral?

7. Which of the substances you tested were neutral?

8. Why do you think you had to rinse the glass rod or teaspoon in between testing each substance?

CONCLUSION:

Write a conclusion based on your results in response to the initial aim for this investigation.

Extension: If you have time in class with your teacher, use your knowledge of how litmus responds to acids and bases to test some of the beverages that you drink every day. You can use litmus paper to indicate whether beverages such as ceylon tea, rooibos tea, orange juice, milk, coffee and fizzy drinks are acids, bases or neutrals. If you do so, record your findings here:

We can say the following about litmus:

- Blue litmus is used to test for acids:
  - acids turn blue litmus red.
  - Bases and neutral substances do not change the colour of blue litmus.
- Red litmus is used to test for bases
  - bases turn red litmus blue.
  - Acids and neutral substances do not change the colour of red litmus.

What about the red cabbage paper that we made earlier? Can these paper strips be used to tell if something is an acid or a base? Let's find out.

INVESTIGATION: Is red cabbage paper suitable as acid-base indicator?

AIM: To determine whether red cabbage is a suitable acid-base indicator.

MATERIALS AND APPARATUS:

- small containers with the same substances as in the previous investigation
- red cabbage paper strips
- glass or plastic rods

METHOD:

1. Use a small strip (2 cm long) of red cabbage paper for each substance that you will be testing.
2. Dip a fresh piece of paper into each of the test solutions. Does the paper change colour? Write the colour of the paper with each substance in your table in the appropriate place.

RESULTS AND OBSERVATIONS:

Record your observations in the table.

Substance	Colour with red cabbage paper
Water	
Soda water	
Vinegar	
Lemon juice	
Sugar water	
Baking soda	
Handy Andy	
Aspirin	
Dishwashing liquid	

QUESTIONS:

1. Which of the test substances are acids? (Check the results from the litmus investigation that you did earlier.)

2. What colour did the red cabbage paper turn in the test substances that were acids?

3. Which of the test substances are bases? (Check the results from the litmus investigation that you did earlier.)

4. What colour did the red cabbage paper turn in the test substances that were bases?

5. Did the red cabbage paper change colour with all the substances? If there were some substances that did not change the colour of the paper, write their names below.

6. Are these substances acidic, basic or neutral (also check your litmus test results)?

7. Do you think red cabbage paper makes a good acid-base indicator? Why do you say so?

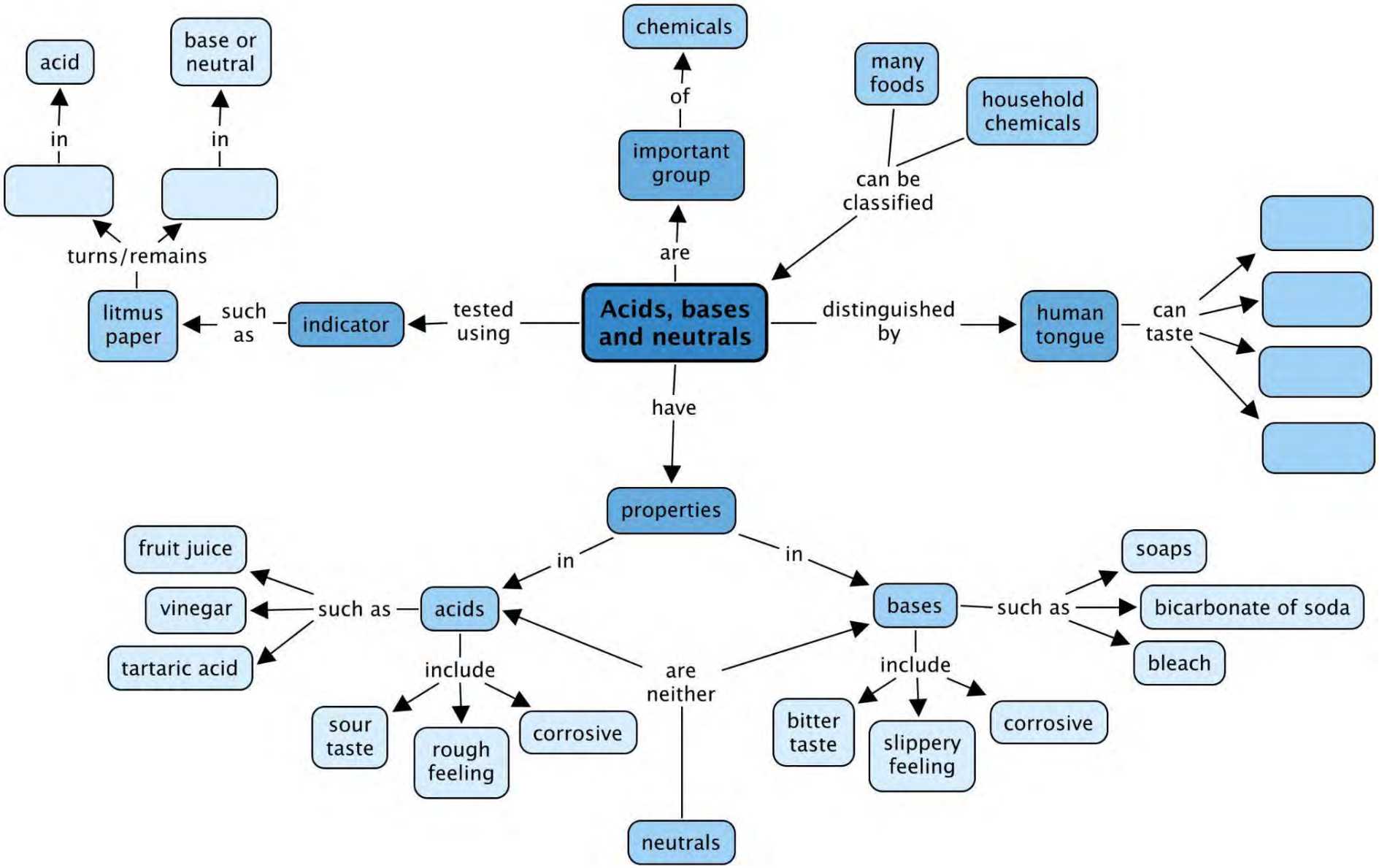
SUMMARY:

Key Concepts

- Our tongues can sense 4 different flavours namely, sweet, salty, sour and bitter.
- Our sense of taste protects us from eating foods that are harmful and stimulates us to eat foods that are nutritious and energy-rich.
- Acids and bases are chemical opposites of each other.
- Though it is not a good idea to taste chemicals, acids have a sour taste and bases taste bitter.
- When they are in solution with water, acids feel rough and bases feel slippery.
- Some acids and bases are present in foods and in household items. These are relatively safe to handle. Others are often very corrosive and should only be handled when you are wearing protective clothing.
- Substances which are neither acidic nor basic, are called neutral substances.
- When an acid is mixed with a base in the right quantities, they neutralise each other. That means they lose their power.
- Some substances change colour when they react with an acid or a base. These substances are called acid-base indicators. One household example of an acid-base indicator is red cabbage juice.
- Litmus is the best known of all acid-base indicators. It does not change colour in the presence of a neutral substance, but responds to acids and bases in the following way:
  - litmus is red in the presence of an acid; and
  - litmus is blue in the presence of base.

Concept Map

The human tongue can taste 4 main different tastes. What are these? Fill them in the spaces below. You also need to complete the section of the concept map about indicators. Can you work out how to do this? You need to fill in the colour that litmus turns (or remains) in each either an acid or a base (or neutral).


Acids, bases and neutrals
chemicals
of
important group
are
many foods
household chemicals
can be classified
acid
base or neutral
in
in
turns/remains
litmus paper
such as
indicator
tested using
distinguished by
human tongue
can taste
have
properties
in
in
fruit juice
vinegar
tartaric acid
such as
acids
include
sour taste
rough feeling
corrosive
are neither
neutrals
bases
such as
soaps
bicarbonate of soda
bleach
include
bitter taste
slippery feeling
corrosive

REVISION:

1. The box below is filled with ideas relating to acids and bases.

You must sort the ideas into two columns in the table. One column is labelled 'Acids' and the other is labelled 'Bases'. Write each idea inside the correct column. If an idea fits into both columns, you must write it in both. [16 marks]

Ideas

- Sour taste
- Bitter taste
- Tartaric acid
- Bicarbonate of soda
- Feels slippery
- Feels rough
- Vinegar
- Soaps
- Lemon Juice
- Citric acid
- Formic acid
- Bleach
- Turns red litmus blue
- Turns blue litmus red
- Corrosive

Acids	Bases

2. Here is another box; this one is filled with words.

You must use the words to complete the sentences that follow. Write out the sentences in full. Each word can be used only once. [11 marks]

Words

- Indicator
- Sour
- Red cabbage
- Bitter
- Poisonous
- Corrosive
- Neutralise
- Sweet
- Neutral
- Litmus
- Salty

a) The most well-known of all acid-base indicators is called _____ .

_____

b) A substance that can eat away at other substances is called _____

_____

c) Foods that are _____ often taste bitter.

_____

d) Some scientists believe the human tongue can taste 4 flavours. These flavours are: _____, _____ ,_____, and_____.

_____

_____

e) An acid-base _____ is a substance that changes colour when it reacts with an acid or a base.

_____

_____

f) _____ substances are neither acids nor bases.

_____

g) An acid will _____ a base (and vice versa).

_____

h) The juice of the _____ makes a very good acid-base indicator.

_____

_____

3. Give an example of a strong acid and a strong base, commonly used in the laboratory. [2 marks]

4. Write one or two sentences to explain what is meant by the term *neutralise*. [2 marks]

5. Write a short paragraph to explain how laboratory acids should be handled. Your paragraph should contain the following words: corrosive; taste; clothes. [3 marks]

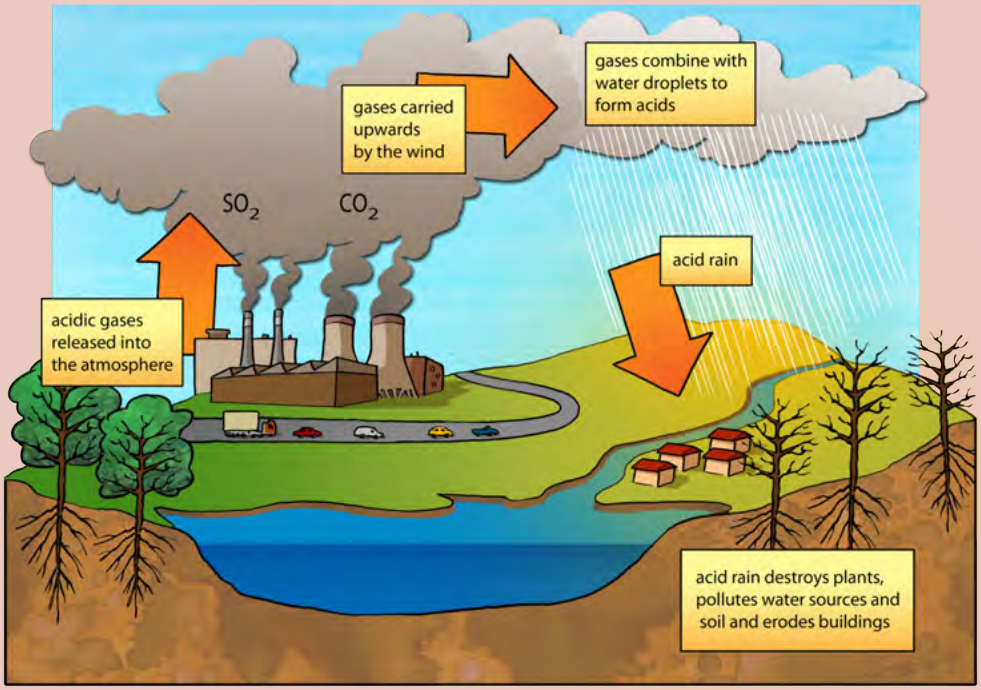
6. Would all acids burn your tongue or is it OK to taste some acids? Explain your answer. [2 marks]

7. Give 2 examples of acids that are safe to taste. [1 mark]

8. How you would be able to recognise an acid when you taste it? [1 mark]

9. How does our sense of taste warn us when food is not good to eat? [2 marks]

10. Have you heard of acid rain before? Read the following information and study the diagram. Then answer the questions that follow.



a) Which two gases are mentioned in the text and on the diagram which contribute to forming acid rain? [2 marks]

b) Where do these gases come from? [2 mark]

c) The gases then combine with water droplets in the atmosphere to make acids. What are some of the environmental impacts of acid rain? Study the diagram for some clues. [3 marks]

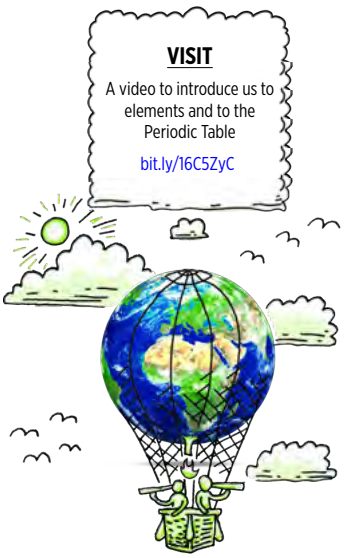
11. Acid rain can also damage buildings as it 'eats away' the stone. What property of acids allow it to do this? [1 mark]

Total [48 marks]

4 The Periodic Table of Elements

KEY QUESTIONS:

- What is an element?
- How can we classify the elements in our world?
- Which table helps us to make sense of the patterns we observe in the chemical properties of the elements?
- How are elements arranged on the Periodic Table?
- What does the position of an element on the Periodic Table tell us about its expected properties?
- What information can we use to represent the identity of an element?
- What are the typical properties of the
  - metals;
  - nonmetals; and
  - semi-metals?

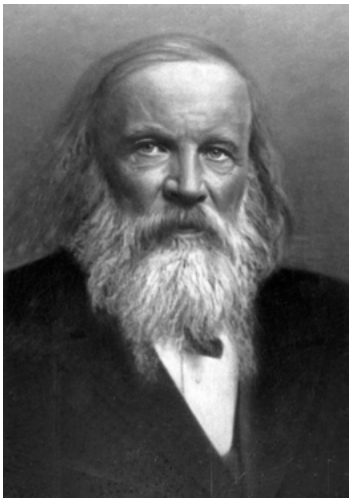


People have been interested in science from the earliest times. Early man discovered how to process natural ores into metals for ornaments, weapons and tools. At least 3000 years ago, ancient people were already using embalming fluids (chemicals) obtained from plants to preserve the bodies of dead people and animals!

Mankind has been studying and experimenting with materials to try to understand matter for thousands of years. Scientists especially, wanted some understanding of all the different substances that they were working with.

An ancient Egyptian mummy that has been embalmed to preserve it.

Over time, many different elements were discovered by scientists all over the world. These elements make up all the materials around us. But what do we mean by the word element? An element is a pure substance which cannot be broken down any further. We will find out more about elements in this chapter.



Dmitri Mendeleev.

Over time, our knowledge about the elements and their behaviour increased and scientists recognised the need to organise this information. They began to observe patterns and similarities in the way some groups of elements behaved and recorded these observations. Scientists wanted some way to **classify** the elements according to their properties that they were observing.

The version of the Periodic Table that we use today was first proposed by Dmitri Ivanovich Mendeleev in 1872. Mendeleev was a brilliant Russian scientist. While other scientists made many contributions to the design of the Periodic Table, Mendeleev was the one who first showed that the table could predict the existence and properties of elements that were still undiscovered at the time.

VISIT

This video tells us more about how Dmitri Mendeleev listed and arranged the elements on the Periodic Table and why this was such an important event in the history of science as we know it.

bit.ly/147Ql9f

Alchemists, experimenting with materials in their laboratory.

NEW WORDS

- element
- Periodic Table
- symbol (or element symbol)
- atomic number

4.1 Arrangement of elements on the Periodic Table

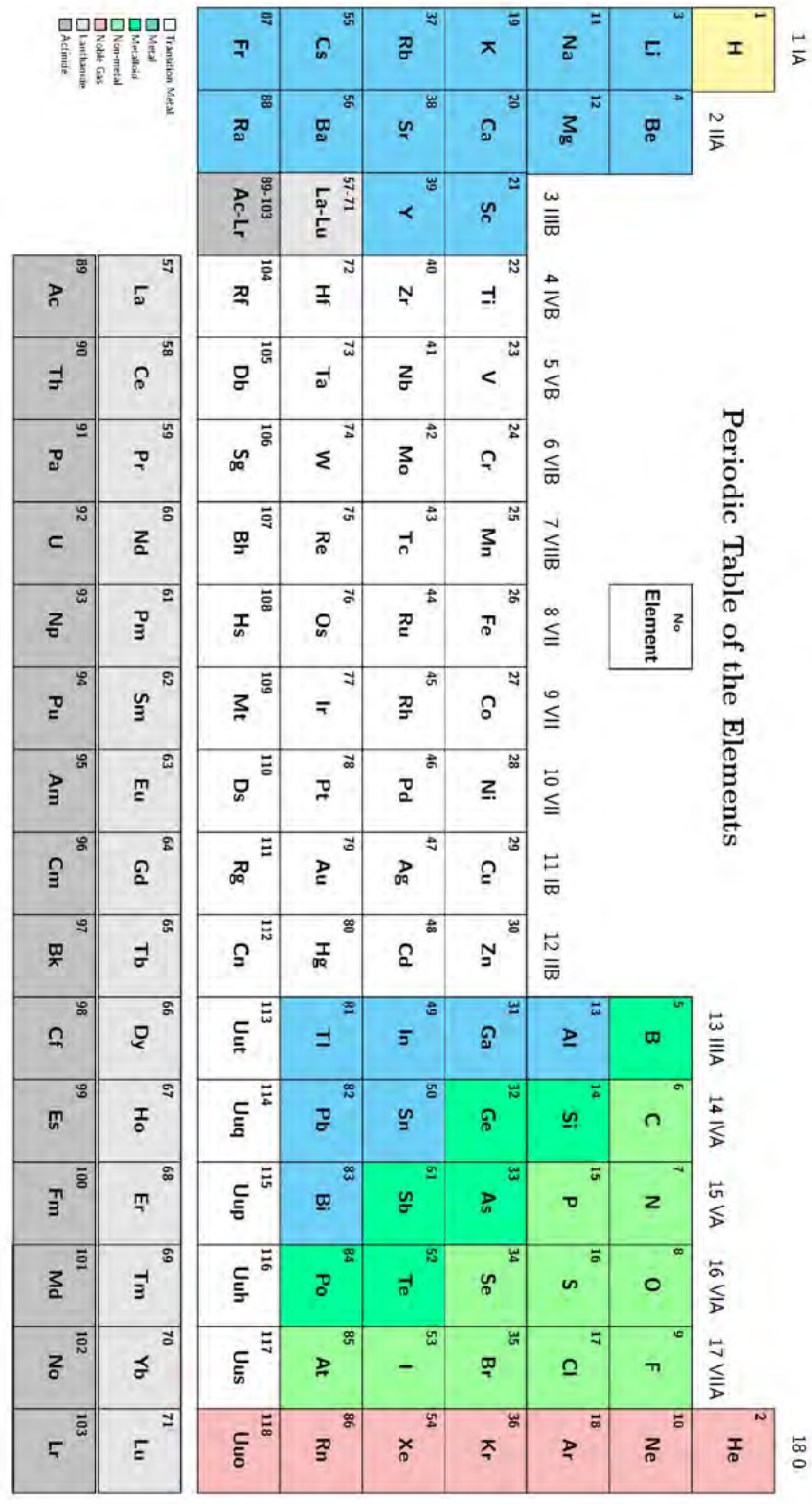
The Periodic Table is a classification system for the elements that make up the matter and materials in our world. Today, there are more than 100 different elements known! Each element has its own name, symbol, atomic number and position on the Periodic Table.

Element names

What is your name? Perhaps it is Thando. Or David. Or Megan. Perhaps you are lucky enough to be the only person in your class with that name. Perhaps you are lucky enough to be the only person in the world with that name! That would make your name unique.

Each element has a unique name. We can think of each name as a unique 'label' we can use to identify the element. There are two other unique labels that we

can use to identify elements. They are the chemical symbol and the atomic number. We will learn more about these in the next section. Each element has some of its own unique properties and later on we will see that those with some similar properties can be grouped together.



The Periodic Table of elements as it is today.

VISIT

There are TWO songs to help you remember the elements of the Periodic Table. Which one is your favourite? Can you learn one (or both) of them? bit.ly/18d0bLI and bit.ly/11OuoPM

VISIT

A tour of the Periodic Table

bit.ly/147Qzgx

TAKE NOTE

There is a bigger version of the modern Periodic Table of elements on the inside cover of your workbook. You can use it for easy reference.

Chemical symbols

If you are a scientist and you work with elements every day, writing out the names can become very tedious. To make writing about elements easier, scientists have given each element a short **symbol.** To make sure we do not become confused with different elements when we write about them, the symbol for each element must be unique, just like its name is.

The names and symbols for some common elements are shown in the following table.

Element	Symbol	Element	Symbol
Aluminium	Al	Magnesium	Mg
Bromine	Br	Nitrogen	N
Calcium	Ca	Oxygen	O
Carbon	C	Phosphorus	P
Chlorine	Cl	Potassium	K
Copper	Cu	Silicon	Si
Gold	Au	Silver	Ag
Hydrogen	H	Sodium	Na
Iodine	I	Sulfur	S
Iron	Fe	Tin	Sn
Lead	Pb	Zinc	Zn

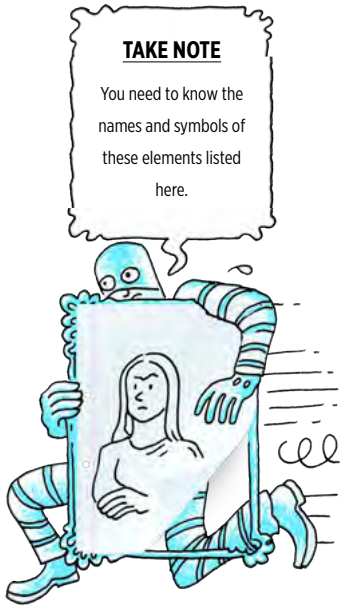
The symbol for carbon is C, the symbol for sulfur is S and the symbol for nitrogen is N. It is easy to see why these symbols were chosen: they simply represent the first letter of each name. This letter is always capitalised (upper case).

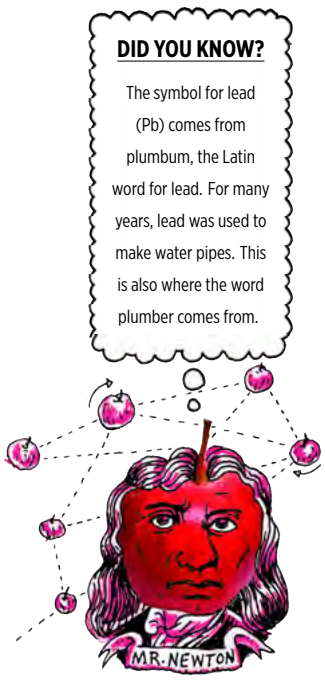
What happens when the different elements all start with the same letter? For example: calcium, carbon, chlorine and copper all start with the letter 'C'! To ensure they all have a unique symbol, a second letter was added to their symbol. This letter is always a small letter (lower case).

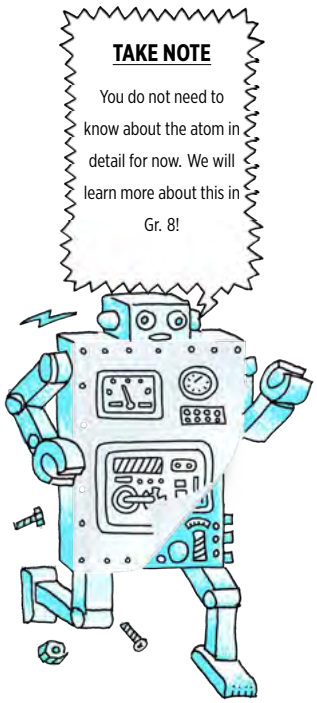
Some chemical symbols are more difficult to understand. Na, for example, is the symbol for sodium. The Na comes from the Latin name for sodium, which is *natrium*. These symbols were chosen very long ago, when many subjects were studied in Latin. Can you imagine how difficult that must have been?!

Some simple rules to remember when using chemical symbols:

1. Every element has its own, unique symbol.
2. The symbol is usually (but not always) the first one or two letters of the name of the element.
3. The first letter of the symbol is always a capital letter.
4. If the symbol has two letters, the second letter is always a small letter.
5. Some elements have symbols that come from their Latin names.







Atomic numbers

If you look at the Periodic Table, you will see that each element also has a unique number. This is called the **atomic number**. To properly understand what the atomic number is, we need to know what an **atom** is. We will learn more about atoms in Gr. 8, but for now, let's briefly go back to our history lesson!

Do you remember we said Mendeleev developed the first periodic table in 1869? Well before that, at the beginning of the 1800's, a man by the name of John Dalton said that all matter is made up of very small particles called atoms. These atoms vary in mass and size. Do you remember we said an element is a pure substance? We can now also say that an element is a substance that contains *only one particular type of atom.* The atoms of one element are different from the atoms of any other element.

All atoms are made up of even smaller particles which we call subatomic particles. These are protons, neutrons and electrons. All you must remember for now is that the protons, electrons, and neutrons of one element *are exactly the same* as the protons, electrons, and neutrons of any other element. It is their number and arrangement that make the elements different.

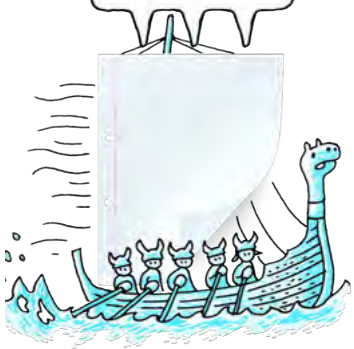
The atomic number of an element refers to *how many protons* that element has in its atoms. Since each element has a different number of protons in its atoms, each element also has a unique atomic number.

Have a look at the Periodic Table. What is the atomic number of hydrogen? How many protons are there in its atoms?

What is the atomic number of carbon? How many protons are there in its atoms?

TAKE NOTE

When things show a regular, repeating pattern, we say it is **periodic**. When the elements were arranged in order of increasing mass, Mendeleev observed a pattern in their properties, which allowed him to arrange the elements into rows and columns in a table, the **Periodic** Table. Elements in the same rows and columns in the table, have similar properties to each other.



Reihen	Gruppe I. — R^1O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^2	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^2 RO^3	Gruppe VII. RH R^2O^7	Gruppe VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

Mendeleev's Periodic Table from 1872. The spaces marked with blank lines represent elements that Mendeleev thought existed, but they were not yet discovered at the time, so he left places for them.

Can you see how the elements are arranged so that their atomic numbers increase from left to right across the Periodic Table? This is not a coincidence!

When Mendeleev first created the Periodic Table, he arranged the 60 elements that he knew of at the time in order of increasing mass. He then saw that there was a regular pattern in other characteristics of these elements. Mendeleev then grouped them into columns and rows according to their properties. These were physical and chemical properties which the scientists had observed from doing many different experiments. This resulted in the arrangement of the elements on the Periodic Table.

The Periodic Table that we use today looks a lot more modern than Mendeleev's original version. You will notice that there are no empty blocks in the modern version of the table. That tells us that all the elements that were still undiscovered in Mendeleev's lifetime, are now known.

In the next activity, we will compare Mendeleev's original Periodic Table with the version that we use today. This will help show us how scientific discovery is sometimes a slow process.

ACTIVITY: Comparing Mendeleev's table with the modern version of the Periodic Table

When Mendeleev first arranged the elements according to their mass and their properties, it resulted in there being some gaps in the rows. But, as a good scientist, Mendeleev did not see this as a problem! Instead, he thought it simply meant that there were elements that had not been discovered yet. And he was right!

Mendeleev put a blank line and the atomic number to show that he thought there is an element which should go there, but it had not been discovered. Look carefully at Mendeleev's original table. See if you can find where it says '__ = 44' in the table.

See if you can find the 2 other elements that had not been discovered at that time. Write their numbers down in the space below.

_____

Now look at the modern version of the Periodic Table. Can you find the elements with these numbers? What are their symbols? What are their names? Write your answers in the table provided.

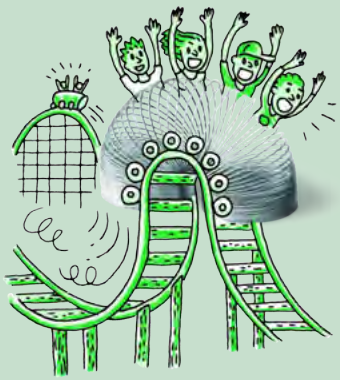
As an extension of this activity you could look up the names of these elements, and research when they were discovered, and add this information to the table.

Number of the element	Symbol of the element	Name of the element	When was this element discovered?

TAKE NOTE

In Life and Living, we looked at the classification of living organisms in our world. Now in Matter and Materials, we are looking at the classification system for elements!

In the next activity we are going to use our new knowledge of element symbols and atomic numbers to hunt for a very valuable 'treasure'. We will find the treasure by following some clues about the Periodic Table.



ACTIVITY: Periodic Table treasure hunt

Your job is to follow the clues, in order to find the treasure. The instructions will help you to spell out the name of the treasure in the blocks below.

1. Clue 1: What is the symbol for carbon (atomic number 6)? Write this symbol in the first block above.
2. Clue 2: Hydrogen is the lightest element. Can you find it on the Periodic Table? Write its symbol in the second block.
3. Clue 3: Which element represents the gas that we breathe to stay alive? Here is a hint: It is represented by atomic number 8. Write its symbol in the third block and give the name of the element below.

---

4. Clue 4: This element is in the fourth row and the ninth column of the Periodic Table. It is a metal that is used in magnets. Write its symbol in the fourth block. Do you know its name? Write its name below.

---

5. Clue 5: This element is represented by atomic number 57. Write its symbol in the fifth block. See if you can find out the name of this element and write it down below.

---

6. Clue 6: This element is represented by atomic number 52. It is a semi-metal that is used in the manufacture of solar panels. Write its symbol in the last (sixth) block. See if you can find out the name of this element and write it down below.

---

7. What is the 'treasure' that you have found?

Complete the following sentence by replacing the names of the elements with chemical symbols. You would have to look up some of the symbols!

SCIENCE...Fluorine Arsenic Carbon Iodine Nitrogen Astatine Einsteinium... ME!

Complete the following table to see how many of the names and symbols of the elements you remember. Try to do this without referring to the Periodic Table.

Element	Symbol	Element	Symbol
	Al		Mg
Bromine			N
Calcium		Oxygen	
	C	Phosphorus	
	Cl		K
Copper			Si
	Au	Silver	
	H		Na
Iodine		Sulfur	
	Fe	Tin	
Lead			Zn

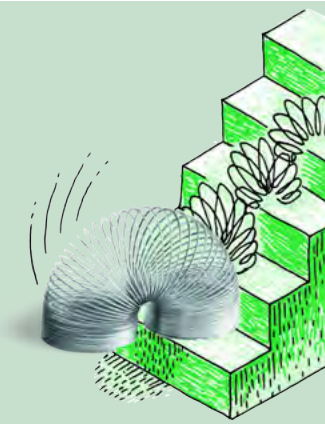
NEW WORDS

- semi-metal
- semi-conductor

4.2 Properties of metals, semi-metals and non-metals

The Periodic Table is an amazing tool! Did you know that the position of an element on the Periodic Table can tell a scientist what properties the element can be expected to have? This is because the elements have not just been arranged randomly! But, rather, they are grouped and arranged according to similar properties. Let's find out what this means.

ACTIVITY: What do some of the elements look like?



INSTRUCTIONS:

1. Your teacher will guide you through this activity. You will either look at real samples of some of the elements, or else refer to the photos below of some of the elements.
2. Your task as a class is to identify the different elements and find their place on the Periodic Table. You will either stick the real samples onto a large blank Periodic Table, or use the blank one here in your workbook, or both.

3. You must then look at what the different elements look like and see if you can identify any similar properties. The questions at the end will help guide you through this.

Here are some photos of the different elements:

DID YOU KNOW?

The Periodic Table is made up of more than 100 elements, but only 90 of the elements occur in nature. The rest have been made by man.

Aluminium foil.

Carbon (graphite).

Copper.

Magnesium.

Sulfur.

Bromine in tube.

Chlorine gas.

Calcium.

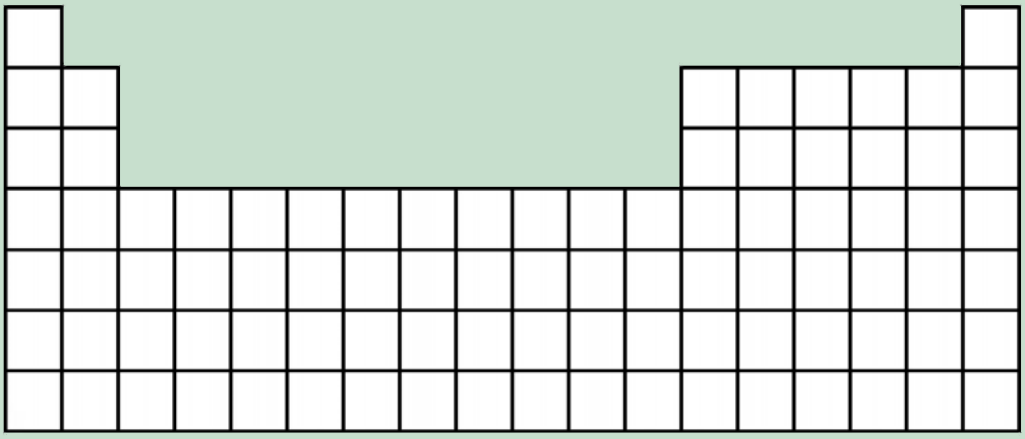
Phosphorus.

Potassium.

Nitrogen gas.

Iron.

If you do not have a large cardboard Periodic Table to work with at the front of the class, write the names of the elements you discuss on the blank table provided here:



After completing this activity, either by sticking actual samples onto a cardboard cut out, or looking at the photos provided here in your workbook and seeing where they are positioned on the Periodic Table, answer these questions.

QUESTIONS:

1. How would you describe the elements that are mostly on the left side of the Periodic Table?

2. How would you describe the elements that are mostly on the right side of the Periodic Table?

You probably saw from the last activity that there is a difference in the elements on the left and right of the Periodic Table. Were you able to identify what these elements are classified as. You have learnt about them before in previous grades. They are **metals** and **non-metals**.

Let's do a quick revision of what we have already learnt about metals and non-metals in previous grades.

The properties of metals and non-metals

Metals and non-metals have distinct properties. That means their properties are unique and different from each other. Can you remember what the unique properties of metals and non-metals are? The next activity will refresh your memory.

ACTIVITY: Blitz revision of the properties of metals and non-metals

Here is a block with different properties of metals and non-metals in it. They have been jumbled and are not sorted. You need to decide whether these properties describe metals or non-metals and sort them into the columns in the table which has been provided. Make sure that all the properties in the block are in your table. If you can think of properties that are not listed in the block, you may also add them to the table.

Properties

- shiny
- lustrous
- dull
- brittle
- malleable
- ductile
- conducts electricity
- conducts heat
- usually a solid
- can be solid/liquid/gas
- electrical insulator
- thermal insulator
- (other)

Do the activity as quickly (but also as neatly) as you can, and time yourself!

Properties of metals	Properties of non-metals

Most elements fall into one of these two categories: metals and non-metals. We use the *properties* of an element to categorise it as a metal or a non-metal.

Think of chromium, for example, which is shiny (lustrous), bends easily (malleable) and conducts heat and electricity well.

A piece of chromium.

1. What are the properties of chromium?

2. Based on these properties, would you categorise chromium as a metal or a non-metal?

3. Can you find chromium on the Periodic Table? (Hint: It may help to find its symbol first.) What is its atomic number?

Sulfur crystals forming on a rock wall inside a volcano.

Now think of sulfur.

Sulfur is usually a dull, yellow powder.

It does not conduct electricity or heat well and large crystals of sulfur break easily when they are dropped.

1. What are the properties of sulfur?

2. Based on these properties, would you categorise sulfur as a metal or a non-metal?

3. Can you find sulfur on the Periodic Table? (Hint: It may help to find its symbol first.) What is its atomic number?

We have now looked at the properties of metals and non-metals. But, when scientists were doing their experiments to observe the properties of the elements, they sometimes found some elements which were difficult to classify as either a metal or a non-metal.

The properties of semi-metals

Some elements are not quite metals, but they are not quite non-metals either. They just don't fit into either category! Does this sound strange to you? Let us explore.

ACTIVITY: Classifying element X

Pretend that you are a member of a team of scientists that has just discovered a new element. The element has not been named yet, so it is simply referred to as 'element X'.

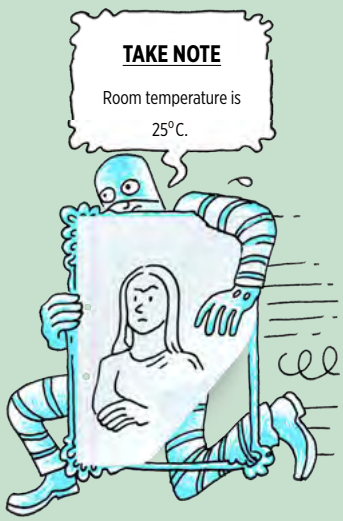
The team has a sufficient amount of element X to make several disks of the material. They create a file about element X. In the file, they place the following picture of one of the disks.

A disk of element X.

Look carefully at the picture. How would you describe the appearance of element X?

_____

_____



The team performs experiments on element X and adds the following data to the file:

1. In an attempt to bend a disk of element X, the disk shattered, like glass. The same result was observed when a second disk was dropped from a height.
2. The material is found to be a poor conductor of heat and electricity at room temperature. Element X was then cooled down significantly by placing it in a freezer. At very low temperatures, it becomes a good conductor of electricity.

Fill out the following checklist for element X by placing crosses next to each property that was observed.

Metallic properties	**YES**	**NO**
Is the material shiny (lustrous)?		
Is the material malleable and ductile?		
Does the material conduct electricity at room temperature?		
Does the material conduct heat?		
Non-metallic properties	**YES**	**NO**
Is the material brittle?		
Does the material have a dull appearance?		
Is the material an insulator?		
Additional comments (what else did you observe?):		

QUESTIONS:

1. Which of the properties of element X are typical of metals?

2. Which of the properties of element X are typical of non-metals?

3. Would you classify element X as a metal or a non-metal?

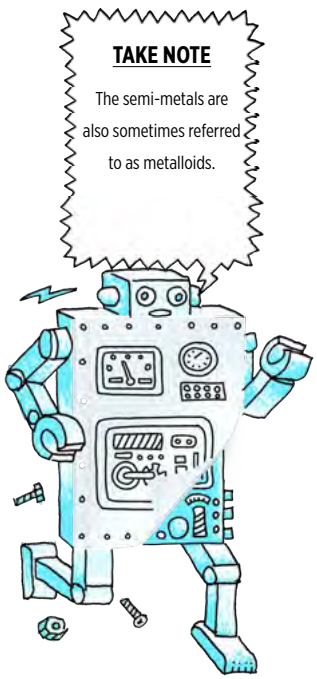
Element X does not quite fit into either category. Some of its properties are metallic and others are non-metallic. Element X is a real element, and its name is tellurium (chemical symbol: Te). Can you find it on the Periodic Table?

There are other elements, like tellurium, that are difficult to classify as either metals or non-metals. This is because they have some properties that are typical of metals and some properties that are typical of non-metals. A special category was invented for these elements: they are called **semi-metals**.

There are not many semi-metals. They are all listed in the following table. You do not have to remember all their names.

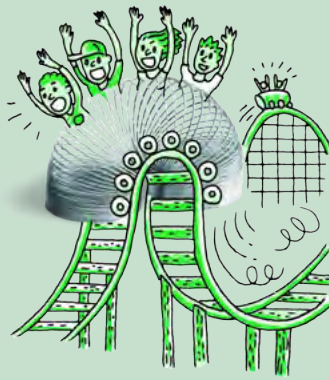
Names and symbols of the semi-metals:

Name	Chemical symbol	Atomic number
Boron	B	5
Silicon	Si	14
Germanium	Ge	32
Arsenic	As	33
Antimony	Sb	51
Tellurium	Te	52
Polonium	Po	84



Now that we have looked at some of the elements and where they are found on the Periodic Table, you might have already recognised that there is a trend in where the metals, semi-metals and non-metals are positioned on the Periodic Table. We are now going to do a colouring activity to see where on the Periodic Table we will find each of the categories of elements.

ACTIVITY: The regions of the Periodic Table



We are going to colour areas on the following version of the Periodic Table. This will help us identify the regions on the table where the metals, non-metals and semi-metals are located.

MATERIALS:

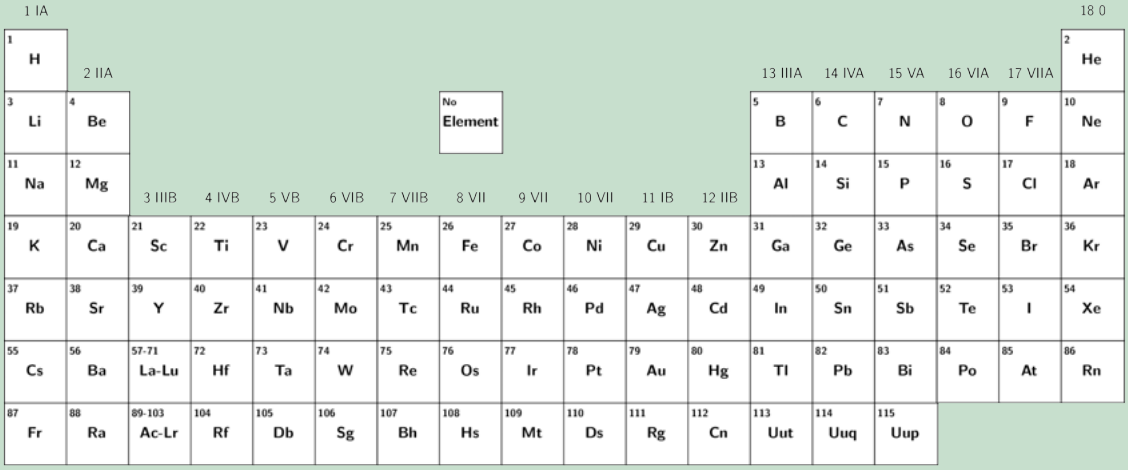
For this activity you will need coloured pencils or kokis or crayons in the following colours:

- Blue
- Yellow
- Red

INSTRUCTIONS:

1. **Semi-metals:**
   Find all the semi-metals on the Periodic Table. You will need to consult the table (names and symbols of the semi-metals) to help you remember which elements are semi-metals. Colour the block representing each of the semi-metals yellow.
2. **Metals:**
   Colour all the blocks to the left of the semi-metals blue. Do not colour hydrogen (H), as it is not strictly a metal. All these elements are metals.
3. **Non-metals:**
   Colour all the blocks to the right of the semi-metals red. All these elements

are non-metals. Now you can also colour hydrogen (H) red. On most versions of the Periodic Table hydrogen is placed with the metals, even though it has physical properties similar to those of the non-metals (it is a gas at room temperature). Hydrogen is placed with the metals, because it tends to behave like the other members of its column in chemical reactions.



Now answer the following questions, using your colourful Periodic Table.

QUESTIONS:

1. Which category contains the most (biggest number of) elements: metals, non-metals or semi-metals?

---

2. Which category contains the least (smallest number of) elements: metals, non-metals or semi-metals?

---

3. State which category of material (metal, non-metal or semi-metal) each of the following elements belongs to:

Element	Chemical symbol	Category: (Metal, non-metal or semi-metal?)
Iron	Fe	
Silicon	Si	
Fluorine	F	
Titanium	Ti	
Nitrogen	N	

We have learnt that the Periodic Table can be divided into regions where metals, non-metals and semi-metals can be found. This is useful information because the elements in different regions share similar properties. Their properties help us to decide what we can use them for. For example, metals are durable, malleable and shiny so they are suitable for making jewellery, pots and pans and motor car parts.

Let's look at some more examples. Where can we find all these elements in the real world? Where do they occur, and what are they used for?

We all know that oxygen (O) is one of the elements in the air we breathe. Rings and other jewellery are often made of gold (Au), silver (Ag) or platinum (Pt). But what do we know about calcium? And what is nickel used for?

1. Think about how long coins are used for. How are properties of metals useful to us when making coins?

Our South African coins are made from various metals and mixtures of metals, such as copper, nickel and stainless steel.

DID YOU KNOW?

Stainless steel is an alloy, meaning it is made up of a mixture of elements, including iron, carbon, chromium and nickel.

2. Why do you think we make jewellery out of the metals gold, silver and platinum, and not for example out of a non-metal such as sulfur? What are the properties of these metals?

Jewellery is made from metals such as gold, silver and platinum.

3. Why do you think these electrical wires are made out of copper? What property of copper is useful in this situation?

These electrical wires are made out of copper.

VISIT

These websites of the Periodic Table highlight some of the uses of the elements: bit.ly/1euHmVi and bit.ly/17zr35Q .

4. Do you think you could make electrical wires out of a non-metal such as bromine or phosphorus? Why or why not?

What do we use some of the non-metals for? We use carbon (coal) as a fuel, we use chlorine as a disinfectant to purify water, iodine is used as an antiseptic for wounds and helium is used to fill balloons. Arsenic, a semi-metal, is poisonous and therefore used as a pesticide for insects, bacteria and fungi. Another semi-metal, antimony, is used to make an alloy with lead which is very hard and has many applications. As you can see, the elements have many uses all around us! In the final activity of this chapter, we will explore some of the uses of the elements in more detail.

ACTIVITY: Uses of the elements

Your teacher will divide the class into small groups. Your group must choose one element from the Periodic Table (if you are unsure, your teacher will help you choose) and research the following questions about this element:

1. Where is this element found?
2. What do we use this element for?
3. What are some of the properties if the element?

Your group must make a poster to present all the information you found about your element.

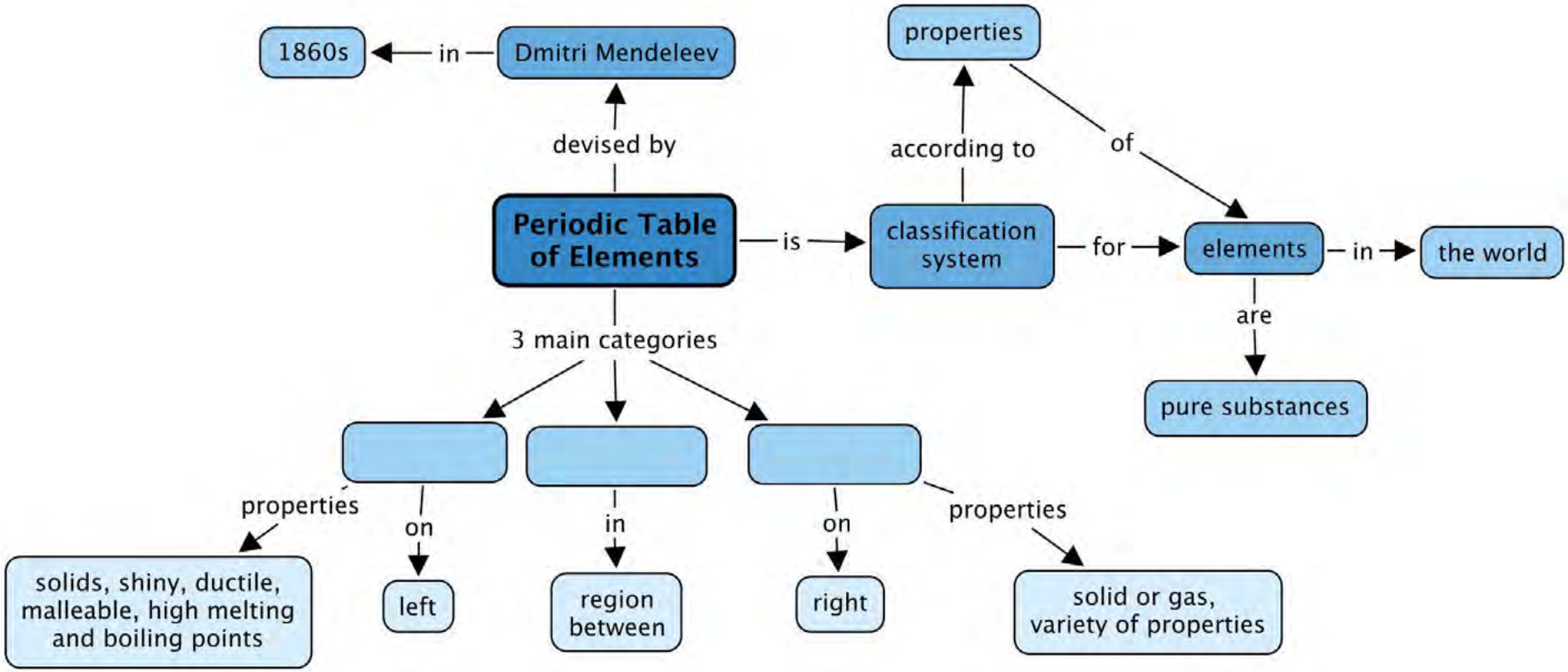
SUMMARY:

Key Concepts

- All the elements that are known, can be arranged in a table called the Periodic Table.
- The discoveries of many scientists over many years contributed to the information in the Periodic Table, but the version of the table that we use today was originally proposed by Dmitri Mendeleev in the 1800s.
- Each element has a fixed position on the Periodic Table. The elements are arranged in order of increasing atomic number, with the lightest element (hydrogen: H) in the top left hand corner.
- An element's position on the Periodic Table tells us whether it is a metal, a non-metal or a semi-metal.
  - metals are found on the left hand side of the table;
  - non-metals are found on the far right hand side of the table; and
  - semi-metals are found in the region between the metals and non-metals.
- An element can be identified in 3 different ways:
  - each element has a unique name;
  - each element has a unique chemical symbol; and
  - each element has a unique atomic number.
- Metals are usually shiny, ductile and malleable. Most are solids at room temperature, and have high melting and boiling points.
- Non-metals can be solids, liquids or gases at room temperature. They have a great variety of properties that usually depend on the state they are in.
- The semi-metals are all solids at room temperature. They usually have a combination of metallic and non-metallic properties.

Concept Map

We learnt that the elements in the Periodic Table fall into 3 main categories. What are these? Fill these in the concept map by looking at the concepts which come after each category.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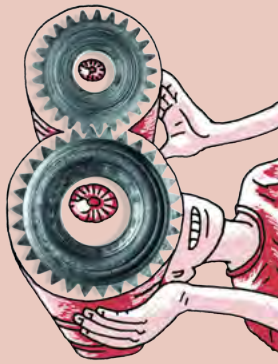

1. What information can we tell from an element's position in the Periodic Table? In other words: [2 marks]
   a) What does it tell us when an element occurs on the left hand side of the Periodic Table?

   b) What does it tell us when an atom occurs on the right hand side of the Periodic Table?

2. There are 3 unique 'labels' that can be used to identify an element. The first is its name. What are the other two? [2 marks]

3. What is the relationship between the atomic number of an element and its place on the Periodic Table? [1 mark]

4. Which element has the lowest atomic number? Write both its name and its symbol. [2 marks]

5. Extension question: What does the atomic number of hydrogen tell us about it? [1 mark]

6. Write the chemical symbols of all the elements that are in the same column as the element with the atomic number 9. (Note: The columns on the Periodic Table are called Groups.) [2 marks: 1/2 mark each]

7. The following table contains some names of elements. There is also a box of chemical symbols. You should place the chemical symbols in the right hand column of the table so that they match the names in the left hand column. [8 marks]

Chemical symbols

- C
- Na
- Si
- N
- He
- Cl
- S
- O

Names of elements	Chemical symbols
Sulfur	
Carbon	
Nitrogen	
Sodium	
Oxygen	
Silicon	
Chlorine	
Helium	

8. Write a short paragraph to explain what a semi-metal is. Also give an example of one semi-metal and say where in the Periodic Table the semi-metals can be found. [3 marks]

9. Name two properties of metals and two properties of non-metals. [4 marks]

Total [25 marks]

GLOSSARY

abundant:	when something exists, or is available, in large quantities; plentiful
acid:	a substance which is corrosive, has a sour taste and feels rough (grippy) between your fingers
alkali:	a base that is dissolved in water
alloy:	a mixture of two or more metals (stainless steel is an example of an alloy)
altitude:	the height of a place above sea level; places that are inland, or on mountains, are said to be at a higher altitude than places on the coast
ascorbic acid:	a natural acid that occurs in some fruits and vegetables; also known as Vitamin C
atomic number:	a unique number that represents a given element and shows its position on the Periodic Table
base:	a substance that can also be corrosive, has a bitter taste, and feels slippery between your fingers
boiling point:	the temperature at which a particular material changes from the liquid to the gas state (boils)
capillary action:	the process by which liquid is drawn up in a narrow tube
chemical formula:	a representation of chemicals using symbols that tell us which elements a compound contains and in what ratio
chemoreceptor:	a sensory nerve cell or sense organ that detects chemical signals
chromatogram:	the pattern formed on the paper by the components separated by chromatography
chromatography:	a process in which a mixture carried by a liquid is separated into components
citric acid:	a natural acid that occurs in citrus fruit
clear:	transparent; see-through
concern:	(noun) something that you are worried about
condensation:	the process of changing a gas to a liquid
condense:	when particles come together; to change from the gaseous state to the liquid state
constant:	a variable, or physical quantity, that is constant or does not change over time
contract:	(verb) the physical size of an object gets smaller
controversial:	controversial issues are issues that people do not agree about; issues that people argue about because they hold different opinions
corrosive:	a corrosive substance damages ('eats away') other materials by chemical action (the related verb is corrode)
dependent variable:	a dependent variable is one that we do not directly choose values for, but can only measure as we go along

disperse:	to spread evenly throughout
distillation:	a technique for separating the components of a liquid solution through evaporation and condensation
ductile:	the property of a material that allows it to be pulled and stretched out into thin wires
durable:	a material that is durable can last for a long time without breaking down
element:	a pure substance which cannot be broken down further
emulsion:	a mixture of two or more liquids that usually do not mix, such as tiny oil droplets in water
environmental concerns:	worries about the negative effects on habitats and ecosystems in our environment, caused by humans and their activities
essential:	necessary and important; required
evaporation:	the process of changing a liquid to a gas
expand:	(verb) the physical size of an object gets bigger
filtrate:	the liquid that has passed through a filter is called the filtrate
filtration:	the process of passing something through a filter
flavour:	the taste and smell of food in the mouth
flexible:	a material that is flexible will change shape easily without breaking when it is bent, and will return to its original shape when it is released
formic acid:	a natural acid found inside the bodies of some ant species
grain:	a very small piece of something
heat:	is the transfer of energy, from a hotter object to a colder object
immune system:	the biological system inside our bodies that protects us from disease and infection
impact:	to have an effect on something else
independent variable:	an independent variable is one whose values we can choose (manipulate); we still have to be able to measure it
indicator:	a substance that changes colour in the presence of another substance, showing that that substance is present
instinct:	a natural or inborn way of responding to something
litmus:	a well known acid-base indicator that turns red when mixed with an acid and blue when mixed with a base
magnetic:	a property of some materials that allows them to be attracted to a magnet
malleable:	the property of a material that allows it to be shaped by flattening with a hammer or squeezing it between rollers
melting point:	the temperature beyond which a particular material changes from the solid to the liquid state (melts)

mixture:	matter consisting of two or more components (substances) that retain their own properties
moulding:	a process that involves melting a substance and then pouring it into a specially shaped hollow container (mould) that will give it that particular shape when it cools down and returns to the solid state; clay can also be moulded
neutral substance:	a substance that is*neither* acidic *nor* basic
neutralise:	to make something chemically neutral
opaque:	something that we cannot see through is opaque; opaque is the opposite of transparent
Periodic Table:	a table in which the chemical elements are arranged in order of increasing atomic number
pigment:	a substance that gives colour to other materials
property:	a distinctive attribute, characteristic or quality (of a certain material)
residue:	the substances that are left behind in the filter after filtering
savoury:	refers to salty or spicy food (not sweet)
semi-conductor:	a material that conducts electricity only under special conditions, for instance at very low temperatures
semi-metal:	an element that has properties of both metals and non-metals
sense:	to become aware of something (specifically through our sense organs, e.g. by smelling tasting, feeling, hearing or seeing something)
sieve:	a device with small holes through which finer particles of a mixture may be passed to separate them from coarser ones
solute:	the substance that is dissolved in a solvent to make a solution, for example sugar (solute) dissolved in water (solvent)
solution:	when a solid, liquid or gas dissolves in a liquid, we call the resulting mixture a solution; a mixture that has no cloudiness
solvent:	the substance that the solute is dissolved in to make a solution
soot and ash:	small particles of burnt material that are the solid components in smoke
still:	the apparatus used for distillation
suspension:	a mixture in which the tiny clumps and pieces are mixed in a liquid but they are undissolved; all suspensions are milky/cloudy in appearance
symbol (or element symbol):	a unique letter (or letters) that represents a given element
taste buds:	taste buds are very small structures contained within papillae on the surface of the tongue responsible for taste
temperature:	a measurement of how hot or cold something is

thermometer:	a device for measuring the temperature of an object or a material
tongue map:	a map of the human tongue, showing which areas on the tongue are sensitive to which flavours; some scientists do not believe that the 'tongue map' is accurate

Here is your chance to discover the possibilities. What else can this beaker be?

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