An initiative supported by Woodside and ESWA

Weathering & Erosion Package

Weathering and Erosion

Soils

Fossils

Landscape Changes

Man-made Changes

Critical Thinking

Year 4

Australian Curriculum – Earth Science

WASP 4 – Contents

The Woodside Australian Science Project (WASP) is an initiative supported by Woodside and Earth Science Western Australia (ESWA).
These activities are designed to support the Earth & Space Science topic required by the Year 4 Australian Curriculum.

Copies of this and other supporting materials can be obtained from the WASP website http://www.wasp.edu.au or by contacting Julia Ferguson, Julia@wasp.edu.au

Earth & Space Science
Science Understanding
Earth's surface changes over time as a result of natural processes and human activity (ACSSU075)

- collecting evidence of change from local landforms, rocks or fossils
- exploring a local area that has changed as a result of natural processes, such as an eroded gully or river banks
- investigating the characteristics of soils
- considering how different human activities cause erosion of the Earth's surface

Science as a Human Endeavour
Nature and development of science
Science involves making predictions and describing patterns and relationships (ACSHE061)

- exploring ways in which scientists gather evidence for their ideas and develop explanations

- considering how scientific practices such as sorting, classification and estimation are used by Aboriginal and Torres Strait Islander people in everyday life

Use and influence of science
Science knowledge helps people to understand the effect of their actions (ACSHE062)

- considering how to minimize the effects of erosion caused by human activity

Science Inquiry Skills
Questioning and predicting
With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge (ACSIS064)

WASP 4 – Contents

Science Inquiry Skills
Planning and conducting
With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (ACSIS065)
Processing and analyzing data and information
Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends (ACSIS068)

An initiative supported by Woodside and ESWA

WASP 4 – Contents

An initiative supported by Woodside and ESWA

Weathering and Erosion

Rapid Oxidation – Teacher Demonstrations

Many students confuse the processes of weathering and erosion.

1. ***Weathering is a destructive process.*** During the process of weathering large lumps of rock are broken into smaller lumps. Apart from falling downwards because of gravity, they do not move away from their original position. Weathering can be the result of heating and cooling, natural chemical reactions such as oxidising or breaking up because of acids and also because of the effect of living things, including humans.

2. ***During the process of erosion smaller lumps move away from their original location.*** Forces such as wind, moving water and living things transport the pieces. Moving things tends to sort their pieces (clasts) by size and density.

3. ***During the process of deposition or sedimentation*** *the broken off pieces are dropped as the moving force loses energy, to create a sediment*.

Weathering of rocks takes many years, indeed for some hard rocks like granite and quartzite it may take thousands of years. The speed of weathering is also dependent on climate. Weathering is faster in the tropics than towards the poles. A basalt rock that has been freshly extruded from a volcano in the tropics can weather down into rich soil in less than 5 years. This is why people live near volcanoes in tropical areas. Some of the soils are so rich that three crops can be harvested each year. Basalt outcrops near Bunbury however have only a thin skin of weathering.

Oxidation - A common chemical reaction in the weathering process

Out atmosphere is a mixture of about 1/5th oxygen, 4/5th nitrogen and a tiny part of carbon dioxide. The nitrogen is pretty inactive but oxygen is not. Exposing the fresh surface of a rock to air can be the start of a chemical reaction where oxygen in the atmosphere binds to rock minerals and starts to break down the rock. The whitish crust visible on this brown sedimentary rock (left) is due to oxidation. The weathered crust can be easier to break down physically.

Aboriginal petroglyphs (rock engravings) often use the difference between the colour of the weathered outside of the rock and the unweathered underlying rock to define the engraved outline. This petroglyph is of a kangaroo and is from Burrup peninsula in WA's north-west

Teacher hint: The easiest way to obtain broken rock showing weathered and fresh surfaces is by collecting the darker rocks from the railway track or road "metal" dump. They usually show an almost black unweathered surface and a brownish rusty weathered surface.

Rapid Oxidation – Teacher Demonstrations

Rapid Oxidation Weathering - Three Teacher Demonstrations

1) Weathering of rock is a slow process taking hundreds and in some cases thousands of years to create an oxidised crust. A similar, but much faster reaction can be seen when an apple is cut into quarters. After a few hours the cut surfaces are oxidised to a brownish colour whereas any freshly cut surfaces are cream coloured. Adding an acid, such as lemon juice, slows the process. That is why we squeeze a lemon over fruit salad to keep it fresh longer.

2) If your school has un-anodised (not covered with a coloured coating) aluminium frames on the windows, students can compare the clean silvery metal of an aluminium cool drink can (bend it a few times until it breaks in two) with the whitish powdery covering of the aluminium metal of the frames. The oxidised aluminium powder can easily be removed by rubbing it with your finger. A gentle scrape with a metal nail or rub with a pot cleaner will reveal the shining un-oxidised metal below. Weathering action on aluminium stops after a couple of years as the crust of aluminium oxide creates a protective coat around the fresh metal.

3) Rusting (oxidised) rocks

Students may also have noticed that iron left exposed to oxygen in the air rusts to a dark red/brown colour. In the Hamersley Ranges that produce much of Western Australia's iron ore, the sediments of Banded Iron Formation consist of layers of greyish silica rich rock interleaved with dark iron rich bands. Over millions of years the iron rich bands have oxidised to rust. This is what gives these mountain ranges their wonderful dark red colours.
The long weathering process also removed most of the silica further increasing the percentage of iron ore making these deposits amazingly rich and much easier to refine.
(Students may also be interested to know that oxidation of iron in the blood is what turns fresh red blood to dark brownish red.)

Example	Evidence of weathering
Cut apple	Fresh cut white. Brown surface on exposed/weathered cut.
Broken rock	Lighter/darker on exposed/weathered surface
Aluminium frame	White powder on weathered surface. Shiny metal on fresh surface

Students can compare and contrast the differences between the outside of pebbles and rocks with their fresh surface inside. If you intend breaking rock please wear safety glasses and make sure your hammer is in good condition. If you are concerned about rock fragments flying from hard rock, wrap the rock in an old tea towel or rag before you hit it.

Rapid Oxidation – Student Worksheet

Natural processes which change Earth's landscape include:

1. **WEATHERING -** Large lumps of rock are broken into smaller lumps.
2. **EROSION -** Smaller lumps move away from their original location.
3. **SEDIMENTATION –** Transported material is dropped as the moving force loses energy and are laid down to create a sediment.

Weathering

Weathering is a destructive process. Weathering of rocks takes many years, indeed for some hard rocks like granite and quartzite it may take thousands of years.

Oxidation – a common chemical reaction in the weathering process.

Exposing the fresh surface of a rock to oxygen in air can be the start of a chemical reaction where oxygen binds to rock minerals and starts to break down the rock. The whitish crust visible on this brown sedimentary rock is due to oxidation.

Aboriginal petroglyphs (rock drawing) often use the difference between the colour of the weathered outside of the rock and the unweathered underlying rock to define the engraved outline. This petroglyph is of a kangaroo and is from the Burrup peninsula.

Rapid Oxidation - Teacher Demonstrations

Since oxidation of rock takes a very long time, your teacher may have some faster examples of oxidation for you.

Example	Evidence of weathering by oxidation present

Rapid Oxidation – Student Worksheet

Oxidation - Weathering working to our advantage

You may have noticed that iron left exposed to oxygen in the air rusts to a dark red/brown colour. The colour comes from rust or iron oxide. Weathered iron plays a major part in Western Australia's economic life.

In the magnificent red coloured Hamersley Ranges that produce much of Western Australia's iron ore, ancient sea sediments were formed from weathered volcanic rocks rich in iron minerals. They were turned to rock about 1.6 to 1.8 million years ago and are now called BIFs or Banded Iron Formations.

The fresh rock consists of layers of greyish hard silica rich rock interleaved with dark iron rich bands. Over millions of years the iron rich bands have oxidised to rust. In times past, when the climate was warmer and wetter, major oxidation weathering of these rocks took place. Warm weather also leached out silica bands and the rusty iron rich weathered (oxidised) rock tumbled downhill to fill river channels and low lying areas below. This secondary enrichment turned already iron rich rock into even richer rock that is easier to excavate and to refine into steel.

Mt Whaleback Open Cut

Acid Rain – Teacher Notes

When plants and animals use food to create energy, carbon dioxide is released into the air as a by-product. Carbon dioxide released by living things and from volcanic activity forms part of the Greenhouse Effect. Without carbon dioxide causing warming of our atmosphere life could not exist. Indeed those few "Snowball Earth" occasions when our planet was almost completely covered with ice and snow were also periods of mass extinction. Life needs to be warm but not too warm. Our present concerns about global warming are because we seem to have excess carbon dioxide (and other Greenhouse gases) being released into the atmosphere and temperatures are rising very quickly.

Carbon dioxide will dissolve in water and form a mild acid, carbonic acid. Sulphur dioxide dissolves to form sulphuric acid. Since the Industrial Revolution, people have burned fossil fuels that release much more carbon dioxide and sulphur dioxide which can dissolve in moisture in the atmosphere to produce ***acid rain***. This acid rain will have an impact on local environments.

Investigation
Materials per student or group

- A lump of limestone, marble or chalk.
  NOTE: Limestone is the whitish rock found near most coasts in WA. It is made of calcium carbonate, sand and often contains fossil fragments. If you live inland, calcrete can be substituted. Calcrete is the hard whitish material found on ridges jutting out of sand near salt lake country. If you choose to use chalk please be aware that modern "blackboard chalk" is really mostly gypsum, another mineral that leaves a white streak on the board but will not produce the correct "fizzing" reaction. The large sticks of "art chalk" have a higher chalk content and provide a much better reaction or broken pieces of marble can be acquired from kitchen and bathroom outfitters.
- A Petri dish or saucer.
- A nail or metal scraper.
- A dropper/pipette or drinking straw.
  NOTE: To use the straw as a pipette, place the straw into the liquid, seal the top end with a finger and lift the partly filled straw still sealed with your finger to where it is needed. The straw (still sealed) can be squeezed to release drops of acid.
- Acetic acid (household vinegar).
- Option – magnifying glass or hand lens/jeweller's loupe or electronic microscope. Watching the reaction through a hand lens/magnifying glass is great fun, as is electronically displaying the reaction through a microscope on the Smart Board or screen.

Acid Rain – Teacher Notes

Method

1. Place the rock onto the Petri dish or saucer. (I used sand to hold it in place)
2. Scrape a depression into the top of the rock to hold some acid
3. Drop a little acid (5 drops) into the depression and observe what happens
4. Repeat until dropper is empty

Observations

What happened when acid was dropped into the depression in the limestone/chalk? The limestone dissolved/was eaten away. The vinegar fizzed/effervesced. The hollow increased. If your limestone was sandy, sand will start to appear on the bottom of the dish.

Discussion

Draw what would happen if mild acid rain fell on a chalk or limestone mountain over a long period of time. What changes would happen to the surface of the Earth?

The rock would be weathered/eaten away. The rock would develop caves and subterranean river systems. This is called karst scenery and can be seen in the southwest of our state near Margaret River. Rainfall before the Industrial Revolution was likely not acidic and if so any acidity would be from natural sources, like volcanoes.

Interesting Fact: Fizzy drinks get their effervescence from injecting carbon dioxide into water at low pressure. Some of the gas dissolves and turns the water into carbonic acid whilst the rest is held as gas bubbles to be released when the bottle is uncapped.

Acid Rain – Student Activity

Weathering is a destructive process.
When plants and animals use food to create energy, the gas carbon dioxide is produced. When we breathe out the exhaled air is rich in carbon dioxide produced by our cells. This can dissolve in water and form a mild acid. Since the Industrial Revolution however, people have burned fossil fuels that release much more carbon dioxide and sulphur dioxide and this dissolves in moisture in the atmosphere to produce ***acid rain***.

Student Activity

Materials per student or group

- A dropper.
- A nail or metal scraper
- A lump of limestone or chalk
- A Petri dish or saucer
- Acetic acid (vinegar)

Method

1. Place the rock onto the Petri dish or saucer. I used sand to hold it in place.
2. Scrape a depression to hold some acid into the top of the rock.
3. Squeeze the end of the dropper and place the tip into the acid.
4. When the squeeze is relaxed the dropper should partly fill with acid.
5. Drop a little acid (5 drops) into the depression and observe what happens.
6. Repeat until dropper is empty.

Observations (What did you see, hear, smell?)
What happened when acid was dropped into the depression in the limestone/chalk?

____

____

____

Discussion
Draw what would happen if mild acid rain fell on a limestone or chalk mountain over a long period. What changes would happen to the surface of the Earth?

A Grave Concern – Teacher Notes

The choice of rock to make gravestones is often more aesthetic and aspirational than scientific. Graveyards are great places to study relative weathering strengths of different rocks as long as they are close by and about the same age. (The names and most of the writing in these photos have been deliberately blurred in the interests of privacy).

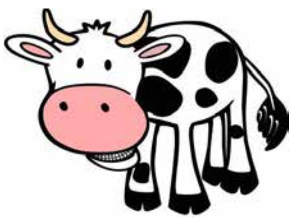
Both these gravestones are made of rock and were placed in the graveyard at almost exactly the ***same*** time. They stand almost side-by-side and have been exposed to the ***same*** weathering conditions.

The one on the left is made of marble, a rock with the ***same*** chemical composition as limestone. The one on the right is made of granite. It has a completely different chemical composition, as it is mostly silica, the chemical used to make glass.

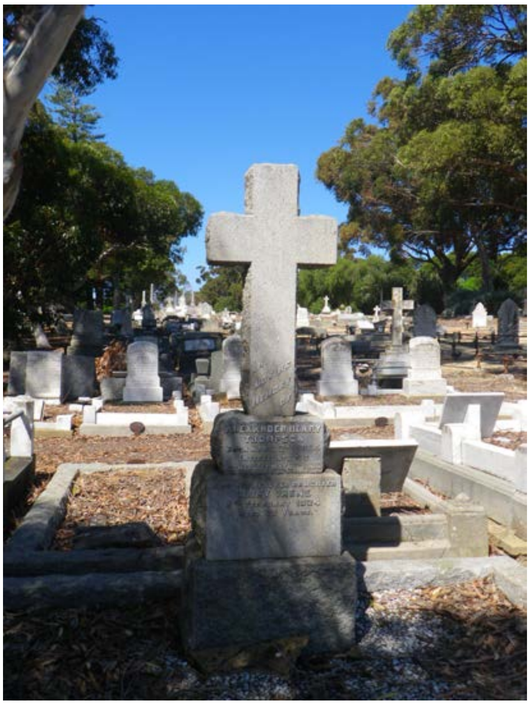
Writing on the left stone has been almost completely obliterated while on the right it is still fairly clear and sharp.

What do you think weathered both rocks? Acid rain
Why was the one on the left more affected than the one on the right? Acid dissolves/eats away limestone and marble much faster than granite.
Was this a “FAIR TEST” on the difference between weathering of limestone and marble? (Did the **c**ow **m**oo **s**oftly?) Explain your answer. Yes!

- Only one thing was **C**hanged (the material the gravestones were made from).
- Only one thing was **m**easured (weathering or the breakdown of lettering on the graves).
- Everything else **S**tayed the **S**ame.



A Grave Concern – Student Extension



Both these gravestones are made of rock and were placed in the graveyard at almost exactly the ***same*** time. They stand almost side-by-side and have been exposed to the ***same*** weathering conditions. The one on the left is made of marble, a rock with the ***same*** chemical composition as limestone. The one on the right is made of granite. It has a completely different chemical composition, as it is mostly silica, the chemical used to make glass.
Writing on the left stone has been almost completely obliterated while on the right it is still fairly clear and sharp.

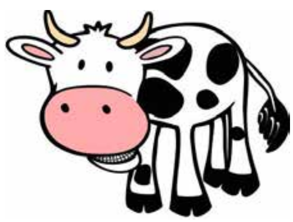
What do you think weathered both rocks? ____

____

Why was the one on the left more affected than the one on the right? ________________________

____

Was this a "FAIR TEST" on the difference between weathering of limestone and marble? (Did the **c**ow **m**oo **s**oftly?) Explain your answer.



____

____

____

____

____

Stalactites – Student Activity

Student Homework

Limestone can dissolve in acids. Of course when there is a change of climate or conditions, the dissolved limestone (calcite) in water can come out of solution (appear again).
These caves on the left were originally empty hollows dissolved out of the limestone but then conditions changed and dissolved limestone (calcite) in the drips formed stalagmites and stalactites.

Materials per student

- Two beakers or jam jars or glasses.
- A saucer or plate.
- A length of woollen or thick cotton thread or string. NOTE – the material needs to be made of natural fibre. To speed things up two or three strands can be twisted together to make a thicker band. The band should be long enough to stretch over the two jars and the saucer.
- Two clothes pegs or heavy objects to hold down the ends of the band.
- Baking soda *or* Epsom salts *or* Washing soda. These can be bought at the supermarket or hardware store.
- Large jug warm water and a mixing spoon.

Method

1. Fill the jug with warm water (not boiling)
2. Stir the baking soda into the water until no more will dissolve. A small disc of undissolved soda will remain on the base of the jug.
3. Attach the clothes pegs to the ends of the band.
4. Soak the band in the solution in the jug.
5. On a warm flat surface place the two jars with the flat plate between them.
6. Fill the jars almost to the top with the solution
7. Drape the ends of the band into the jars. The clothes pegs should hold them down
8. Let the centre of the band drape downwards towards the saucer below
9. Observe what happens over the next few days or weeks
10. **The experiment must be left in a warm, draught free position.**

Stalagmites stand up with all their might.
Stalactites hang down holding on tight.

Minerals, which are weathered away from one part of Earth's surface, can be deposited as rock in another place. Landscapes in both areas change.

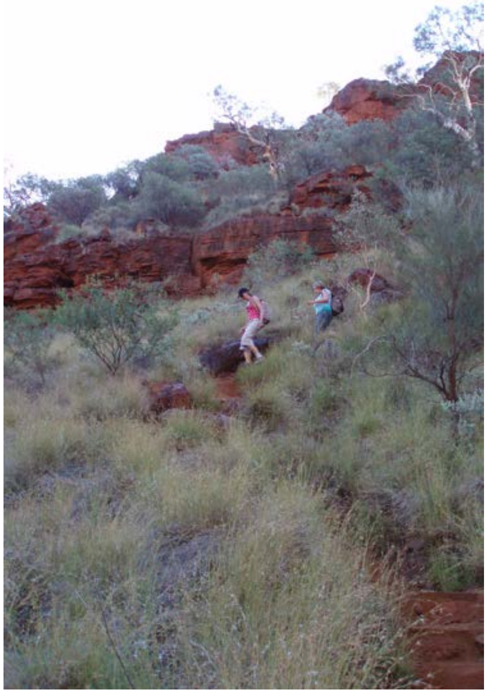
Biological Weathering– Teacher Notes

Weathering is a destructive process.
Living things and their products cause biological weathering.

What do you think has caused this once magnificent statue of a lion to crumble? The statue is about 600 years old and is in a temple in Hakone Prefecture in Japan.

Mosses and lichens cover the statue's surface. Their roots penetrate the rock and force bits to fall off.

There are two different living things causing weathering in this picture. One is a plant and the other is an animal. Name each one and how they are causing destruction to the landscape.



1 The first biological weathering agents are bushes, spinifex and grass. Their roots are forcing rocks apart.

2 The second biological weathering agents are humans. Their feet are killing plants and leaving open sands that can blow away or be washed away by rain.

Which is the biological weathering agent in this photograph?

This tree root has forced its way down into the rock and caused it to crack. As soon as the rock crack this opens the way for oxidation and removal of broken rock by running water.
This tree lies in a small cliff face above a pathway which curves round the Swan River. Broken rock has started falling down on the path below.

Biological Weathering– Teacher Notes

Would filling the crack with concrete help? No. The growing roots would keep destabilising the cliff face

What advice would you give to make this area safer?
Remove the tree or move the path.

Describe examples where living things have caused destructive weathering to land surfaces in your schoolyard.

- Tree roots pushing up through paths, yards and breaking walls.
- Weeds breaking apart pathways.
- Skateboards breaking the edges of walls and pathways.
- People walking across grassed areas making paths of bare soil
- Digging up planted areas to put in water pipes or electricity conduits

Could humans be described as biological weathering agents? Explain your answer. Yes they could because they are living things and can be destructive.

Biological Weathering – Student Activity

Weathering is a destructive process. Biological weathering is caused by living thing sand their products.

What do you think has caused this once magnificent statue of a lion to crumble? The statue is about 600 years old and is in a temple in Hakone Prefecture in Japan.

____

____

____

There are two different living things causing weathering in this picture. One is a plant and the other is an animal. Name each one and how they are causing destruction to the landscape.

1 ____________________________________

____

____

____

2 ___________________________________

____

____

____

Biological Weathering – Student Activity

What biological weathering agent is at work here?

____

____

____

The tree lies at the top of a small cliff face above a pathway which curves round the Swan River. Walkers and cyclists use the path. Broken rock has started falling down on the path below.

Would filling the crack with concrete help? Explain your answer. __________________________

____

____

What advice would you give to make this area safer? ________________________________

____

____

Give examples describing where living things have caused weathering of the surface of your schoolyard.

____

____

____

Could humans be described as biological weathering agents? Explain your answer.

____

Temperature Weathering – Teacher Notes

Temperature changes causing weathering

Although in Western Australia at present it really only gets cold for part of the year, in Permian times about 300 million years ago, half of Australia was covered by ice. Great glaciers scoured their way over the Yilgarn Plateau north towards the Pilbara breaking off rocks and using them to flatten the landscape. When the glaciers melted they flooded the Carnarvon and Canning Basins.

This rock was found north east of Minginew in the Central Wheatbelt. It still shows scrapes and gouges where it lay at the bottom of a glacier that pushed its way across the country during Permian times.

Glaciers Scraping the Landscape – Student Activity

Materials

- Ice cube tray or two small plastic cups.
- Small pieces of broken rock (road metal, quartz or concrete).
- Water
- Freezer
- A cement block or pathway.

Method

1. Fill containers with water
2. Into one place the rock pieces
3. Freeze overnight
4. Select two strong (and heavy) students
5. Each student draws their cube along the cement surface pressing down as hard as they can
6. Stop before the surface gets too damaged!

Observation

What was the difference between the effect of the two blocks on the hard surface?
They both left a wet mark but after a little while the block with rocks began to scrape the surface.

Discussion

What change to the landscape would glaciers make? They would grind rocks in the landscape flat.

Temperature Weathering – Teacher Notes

Expanding Ice, Changing Landscape - Teacher Demonstration

Since prehistoric times masons have used the expansion of water on freezing to break resistant rock. They chisel out an initial furrow in the rock, apply water over freezing nights and watch the cracks expand, lengthen and deepen.

Materials

- One empty cool drink bottle with lid
- Plastic bag to contain bottle
- Water
- Permanent marking pen or masking tape and ruler
- Freezer

Method Experiment A

1. Fill bottle with water
2. Screw lid on tightly
3. Place in freezer overnight
4. Observe change

Method Experiment B

1. Fill bottle approximately 2/3rd full
2. Mark the level of water on the outside of the bottle.
3. Measure the height from bottle base to water level
4. Place bottle upright in bag
5. Place upright bottle and bag in freezer overnight.
6. Observe and mark the level of water/ice in the bottle
7. Measure the height from bottle base to water/ice level

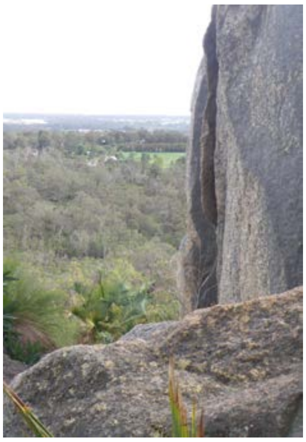
Observations

Experiment A: What changed overnight? The bottle has expanded and may have even cracked.

Experiment B: What changed overnight? The ice is sitting above the marked water level on the bottle.

Expansion of water on freezing expands cracks in rock and is a process of weathering

Heat Causes the Outer Layers of Rocks to Peel Off



In desert areas rocks can be subjected to extreme heat during the day with temperatures rising above 40°C and then falling below freezing point at night. When rocks are heated they expand and when they cool they shrink. The inner layers of great rocks are insulated from heating and cooling by their outer layers. They are slower to heat and cool. In the cooler evenings the outer layers shrink while the inner layers are still expanding. This causes curved shearing in the rock called “onion skin weathering”.

Temperature Weathering – Student Activity

Although in Western Australia at present it really only gets cold for part of the year, in Permian times about 300 million years ago, half of Australia was covered by ice. Great glaciers scoured their way over the Yilgarn Plateau north towards the Pilbara breaking off rocks and using them to flatten the landscape. When the glaciers melted they flooded the Carnarvon and Canning Basins.

This rock was found north east of Minginew in the Central Wheatbelt. It still shows scrapes and gouges where it lay at the bottom of a glacier that pushed its way across the country during Permian times.

Glaciers Scraping the Landscape – Student Activity

Materials

- Ice cube tray or two small plastic cups.
- Small pieces of broken rock (road metal, quartz or concrete).
- Water
- Freezer
- A cement block or pathway.

Method

1. Fill containers with water
2. Into one place the rock pieces
3. Freeze overnight
4. Select two strong students
5. Each student draws their cube along the cement surface pressing down as hard as they can
6. Stop before the surface gets too damaged!

Observation

What was the difference between the effect of the two blocks on the hard surface?

____

____

Discussion

What change to the landscape would glaciers make? _____________________________________

____

Expanding Ice, Changing Landscape - Teacher Demonstration

Since prehistoric times masons have used the expansion of water on freezing to break resistant rock. They chisel out an initial furrow in the rock, apply water over freezing nights and watch the cracks expand, lengthen and deepen.

Materials

- One empty cool drink bottle with lid
- Plastic bag to contain bottle
- Water
- Permanent marking pen or masking tape and ruler
- Freezer

Method Experiment A

1. Fill bottle with water
2. Screw lid on tightly
3. Place in freezer overnight
4. Observe change

Method Experiment B

1. Fill bottle approximately 2/3rd full
2. Mark the level of water on the outside of the bottle.
3. Measure the height from bottle base to water level
4. Place bottle upright in bag
5. Place upright bottle and bag in freezer overnight.
6. Observe and mark the level of water/ice in the bottle
7. Measure the height from bottle base to water/ice level

Observations

Experiment A: What changed overnight? ____

____

Experiment B: What changed overnight? ____

____

Expansion of water on freezing expands cracks in rock and is a process of weathering

Erosion is the removal and transport of materials by gravity, water, wind or animals. During this process, clast sorting usually occurs.
Clasts are the broken fragments of weathered rock

Movement of the debris caused by weathering can be caused by the pull of gravity, push of wind, water or even displacement by animals. While movement is happening the broken bits of rock rub together and become smaller and rounder. If the moving agents are wind or water, the clasts (broken bits) become sorted both by size and by density along their path. This is because, as the moving wind or water travels over the ground, friction causes it to lose speed and its carrying energy. When the rock is collected up into moving glaciers however the clasts cannot move internally and when melting occurs they are just dumped in unsorted mounds.

Erosion by Wind and Water - Teacher Demonstration

The sorting action of water can be demonstrated by finding a downpipe from the roof where the rainwater isn't collected into a tank. The energy of water flow decreases as it moves over the surface of the soil. Larger pieces of rock are found close to the pipe mouth. Medium sized pieces are dropped out next, as the slower moving water can no longer carry them.

Energy decrease

Rock size decrease

Alternatively place a pile of mixed soil and bits of rock at the top of a ramp. Lightly sprinkle with water from a watering can held about half a metre above the pile. The clast size will grade (become smaller) away from the pile as water washes them downhill.

Similarly the sorting energy of wind can be demonstrated by placing a mix of dry pebbles, sand and fine silt on a flat surface and then blowing on it with a hairdryer set at "low". This is best performed outside as dust can travel quite a distance. Perhaps the school gardener may demonstrate this with his leaf-blower and a pile of dry soil and leaves.

Students should not stand in front of the blast, as they will get dust in their eyes.

If this activity is carried out inside the classroom, lay old newspaper in a pathway away from the hairdryer as this will help collect up the sediment afterwards. Newspaper should overlap away from the hairdryer to stop paper blowing away.

Erosion is the removal and transport of materials by gravity, water, wind or animals. **During the movement sorting occurs.**

Sorting by (Human) Movement - Teacher Demonstration or Student Activity

An Aranda or Arrente yandy

A dustpan used as a yandy

Materials

- A yandy, a dustpan or a flattish tray. (The large meat trays provided by supermarkets are excellent but trays under student desks will do). If you have Aboriginal "aunties" who are willing to visit the school, they may be able to demonstrate how moving mixed materials in a yandy will separate them out. Women used yandies to separate out grain from sand and in desert areas where water was rare and panning for gold difficult also to separate gold dust from soil and crushed rock. Refugee girls from sub-Saharan Africa and from islands to our north are also proficient in this skill. Because boys do not have broad hips (wide set acetabulae) they are often less able to work a yandy than girls because their hips have more limited movement. (More information is in the extension activity).
- A mixture of dry materials of differing size and density. I would suggest yellow builder's sand or beach sand, some dried peas, some rice and some heavy metal objects such as washers or bolts.

Method

1. Place dry mixture in yandy or tray
2. Using a gentle swivelling movement from the hips or knees swirl the materials round in a constant motion. Hold one end of the yandy slightly higher than the other. Do not change direction or speed.

Add some dried leaves and pieces of paper to the mix. If it is windy the mix can be swirled and tossed into the air. Paper, leaves and fine dust will be carried away in the wind. Students should avoid standing downwind during this activity.

EXTENSION - Aboriginal Use of a Yandy

The yandy or coolamon, is a women's tool however in its preparation, any cutting and scraping of the wood with stone tools, was men's work. It was usually made from part of a hollow tree. Sometimes fire would be used to increase the hollow. The yandy is a multi-purpose tool. It has sharper edges on the ends for digging up lizards and small game out of the ground and for carrying them back to camp. It was used to carry babies, water and fruits. Being constantly on the move, Aboriginal tools either had to be multipurpose or able to be quickly created anywhere. Yandies were much valued and carried about.

Yandy with sand and seeds. The large brownish blobs below it are resin from grass trees.

Australian native grain seeds do not stay on the stalk when they are ripe, as do most grains favoured by European farmers. Women knew that wind would blow the ripe seeds all over the place to be concentrated into hollows or wind-shelter spots behind clumps of spinifex. This is a classic example of erosional sorting. Aboriginal ladies and girls would gather up the concentrated seed and sand mix into the yandy. Any large unwanted material would be hand picked out and the remainder lightly crushed between their hands or between rocks to loosen any inedible outer seed coat or husk. They would then move out onto a windy clay pan and toss the mix up into the air to free the seed husks and let them blow away. When the remaining mix had been yandied and the seeds separated they would be ground between rocks, have a little water added and baked on hot rocks in the fire to make Johnny Cakes.

In other parts of the world, woven flat baskets were used to winnow (wind separate) seeds from chaff and pods.

Smaller and Rounder – Teacher Notes

As material is moved along by wind or by water, clasts become smaller and rounder because of collisions with each other and with the surface along which they are moving. If students have waded in fast flowing streams or in the wash at the edge of the sea they may be aware of feeling the sand and pebbles beside their ankles bouncing and rolling in the energetic water flow.

Student Activity

Experimental group *Control group*

Materials

- Plasticine cut into small cubes
- Talcum powder and a piece of old newspaper
- A large jar container with a lid
- Group of energetic students

Method

1. Either select one group of students to demonstrate to the rest of the class or organise students into groups.
2. Cut plasticine cubes. These should be about 1cm^3 or less.
3. Lay out the newspaper, place the cubes on top and gently dust with talcum powder.
4. Set a few cubes as the "Control Group" against which any change is measured.
5. Place the other cubes into the container. Ideally they should only fill about one quarter of the space.
6. The container will be shaken for eight minutes.

Observations

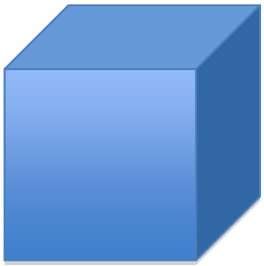
Describe changes to the cubes after they were shaken for 8 minutes? Their shape changed. Their edges became rounder and the corners were rounded and not angular.

Was this a "Fair Test"? No. We could not control how hard and how often each person shook the container.

How could this problem be overcome? Use a machine like a paint shaker or stone tumbler to agitate the cubes equally.

Smaller and Rounder – Teacher Notes

Discussion
This activity is a model for rocks tumbling along a river for 8 minutes. It takes most pebbles hundreds of years to tumble their way from the top of a river down to its mouth on the sea. Draw what you think would happen to a cubic pebble on such a journey. Draw your answers in the table below

Beginning	Middle	End
		

Student's drawings should demonstrate a decrease in size and an increase in roundness along the path of erosion.

Use your knowledge
These clasts (broken bits of rock on the left) were found along a creek bed in the Hamersley Ranges. The large clasts are 5cm long. Do you think they had travelled (been eroded) for a long distance from their source? Explain your answer. They are not far from source as the clasts are large, poorly sorted and very angular.

EXTENSION - And Down They Go!
Students repeatedly roll clay cubes down a ramp. This activity shows the material removed from the cubes by friction with the ramp

Materials
- Plasticine cubes or clay cubes as in the previous activity. The Art Room may have old clay that they may be happy to give you. These are easier to erode.
- A concrete or hard based ramp. (Ramps built for disabled students are fine)
- A hose and water or buckets of water and a broom.

Smaller and Rounder – Teacher Notes

Method

1. Cut eight cubes from the clay.
2. Repeatedly roll them down the slope of the ramp.
3. Observe any changes to the cubes.
4. Once the material is becoming obviously rounded and smaller stop the activity.
5. Hose off any clay left on the ramp.

Smaller & Rounder – Student Activity

Erosion is the removal and transport of materials by gravity, water, wind or animals.

As material is moved along by wind or by water, the clasts become smaller and rounder because of collisions with each other and the surface along which they are moving.

Student Activity

Materials

- Plasticine cut into small cubes
- Talcum powder and a piece of old newspaper
- A large jar container with a lid
- Groups of energetic students

Method

1. Collect plasticine cubes.
2. Lay out the newspaper, place the cubes on top and gently dust with talcum powder.
3. Set a few cubes as the “Control Group” against which any change is measured.
4. Place the other cubes into the container. Ideally they should only fill about one quarter of the space.
5. Shake the container for eight minutes.

Observations

Describe changes to the cubes after they were shaken for 8 minutes? ________________________

____

Was this a “Fair Test”? Explain your answer. ________________________

____

____

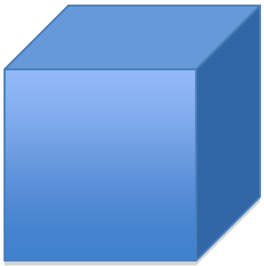
How could this problem be overcome? ____

____

Smaller & Rounder – Student Activity

Discussion

This activity is a model to find the effect of tumbling rocks along a river for 8 minutes. It takes most pebbles hundreds of years to tumble their way from the top of a river down to its mouth on the sea. What do you think would change to a cubic pebble on such a journey? Draw your answers in the table below.

Beginning	Middle	End
		

Use your knowledge

These clasts (broken bits of rock) on the left were found along a creek bed in the Hamersley Ranges. The large clasts are 5cm long.

Do you think they had travelled (been eroded) for a long distance from their source? Explain your answer.

____

____

____

Biological Erosion – Teacher Demonstration

Erosion by Animals

Humans and other animals can create footpaths across vegetated areas. The weight of passing animals compacts the underlying soil causing a depression and making it more difficult for rain to penetrate and feed plants. During subsequent rains plant roots no longer hold the exposed soil together and it is easily eroded. Australian animals are soft footed and do not damage the plants as much as introduced cloven hooved cows and sheep.

This narrow incised track is the result of over 2,000 years of humans tramping up and down hill to visit a Bronze Age hill fort in southern England.
Generations of feet have killed the grass and created a furrow 15 metres deep. Rains have washed away soil and cut deeply into the soft underlying chalk rock.

Nearby, since the Stone Age, people have cut through the grass turf to expose white chalk and create outlines of horses and giants. These white furrows have also been deepened by rain over time.
Because they are no longer regular walkways however, local people have needed to keep clearing them every three or four years to keep the outlines distinct.
https://en.wikipedia.org/wiki/Uffington_White_Horse

Are there any signs of biological erosion in your school? Yes. Foot and bicycle tracks across grassed areas. Chips and furrows from skateboards. Bare patches before wickets and goals on the sports fields. Tyre tracks where people have parked outside designated parking areas.

Erosion by Humans

The open cut mine sites provides a case where man is the erosive agent. Yellowish red weathered rock at the surface is seen to grade down to greyish green fresh rock that contains the ores.
Weathered rock and soil are scooped up and trucked away, (eroded) to form reserve piles elsewhere. These are held until operations close and are used to return the area to (as close as possible) its original state.
The fresh rock is exposed, drilled and blasted into fragments. These fragments are trucked to crushers. Here large lumps are broken down to smaller sized pieces. Rolling around in a ball mill using the same process that happens in rivers where rocks crash together to become smaller and rounder then finely grinds them. They are then placed on moving tables with fluids that sort them into the denser ore and the less dense mullock (waste material). The ore is then further chemically and heat-treated to release its metals.

What is the name of the largest open cut mine in WA?
The Kalgoorlie Super Pit (or Fimmiston Open Cut) – at time of writing

Biological Erosion – Teacher Demonstration

Biological (human) Control of Erosion

Although humans are directly and indirectly responsible for causing erosion, we can also help recovery of the landscape.
We can do this by:

1. Saving topsoil and replacing it after excavation.
2. Aerating compacted soil. Many lawn owners and sports field gardeners reinvigorate their turf by punching holes in it to allow better penetration of water to plant roots.
3. Depositing material in benches to stop fast rainwater flow eroding it away.
4. Laying rocks and dead branches on top of the soil to stop it being blown away by the wind until plants start growing again.
5. Replanting the area damaged with local plant species.
6. Planting with a mixture of fast growing and slow growing species so that tall plants will shelter the slower growing smaller plants.

For example, on the coast, regular onshore winds create sand dunes that move slowly landwards. If they are not stopped moving they can cover roads and even houses. Dead branches are laid on their surface to slow wind and decrease its erosive power. These branches also dissuade animals (including humans) from making erosive tracks across the dunes. The dunes are then planted out with salt tolerant long rooted grasses to fix the soil and stop most of the movement.

Holding Back Erosion - Teacher Demonstration

Materials

- Sand (from the sandpit)
- Grass clippings or dead leaves and pieces of twig
- A bucket
- A watering can or sprinkler

Method

1. Using the bucket, make two sandcastles, one castle of sand and the other of sand and plant mix.
2. Sprinkle each with water for ten seconds.
3. Compare which castle was most eroded.

Observation

What did you observe? The pure sand castle eroded much faster than the sand mix

On roadside cuttings soil can be held in place by a damp paper, fertiliser and seed mix which is blown onto the unstable surface. The paper temporarily holds the soil in place until the fertilised seed becomes established. This is an Australian invention which has been exported across the world.

Biological Erosion – Student Worksheet

Erosion by Animals

Humans and other animals can create footpaths across vegetated areas. The weight of passing animals compacts the underlying soil causing a depression and making it more difficult for rain to penetrate and feed plants. During subsequent rains plant roots no longer hold the exposed soil together and it is easily eroded. Australian animals are soft footed and do not damage the plants as much as introduced cloven hooved cows and sheep.

This narrow incised track is the result of over 2,000 years of humans tramping up and down hill to visit a Bronze Age hill fort in southern England.
Generations of feet have killed the grass and created a furrow 15 metres deep. Rains have washed away soil and cut deeply into the soft underlying chalk rock.
Nearby, since the Stone Age, people have cut through the grass turf to expose white chalk and create outlines of horses and giants. These white furrows have also been deepened by rain over time.

Are there any signs of biological erosion in your school? Describe any.

____

____

Erosion by Humans

The open cut mine sites provides a case where man is the erosive agent. Yellowish red weathered rock at the surface is seen to grade down to greyish green fresh rock that contains the ores. Weathered rock and soil are scooped up and trucked away, (eroded) to form reserve piles elsewhere. These are held until operations close and are used to return the area to (as close as possible) its original state.
The fresh rock is exposed, drilled and blasted into fragments. These fragments are trucked to crushers. Here large lumps are broken down to smaller sized pieces. Rolling around in a ball mill using the same process that happens in rivers where rocks crash together to become smaller and rounder then finely grinds them. They are then placed on moving tables with fluids that sort them into the denser ore and the less dense mullock (waste material). The ore is then further chemically and heat- treated to release its metals.

What is the name of the largest open cut mine in WA? _____________________________________

Biological Erosion – Student Worksheet

Biological (human) Control of Erosion

Although humans are directly and indirectly responsible for causing erosion, we can also help recovery of the landscape.

We can do this by:

____

____

____

____

For example, on the coast, regular onshore winds create sand dunes that move slowly landwards. If they are not stopped moving they can cover roads and even houses. Dead branches are laid on their surface to slow wind and decrease its erosive power. These branches also dissuade animals (including humans) from making erosive tracks across the dunes. The dunes are then planted out with salt tolerant long rooted grasses to fix the soil and stop most of the movement.

Holding Back Erosion - Teacher Demonstration

Materials

- Sand (from the sandpit)
- Grass clippings or dead leaves and pieces of twig
- A bucket
- A watering can or sprinkler

Method

1. Using the bucket, make two sandcastles, one castle of sand and the other of sand and plant mix.
2. Sprinkle each with water for ten seconds.
3. Compare which castle was most eroded.

Observation

What did you observe? ____

____

____

On roadside cuttings soil can be held in place by a damp paper, fertiliser and seed mix which is blown onto the unstable surface. The paper temporarily holds the soil in place until the fertilised seed becomes established. This is an Australian invention which has been exported across the world.

Erosion Revision – Teacher Notes

What do you think caused the erosion (moved away the soil) in each of these cases and what can be done to stop it?

What caused the erosion along the pathway?
Human and native animals' feet killed off the spinifex and scrub. They also dislodged rocks and soil making a furrow. This furrow was used as a river bed during rains, carrying off more rocks and soil.

What can be done to stop the erosion?
Block off the pathway and direct tourists to a formal, properly laid pathway.

What caused the deeply cut gutter running away from the side of the road allowing precious top soil to be washed and blown away?
Rainwater runoff from the road.

What can be done to stop this erosion?
Put in proper drainage channels and drains.

What caused the erosion of the cliff and the loss of the pathway that used to run along the bottom of it?
Storm water waves cutting away at the cliff base.
This is a natural process as a result of geologically recent sea level rises and soft easily eroded limestone cliffs.

What can be done to stop this erosion?
Large heavy rocks can be dumped at the foot of the cliff to break/decrease the erosive power of the waves. Either a major expensive engineering project is needed to rebuild and reinforce the path or it can be re-routed on top of the cliff.

Erosion Revision – Teacher Notes

What caused the erosion of the high plateau to form the ravine?
The river slowly eroded this narrow valley over more than a million years

What can be done to stop this erosion?
The river would have to be dammed and diverted. This is the Fortescue River that runs through Karijini National Park. You can't dam rivers in National Parks!

What caused the erosion that cleared away the sand from around these amazing limestone pillars?
Wind eroded/blew away the sand exposing the rhyzoids (fossil root systems)

What can be done to stop this erosion?
Trees could be planted as a windbreak but again this is a National Park, The Pinnacles.

What caused erosion that cleared away the rock on the far side of Mundaring Weir where some of Perth's water supply is stored?
This quarry was dug out/eroded by man. The rock was taken away to make the base of a railway when the dam was being built.

What can be done to stop this erosion?
Rehabilitate the site by planting native plants.

Erosion – Student Revision

What do you think caused the erosion (moved away the soil) in each of these cases and what can be done to stop it?

What caused the erosion along the pathway?

____

____

What can be done to stop the erosion?

____

____

What caused the deeply cut gutter running away from the side of the road allowing precious top soil to be washed and blown away?

____

What can be done to stop this erosion?

____

What caused the erosion of the cliff and the loss of the pathway that used to run along the bottom of it?

____

____

What can be done to stop this erosion?

____

____

____

____

Erosion – Student Revision

What caused the erosion of the high plateau to create the ravine?

____

____

What can be done to stop this erosion?

____

____

____

What caused the erosion that cleared away the sand from around these amazing limestone pillars?

____

What can be done to stop this erosion?

____

____

What caused erosion that cleared away the rock on the far side of Mundaring Weir where some of Perth's water supply is stored?

____

What can be done to stop this erosion?

____

____

Soils

A Recipe for Soil – Teacher Demonstration

Soils are the top layer of most of the Earth's crust, consisting of the unconsolidated products of rock erosion and organic decay, along with bacteria and fungi.
Soil supports all plant (and indirectly animal) life on land and in the ocean. This photograph demonstrates a cutting through soil and into the underlying limestone rock near Fremantle. A progression upward from yellowish fresh rock to dark humus rich topsoil is visible. Perhaps a road cutting near your school could be used to demonstrate a similar progression?

Will Keith Kellogg, father of the breakfast cereal industry, famously quoted

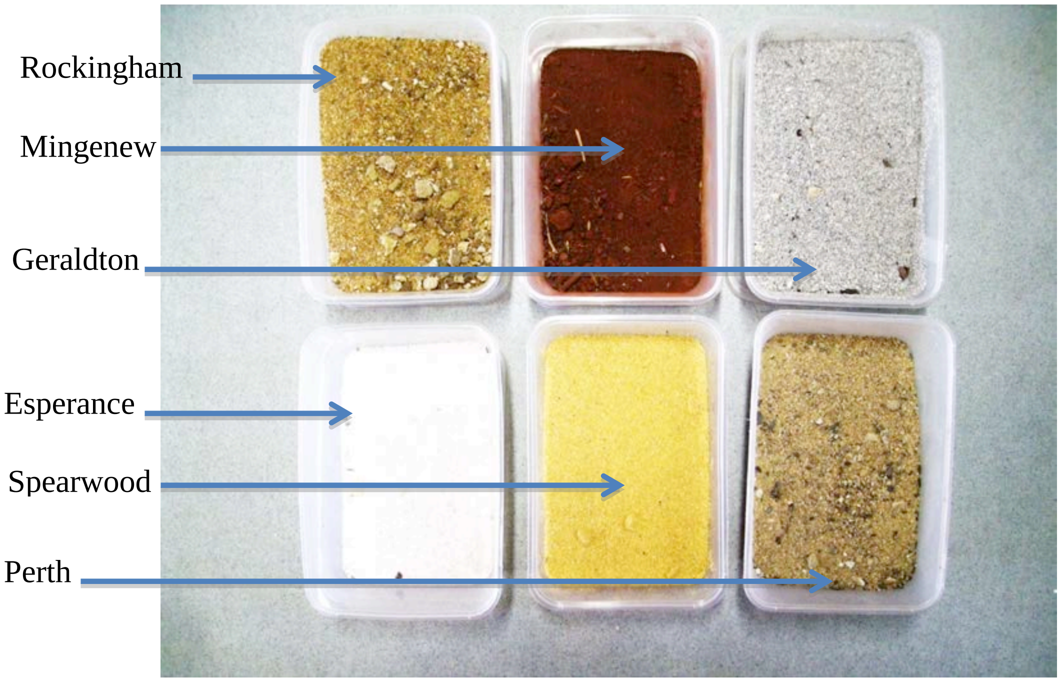
"There is no soil without life nor Life without soil"

Some interesting soil facts

1. One tablespoon of soil has more living organisms than there are people alive on Earth
2. It takes about 200 years to create 1cm of topsoil
3. Nearly all antibiotics used by doctors to fight infections are obtained from soil organisms (mostly fungi). If the name of the medicine ends in "mycin" it is derived from a fungus e.g. streptomycin, Penicillin is also from a fungus.

There are many different soils in Western Australia. Six appear below. Their characteristics depend on:

- The differing chemical composition of rocks from which their mineral fragments came.
- Their history of erosion and deposition (what has been removed and what has been added).
- The climate when the rocks were originally weathered and under which the soils remain.
- The activities of the living things that are in them and around them.



A Recipe for Soil – Teacher Demonstration

Soils are useful resources for:

- Growing food, wood, shelter and recreation areas
- Making rammed earth buildings
- Sheltering decomposers and other animals
- Holding and filtering water
- Burning for fuel (peat)

Teacher Demonstration

Teachers may wish to introduce students to the subject of soils by mixing together materials and asking students what they are making. When students recognise that you are making "soil" you can extend the activity by asking what proportions of each ingredient would be best to create a good fertile soil.
Some students may interchange the words "soil" and "dirt". Technically "dirt" is misplaced soil.

Materials

- A mixing bowl and spoon
- Clean sand (building sand or beach sand)
- Some dry living material (dead leaves, grass etc.)
- Some compost (school garden)
- Water in a jug

What is missing from this mix? Living things. Soil has living things.

Some students may point to desert soil and say nothing lives there. Many living things in desert soil survive when there is no water and in great heat by having a resistant stage in their life cycle. Plants may survive as seeds to revive when it rains. Fungi have hard resistant spores. Algae, bacteria, mosses and lichens can form hard microbial crusts. Some plants hold water reserves in their bodies such as cacti. Trees can have extremely deep roots like the desert oaks. Aboriginal people used to penetrate their hard bark and drink the water their roots were pulling up from many metres below. Animals like the water holding frog (Tiddalick) move underground and change their metabolism to slow down until water is available again. Some mammals such as wallabies and quokkas actually make their own water during the chemical breakdown of food. They also do not have separate systems for defecation and urination and save water by having a single cloaca to do both processes together. Insects like termites build structures that are naturally air-conditioned

Soil Brainstorm – Teacher Notes

This activity will outline the extent of student's prior knowledge and vocabulary.

Descriptive words should be chosen to be:
Objective (mean the same to everyone) such as "red, or grey" or "fine grained".
Not subjective (reflecting personal opinion which may not be shared by everyone) such as "nice", "big" or "horrible".

What do soils look like?
Colours –red/brown/grey/patchy
Wet/moist/dry

What do soils smell like?

Soils only smell when they are moist.
The smell is due to humus.

What do soils feel like?
Damp/gritty/smooth.

Are soils a resource? What are they used for?
Making gardens/growing vegetables/feeding cows/building mud brick houses, making ceramics

Definition of a soil

Weathered rock fragments mixed with living things and their products.

Why is soil a resource? Because they are useful to humans.

Soil Brainstorm – Student Activity

What do soils look like?

What do soils smell like?

What do soils feel like?

Are soils a resource? What are they used for?

Definition of a soil ____

____

Why is soil a resource? ____

____

Soil Colours – Teacher Notes

Note: Moisture in soils affects their colour. For this activity all soils should be left to dry.

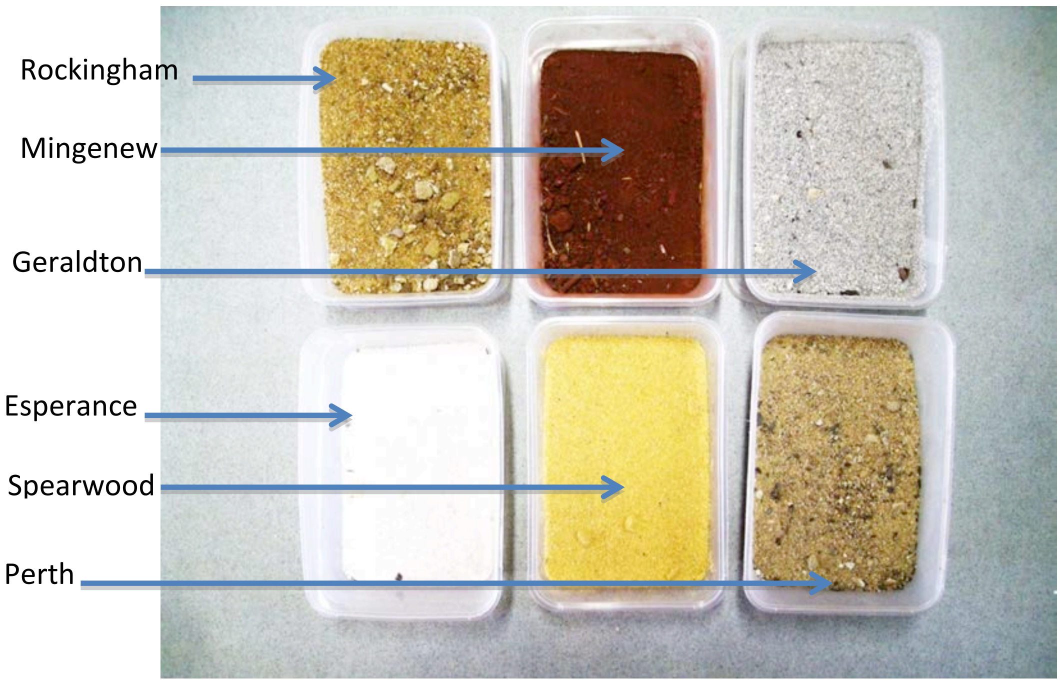
There are many different soils across Western Australia. Their characteristics depend on:

- The differing ***chemical composition of rocks*** from which their mineral fragments came.
  In the photograph below the bright yellow soil from **Spearwood** is from a fossil sand dune, where moving groundwater has leached out all the carbonates making it mostly silica with a little iron to give it colour.
  The white soil from **Esperance** near the coast has come from granites and gneisses. Water and wind have removed all the other minerals leaving pure silica sand.
  The soil from **Geraldton** contains many shell fragments giving it its whitish/grey colour.
  The buff coloured soils from **Perth and Rockingham** lie above and beside weathered limestone.
  The magnificent soil from **Mingenew** was formed from deeply weathered granite. The silica has been leached out leaving silts rich in aluminium and iron. These are the kind of soils farmers love.

- Their ***history of erosion and deposition*** (what has been removed and what has been added).

- The ***climate*** when the rocks were originally weathered and under which the soils remain.

- The ***activities of the living things*** that are in them and around them.



These specimens above were selected because of their colour differences and are not necessarily typical of all soils in these regions.

Soil Colours – Teacher Notes

Materials per student

- Three different coloured soil specimens. (Specimens A, B and C). Sieved potting mix will produce a good fine dark soil. Builder's sand and creek bed soil can be mixed to make a pale soil. Ask the school's gardener or the teacher in charge of the sustainability garden for some good brown soil from the vegetable patch.
- Three pieces of transparent sticky tape about 7cm long.

Method

1. Enter the source location of the soil and describe its colour (e.g. source garden, colour dark brown). It is better to write first before sticking on the specimen.
2. Take a length of sticky tape and press it into each soil sample leaving the ends untouched.
3. Place the tape on the worksheet provided pressing down on the ends to hold it in place.
4. Repeat for the other samples.

NOTE: In scientific reports we usually refer to a colour chart like the one you see for selecting paint in hardware shops. This stops confusion because what one person might see as brown, another may describe as grey. This can be a particular problem with people who are "colour blind".

Observations

Specimen A

Description ____

Specimen B

Description ____

Specimen C

Description ____

Soil colours – Student Activity

There are many different soils across Western Australia. Their characteristics depend on:

- The differing ***chemical composition of rocks*** from which their mineral fragments came.
- Their ***history of erosion and deposition*** (what has been removed and what has been added).
- The ***climate*** when the rocks were originally weathered and under which the soils remain.
- The ***activities of the living things*** that are in them and around them.

Materials per student

- Three different coloured soil specimens. (Specimens A, B and C)
- Three pieces of transparent sticky tape about 7cm long

Method

1. Enter the source location of the soil and describe its colour.
2. Take a length of sticky tape and press it into each soil sample leaving the ends untouched.
3. Place the tape in the worksheet provided pressing down on the ends to hold it in place.
4. Repeat for the other samples.

<u>Specimen A</u>

Description ____

____

____

<u>Specimen B</u>

Description ____

____

____

Soil colours – Student Activity

Specimen C

Description ____

____

____

Humus in Soil – Teacher Notes

Mulch is dry material that has not decomposed. It can be made of organic material and non-organic material such as stones. The Israelis placed three large stones around each tree trunk when they planted out in the desert. Mulch is mostly added as a protective layer on top of the soil to minimise moisture loss, reduce weeds and eventually break down to provide nutrients.

Composting is the process of breaking down living things and their products to enrich soil. Homes built away from town sewerage can have composting toilets. Worms, bacteria and fungi help process the material.

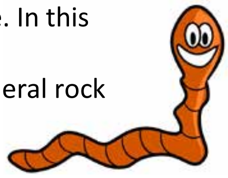
Humus is the end product of composting. It is made of decomposed organic material (living and dead things).

Worms composting my kitchen scraps and shredded newspaper

Both humus and mulch float when soil is mixed well with water.

Student Activity

Please Note
Science uses the expression "living" for anything that is alive or has been alive. In this case both compost and mulch are classified as "living".
"Non-living" is used for things that have never lived. In this case the small mineral rock fragments are "non-living".
Please remove any worms or insects from the soil before starting.



Materials per student or group

- A spoon
- About two tablespoons of good garden soil. The school's vegetable patch might provide this
- A piece of scrap paper to make a cone. This reduces spillage when filling the test tube
- A test tube or small jar with lid
- Water
- A ruler

Humus in Soil – Teacher Notes

Method

1. Place the paper cone with the open end downwards leading into the test tube or jar.
2. Feed soil down the cone into the test tube or jar.
3. Two thirds fill the test tube or jar with water.
4. Draw what you see in the before column.
5. Place your thumb over the top of the test tube to seal it or screw the lid firmly onto the jar. If your thumb is too narrow to seal the top of the test tube you can use the pad of flesh at the base of your thumb.
6. Shake the tube or jar well for 30 seconds. Make sure the water and soil are well mixed.
7. Hold the container upright and immobile to two minutes.
8. Observe what has happened at the top of the water and draw this into the worksheet provided (after).

Observations

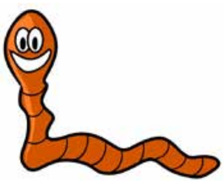
Before	**After**

What did you observe after the soil contents had settled after two minutes?
Dark humus floated to the top of the water in the test tube
The material that floated is called humus. Humus is made from living things and their products.
How thick is the humus layer? Will vary but measurement should include both number and unit. E.g. 2cm
How thick is the rest of the soil? As above e.g. 8cm

What percentage of the soil is humus? $\frac{\text{Humus X 100}}{\text{Humus + Rest of soil}}$ e.g. 25%

Good soil is 10% humus or more. Was the soil you tested good soil? Explain your answer. The soil was good as it had over 10% humus.
What could your school use to make good garden humus? List 4 free things your school could use to make their own humus or compost. Shredded paper & newspaper, food preparation scraps and meal scraps, dead leaves and grass clippings

EXTRA for experts - what do worms have to do with good soil?



Worms with bacteria and fungi break down scraps in the compost bin and in the soils to provide humus that fertilises and conditions the soil making nutrients accessible to plants. Worms also aerate the soil and allow water to penetrate it more easily.

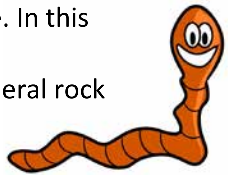
Humus in Soil – Student Activity

Please Note

Science uses the expression "living" for anything that is alive or has been alive. In this case both compost and mulch are classified as "living".

"Non-living" is used for things that have never lived. In this case the small mineral rock fragments are "non-living".

Please remove any worms or insects from the soil before starting.



Materials per student or group

- About two tablespoons of soil
- A piece of scrap paper to make a cone
- A test tube or small jar with lid
- Water.
- A ruler

Method

1. Place the paper cone with the open end downwards leading into the test tube or jar.
2. Feed soil down the cone into the test tube or jar.
3. Two thirds fill the test tube or jar with water.
4. Draw what you see in the before column.
5. Place your thumb over the top of the test tube to seal it or screw the lid firmly onto the jar. If your thumb is too narrow to seal the top of the test tube you can use the pad of flesh at the base of your thumb.
6. Shake the tube or jar well for 30 seconds. Make sure the water and soil are well mixed.
7. Hold the container upright and immobile to two minutes.
8. Observe what has happened at the top of the water and draw this into the worksheet provided.

Observations

Before	**After**

Humus in Soil – Student Activity

What did you observe after the soil contents had settled after two minutes?

____

____

____

The material that floated is called humus. Humus is made from living things and their products.

How thick is the humus layer? ____

How thick is the rest of the soil? ____

What percentage of the soil is humus? $\frac{\text{Humus} \times 100}{\text{Humus + Rest of soil}}$ ____________________%

Good soil is 10% humus or more. Was the soil you tested good soil? Explain your answer.

____

____

What could your school use to make good garden humus? List 4 free things your school could use to make their own humus or compost.

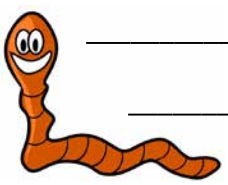
____

____

____

____

EXTRA for experts - what do worms have to do with good soil?



____

____

____

Soil Grain Size– Teacher Notes

Soils are the top layer of most of the Earth's crust, consisting of the unconsolidated products of rock erosion and organic decay, along with bacteria and fungi. Most soils have a variety of grain sizes.
Clay soils are very fine grained and feel smooth and silky to touch.
Silty soils are mostly fine grained but have a slightly gritty texture.
Sandy soils are mostly medium to coarse grained, individual grains being easily seen.
In Soil Science laboratories they sieve soil through expensive brass or stainless steel sieves of different mesh grades. Often seed growing soil mixes require slightly coarser soils because they allow easier penetration of water and developing roots.

A quite efficient, and much cheaper estimation can be made using the natural subconscious ability of our hindbrain or cerebellum to measure the difference between what is sensed by nerves in each hand.

Student Activity

1. Ask your students to place the palm of one hand on their face and the other on the top of their desk and ask them which is cooler? The desk. Did you have to think hard to make that decision? No
2. Ask your students to keep one hand on their face and place the other either on the carpet or on the sole of their shoe and ask them which is rougher? The carpet/sole of the shoe. Did you have to think hard to make that decision? No
3. Repeat with bowls of warm and cool water.

We can compare sensations with our left and right hand effortlessly. By testing the grain sizes in some soil with one hand against the standards of the batten in the other, students can estimate the proportions of coarse, medium and fine particles in the soil without stress.

A Materials to make the standard C, M & F batten
I use garnet paper rather than the traditional sand paper because the red colour is striking and is more able to cover subsequent stains.

- Strong scissors
- 1 sheet of 40-grade sandpaper cut into 2.5cm squares. This is the **c**oarse grain reference.
- 1 sheet of 120-grade sandpaper cut into 2.5cm squares. This is the **m**edium grain reference.
- 1 sheet of 240-grade sandpaper cut into 2.5cm squares. This is the **f**ine grain reference

Soil Grain Size– Teacher Notes

- A piece of stiff cardboard or plastic 15cm by 5cm. The battens in the photograph were cheap plaster scrapers provided by the local hardware store.
- Glue (the stronger the better)
- A pen

Method

Teacher preparation:

1. Cut out the battens.
2. Cut out the sandpaper squares.

Student method:

3. Write your name on the back of the batten
4. Collect a square of each grade of sandpaper
5. Stick the sandpaper onto the batten with the:
   Coarsest at the top.
   Medium at the middle.
   Finest at the foot.
   (You may wish to label them **C, M & F**).

B To measure the grain size of a soil

Materials

- A container of dry soil
- A **CMF** batten
- A hand lens (option)

Method

1. Gently shake the soil a little to separate out the larger grains to one edge of the container (see above).
2. Hold the CMF batten in one hand with your thumb gently rubbing against the coarse sandpaper at the top.
3. Rub the soil between the finger and thumb of the other hand.
4. Is the soil coarser or finer than the sandpaper?
5. Repeat with the medium and fine sandpapers.

Soil Grain Size– Teacher Notes

Observation

Which grain size (or sizes) is in your soil specimen? ________________________________

What proportion of each was there? ____

Discussion

Would the grain size measurements you have collected be considered as good scientific data? Explain your answer.

Although these measurements are good enough for the average gardener, they are not sufficient to be classified as scientific data.

Scientific data has to be:

1. Observable They were
2. Measurable against International Standards. Our results would have to be reported in specific measurements such as between 0.05 and 0.3mm, not as generalisations such as "medium".
3. Repeated We only measured once

This is why soil laboratories use sieves that only permit specific grain sizes to pass through to provide data for their reports.

Soil Grain size– Student Worksheet

Clay soils are very fine grained and feel smooth and silky to touch.
Silty soils are mostly fine grained but have a slightly gritty texture.
Sandy soils are mostly medium to coarse grained, individual grains being easily seen.

In Soil Science laboratories they sieve soil through expensive brass or stainless steel sieves of different mesh grades. A quite efficient, and much cheaper estimation can be made using the natural subconscious ability of our hindbrain or cerebellum to measure the difference between what is sensed by nerves in each hand.

Student Activity

A Materials to make the standard C, M & F batten

- 1 batten (stiff cardboard or plastic)
- 1 square each of coarse, medium and fine garnet paper
- Glue
- A pen

Method

1. Write your name on the back of the batten
2. Collect a square of each grade of sandpaper
3. Stick the sandpaper onto the batten with the:
   Coarsest at the top.
   Medium at the middle.
   Finest at the foot.
   (You may wish to label them **C, M & F**).

Soil Grain size– Student Worksheet

B To measure the grain size of a soil

- A container of dry soil.
- A CMF batten.
- A hand lens (option)

Method

1. Gently shake the soil a little to separate out the larger grains to one edge of the container (see above).
2. Hold the CMF batten in one hand with your thumb gently rubbing against the coarse sandpaper at the top.
3. Rub the soil between the finger and thumb of the other hand.
4. Is the soil coarser or finer than the sandpaper?
5. Repeat with the medium and fine sandpapers.

Observation

Which grain size (or sizes) is in your soil specimen? ____

What proportion of each was there? ____

Discussion

Would the grain size measurements you have collected be considered as good scientific data? Explain your answer.

____

____

____

____

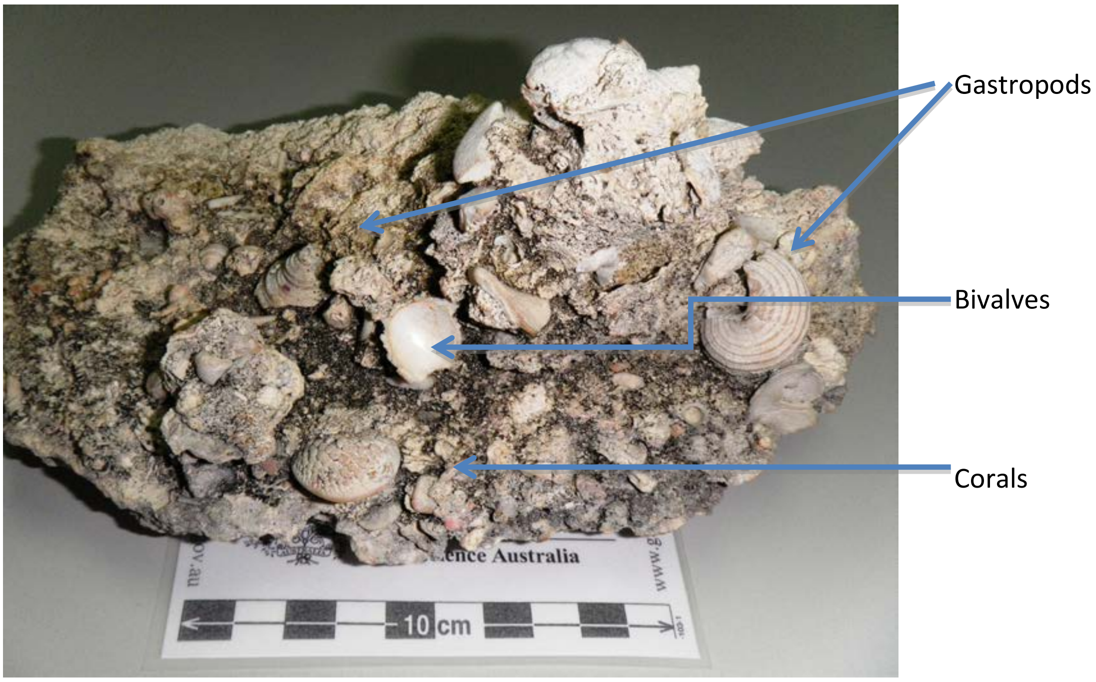
Fossils

Fossil Evidence of Change – Teacher Notes

Students may need access to an atlas or map of Western Australia to find where these specimens come from.
Hutton, the father of modern geology said, "**The present is the key to the past".**
We should be able to interpret the environment in which rocks and fossils from the past were laid down by comparing and contrasting them with ones found in our present times. Fossils are the petrified (turned into rock) remains of living things. Material is soaked in mineralised groundwater within the Earth to become fossils.

Very few remains of living things survive to be fossilised. Most are eaten by predators or broken apart by decomposers. To survive as a fossil, the living thing has to die and be rapidly buried to keep away scavengers and to exclude oxygen, restricting bacterial growth.

Fossils can tell us about changes in landscapes over geological time.



Seventy thousand year old fossiliferous limestone found 5m above present sea level near Hamelin Bay in Southwest WA

What change in landscape must have taken place to explain why fossilised beach shells lie above present day sea level? Either the land must have risen or the sea level fallen. In this case the sea level has fallen.
Because the fossilised (mineralised) shells are mostly whole or only broken into large pieces we can interpret that 70,000 years ago, it was a storm beach where waves only reached occasionally. Shells that wash up and down on present day beaches are quickly broken into small fragments. The shells are very similar to those that we have today but there are slight changes.

Similar, but much earlier fossil beaches are found near the top of Mt Everest at 8,400m. Everest is the tallest mountain in the world. What changes in landscape must have taken place for this to occur? The mountain must have risen. Everest continues to rise about 4mm per year as India pushes northward under the Euro-Asian tectonic plate.

The fossil on the left was found in a road cutting high in the hills of Cape Range National Park east of Ningaloo Reef. The fossil has been estimated as about 23 million years old. The coral skeleton on the right was found washed up on a beach just outside Ningaloo Reef recently.
Is the modern coral skeleton similar to that of ancient fossil? Yes. They are both of the same species.

What can we interpret from this evidence? The ranges were undersea about 23 million years ago and the climate in both cases must have been similar, since corals only grow in clear warm waters.

These three teeth are from sharks. The one on the right is from a modern shark whilst the other two are probably from about 40 million years ago. The one on the left is from northern Australia, the one in the centre is from Texas in the USA and the one on the right is from New Zealand.

What can we interpret from this evidence? Sharks have very wide ranging territories and they have changed little over a very long time. Apart from the fact that the areas the fossils came from are now on land and in the past they must have been marine, we can interpret very little.

EXTRA FOR EXPERTS

Some depositional features can also be "fossilised". The wind or water laying down the silt and sand will make patterns in the sediment, which then becomes rock.

What do the sedimentary features in this 1.6 billion year old sandstone from the mountain ranges near Tom Price remind you of? Ripples in sand near the shore.
What would the landscape have been then? The sandy edge of a shallow sea.

This bed of rock lies immediately above the specimen above and so must be younger.

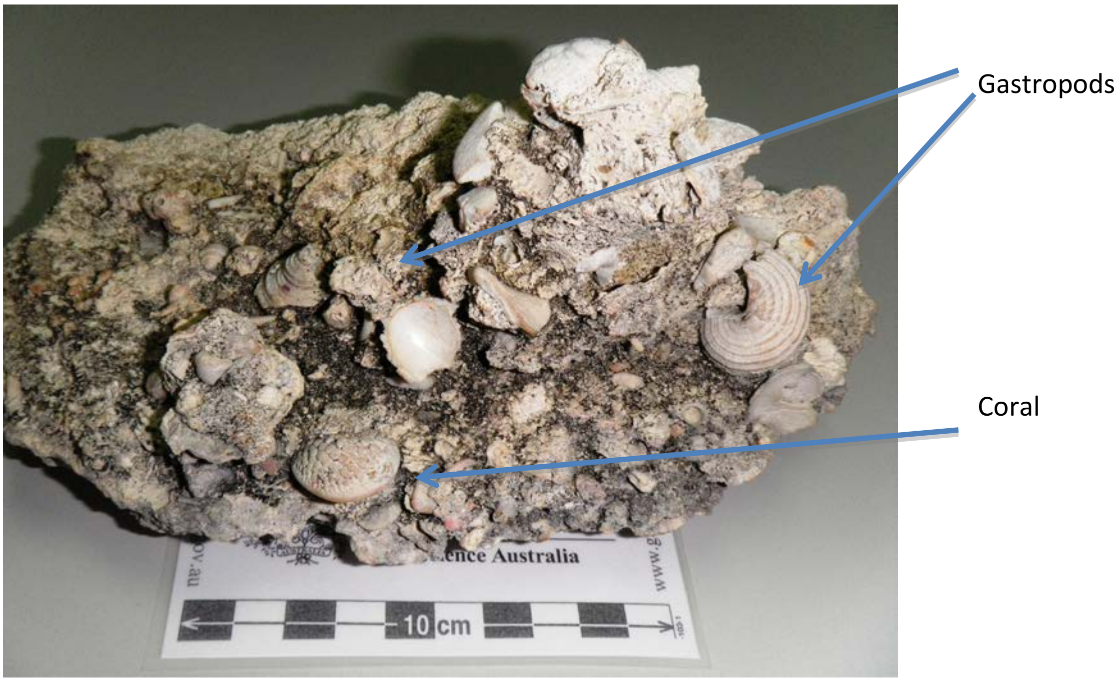
What do you think this pattern was created by? The sand and mud drying out in sunshine and mud cracks forming.
So, what changes happened in this very ancient landscape over the time it took these two rocks to be deposited?
The sea dried up and the mud cracked or the land rose, exposing the sands and mud to sunshine.

Fossil Evidence of Change – Student Activity

Hutton, the father of modern geology, said, “**The present is the key to the past”.**
Clues about past times can be found by looking at evidence from the present day.

Fossils are the petrified (turned into rock) remains of living things. Very few remains of living things survive to be fossilised. Most are eaten by predators or broken apart by decomposers.

Fossils can tell us about changes in landscape over geological time.



Seventy thousand year old fossiliferous limestone found 5m above present sea level near Hamelin Bay in Southwest WA

What change in landscape must have taken place to explain why fossilised beach shells lie above present day sea level?

____

Because the fossilised (mineralised) shells are mostly whole or only broken into large pieces we can interpret that 70,000 years ago, it was a storm beach where waves only reached occasionally.

Similar, but much earlier fossil beaches are found near the top of Mt Everest at 8,400m. Everest is the tallest mountain in the world.

What changes in landscape must have taken place for this to occur? _______________

____

____

Fossil Evidence of Change – Student Activity

The fossil on the left was found in a road cutting high in the hills of Cape Range National Park east of Ningaloo Reef. The fossil has been estimated as about 23 million years old. The coral skeleton on the right was found washed up on a beach just outside Ningaloo Reef recently.

Is the modern coral skeleton similar to that of ancient fossil? __________________________

What can we interpret from this evidence? ____

____

These three teeth are from sharks. The one on the right is from a modern shark whilst the other two are probably from about 40 million years ago. The one on the left is from northern Australia, the one in the centre is from Texas in the USA and the one on the right is from New Zealand.

What can we interpret from this evidence? ____

____

EXTRA FOR EXPERTS!

Some depositional features can also be “fossilised”. The wind or water laying down the silt and sand will make patterns in the sediment, which then becomes rock.
What do the sedimentary features in this 1.6 billion year old sandstone from the mountain ranges near Tom Price remind you of?

____

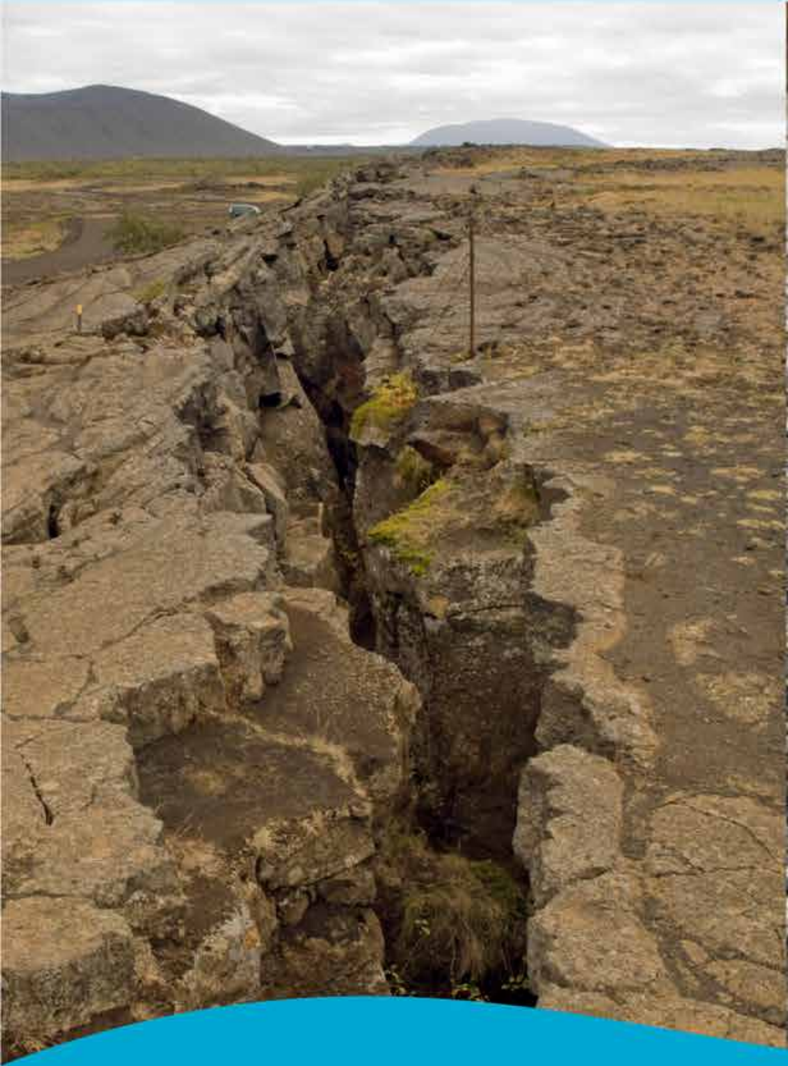
What would the landscape have been then? ____

This bed of rock lies immediately above the specimen above and so must be younger.
What do you think this pattern was created by?
____

So, what changes happened in this very ancient landscape over the time it took these two rocks to be deposited?

____

Landscape Changes



Loss of Topsoil – Teacher Demonstration

Teacher demonstration

Materials

- A bucket
- Water
- An area of lawn
- A similar sized area of sandpit or un-vegetated soil

Method

1. Half fill the bucket with water and ask a student to swill it onto the lawn.
2. Observe the effect of the "flood" on the grassed area.
3. Repeat on the area without vegetation.

Observations

Effect of vegetation on soil loss	Effect of no vegetation on soil loss
Roots held the topsoil together and the flood only slightly scoured a channel in the soil	**The flood scoured out a channel in the sand and moved away most of the soil to be dumped elsewhere**

Vegetation protects the flooded area and stops dumping downstream.

The effect of flooding on vegetation. This riverbank has been stripped away.

Loss of Topsoil – Teacher Demonstration

When floodwaters cover vegetation for any time many plants die. They die because:

1. The energetic water movement and carried debris will uproot plants and damage them. Floodwater also exposes plant roots by carrying away precious topsoil.
2. They cannot access oxygen for respiration (energy production) because of the barrier of covering water.
3. They cannot access carbon dioxide to make their own food through photosynthesis. Because of the barrier of covering water
4. Floodwater is murky and full of silt. Light cannot penetrate the water to power photosynthesis. As water movement subsides silt settles out to cover the plants.
5. Floodwater is colder than the air above and this slows plant growth and recovery. (The enzymes necessary for plant activity are only optimal between the temperature ranges that plants would normally experience).
6. Good topsoil is washed away leaving poorer soil below

Anaerobic bacteria thrive in the nutrient rich, damp, oxygen poor environment left as everything dries out. The stink of incomplete decomposition is unforgettable and disgusting.

Loss of Topsoil – Student Worksheet

Teacher Demonstration

Materials

- A bucket
- Water
- An area of lawn
- A similar sized area of sandpit or un-vegetated soil

Method

1. Half fill the bucket with water and swill it onto the lawn.
2. Observe the effect of the “flood” on the grassed area.
3. Repeat on the area without vegetation.

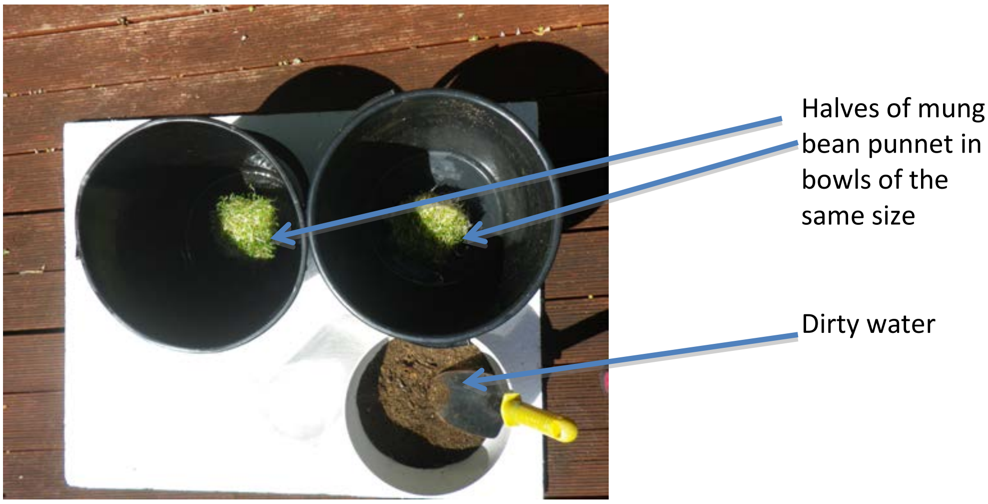
Observations

Effect of vegetation on soil loss	Effect of no vegetation on soil loss

Vegetation protects the flooded area and stops dumping downstream.

What effect has flooding had on this river?

The Effect of Floodwater on Plants – Teacher Notes



We shall be copying the effects of floodwater on plants by leaving one pot of plants under normal water and submerging another pot of plants in floodwater.

What do we have to do to ensure our experiment is a "Fair test?"

Hint: Cows Moo Softly

We **C**hange one thing
We **M**easure one thing
And everything else **S**tays the **S**ame

What is the thing we have to change? One lot of vegetation must be covered in floodwater
What is the thing we have to measure? The condition of the vegetation after spending several days covered in water
What do we have to keep the same? Everything else. We must keep the same kind of vegetation, the same light and heat, and use the same equipment.

Materials (suggested)

- Two clumps of vegetation the same type and size. Two sods of grass or weeds are good as is an inexpensive box of sprouted mung beans or alfalfa seeds slit into two equal sized portions
- Two buckets of the same size and colour
- "Floodwater" sufficient to completely immerse the plants. (I recommend mixing three or four handfuls of garden soil in a bucket of water).
- Two heavy objects to pin down the plants to the bottom of the buckets. Trowels are ideal.
- Some water to keep the "dry" plant alive.

Method

1. Place the two same sized plants each into their own bucket.
2. Place the buckets in a safe place where they will remain.
3. Hold the plants in place at the bottom of the buckets using the trowels
4. Stir up the floodwater mix and pour into one bucket holding the plant at the bottom of the bucket with the trowel. Leave this trowel in place for the rest of the experiment or the plant will float up to the surface.
5. Daily sprinkle the "dry" plant with water to keep it alive and stir up the floodwater to spread the silt about.

The Effect of Floodwater on Plants – Teacher Notes

Observations

The floodwater (immersed) plant became flattened, silt covered and rotted away. (The speed of rot depends on temperature). The "dry" plant remained healthy.

Discussion

How would flooding affect landscape? Plants would die and the soil previously held together by their roots could blow away in the wind.

Extension

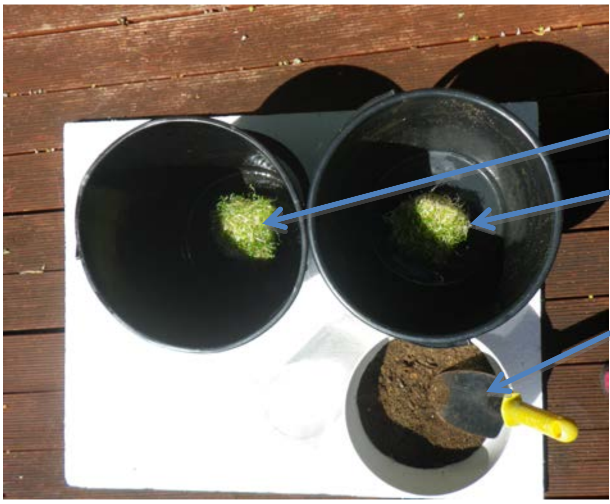
Visit http://www.floodsafe.com.au/learn-more-about-floods/floodwater-dangers and list the main cause of human deaths in floodwater.

List four reasons why you should never enter floodwaters.

It can be terribly tempting to want to lower yourself into apparently smooth flowing floodwater or to try to wade or drive across a flooded creek. This is not a good idea.
You cannot tell from the surface:

- How deep the water is.
- How much debris is being swept along that could injure you or snag you.
- How fast the flood is flowing at depth.
- Whether the water is clean or polluted with sewerage.

The Effect of Floodwater on Plants – Student Activity



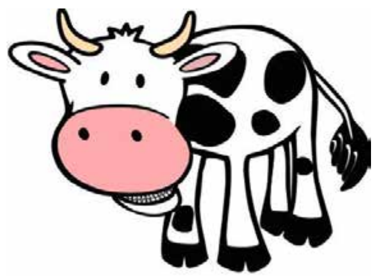
Halves of a punnet of mung bean seedlings.

Mixed soil & water to make floodwater

We shall be copying the effects of floodwater on plants by leaving one pot of plants under normal water and submerging another pot of plants in floodwater.

What do we have to do to ensure our experiment is a **Fair test?**

Hint Cows Moo Softly



We **C** ______________ one thing

We **M**____________________ one thing

And everything else **S**_________ the **S**________________

What is the one thing we have to change? ____

____

What is the one thing we have to measure? ____

____

What do we have to keep the same? ____

____

Materials

____

____

____

The Effect of Floodwater on Plants – Student Activity

____

____

Method

____

____

____

____

____

____

____

Observations

____

____

____

Discussion

How would flooding affect landscape? ____________________________________

____

Extension You don't know what you are getting into!

Visit http://www.floodsafe.com.au/learn-more-about-floods/floodwater-dangers and state the main cause of human deaths in floodwater.

List four reasons why you should never enter floodwaters.

____

____

____

____

Changes Due to Drought– Teacher Notes

We live in the world's driest inhabitable continent
The most recent major drought from 2002 – 2003 took its toll on the landscape and on farmers. Winter 2002 was the fourth driest in WA for over a century. Drought occurs when the normal water needs of people cannot be met by rainfall.

Droughts can cause severe erosion because of loss of vegetation, which holds the soil in place. Droughts cause dams and watercourses to dry up leading to loss of water quality and to algal blooms.
Drought also encourages increased evaporation pulling salt to the surface of the landscape
Severe bushfires and dust storms are more likely during droughts.

Wind

Dry sand and soil is easier to blow and wash away than wet sand. When drought hits the land, shallow rooted plants die and the topsoil held in place by those roots can be removed and is blown out to sea and lost.

The erosive power of wind is strongest close to the ground, so sand carried in the wind is most abrasive closest to the ground. This explains undercutting near ground level of large granitic outcrops such as the Hippo's Yawn at Wave Rock.

I couldn't walk my little hairy dog on the beach when there was a strong westerly wind as sand blew into his eyes. Being somewhat taller, I found that although my knees were blasted by sand, my eyes were quite unaffected, unless the wind was particularly strong. I could however walk the dog on the lawns behind the beach where although the wind was still blowing equally strongly. In the grassed area, sand and soil were held in place by damp soil and grass.

The following short activities ask students to **predict** (guess ahead) what will happen.

Observing How Damp Soil is More Resistant to Wind than Dry Soil

This activity can be messy with excitable classes. Although it can be carried out on desks covered with old newspaper, it is easier to clean up if carried out in the sandpit or on the walls surrounding it.

Materials

- Moist sand or soil and dry sand or soil (Sand is less messy)
- Drinking straws
- Sandpit or garden
- Water

Changes Due to Drought– Teacher Notes

Before blowing

After blowing

Method

1. Make two "sandcastles", both the same size but one with dry sand and the other with moist (not wet) sand. An alternative is to fill half a take away container with wet sand and half with dry (as pictured).
2. **Predict** what you think will happen if the wind blows across dry sand and wet sand.
3. Blow through the straw for 10 seconds on each castle.
4. **Compare and contrast** what happened to the two sandcastles.
   HINT "**Compare**," means what was the same between them.
   "**Contrast**" means what was different between them.

Prediction It doesn't matter if the student gets the correct prediction or not as long as the prediction is reasonable.

Observations
What could you **compare** between the wet sand and dry sand? Same size, same material, same activity etc.
What **contrasted** between them? The dry sand blew away faster than the wet sand. More sand blew away from the dry sand than the moist one.

Discussion
What changes to the landscape do you predict will happen if wind blows across a drought stricken landscape? Soil will blow away exposing bare rock. Precious topsoil will be blown away and farmers cannot plant their crops.

Observing How Drying Soil Brings Salt to the Surface

Salt from the sea is blown in on the wind onto our landscape. Some salt also comes from rivers drying up. These processes have been going on for millions of years. Salt is usually dissolved when it rains and is carried down through the soil. It usually rises to the surface when drought occurs. Scrubs and trees use groundwater and release it into the air. When drought occurs vegetation dies and groundwater is allowed to rise to the surface of the land bringing up salt. When the water evaporates, a crust of salt is left on the land. Most plants cannot tolerate salt and die.

Changes Due to Drought– Teacher Notes

Materials

- A plastic cup or small beaker
- Sand or soil
- Salty water. Just mix salt into warm water until no more will dissolve.

Method

1. Almost fill the cup with sand
2. Pour in the salty water until the soil or sand is all damp
3. Place cup on warm windowsill and observe

The salt will rise to the surface as the water and evaporate forming a thick salty crust. The speed at which it does this depends on the local climate. In a hot dry area, salt should start appearing in one week.

Changes Due to Drought – Student Activity

We live in the world's driest inhabitable continent

Droughts can cause severe erosion because of loss of vegetation, which holds the soil in place. Droughts cause dams and watercourses to dry up leading to loss of water quality and to algal blooms. Drought also encourages increased evaporation pulling salt to the surface of the landscape. Severe bushfires and dust storms are more likely during droughts

When drought hits the land, shallow rooted plants die and the topsoil held in place by those roots can be removed and is blown out to sea and lost.

The erosive power of wind is strongest close to the ground, so sand carried in the wind is most abrasive closest to the ground. This explains undercutting near ground level of large granitic outcrops such as the Hippo's Yawn at Wave Rock.

Observing How Damp Soil is More Resistant to Wind than Dry Soil

Materials

- Moist sand or soil and dry sand or soil
- Drinking straws
- Sandpit or garden
- Water

Method

1. Make two "sandcastles", both the same size but one with dry sand and the other with moist (not wet) sand.
2. **Predict** what you think will happen if the wind blows across dry sand and wet sand.
3. Blow through the straw for 10 seconds on each castle.
4. **Compare and contrast** what happened to the two sandcastles.
   HINT "**Compare**," means what was the same between them.
   "**Contrast**" means what was different between them.

My Prediction ____

____

Observations

What could you **compare** between the wet sand and dry sand? ______________

____

Changes Due to Drought – Student Activity

What **contrasted** between them? ____

____

Discussion

What changes to the landscape do you predict will happen if wind blows across a drought stricken landscape?

____

____

____

Evidence of Local Landscape Change – Student Activity

Collect evidence of changes to Earth's surface in your local area and make a poster demonstrating these changes.

The poster should describe at least one example of:

- Local weathering causing change
- Erosion causing change
- Human activity causing change

Each example should have:

• A title explaining the type of change	1 mark each
• A photograph or drawing of the location	4 marks each
• Labels indicating the change	1 mark each
The poster should have a clear title	1 mark
The poster should be easy to read	1 mark
Your name clearly written on the back	1 mark

Total marks

Hints

1. ***Reduce the words to only those, which are necessary. Most good posters rely on clear images and few colours***
2. ***Select the best example you can find.***
3. ***If in doubt, check with your teacher.***

This poster is due ____

Man-made Changes

Man-made Changes – Teacher Notes

This activity encourages students to sketch what landscape changes would be visible as a result a change in human activity over the last 160 years. A suggested sketch of what students might draw is appended. In Science, the ability to produce a labelled sketch is important. Labels can be used to highlight changes.

1. In the first scene there would be trees, bushes and animals. Because Aboriginal people visited the area only when there was good food and they were careful to “Care for Country”. There would be no obvious tracks or buildings. Students might sketch a “whirly” or temporary shelter.

2. In the second scene the explorer would have cut and tramped a narrow track through the scrub for himself and his horse. They may also have left cuts or “blazes” on tree trunks at about eye height so they would know their way back. Most of the tall trees would remain standing, as would most animals. Aboriginal people might continue to hunt game and gather small game, roots, vegetables, seeds and nuts across this area.

3. By the third scene tree density would be less as loggers cut and removed hardwood from the bush. Large trees would be selected first. Dragging out trees would need wider paths for teams of horses. This would have scared away some native animals and Aboriginal people.

4. The farmer would have cut down trees, dragged away smaller bushes and set the wood on fire to expose the land to European farming practises. The farmer would need to build shelter for his family, animals and equipment. The toilet would probably be an outside “dunny”. A bore or well and water tank would be necessary to provide water for the family and their animals. Any cropping areas and the vegetable patch would have to be fenced to keep out animals. Storage silos for fertiliser and seed might be seen on the farm property. To carry wagons of crops to market, roads would have to be widened and improved. Few native animals would still be in the area

5. A change in farming practice from broad acre farming to dairy would mean fences would be built. A dairy would also have to be built to provide the infrastructure to collect milk from the cows and trucks bought to take the milk to buyers for processing. The farming family would expect to have telephone connections, running water and an inside toilet. Radio and television reception would also be expected. The road would be sealed and signs might be visible.

6. The area is becoming urbanised. The old farmstead might remain or it might have been bowled over for redevelopment. Each house would expect to be connected to mains water and sewerage. Increased population could support supermarkets and schools. Very few native animals remain but birds may still visit the area.

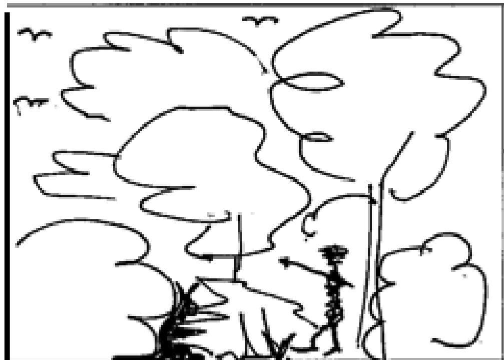
Man-made Changes – Teacher Notes

Humans change their landscape over time depending on land use and peoples expectations.

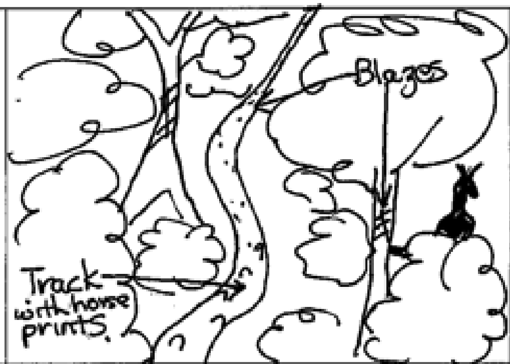
200 years ago this area was "all trees" with kangaroos and possums. Aboriginal people would come to hunt and collect food.	139 years ago an explorer came and beat a pathway through the trees wide enough for a man and a horse.	40 years later loggers came and cut down the trees. The wood was exported to England. This was Western Australia's first moneymaking export.
A farmer needed land. He cleared away the stumps and bushes, built a house and planted wheat.	40 years ago the price of wheat fell so he brought in dairy cows and fenced off the paddocks.	The town grew and needed more land for people to live in. A new suburb was built with its own school.

Man-made Changes – Teacher Notes

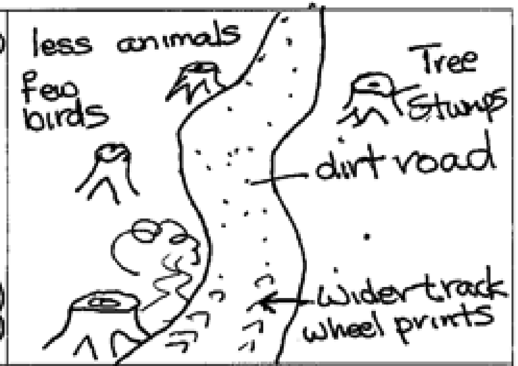
This is a suggestion of what students might sketch to show how landscape may change over time due to human activities



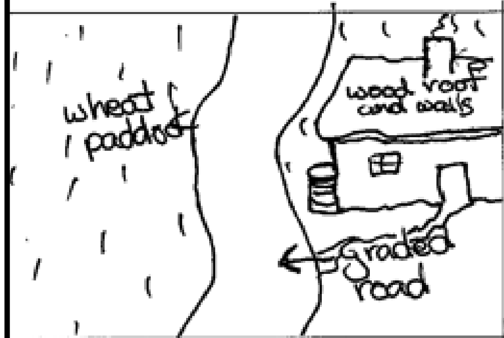
200 years ago this area was" all trees" with kangaroos and possums. Aboriginal people would come to hunt and collect food



139 years ago an explorer came and beat a pathway through the trees wide enough for a man and a horse.



40 years later loggers came and cut down the trees. The wood was exported to England. This was Western Australia's first money-making export.



A farmer needed land. He cleared away the stumps and bushes, built a house and planted

40 years ago the price of wheat fell so he brought in dairy cows and fenced off the

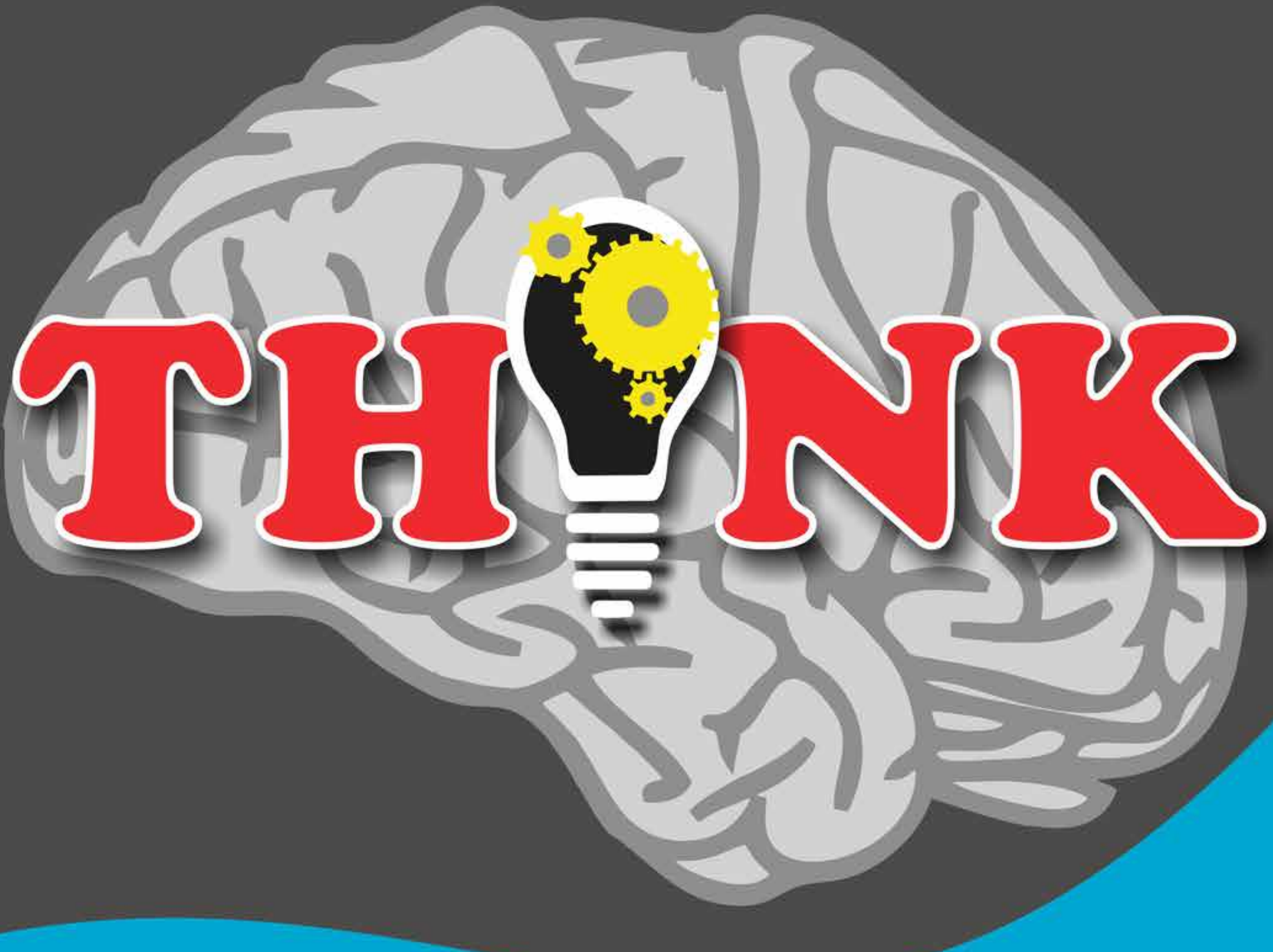
The town grew and needed more land for people to live in. A new suburb was built with

Man-made Changes – Student Worksheet

Humans change their landscape over time depending on land use and peoples expectations.

200 years ago this area was" all trees" with kangaroos and possums. Aboriginal people would come to hunt and collect food.	139 years ago an explorer came and beat a pathway through the trees wide enough for a man and a horse.	40 years later loggers came and cut down the trees. The wood was exported to England. This was Western Australia's first moneymaking export.
A farmer needed land. He cleared away the stumps and bushes, built a house and planted wheat.	40 years ago the price of wheat fell so he brought in dairy cows and fenced off the paddocks.	The town grew and needed more land for people to live in. A new suburb was built with its own school.

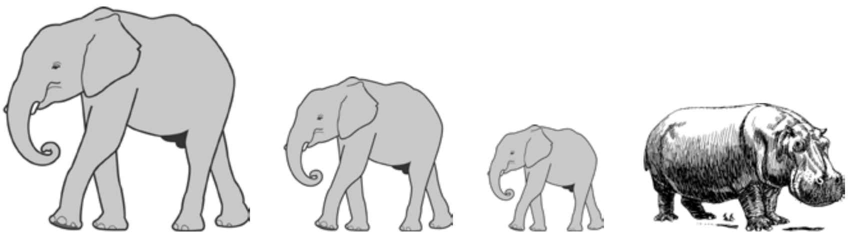
Critical Thinking



Critical Thinking – Teacher Notes

This can be run as a "Think, Pair Share" activity or as a general class discussion
"Science is just trained and organised common sense"

All Elephants are Grey - Discussion



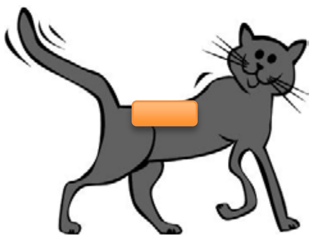
Statement 1 "All elephants are grey"
Statement 2 "That animal on the right is grey. It must be an elephant!"

This expansion is a simple logical extension of the first statement but is it correct?
Discuss this with your group and write what you think below.
Answers will vary

As scientists we have to reflect on what we know and decide if Statement 2 agrees with what we have already observed and read about. Is there anything we need to know or research before we decide if Statement 2 is true? Yes. We need to know:

1. If all elephants really are grey. Actually some Asian elephants are reddish brown.
2. If the grey animal has other important characteristics that it shares with elephants. It doesn't have a trunk, or big ears and it prefers to eat water plants. It is a hippopotamus that happens to be grey!

A good scientist does not make a statement based on only one observation then design an experiment



Hot, Buttered Cats – Discussion

Statement 1 Cats always fall on their feet
Statement 2 Buttered toast always falls buttered side down.

Does this mean that if you strap buttered toast onto the back of a cat and push it off a high ledge, the cat will not fall? No. This is too simplistic, although some people would argue that the cat would start spinning in space and never fall to the ground

Should scientists try this experiment to see what happens? No. Scientists should be ethical and treat living things with respect. No cats should be damaged to prove or disprove this flawed argument!

Discuss how you could test the idea put forward in **statement 2** and design an experiment to test this idea.

Critical Thinking – Teacher Notes

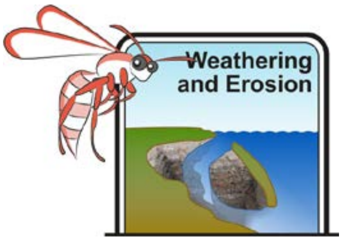
Use these headings:

Aim	(What are you testing?)
Materials	(What equipment do you need?)
Method	(What will you do?)
Observations	(What could you see, feel, smell, and hear and what measurable data did you collect?)
Conclusion	(What idea could the data collected support)

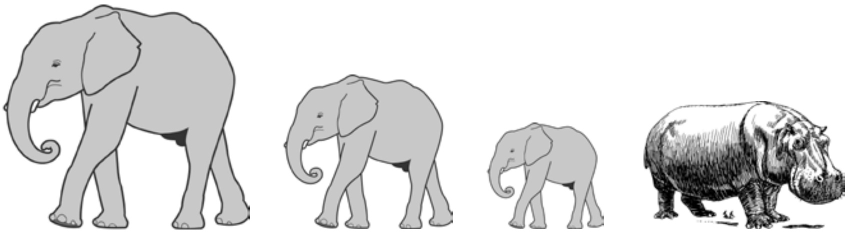
"But it didn't work!"
Students may need to be convinced that a negative result is as important as a positive one.
Knowing that a material is useless for writing on will stop others trying to use it.
Knowing which medicines don't work will save expense and lives and keep researchers looking for a cure.

Students can use **C**ows **M**oo **S**oftly as a guide. If your school has a canteen, sometimes they will give you old bread to test this. It is a fun experiment and demonstrates well that when there is more than one variable (student size, how the bread is dropped, how far the bread is dropped, if a wind is blowing, not all slices are equal in size and equally buttered etc.) a range of results is collected and the experiment has to be repeated several times and the results averaged to get a meaningful result. Whether bread falls butter side down depends on how far it falls and how it is dropped (assuming the students all held the bread at the same height and each slice was the same size).

Critical Thinking – Student Activity



All Elephants are Grey – Discussion



Statement 1 “All elephants are grey”
Statement 2 “That animal on the right is grey. It must be an elephant!”

This expansion is a simple logical extension of the first statement ……… but, is it correct? Discuss this with your group and write what you think below.

____

____

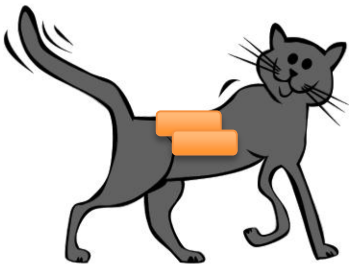
As scientists we have to reflect on what we know and decide if Statement 2 agrees with what we have already observed and read about. Is there anything we need to know or research before we decide if Statement 2 is true?

____

____

____

A good scientist does not make a statement based on only one observation then design an experiment



Hot, Buttered Cats – Discussion

Statement 1 Cats always fall on their feet
Statement 2 Buttered toast always falls buttered side down.

Does this mean that if you strap buttered toast onto the back of a cat and push off a high ledge, the cat will not fall?

____

____

Should scientists try this experiment to see what happens? Explain your answer.

____

____

Discuss how you could test the idea put forward in statement 2 and design an experiment to test this idea.

Use these headings

AIM (What are you testing?) ____

____

Materials (What equipment do you need?)____

____

____

Method (What will you do?) ____

____

____

Observations (What could you see, feel, smell, and hear and what measurable data could you collect?)

____

____

____

____

Conclusion (What idea did the data collected support)

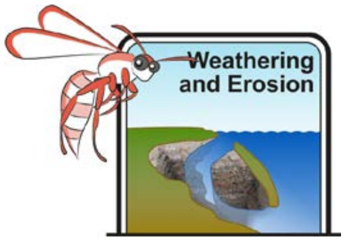
____

____

____

____

____



Evidence of Change – Teacher Notes

Senses and common sense

These activities are to provide a basic understanding of how scientist collect data and how they conduct experiments.

Science is just trained and organised common sense. (J.H. Huxley)

Our survival depends on our senses to tell us if there are changes in our surroundings and then our brain determines whether the change provides an opportunity or a threat and suggests the best response. Scientists observe and measure changes and then try to give the best possible reasons why change occurs.

Name our five senses Sight, Smell, Touch, Hearing, Taste.

Which sense do we ***NOT*** use in Science unless told to by the teacher? Please explain the reason for your answer. We do not use our sense of taste because many things are poisonous or unclean. We do not wish to become damaged or dead.

What does a scientist do if they want to smell something? They gently waft the air above the material towards their nose.

When a scientist describes anything they have to be careful that everyone will understand exactly what they mean.

Three people saw the same thing and described it.
“It was huge and frightening and I did not like it”.
“It was quite small and had poor dress sense”.
“I found it amusing.”

What do you think they were describing? Responses will vary

Why are the descriptions so different? These descriptions are subjective not objective. They relate only to each persons size, preferences and experience.

Which of these footprints is big and which is small?

A is small and B is big

Which of these footprints is big and which is small?

A is big and B is small

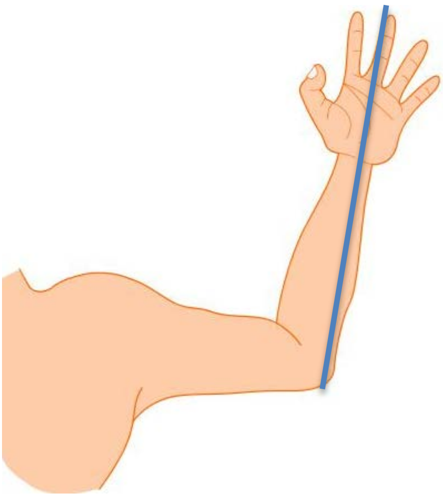
Evidence of Change – Teacher Notes

How can the same footprint (A) be both big and small? They only relate to each other.

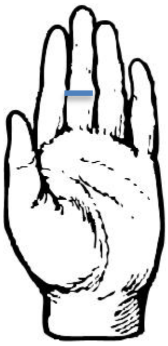
Do scientist use relative descriptions such as” bigger” or “hotter” or “nice” in their reports No

Measurement and Standards

In olden times people did not use standard measurements so that measurements could be different in different places. Authorities tried to produce standard lengths to stop disagreement in trade and taking taxes. In many parts of the ancient world the basic measurement of length was one cubit. This is the distance from your middle finger tip to the bottom of your elbow.



One cubit



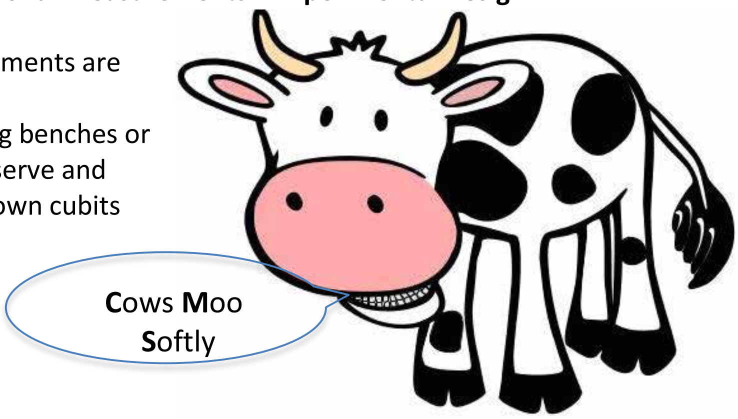
One digit

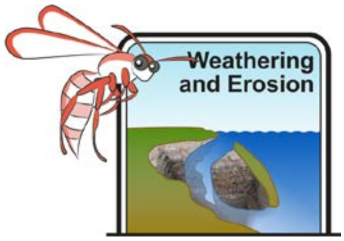
To make things more confusing in Egypt the “Royal” cubit was 27 digits whereas earlier in Mesopotamia the Royal cubit was 30 digits!
If you had to pay one dollar per cubit to buy cloth in the market, in which country would you get the most cloth for your dollar? Assuming the measurement of 1 digit was the same in both places, you would get more in Mesopotamia, but the digit units in both countries were not the same size.

Using the few standard cubit rods uncovered during archaeological digs, the Egyptian cubit was 525mm whereas the Mesopotamian one was 497mm. So you would get more cloth in Egypt!

Compare Standard Measurements and Personal Measurements – Experimental Design

TEST the assumption that standard measurements are necessary for science data
This activity is most easily done outside using benches or tables in the yard. Students are asked to observe and measure the length of the table using their own cubits and digits and then repeat using a standard ruler. They then return to the classroom and their measurements are boarded.





Evidence of Change – Teacher Notes

To make a good science experiment, we must:

Change one thing — Arms or ruler for measuring

Measure one thing — The length of the table or bench

Discuss/class vote which units would be best

Kilometres?

Metres?

Centimetres?

Millimetres?

S Everything else **s**tays the **s**ame. (Same students, same class, same school, same table, same time, same season etc.)

Materials (What would you need?)

- Worksheet and pencil or pen
- 1 ruler per group
- Students
- Calculator

Method (What will you do?)

1. Measure the length of the table or bench using a standard ruler
2. Enter this data in the table provided for your observations.
3. Repeat using your arm and finger to measure the table in cubits and digits
4. Add up each column and enter the total figure.
5. Divide the total by the number of readings to find the average for both
6. Copy this into the table provided below

Observations (What data did we collect)

Student name	Length in cubits & digits	Length in cm or mm
Average length = $\frac{\text{Total length}}{\text{Number of students}}$		

Conclusion (What did the data above suggest about using relative or non standard measurements compared to standard measurements?) If you use subjective or non-standard measurements then the results cannot be compared but if you use standard measurements the results are the same/comparable. This is a “Fair Test”.

In science experiments we use:

Rulers — to measure distance

Thermometers — to measure heat and cold

Weighing machines — to measure weight or mass

Can you think of any other things we use to measure things in Science?

Answers will vary

Evidence of Change – Teacher Notes

Extension Students can design and carry out their own tests using the CMS model.
Do boys or girls have longer arms? If you have a single sex class this could be changed to brown-eyed people have longer cubits than blue-eyed people

Evidence of Change – Student Activity

Science is just trained and organised common sense. (J.H. Huxley)

Scientists observe and measure changes and then try to give the best possible reasons why that change happens.

Name the five senses we use to observe changes. ______________________________

____

Which sense do we ***NOT*** use in Science unless told to by the teacher? Please explain the reason for your answer.

____

What does a scientist do if they want to smell something? ________________________

____

When a scientist describes anything they have to be careful that everyone will understand exactly what they mean.

Three people saw the same thing and described it.
“It was huge and frightening and I did not like it”.
“It was quite small and had poor dress sense”.
“I found it amusing.”
What do you think they were describing? ___________________________________

Why are the descriptions so different? _____________________________________

____

Which of these footprints is big and which is small?

____

Which of these footprints is big and which is small?

____

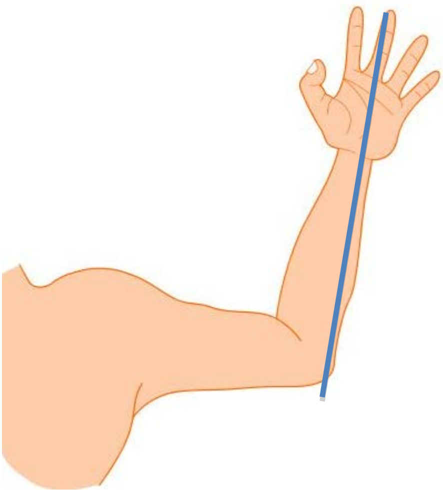
How can the same footprint (A) be both big and small? ______________________________

Do scientist use relative descriptions such as ” bigger” or “hotter” or “nice”? _______________

Evidence of Change – Student Activity

Measurement and Standards

In olden times people did not use standard measurements so that measurements could different in different places. In many parts of the ancient world the basic measurement of length was one cubit. This is the distance from your middle finger tip to the bottom of your elbow.



One cubit

One digit

To make things more confusing in Egypt the “Royal” cubit was 27 digits whereas earlier in Mesopotamia the Royal cubit was 30 digits!

If you had to pay one dollar per cubit to buy cloth in the market, in which country would you get the most cloth for your dollar?

____

Using the few standard cubit rods uncovered during archaeological digs, the Egyptian cubit was 525mm whereas the Mesopotamian one was 497mm.

Compare Standard Measurements and Personal Measurements – Experimental Design

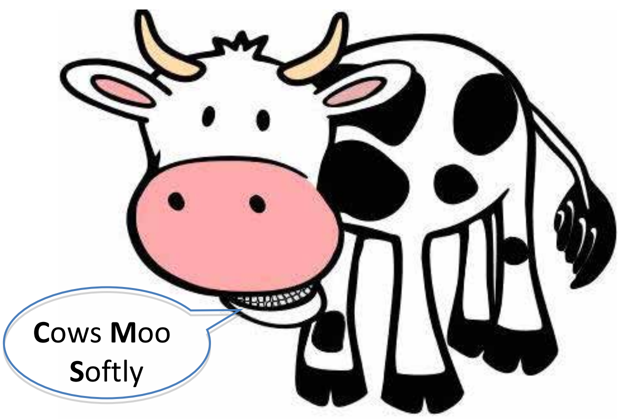
Let’s test the assumption that standard measurements are necessary for science data
To make a good science experiment, we must:

C_________________________

M________________________

S_______________________

____



Evidence of Change – Student Activity

Materials (What would you need?)

Method (What will you do?)

Observations (What data did we collect)

Student name	Length in cubits & digits	Length in cm or mm
Average length = <u>Total length</u> / Number of students		

Conclusion (What did the data above suggest about using relative or non standard measurements compared to standard measurements?)

In science experiments we use:

Rulers to measure distance

________________________________ to measure heat and cold

________________________________ to measure weight or mass

Can you think of any other things we use to measure things in Science?

Ruler Rules! – Teacher Notes

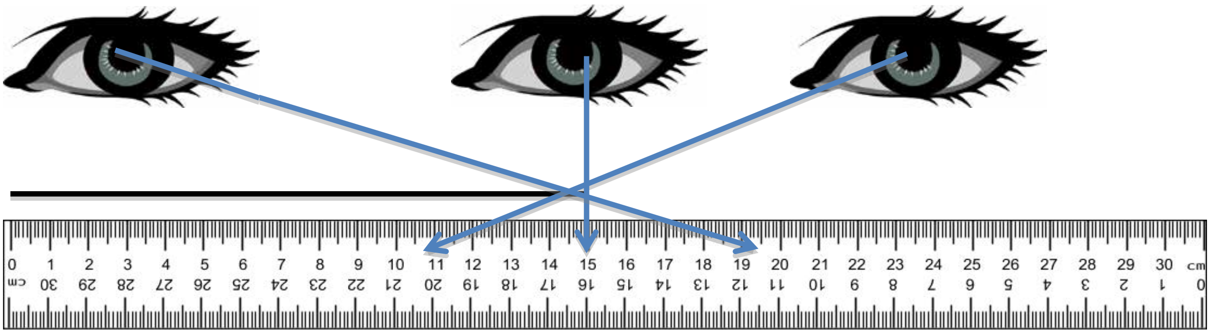
This activity is for students who have not yet been shown how to read a ruler properly

Materials

- I ruler
- One piece if string or paper

Avoiding parallax

Find an obvious vertical structure in the classroom such as a doorframe or window frame. Ask students to point their index finger of their right hand towards the ceiling. Students should the close their left eye and use their right eye to line up the finger with the frame. Without moving their finger, students close their right eye and open their left. The raised finger will appear to jump to the right. This phenomenon (change) is known as parallax. It is the result of our eyes being apart since neither the finger nor the frame actually moved. For this reason reading any instrument is best done with the eyes directly overhead of the meter.

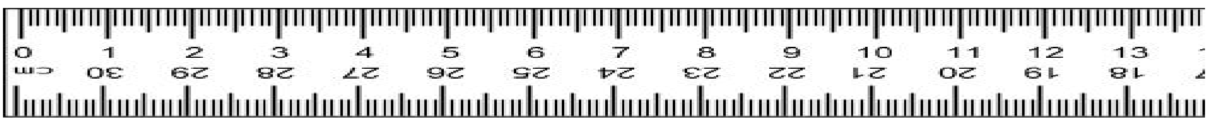


Which is the correct reading? 15cm

Similarly when reading thermometers or levels of liquid in a container, the thermometer or cylinder is raised to eye level or the bead is brought down to liquid level. Students may notice that water often has a downward curved surface (or meniscus). Scientist agreed to measure from the lowest point of this curve. (More information can be found in the "Water" section of Year7 WASP).

Mismeasuring

Many students have been found to place the start of the ruler, not the start of readings on the ruler at the beginning of the object to be measured. Similarly old rulers that have been used for other purposes, such as building trebuchets may have the start of measurements worn away.



A student mistakenly used the whole length of this ruler to measure 30cm when they were cutting wood for a model. Would they have cut too much or too little? Too much.

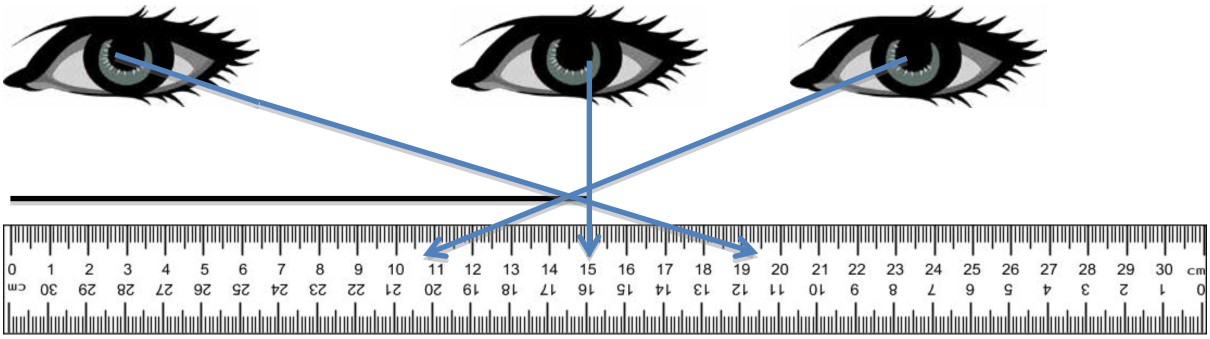
What mistakes could happen if a student used a ruler where one end had been worn away? If they did not compensate for the missing length their readings would be too long.

Another student used a bent ruler to measure wood for the model. Would they have cut too much or too little? Too little.

Students may test this by using a 10cm piece of string. Laid straight it will measure 10cm. As it is curved more it will measure less.

Ruler Rules! – Student Activity

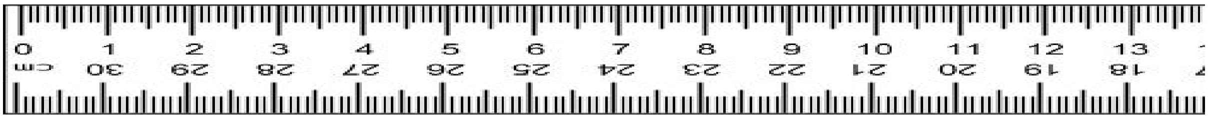
Avoiding parallax



Which is the correct reading? ______________________________

Mismeasuring

Many students have been found to place the start of the ruler, not the start of readings on the ruler at the beginning of the object to be measured. Similarly old rulers that have been used for other purposes, such as building trebuchets may have the start of measurements worn away.



A student mistakenly used the whole length of this ruler to measure 30cm when they were cutting wood for a model. Would they have cut too much or too little?

____

What mistakes could happen if a student used a ruler where one end had been worn away?

____

Another student used a bent ruler to measure wood for the model. Would they have cut too much or too little?

____