YEAR 3
EARTH'S ROTATION

Australian Curriculum Earth Science activities

with links to other subjects.

PALMS

PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

ConocoPhillips & ESWA supporting earth science education

EARTH SCIENCE WESTERN AUSTRALIA

ConocoPhillips Australia

YEAR 3 - Teacher Introduction

The Primary Australian Literacy Mathematics & Science (PALMS) Program aims to enrich and support the teaching of earth science from Kindergarten to Year 5 across Australia. This will be achieved by providing, within the mandated Earth and Space Science curriculum, hands-on activities integrating aspects of Chemical Sciences, Physical Sciences and Biological Sciences as well as relevant components of English, Mathematics and other subjects into teaching packages.
These teaching packages will be made available at www.palms.edu.au.

Earth's rotation on its axis causes regular changes, including night and day.

Activities marked **PPP** (PALMS PARENT POWER) are ones you may wish to send home with the students to do with their parents or by themselves. They replay the concepts recently covered in Science. Studies demonstrate that if a student describes what they have learned to another, they deepen their own understanding and retain it longer.

Topic No.	Topic	Activities	Student Worksheet	Subjects	Page No.
1	Sun as a Source of Energy	Seeing is Believing		Science + Health	1
		Light Print Paper	X	Science + technology	2 + 7
		Sun Changed Paper	X	Science Structured Learning	9 + 13
		PPP - Think Ink	X	Science	16 + 18

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YEAR 3 - Teacher Introduction

Topic No.	Topic	Activities	Student Worksheet	Subjects	Page No.
1	Sun as a Source of Energy	What Colour is White Light?	X	Science + Health	20 + 22
		Sunlight Source	X	Science + English	24 + 25
		Invisible Light	X	Science + Health	27 + 31
		Changing Christmas Baubles	X	Science	33 + 35
		Word Wall	X	Science + English	37 + 38
		What is Hot?	X	Science + Maths	39 + 43
		Parallax Error	X	Science + Maths	44 + 45
		Cool School	X	Science + Maths	46 + 49
		Prediction & Testing	X	Science	53 + 55
		Heat from the Sun	X	Critical thinking	56 + 57
		Sunlight and Shade	X	Science	58 + 59
2	Earth spins	What the Sailor Saw	X	Science	61 + 63
		Earth Spins		Science + HASS	64
		Time Words	X	Science + English	67 + 68
		Day & Night		Science + HASS	69

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YEAR 3 - Teacher Introduction

Topic No.	Topic	Activities	Student Worksheet	Subjects	Page No.
3	Timescales	Aboriginal Time	X	Science + HASS	71 + 74
		Day v Night		English	76
		Time Vocabulary		Science + English	77
		Midday Around the World		Science + HASS	78
		12 Hours		Science + Maths + HASS	80
		Timely Fractions	X	Science + Maths	82 + 83
		Book of Hours	X	Science + English + Maths	84 + 85
		Relative Time Graph	X	Science + Maths	86 + 89
		Time Zones		Science + Technology	92
		Solar & Sidereal Day		Science + HASS	94
4	Shadows	Investigating Shadows	X	Science	97 + 99
		Shadow Graph	X	Science + Maths	102 + 105
		Shadows & Art		Science + Art	107
5	Sundials	Nodal Sundial	X	Science + Maths	108 + 113
		T Bar Sundial	X	Science + Maths + Tech.	117 + 120
		Gnomon Sundial	X	Science + Maths + Technology	123 + 128

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Topic No.	Topic	Activities	Student Worksheet	Subjects	Page No.
5	Sundials	PPP - Digital and Analogue Time	X	Science + Technology	133
6	Sun, Earth & Moon	Getting the Right Perpective	X	Science + Art	135 + 139
		Modelling to Scale	X	Science and Maths	141 + 143
		Rotation and Orbit Models		Science + HASS	145
		Worship the Sun	X	English + Science	149 + 150

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YEAR 3 - Teacher Introduction

Australian Curriculum

Earth & Space Science

Earth's rotation on its axis causes regular changes, including night and day.

Elaborations

- Recognising the sun as a source of light.
- Constructing sundials and investigating how they work.
- Describing timescales for the rotation of the Earth.
- Modeling the relative sizes and movement of the sun, Earth and moon.

English

Language has different written and visual communication systems, different oral traditions and different ways of constructing meaning
Identify text structures, language features to describe characters, settings & events.
Identify features of online texts that enhance navigation
Learn extended and technical vocabulary.
Use interactive skills

Maths

Tell time to the minute
Make models of three-dimensional objects and describe key features
Create simple column graphs
Recognise the connection between addition and subtraction and solve problems using efficient strategies for multiplication.
They model and represent unit fractions.
Students identify symmetry in the environment. Match positions on maps with given information.

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YEAR 3 - Teacher Introduction

Maths (continued)
Students recognise angles as measures of turn in everyday situations.
Interpret and compare data displays.
Students count to and from 10 000.
Use Iosmetric units for length, mass and capacity.

History (HASS)

Pose questions using past sources
Impact of changing technology

Geography (HASS)
Connections – Where did it come from & how did it get here?
Connections of people in Australia to other places in Australia, countries in the Asian region and across the world.

Seeing is Believing - Teacher's Notes

It is important that students know *never* to stare into the Sun.

Their eyesight can become damaged. Damage is instant. It may take months or years for the eye to recover. Prolonged exposure will result in permanent damage. . Even the best sunglasses are not strong enough to protect their eyes from direct sunlight or from light from laser pointers. You can demonstrate a very mild example of the effect of staring into strong light.

Materials

- A torch/flashlight or weak point source of light
- White paper or a white/pale coloured wall
- A clock/watch to measure time.

Standing at your desk or at the front while holding the torch, ask students seated at their desks to close one eye. They then focus on the light from your torch for 10 seconds. Ask them then to look at a white wall or white piece of paper. A black spot will appear on the white surface. The spot will disappear over the next minute as their eyesight recovers. (A similar effect can come from staring at a ceiling light for 10 seconds).

At the back of their eyes lies a chemical called visual purple. Light energy bleaches this momentarily causing an electrical signal to be sent to the brain and "light" is registered. If it is over-stimulated it takes longer and longer to recover. The unstimulated nerve registers the zone as "no light" or black. Students with eye problems should be excused from this.

Q Did the light cause a change? YES

Q What was that change? Staring at the light produced a temporary blind spot in our vision

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

Light Print Paper – Teacher's Notes

The myth that the astronomer Galileo went blind in one eye from observing the Sun through a telescope has been discredited. His blindness was not reported until he was 72, about 25 years after his solar studies. Descriptions of his disability suggest the more reasonable cause was cataracts.

Sol was one of the old names given to our sun. That is why it and the planets, asteroids and meteors which circle it are called the **Sol**ar system.

Our Sun is the only star in our solar system. It alone can produces light. The planets, moons and other heavenly bodies merely reflect light from the Sun.

Apart from light produced by chemosynthetic organisms found near black smokers in deep ocean trenches and from some bioluminescent creatures such as glow-worms, most life on Earth depends on simple plants that use light energy from the Sun to photosynthesise (make food) for themselves and for the animals that eat them. The green chemical chlorophyll helps plants bind together carbon dioxide and water to make simple sugars. Sunlight is the energy that powers most food chains. We cannot live without it

Sun > grass > grasshopper > emu > dingo > decomposers.

Light Print Paper – Teacher's Notes

A negative of parsley seeds, a key and a pair of scissors

A pleasant introduction to sunlight as energy can be done by using light sensitive paper. Photosensitive paper will change colour when exposed to light. Sunlight energy causes changes to chemical bonds in the solution the paper has been treated with creating a new substance with a new colour or lack of it. It can be bought (12 sheets for about $15.00 in 2016) and then cut into smaller pieces so each student can make their own light print to take home or display. Students can take quite some time cutting the paper to size and exposure to light will affect the clarity of the final print. It is a good idea therefore for the paper to be pre-cut to size by the teacher or aide and returned to its light excluding envelope before the experiment starts.
Asking students to write their name on the back of their paper with a black pencil stops arguments over which print belongs to whom.

Some vocabulary (These can be used to help students with their Word Wall Worksheet).
Transparent materials (E.g. glass or clear plastic) allow light to travel through.
Translucent materials (E.g. frosted glass) allow some light to travel through but the rays are distorted and the image vague.

Light Print Paper – Teacher's Notes

Opaque materials (E.g. brick or wood) do not allow any light to travel through.
Photographic negative A print where the background appears dark and the subject appears light.

In the example above I asked students to cut the initial of their first name from old cardboard, which they laid on the paper before exposing it. Small leaves, ferns or other opaque shapes can also be used. The opaque masters must be smaller than the 3cm square of photosensitive paper and lie flat. The paper was stopped from blowing away by being placed in a transparent Petri dish. Small stones can also be used to hold down the two layers of paper.

Materials

- A reasonably sunny day. On a sunny day the print should take less than 5 minutes to appear.
- Photosensitive paper. This is sometimes known as Sunprint paper. This can be sourced from education suppliers, from Scitech and through the Internet.
- Scissors
- Scrap paper, card or small shapes
- A bowl or tray of water
- Ruler or rocks to hold paper in position while drying or plastic or glass Petri dishes

Light Print Paper - Teacher's Notes

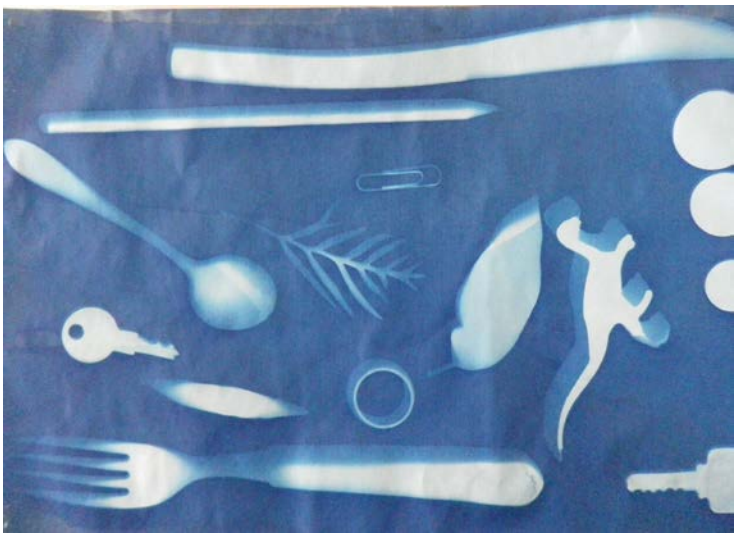
Method

1. Select a sunny dry day.
2. Cut out a shape from the opaque paper or select a shape provided.
3. Place the opaque shape onto the photosensitive paper.
4. Place a transparent plastic sheet, often provided with the paper, over the photosensitive paper and opaque shapes. This stops wind blowing the paper away or place these into a glass or plastic Petri dish.
5. Leave in the sunlight for about 5 to 10 minutes until the paper becomes coloured.
6. Rapidly remove the opaque material and wash the paper in the water bath. Lie flat to dry or peg up on a string.

Students can wear these prints as badges if attached by small gold safety pins or if the school has a badge-making machine they can make ones to take home.

Light is energy. We know this because it can change things.

15 things were laid on white light sensitive paper and exposed to sunlight.



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Light Print Paper - Teacher's Notes

What do you think they were? Write down your guesses.
A knife, a pencil, three coins, a paperclip, two leaves, a thin leaf, a dinosaur, a ring, a key, a fork and two keys.

What had changed? The colour of the paper behind the objects.

What had caused the change? Being in light (exposed to light).

Why do most plants need sunlight? To make food (photosynthesise)

Why are indoor plants usually placed in front of windows not walls?

See they are in sunlight (during the day).

PREDICT What do you think would happen if the plants were moved away from the window?

The plants would die.

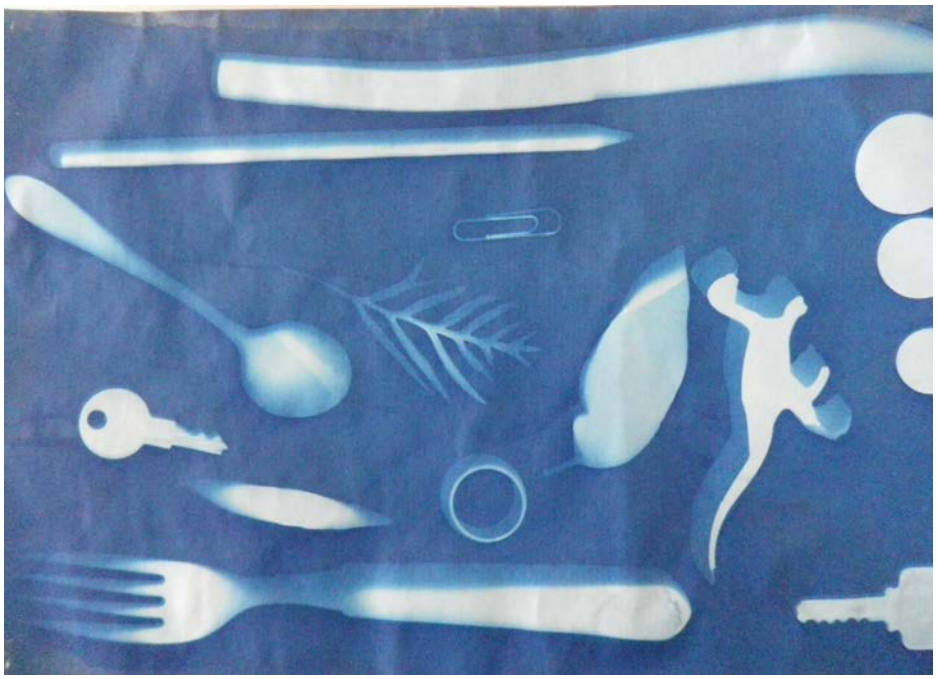
Can you think of anything else that is changed by light from the sun?

Answers will vary. May include things fading etc.

Name _____

Light Print Paper - Student Worksheet

Light is energy. We know this because it can change things. 15 things were laid on white light sensitive paper and exposed to sunlight.



What do you think they were? Write down your guesses.

_____

_____

_____

_____

What had changed? _____

Name _____

Light Print Paper - Student Worksheet

What had caused the change? _____

Why do most plants need sunlight? _____

_____

Why are indoor plants usually placed in front of windows not walls?

_____

_____

PREDICT What do you think would happen if the plants were moved away from the window?

_____

Can you think of anything else that is changed by light from the sun?

_____

_____

Sun Changed Paper - Teacher's Notes

Science tries to explain the causes of change. It relies on a structured approach to observe the change (phenomenon) suggest a possible cause or causes for the change and then test each possible cause by itself. This will give us information that can be observed and measured by anybody. It does not rely on unsupported opinion that may vary from person to person.

Science activities in early and middle childhood can be structured using the first letters of the mnemonic **COWS MOO SOFTLY**

C Change one thing
M Measure one thing
S Everything else **S**tays the **S**ame

When we run experiments we always have an unchanged part so we can see and measure any changes. The part left unchanged is called the **CONTROL** and the part that has had one thing changed (in this case it has been exposed to sunlight) is called the **EXPERIMENT**. If we obey the rules above our experiment is a **"FAIR TEST"**. This scientific method gives us the best chance to get good results (data).

HINTS

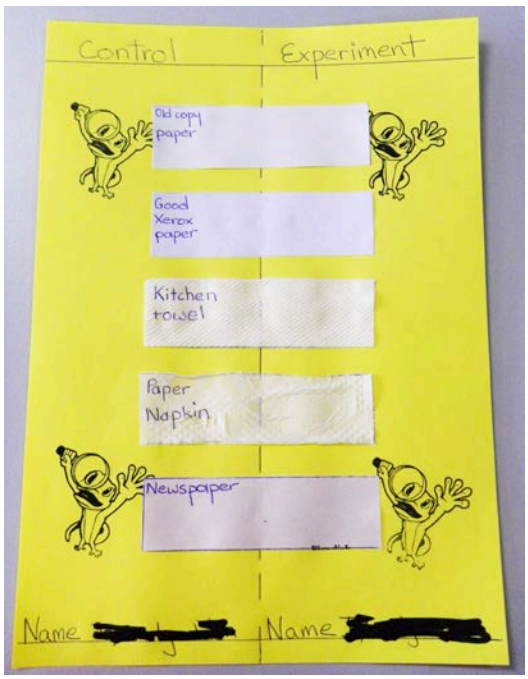
Select your papers with care. Expensive white paper has been bleached and coated with kaolin (china clay) to give it a whiter, smoother and more reflective surface. Light cannot easily penetrate through the coating. Recycled paper, paper used for newspaper and paper kitchen towels are less bleached and more porous allowing the energetic light rays to penetrate and cause change.

In Scotland and England until recently wet linen sheets and clothing were laid out on grass during sunny days to bleach whiter. Oxygen released from photosynthesis in the grass used energy from the sun to form ozone, an oxidizing agent or bleach. (Sometimes urine and lye were also added!)

Sun Changed Paper – Teacher's Notes

Materials per student or group

- A sunny day
- Scissors
- Ruler
- Pen or pencil
- An A4 sheet of white or coloured paper
- 4 or 5 same sized strips of different white papers. I used, old cheap copy paper, good white copy paper, kitchen towel, a paper napkin and the unprinted strip from the edge of a newspaper.
- Glue



Method (See picture for more information)

1. Draw a dashed line that vertically halves the sheet of paper along its length. Students may carefully fold the paper in half and draw along the fold or use a ruler to find the width of the sheet of paper (21cm), half this and measure (10.5cm)

Sun Changed Paper - Teacher's Notes

2. Write **"CONTROL"** at the top on one side and on the other **"EXPERIMENT"**.
3. At the bottom of each column write the names of the experimenter or experimenters.
4. Cut strips of each paper to the same size. I used strips 10cm x 3cm.
5. Label each strip.
6. Glue the strips across the vertical dividing line you have drawn.
7. Using the scissors cut the sheet into two halves along the dashed line.

You now have two halves of the experiment. The control strip will be left unchanged inside. The experimental strip will be placed outside in the sunshine and left for at least 2 hours. Anchor your strips with stones, books and rulers so that they do not blow away.

NOTE: The strips cannot be left on a sunny windowsill if the glass is tinted. Many classroom windows have tinted glass that reduces the energy of sunlight. These papers will be unaffected.

8. Bring the experimental paper back inside and lie it alongside the control. This will allow you to observe any changes.
9. Write any changes in the "Observation" table.

Observations

Type of white paper	Control colour (Before)	Experimental colour (After)
Old rough paper	Cream	Yellowish
Good quality paper	Bright white	White
Kitchen towel	Cream/white	Brownish
Paper napkin	White	Yellow
Newspaper	Grey	Brownish

Sun Changed Paper - Teacher's Notes

Discussion

What was the one thing we **CHANGED?** Sunlight or no sunlight

What was the one thing we **MEASURED?** Change of colour of the paper

Did everything else **S**tay the **S**ame? YES

Was this a fair test? **YES!**

Would it have been easy to measure a change without the control sheet?
No. Some of the changes were very slight.

Why is it a good idea to hang out your clothes overnight if you live in the north of our state? This stops the Sun bleaching and rotting our clothes. If coloured materials are folded across the washing line a white line can be bleached into the material lying over the line and exposed to the most sunlight. Once bleached it cannot be changed unless dyed again.

Conclusion

What have we learned by this experiment? Sunlight can change the colour of some materials.

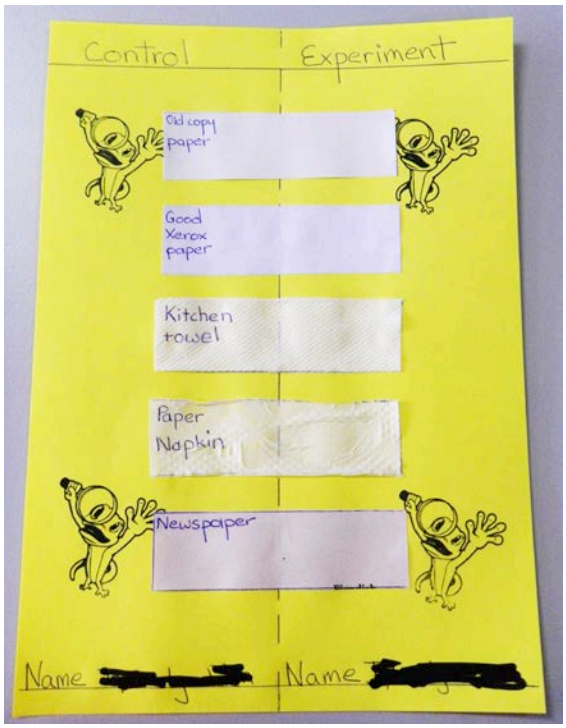
Name _____

Sun Changed Paper - Student Worksheet

Sunlight can change some paper

Science tries to explain the causes of change. We conduct experiments as "Fair Tests" using CMS rules.
(COWS MOO SOFTLY)

C **C**hange one thing
M **M**easure one thing
S Everything else **S**tays the **S**ame



Your teacher will provide you with materials and you will follow C M S rules for a **Fair Test**".

Name _____

Sun Changed Paper - Student Worksheet

Predict

What do you think will happen?

_____

_____

Are all pieces of paper the **S**ame **S**ize? _____

Observations

Type of white paper	Control colour (Before)	Experimental colour (After)

Discussion

What was the **ONE** thing we **C**HANGED? _____

_____

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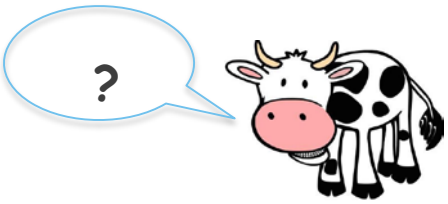
Name _____

Sun Changed Paper - Student Worksheet

What was the **ONE** thing we **M**EASURED? _____

_____

Did everything else **S**tay the **S**ame? _____



Was this a fair test? _____

Would it have been easy to measure a change without comparing with the control sheet? Explain your answer.

_____

_____

Why is it a good idea to hang out your clothes overnight if you live in the north of our state? _____

_____

What have we learned by this experiment? _____

_____

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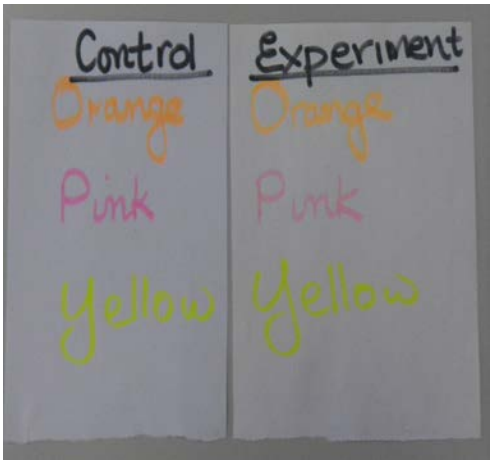
Think Ink - PPP - Teacher's Notes

This investigation could be done as part of PALMS parent power!



As a follow up to the 'Sun Changed Paper' activity students can use post-it notes or highlighter pens to test if sunlight energy affects their colour. As long as only one thing is changed and everything else remains the same it will be a "Fair Test".

In the experiment above with post-it notes, the green was most bleached, followed by the pink and yellow notes. The orange background paper was also affected.

The pink highlighter pen was most affected with the orange less so.

Evidence from home that sunlight changes things (including people)

- Clothes bleaching when hung out in sunlight. Black clothes lose colour quickly.
- Bathers and beachwear bleaching in sunlight.
- Car Duco (automotive paint or lacquer) changing due to sunlight (and oxidation), especially up north. My old car is several tones lighter on the roof than on the side panels.
- Houses needing repainting due to sunlight (and oxidation)

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Think Ink - PPP - Teacher's Notes

- Glare from sunlight removed by sunglasses. Area of skin around eyes not sunburnt – owl eyes.
- Posters, wallpaper, upholstery and carpets fading in sunlight.
- Plants grow in it and die without it.
- In parts of the world far from the equator, people can suffer from SAD (Season Affective Disorder or winter blues). They become depressed during the short dark days of autumn and winter but cheer up during spring and summer. Light therapy helps to fix things. In northern Russia some schools use these special lights to help students keep positive and achieve.

Name _____

Think Ink - PPP

Think Ink - Palms Parent Power!

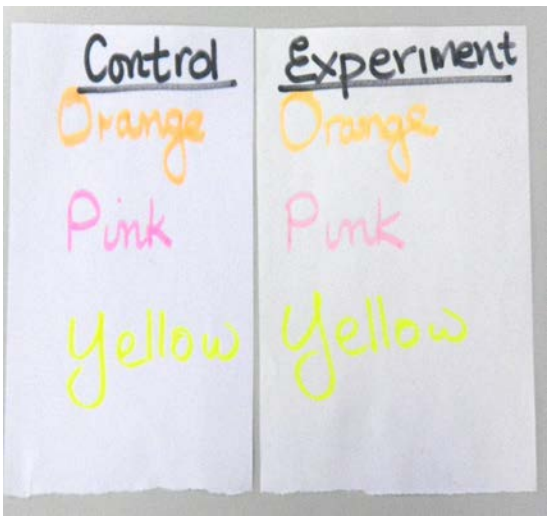
We have been experimenting to demonstrate that sunlight is energy, because it changes things.

When we test things we split them into two groups. One is left unchanged so we can use it to measure the effect of what we are testing. This is called the **CONTROL**. The other half is the **EXPERIMENT**. We only test for one thing at a time so any difference must be due to the thing we have changed (in this case exposure to sunlight or not).

In class we conducted an experiment to see how exposure to sunlight affected different types of paper.

As a follow up to this perhaps you would like to investigate how exposure to sunlight affects different coloured papers or highlighter pens.

On the left we have two identical columns of Post-it Notes. This is spilt down the middle and one half is placed outside on two sunny days. On the right we have a similar test with different



Name _____

Think Ink - PPP

coloured ink being tested by half being exposed to the sun.

This is also a great time to consider if you have any other evidence at home that energy in sunlight changes things. Examples may include faded curtains or bleached clothes.

What Colour is White Light? - Teacher's Notes

Looking into the Sun can damage our eyes so most of these activities are carried out using man-made lights indoors.

The sun emits a broad range of energies we call the electromagnetic spectrum. This spectrum includes all radio waves, microwaves, infra red light, the rainbow colours of light we can see, ultraviolet radiation, X rays and gamma rays. The light range our eyes register is called the ***visible spectrum***. It is a small fraction (about 1\26th) of the energy range emitted by the Sun.
These streams of energy constantly radiate in all directions from the sun, hence solar radiation . uckily our planet's magnetic field not only provides us with a North and South Pole for navigation, with the atmosphere it also screens us from the more harmful types of radiation with a magnetic energy shield. Telescopes are sent into orbit above the atmosphere because they can scan the whole electromagnetic spectrum from space.

Fireworks glasses or refraction glasses can be cheaply bought from OZ 3D Optics (70c - $1.10 each) and other Internet suppliers. You may wish to share the expense with other classes as the more you buy the cheaper they become. These have optical grids which bend or refract light so that different wavelengths (colours) are separated. Artificial light sources, lamps or strip lights appear to have multicolour rays radiating from them.

Never allow students to look at the Sun with these glasses on.

Ask your students what colour the light in the room is. Usually they will reply "white" or "yellowish".
Explain that, as scientists, our ideas can change with changes in technology. Provide each group with glasses and ask them to report on what they observed.
The white light became a rainbow of colours – the visible spectrum.

White light is made up of a mixture of all of these colours, When white light travels through raindrops it is split up into its colours and is called a **rainbow.**

Alternative Activity

Give students a CD and ask them to slowly spin the mirrored surface round under a ceiling light. The white light will be diffracted into all the colours of the rainbow.

The curved surface of a raindrop or a bubble acts in a similar fashion to split white light and emit the separate colours of the rainbow.

Some birds, insects, fish and snakes can see ultra violet and infrared light. Pit pythons and rattlesnakes, which hunt at night, cannot see their prey but sense heat from pits in their jaws. Most living things emit heat. If you use infrared glasses you can "see" living things in the darkest night. Soldiers also use these glasses to spot the enemy at night. Many flowers which appear white to humans, actually have ultra violet emitting markers which direct insects to "landing pads" so that they can be efficiently fertilised. Butterflies use UV light markings on their wings to attract mates but their predators cannot see the attractive patterns. Reindeer recognise edible lichen by its UV emission and can differentiate white-coated wolves (who do not produce UV light) from snow, which reflects it.

Name _____

What Colour is White Light? - Student Worksheet

What colour are the classroom lights? _____
Check your answer with three classmates to make sure.

Do you all agree? _____

Your teacher will hand you some special glasses which will break up the classroom light into its parts. Put the glasses on and look at the light again.
What colours can you see now? _____

_____

White light is made up of a mixture of all of these colours, When white light travels through raindrops it is split up into its colours and is called a

_____

Light energy from our Sun has many more types of energy but humans can only see the colour of the visibly spectrum.

Most humans draw the Sun as yellow. It is actually white when viewed from space.

Name _____

What Colour is White Light? - Student Worksheet

Hold the mirrored side of an old CD directly under a light. Draw what you see on the picture below.

The ridges on the mirrored surface of the CD split the white light into all the colours of the visible spectrum.

R_____ O_____ Y_____

G_____ B_____ I_____

V_____

Sunlight Source - Teacher's Notes

How do you know the Sun is a source of light?
This is a "Think, Pair & Share" activity where students can assemble ideas to contribute to a class finding.
Nothing is ever "proven" in science. Because ideas may change or new technologies provide insights that were not previously available.

Materials

- Scrap paper
- Worksheet provided
- SmartBoard, whiteboard or blackboard

Method

1. Suggest to the students that they are early scientists and that they have been asked to scientifically demonstrate that the Sun is a source of light. They are told that the teacher will randomly select one member of each pair to give a verbal report. This reduces intellectual parasitism.
2. Give them 3 silent minutes to think up their own ideas and jot them down on scrap paper before they form pairs. They should use the worksheet to answer the question – how do you know that the Sun is a source of light?
3. The teacher selects one of each pair to report on their suggestions.
4. They share their answers which are assembled on the class board.
5. They make suggestions on possible improvements.

Name _____

Sunlight Source - Student Worksheet

How do you know the Sun is a source of light?

This is a "Think, Pair & Share" activity.

Nothing is ever "proven" in science because ideas may change or new technologies provide insights that were not previously available.

How do you know that the Sun is a source of light? Discuss this with your partner and come up with 3 good pieces of evidence.

1. _____

_____

2. _____

_____

3. _____

_____

Name _____

Sunlight Source - Student Worksheet

Share your evidence with the class

What is the most convincing evidence that you think that the sun is the source of light?

_____

_____

Invisible Light - Teacher's Notes

As scientists we are obliged to test all ideas before we can agree or disagree with them. Our Western Australian schools usually have a rule "No hat - No play". It insists that students should not be allowed outside without their hats. Lets find out why.
Teachers may say that nasty ultra violet light will damage our skin and eyesight and that a hat will help counter this but is this so? You can't see, hear, taste, smell or feel this threat.
I have tested this activity in the south of this state in cold midwinter with a slight drizzle falling. It still works! It takes the stress out of having to keep hassling students about their hats as they leave the classroom.

Materials per student

- School hat. If students do not have hats fold a 'pirate' hat from a double sheet of newspaper.
- A box of UV beads (available from Scitech – enough for two classes was just under $10 in 2016 – educational suppliers or other Internet sources). I find getting all the beads the same colour stops bickering. Pale yellow beads are the least sensitive to UV light.
- Half a length of pipe clear for each bead
- A UV torch (if possible)

Method

1. Thread the pipe cleaner through the hole in the bead and twist it once to keep it in position (and to stop it rolling away and getting underfoot).
2. Ask students to use their five senses to observe the bead (NOT the pipecleaner). They should enter their observations into the table.

Sight	Feel	Hearing	Smelling	Taste
Cylinder White	Hard/solid Has a hole	No sound	No smell	We do not taste

Solid/hard Has a hole Plastic Translucent Has a join Shiny	Cylinder Has a join smooth			things in Science

3. Ask students to wind the pipe cleaner around their third finger on their left hand (they are now 'engaged to Science'). Students may need to help each other.
4. Explain that we have
    - The same students
    - In the same place
    - At the same time
    - With the same type of bead
    - On the same finger
    - Of the same hand
5. Ask students how many things should we change in a Science experiment that is a 'fair test'? ONE!
6. Take students out to a sunny or well lit position and ask them:
    - If the bead sounds different? No
    - If the bead feels different? No
    - If the bead smells different? No
    - If the bead looks different? Yes. The bead has changed colour.
7. Ask the students what it is about being outside that is different from being inside that could have reasonably cause the bead to change colour. Standard answers are heat/cold, light, wind, grass and occasionally that it is a 'mood' bead (as students are happier outside)
8. Ask student if they, as scientists, would believe any of these ideas without testing. NO!

Invisible Light – Teacher's Notes

9. Take students back inside the classroom and test their ideas.

Idea	Test	Result
Heat	On the outside of their top place the bead in their warm armpit for 10 seconds.	Nil
Cold	Put the bead on the cold linoleum floor or cold bench top for 10 seconds.	Nil
Wind	Blow on the bead for 10 seconds.	Nil
Grass	Place some grass on the bead for 10 seconds.	Nil
Light	"Power ranger" point the bead at the ceiling light for 10 seconds.	Nil
Mood	Split the class into two. One half whispers nice things to the bead whilst the other half whispers about the bead's shortcomings.	Nil

Students may appreciate that something outside did cause the change but our human senses cannot observe the cause. When we returned inside that energy was no longer present.
If you have a UV torch you will be able to shine it on the beads and they will change colour.

Invisible Light - Teacher's Notes

Ask students to complete the questions on the worksheet.

What specifically caused the bead to change colour? Ultraviolet light

Where did this energy come from? The Sun

Why do we need to protect ourselves from this energy? Because it is harmful

Why do all schools in Western Australia have the same rule?

NO HAT
NO PLAY

To protect their students

Should you have used a hat and sunscreen today? Yes

Ultraviolet light causes skin cancer and can also contribute to the growth of pterygiums over the eyeball. Wearing your hat and appropriate clothing will decrease your risk of cancer.
Students may put the bead under their school hat and walk outside. Under the shade of the hat the bead will/should remain white.

Name _____

Invisible Light - Student Worksheet

No Hat No Play

As scientists we are obliged to test all ideas before we can agree or disagree with them. Our Western Australian schools usually have a rule "No hat - No play". It insists that students should not be allowed outside without their hats. Let's find out why.

Observations

Your teacher will give you each a bead on a pipe cleaner.

These descriptions are **ONLY ABOUT THE BEAD!**

Sight	Feel	Hearing	Smelling	Taste

Name _____

Invisible Light - Student Worksheet

How many things should we change in any Science experiment that is a "Fair test?"

_____

What specifically caused the bead to change colour?

_____

Where did this energy come from?

_____

Why do we need to protect ourselves from this energy?

_____

Why do all schools in Western Australia have the same rule?

NO HAT
NO PLAY

_____

_____

Should you have used a hat and sunscreen today? _____

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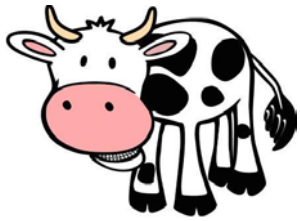
Changing Christmas Baubles - Teacher's Notes

Last year, when I hung up my Christmas decorations I used lots of new red glass ball decorations both inside the house and outside over my Christmas tree.

When the time came to take them in I discovered that the balls hung inside the house still looked the same but the ones from the garden had changed. They were different. Almost all colour had gone from the top of the balls (see photograph).

Explain what you think might have caused the change.
Sunlight falling on top of the balls had bleached the colour from them or more correctly, energy from the Sun had changed the chemistry of the paint.

Changing Christmas Baubles - Teacher's Notes



Describe an experiment you could use to find out if you were correct.

They would have to create an experiment where one set of decorative balls was kept inside and another set kept outside. Other conditions would have to be kept the same.
To measure any change in colour download the free App "Colour Assist" onto your mobile phone. The camera can be pointed at the top and bottom of the baubles and differences in colour measured to an international standard.

Is this experiment a fair test?

To check if this is a "Fair Test".
Change one thing = Inside and outside.
Measure one thing = Change in colour.
Everything else was kept the same.

Name _____

Changing Christmas Baubles - Student Worksheet

Scientists try to explain change

Christmas celebrations originated in the deep dark winter of the northern hemisphere.

Last year, when I hung up my Christmas decorations I used lots of new red glass ball decorations both inside the house and also outside over my Christmas tree.
When the time came to take them in, I discovered that my baubles hung inside the house still looked the same but the ones from the garden had changed (see above). Almost all colour had gone from the top half of the balls.

Explain what you think might have caused this change.

_____

Name _____

Changing Christmas Baubles - Student Worksheet

Describe an experiment you could use to find out if you were correct.

_____

_____

_____

_____

Is this experiment a fair test?

_____

_____

_____

_____

Word Wall - Teacher's Notes

This activity is a great way to remind students of what they have done so far and to informally correct any misunderstandings.

Students may like to use their notes to fill in their word wall.

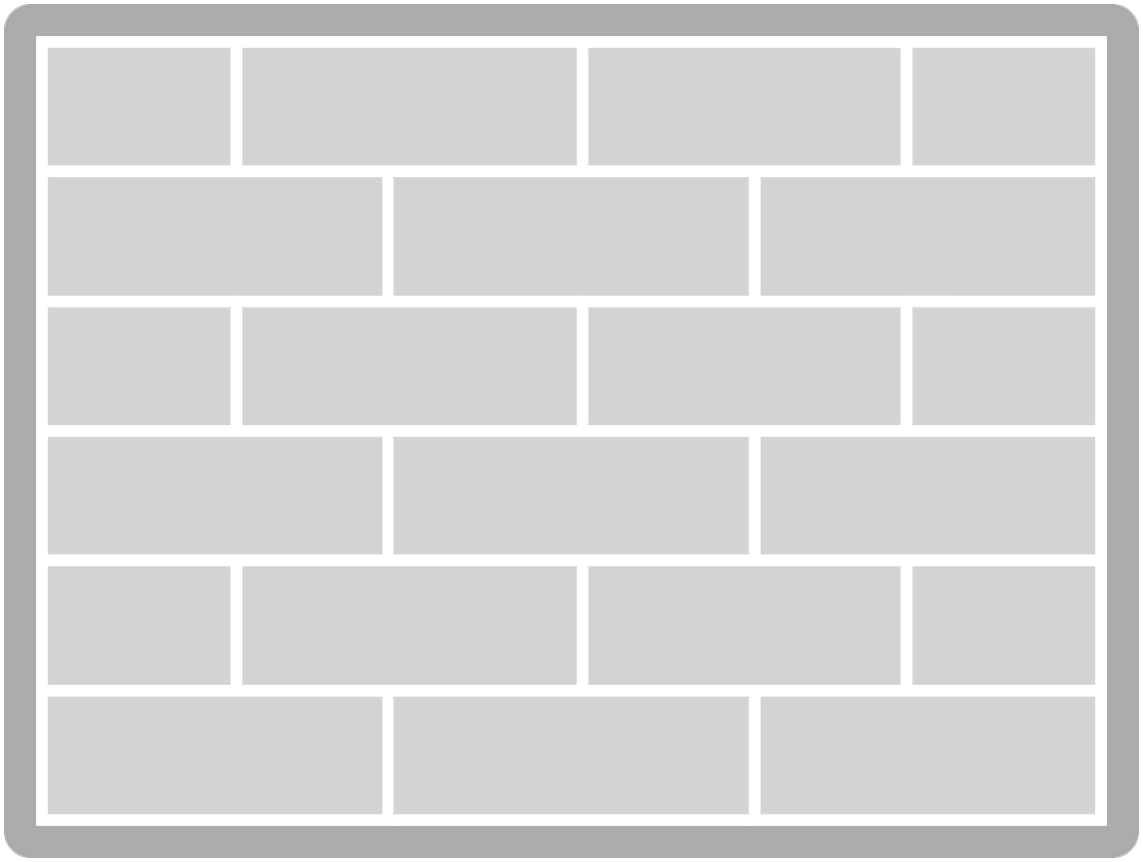
Some suggestions are below.

	light	ultraviolet	
Sun	visible	heat	
	fair	experiment	
hat	senses	testing	
	control	ink	
prediction	rainbow	torch	

Name _____

Word Wall - Student Worksheet

We have been learning about light. Fill in the wall below, place words you have learnt during this topic on each full brick.



Write the important words and their meanings below.

_____

_____

_____

What is Hot? - Teacher's Notes

Our sun is a giant thermo-nuclear reactor.
When we investigated light from the Sun, we noted that there were parts of the spectrum (spread) of radiation that humans could not see such as ultra violet and infra red radiation. Infra red radiation lies just beyond the red end of the visible spectrum and although it cannot be seen it can be felt by thermo (heat) receptors in the skin. Our bodies and the bodies of plants and animals are powered by enzymes, which require heat to function well. Life on Earth depends on just the right amount of heat reaching us.

Heat can be transferred in three ways:
Radiation Waves of heat can radiate through empty space. This is how heat from the sun enters our atmosphere.
Convection Heat is transferred from one place to another by the movement of fluids (liquids and gasses) such as wind and water currents.
Conduction Heat is transferred between solids such as walking on a hot road with bare feet.

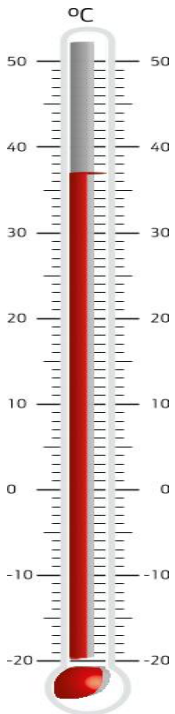
About 23% of incoming heat energy is retained within the atmosphere and is moved around by convection currents such as wind and ocean currents. The rest is directly radiated back into space.

When experimenting we try not to use subjective words such as hot, cold, warm or chilly as their meaning is not precise. Hot weather in northern Europe is very different to hot weather in Western Australia.

Heat is measured by a thermometer (thermo = heat, meter = measurer)

What is Hot? - Teacher's Notes

This activity is to encourage students to use standard measurements rather than subjective words such as hot or cold.



I have always lived in Marble Bar so I find 33°C in Geraldton in summer, rather cold.

We left Albany in winter and drove northwest to Perth where the temperature was a much warmer 16°C.

In Marble Bar the temperature overnight in summer fell to a cool 28°C. I had to put on a jumper.

During the heat of summer in Kalgoorlie the temperature can rise to 38°C in the day and fall to 16°C at night. I enjoyed the evening cool.

In Broome the average temperature of 30 to 33°C is always pleasantly warm.

I was told the weather in Esperance was chilly so I took my snow boots. The lowest temperature was 8°C!

Mark each temperature on the thermometer on your worksheet. Cool temperatures mark with a blue cross and hot temperatures with a red cross

How can the same temperature be hot to one person and cold to another?

The words only describe what it feels like to each person. Each person has had different experiences and they are describing if there is more or less heat than what they are used to.

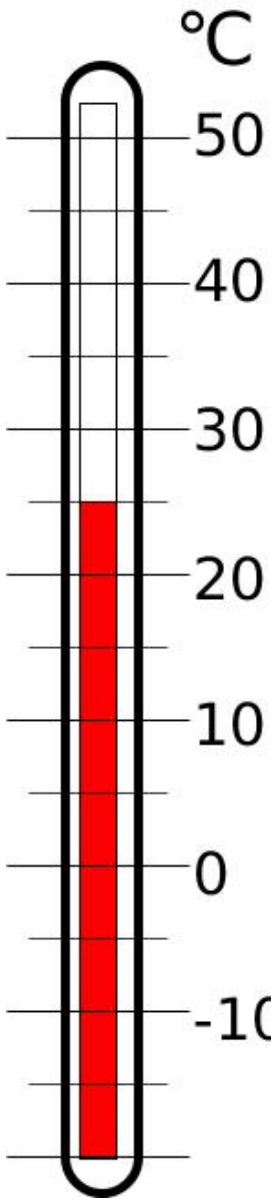
Why do you think that weather reports always include the temperature in degree Celcius?

Then everyone knows exactly what is the actual temperature. The number means the same thing all around the world.

What is Hot? - Teacher's Notes

Historical background

The word "thermometer" comes from the Latin "thermo" meaning heat and "meter" to measure. If we describe something as hot or cold it may mean different things to different people. People in Scotland describe the weather as hot if it rises over 18°C whereas in WA that would merely be "warm" because we are used living in a higher range of temperature. Heat makes the coloured fluid expand.



The idea of having a numerical scale for temperature was first mentioned by the Roman physician Galen. He measured equal volumes of ice and cold water and suggested that the mix was "neutral" temperature. He added four degrees of heat and four degrees of cold on either side.
In 1612, an Italian inventor called Santorio Santorio added a wider numerical scale and the thermometer could measure changes in temperature for humans. By 1715 the German inventor Daniel Farenheit made a thermometer that measured changes between the boiling point of water and its freezing point using a scale of 180 degrees. Slightly later a Swede called Anders Celcius used the same maximum and minimum but had a scale of 100 units or degrees Celcius. Some people use the term "centigrade" which means "divided by 100. (Chemists use a scale which extends well below and above this which was invented by the Scot, William Kelvin).

Students need to be reminded that when they take "the temperature" of a location they are really measuring air temperature. Although air often cannot be seen, felt smelled or touched, it is a gas and is responsible for moving heat around our environment. On hot summer days the air temperature may be 40°C when the dark surface of the playground

can reach 50°C and above. On freezing cold days the air temperature can be well below ground temperature. Official weather reports use the temperature of air inside a Stevenson screen which shelters the thermometer from rain, snow, wind, leaves and animals.

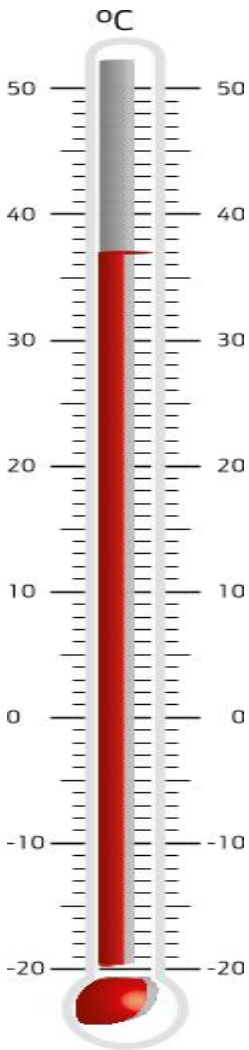
Of course, you never hold a thermometer by its bulb as that would mean that you are really measuring your skin temperature not air temperature.

Most school thermometers rely on an enclosed liquid, often alcohol or mercury that expands on heating and contracts on cooling. The famous astronomer Galileo Galilei was the first person to try using wine in a thermometer. Alcohol is more sensitive to heat and expands much more than water. The thermometers are calibrated using the boiling point and freezing point of water so that a reading in Australia will be the same as another on the other side of the world if the temperature is the same.

Name _____

What is Hot? - Student Worksheet

Mark each temperature on the thermometer on your worksheet. Cool temperatures mark with a blue cross and hot temperatures with a red cross



"I have always lived in Marble Bar so I find 33°C in Geraldton in summer, rather cold."

"We left Albany in winter and drove northwest to Perth where the temperature was a much warmer 16°C."

"During the heat of summer in Kalgoorlie the temperature can rise to 38°C in the day and fall to 16°C at night. I enjoyed the evening cool."

"In Broome the average temperature or 30 to 33°C is always pleasantly warm."

"I was told the weather in Esperance was chilly so I took my snow boots. The lowest temperature was 8°C".

How can the same temperature be hot to one person and cold to another?

_____

_____

Why do you think that weather reports always include the temperature in degrees Celcius?

_____

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Parallax Error - Teacher's Notes

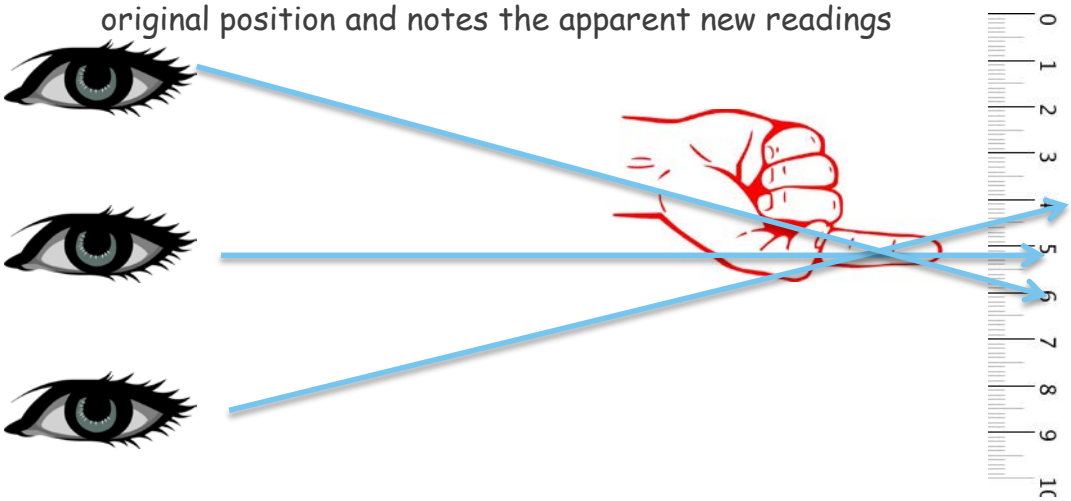
When reading a thermometer, or any other graded instrument, the student's eye has to be level with the part being read. If the eye is above the reading will be too low and vice versa. Always raise or lower the thermometer to be easily and correctly read at eye level. Students working in pairs can quickly observe this error.

Materials per pair

- A ruler

Method

1. Students face each other
2. ne student holds the ruler upright and does not move
3. The other holds one hand so that their index finger appears to be pointing at the 15cm reading
4. Without moving their pointing finger, the second student moves their head so their eyes are about 5cm higher and lower than the original position and notes the apparent new readings



Name _____

Parallax Error - Student Worksheet

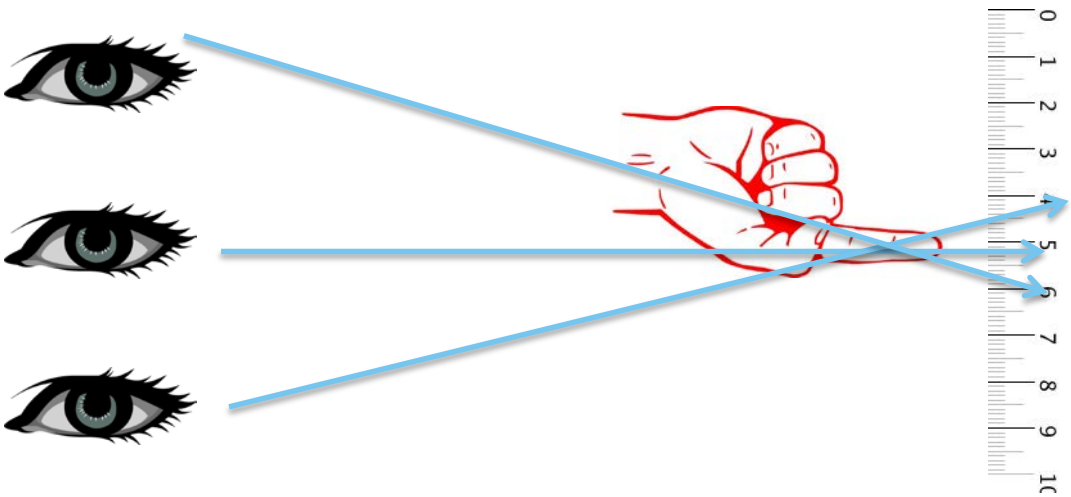
When reading a thermometer, or any other graded instrument, your eye has to be level with the part being read.

Materials per pair

- A ruler

Method

1. Face your partner
2. One student holds the ruler upright and does not move
3. The other holds one hand so that their index finger appears to be pointing at the 15cm reading
4. Without moving their pointing finger, the student then moves their head so their eyes are about 5cm higher and lower than the original position and takes reading.



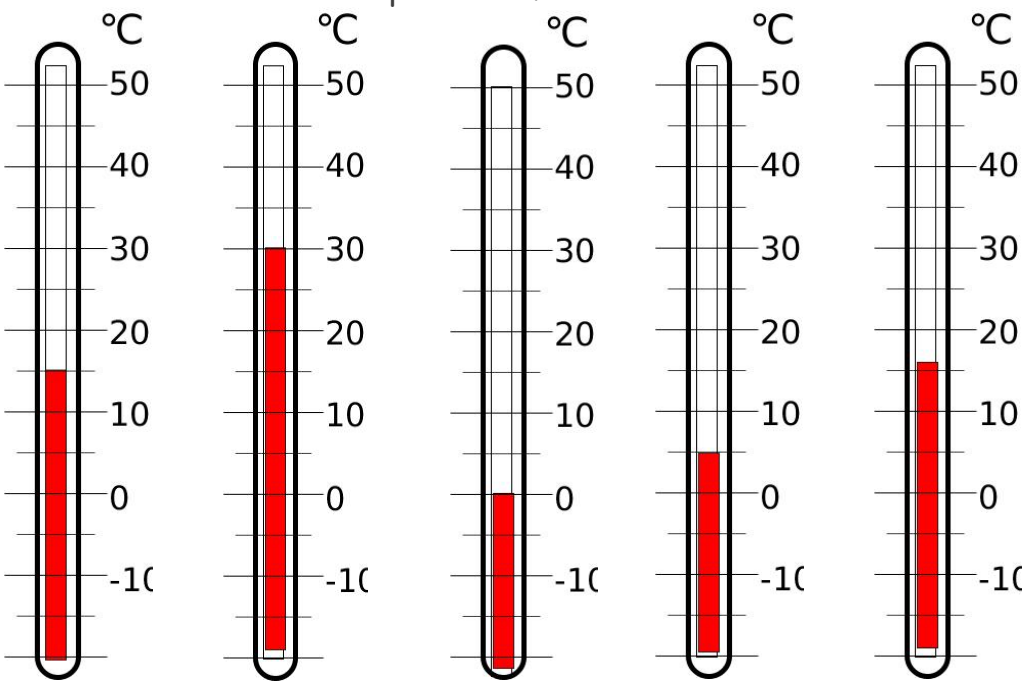
How did moving your eyes change the reading? _____

_____

Cool School - Teacher's Notes

Early scientists looked for something to use as a commonly understood very cold thing to use to be the base level for a thermometer. They used the temperature at which water freezes. To be zero. We now take readings down to -273°C, which is known as absolute zero.
Before asking students to take temperatures around the classroom or school, they may need practice in reading units and half units on thermometers.
School classroom thermometers often only have temperatures labeled at 10 degrees and multiples thereof. Students may have to be guided on how to estimate the temperature between labeled readings.

Estimate the correct temperature for each thermometer.



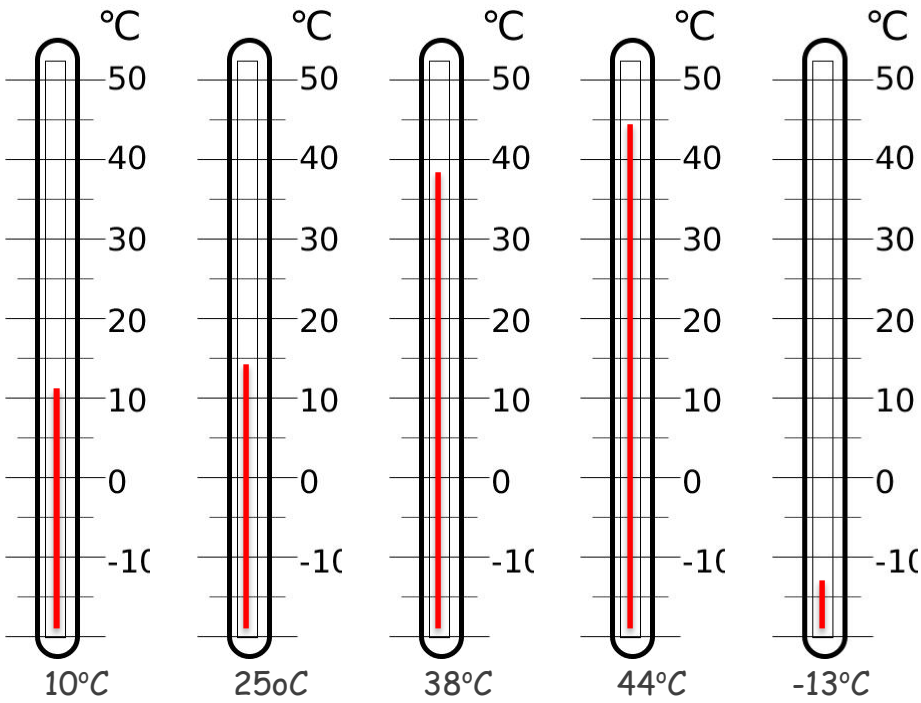
15°C 30°C 0°C 5°C 17°C

Cool School - Teacher's Notes

Which is the highest reading possible? 50°C Unless your thermometers are otherwise graded.
Which is the lowest reading possible? - 20°C
What do you estimate the temperature in the classroom is now? Please remind the students to add the unit of degrees Celcius. Celcius was originally known as Centigrade. This was a scale divided into one hundredths.
Measure the temperature using a thermometer and tell the students.
How accurate was your guess? Very accurate (within 2oC), accurate (spot on) or inaccurate (more than 2°C off).

Why do you think we need to use thermometers rather than guesses to measure the temperature? Guesses can be very inaccurate
Why do we have thermometers, which can read below the freezing point of water and above the boiling point of water? We need to know these temperatures so we can do things safely. If we fry chips in oil and we heat it too much, first the chips will burn and then the pan will go on fire. If the temperature of the oil is too low the potatoes will absorb oil and not cook. When we are healthy our body temperature is 37°C. If the body temperature is above or below this we can tell that we are ill. Any reasonable answer will do.
What do we use to measure cold? A thermometer. Hot and cold are just positions along the scale.

Cool School - Teacher's Notes



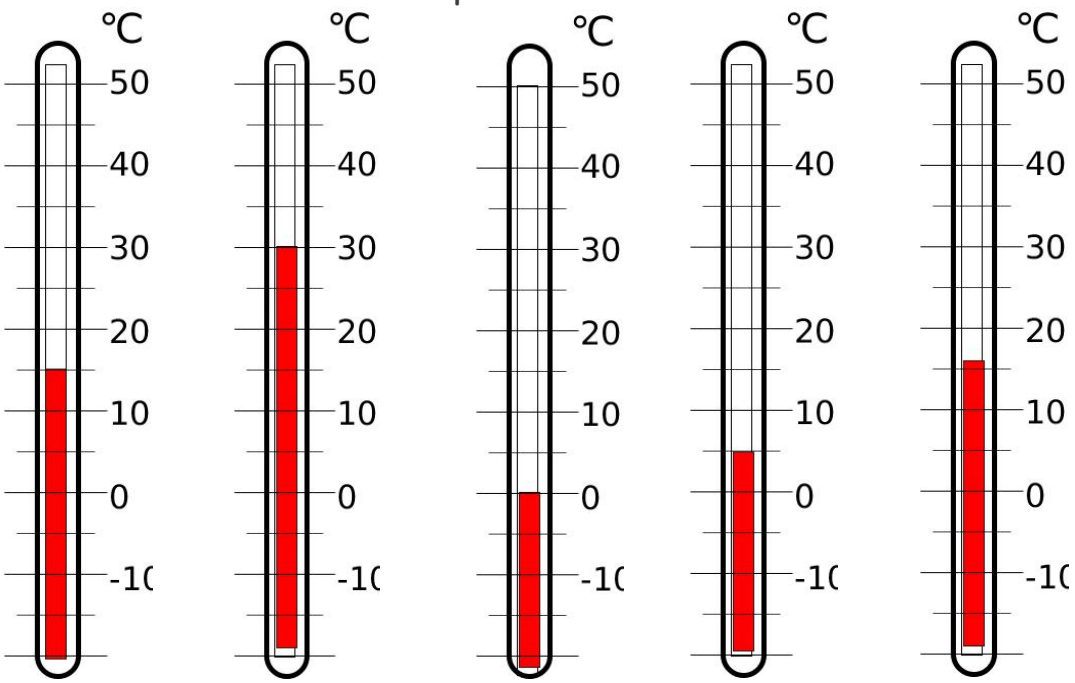
Colour in a red line indicating the temperatures given
Television news programs always include information on what the next 24 hours temperature readings will be. Why? We can wear clothes to keep us warm or cool. We can decide which sports to play or not. We can decide whether to walk, ride our bicycles or use the car. We can decide whether to put new plants in the garden or leave off for a cooler or warmer day.

If there are 3 days of over 40°C, many schools ask parents to keep their students at home. In some communities however school is the coolest palce to be!

Name _____

Cool School - Student Worksheet

Estimate the correct temperature for each thermometer.



_____

Which is the highest reading possible? _____

Which is the lowest reading possible? _____

What do you estimate the temperature in the classroom is now?

_____

Your teacher will tell you what the temperature is using a thermometer.

Name _____

Cool School - Student Worksheet

How accurate was your guess? _____

Why do you think we need to use thermometers rather than guesses to measure temperature?

_____

Why do we have thermometers, which can read below the freezing point of water and above the boiling point of water?

_____

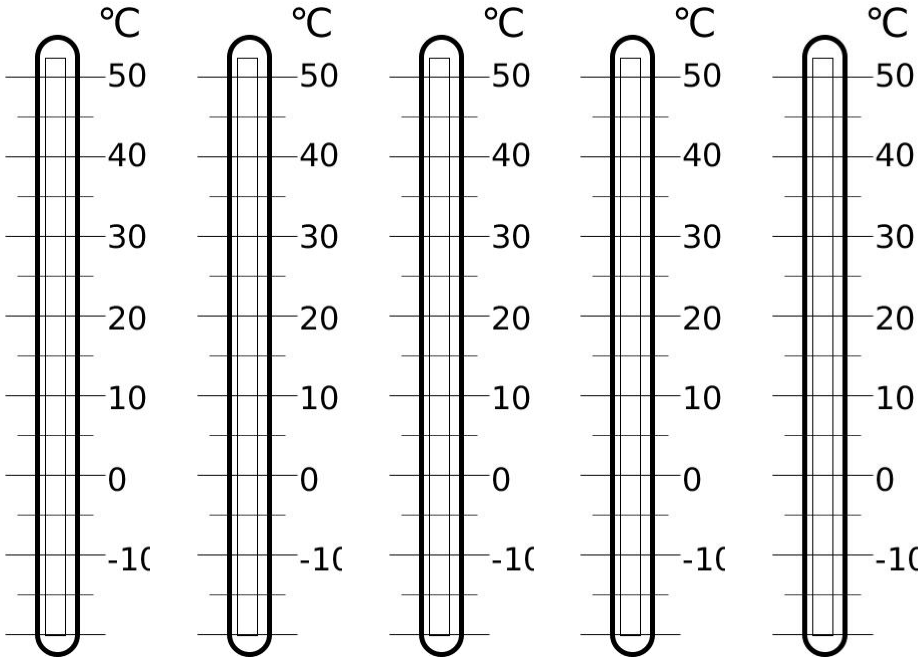
_____

What do we use to measure cold? _____

Name _____

Cool School - Student Worksheet

Colour in a red line indicating the temperatures given.



10°C 25°C 38°C 44°C -13°C

Television news programs always include information on what the next 24 hours temperature readings will be. Why?

_____

_____

_____

Name _____

Cool School - Student Worksheet

What does 40°Cmean to you? Draw a picture of a day when it reaches 40°C below.

Prediction and Testing - Teacher's Notes

Scientists often make predictions about what they think will happen. They try to base these sensible scientific guesses on information they and other scientists already have. The important thing that follows this is that, where possible, these predictions are tested. inding that an idea doesn't work is just as important as finding what does, particularly in medical science. We get better and better at predicting things as more information comes in and as technology improves. Students who have made "wrong" predictions can learn and make a better one next time.

Materials per group

- Thermometer
- Rough map of school or classroom

Method

1. Brainstorm to find student predictions of the hot and cold areas in the room and in the yard.
2. Students should state their predictions giving a reason why they chose this or these particular areas. E.g. I think that ….. is a hot/cold area because … .
3. Board student predictions and reasons.
4. Select groups to take the temperature of specific areas reminding them to take air temperature not surface temperature. And not to hold the thermometer by the bulb.
5. Board their findings

Observations

Students may suggest that some areas are hotter because they are sunny, are near the heater or are protected from the wind.

Ask the students what the source or sources of this heat are? Sun, radiators, outlet fans from canteen kitchens.

Prediction and Testing - Teacher's Notes

Temperature outside each hour during one day

If you have sufficient thermometers and students remain with you all day then they will be able to take their own readings. If however this is not possible please use the data provided or use the information given daily on your weather app.

DAY Monday Date 25/6/2016
Location West Perth

Predict which time of day will have the hottest temperature. Suggest during school time. If you live on the equator and in the middle of a time zone theoretically the hottest time would be about noon. If you live at the western edge of a time zone, like Perth, the heat of the day will be delayed. Heat build up is also modified by wind and cloud cover.

TIME	9am	10am	11am	12am	1pm	2pm	3pm
Temperature in °C	22	24	30	32	33	32	28

When was the hottest part of this day? 1pm
Using the information you have collected, predict when the hottest part of tomorrow will be. 1pm or there about.
Is there a regular pattern for temperature each day? The warmest time is between 11am and 3pm. (Between eleven and three stay under a tree).

Name _____

Prediction and Testing - Student Worksheet

DAY _____ Date _____

Location _____

Predict which time of day will have the hottest temperature.

_____

Now take measurements at your chosen location at the following times.

TIME	9am	10am	11am	12am	1pm	2pm	3pm
Temperature ^{oc}							

When was the hottest part of this day? _____

Using the information you have collected, predict when the hottest part of tomorrow will be.

_____

Is there a regular pattern for temperature each day? _____

_____

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Heat from the Sun - Teacher's Notes

Our Sun radiates heat energy towards earth and most of it is bounced straight back into space off reflective (shiny) surfaces such as snow, ice, water and clouds.
How can we demonstrate that this heat comes from the Sun?

Background research questions. Answer with your best guess.

1. Is it usually warmer at night or during the day?
   During the day
2. Why is this so?
   During the day, our part of Earth is turned towards the Sun
3. When is the warmest time of day?
   Midday, because the Sun is directly overhead. (Less heat is lost through the atmosphere).
4. If you face the Sun, which part of your body is warmest, your back or your front?
   Your front
5. Which parts of the immediate school area are cool, warm and hot?
   This is a poor question because different people have different ideas as to what is hot and what is cool.
6. What do we use to measure heat? A thermometer (thermo=heat, meter=measurer)

Name _____

Heat from the Sun - Student Worksheet

How can we demonstrate that heat comes from the Sun?

Background research questions. Answer with your best guess.

1. Is it usually warmer at night or during the day?

   _____

2. Why is this so?

   _____

3. When is the warmest time of day?

   _____

4. If you face the Sun, which part of your body is warmest, your back or your front?

   _____

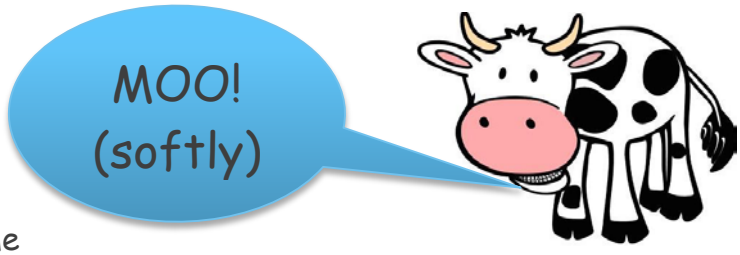
5. Which parts of the immediate school area are cool, warm and hot?

   _____

6. What do we use to measure heat? _____

Sunlight and Shade - Teacher's Notes

We shall be drying wet paper towel in sunlight and out of sunlight to see whether sunlight or shade provides the most heat.
Students are asked to plan how to make this activity a "FAIR TEST".



Change one thing
Measure one thing
Everything **s**tays the **s**ame

To make this experiment a fair test what will we have to keep the same? Same paper, same size, same time, same conditions, same amount of water.
What will we be changing? We will change one thing, whether the paper is left to dry in the sunshine or in the shade. We will be changing heat from the Sun.
What will we be measuring? How long each piece of paper takes to dry.
I'd recommend that you use 1 teaspoon of water (5mL) on each sheet of paper towel. Materials required could be paper towel, water, teaspoons and something to tell the time e.g. clock, watch or mobile phone.
Share your answers with two other groups.

Observations

Group	Time to dry in sunshine (minutes)	Time to dry in shade (Minutes)

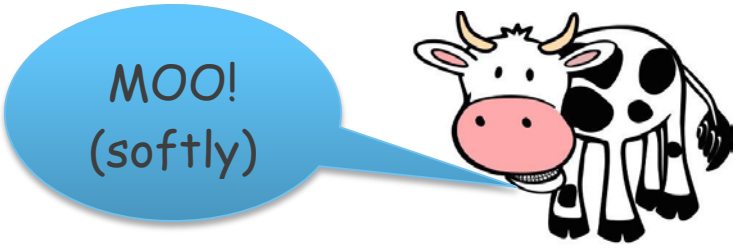
Ask the students why we used other groups' answers. To make sure one answer wasn't a fluke/atypical/due to something else or an atypical result.
Does sunshine include heat? Yes.
Why would people prefer to dry clothes in the shade? To avoid bleaching them.

Name _____

Sunlight and Shade - Student Worksheet

We shall be drying wet paper towel in sunlight and out of sunlight to see whether sunlight or shade provides the most heat.
We will time how long paper takes to dry.

Plan how to make this activity a "FAIR TEST".



Change one thing
Measure one thing
Everything stays the same

To make this experiment a fair test what will we have to keep the same?

_____

_____

What will we be changing? _____

What will we be measuring? _____

Share your answers with two other groups.

Name _____

Sunlight and Shade - Student Worksheet

Observations

Group	Time to dry in sunshine (minutes)	Time to dry in shade (Minutes)
1		
2		
3		

Why will sharing results give us a better answer?

_____

Did the paper in the sunshine dry faster? _____

Why would people prefer to dry clothes in the shade?

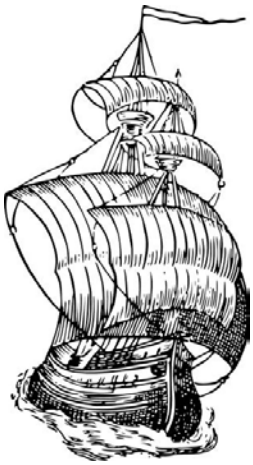
_____

What the Sailor Saw – Teacher's Notes

Modern scientists can use satellites and the space base images to see that the Earth is almost round like a ball, that it spins on its axis once a day and that it orbits the Sun once a year.

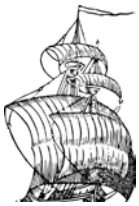
Many people thought that the Earth was flat, and some still do.
Sailors were amongst the first to provide evidence that it was round.

If you were a sailor standing on the beach 400 years ago and you were watching a sailing ship, you might have drawn a picture like the one below.



10 minutes ago

30 minutes ago



60 minutes ago

100 minutes ago

Is the ship sailing towards you or away from you? It is sailing away from me as the ship is getting smaller and at 100 minutes I can only see the top of it.
How does this sketch help the sailor to realise that the Earth is round?
The bottom/hull of the ship cant be seen when it is far away. As it comes up over the horizon it becomes more visible. It must be sailing on a curved

surface. The Earth is spherical.

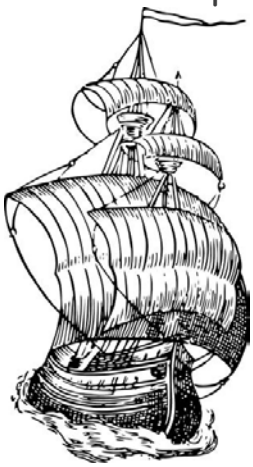
The first ship to sail round the world was the Santiago initially captained by Ferdinand Magellan. It left Spain in 1519 and sailed south through the Atlantic Ocean round the southern end of South America into the Pacific Ocean. Magellan died in a war in the Philippines and the journey was completed under captain Elanco.

Sailors had always realised that the Earth was round because they had seen that as a ship sails away from the viewer it not only gets smaller but it disappears over the horizon from the base up.

Name _____

What the Sailor Saw - Student Worksheet

Sailors were amongst the first people to provide evidence that the Earth was round. If you were a sailor standing on the beach 400 years ago and you were watching a sailing ship, you might have drawn pictures like the ones below.



10 minutes ago

30 minutes ago

60 minutes ago

100 minutes ago

Is the ship sailing towards you or away from you? How can you tell?

_____

_____

How did this sketch help the sailor to realise that the Earth is round?

_____

_____

Earth Spins - Teacher's Notes

Historical Background

Most people thought that Earth and mankind lay at the center of the stars, although earlier ancient Greek and Indian scientists had speculated that the Earth spun around its axis daily and orbited around the Sun annually. Evidence to support these ideas was difficult to produce. The fact that the much respected Greek philosopher Aristotle thought that the Sun orbited the Earth made it difficult for others to refute his belief up until medieval times. Newton suggested that if the Earth turned on its axis it would bulge at the equator and flatten at the poles. Later accurate surveying of the planet supported this idea.

By the early 1800s scientists tried dropping weights from particularly high towers and it was noted that the weights landing spots were displaced from under the spot from where they had been dropped suggesting that the planet had moved slightly while the weight was dropping.
The French scientist and mathematician Leon Foucault (1819-1868) finally produced an experiment that demonstrated that the Earth spins on its axis. He suspended a very heavy pendulum from a very long (67m) wire attached to the dome of the Parthenon in Paris. The pendulum was left free to swing in any direction it wished. A stylus on the base of the pendulum made marks in sand laid on the floor tracing any change of movement. The pendulum should just have swung back and forth BUT it actually rotated 11^0 clockwise per hour. Something had forced the pendulum to slowly change its direction of swing. The cause was the planet spinning on its axis under the experiment in the Parthenon that caused the change of direction of swing.

(Inertia causes any body to remain in its original position unless acted on by another force. This is easily demonstrated by sitting on an office chair with a full glass of water and swinging round. Yourself and the glass will spin round but the water lags behind because of inertia and a circular

splash is made. It is easier however to ask a student to demonstrate this outside by spinning round quickly with an arm extended and holding a glass of water).

Teacher Demonstration

This is based on an activity by Janice Van Cleave in her book "Icy, freezing, frosty, cool and wild experiments"

Materials

- An office chair
- A short pendulum made from a piece of string and a weight
- A piece of paper with a large arrow drawn on it.

Method

1. Sit on the chair with the paper on your knee. The arrow should be aligned along your upper leg.
2. Start the pendulum swinging along the direction indicated by the arrow.
3. Gently swing the chair clockwise.
4. Observe changes in the pendulum swing.

The pendulum swing change was caused by rotation about the axis of the chair. Similarly oucault's pendulum swing changed because of rotation

about the axis of the Earth.

Interesting fact

Pilots have to adjust their flight paths to account for the Earth turning under them. If they pointed their plane toward their final destination at the beginning of their flight it would no longer be in the same spot when they arrive.

Time Words – Teacher's Notes

Early thinkers thought that the Sun orbited the Earth. To them this explained why the sun appears to rise in the east on the morning and fall to the west at night. Hunter-gatherer people like Aboriginal Australians and Early Stone Age Europeans did not need to measure small amounts of time but their language tells us they understood the regular predictable progression of time through a day and a night. Ask your students to form pairs and see how many words they can write down that mark the passage of time over 24 hours that don't involve the use of numbers or a clock.

Method

After providing a few starter words the groups (of two or three students) are given scrap paper and 5 minutes to write down all the time words they can think of and then 5 more minutes to arrange them into a sequential timeline on the worksheet provided. Students share their words to be entered on a common day to night timeline on the board. This should demonstrate that time travels in a regular and predictable way.

An easy way to remember the direction the Earth turns is to make a fist of your right hand with your thumb pointing upwards to the north. The direction your fingers fold to form the fist is the direction the world turns on its axis.

Most mobile phones have free compass Apps. To help you find north.

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Name _____

Time Words - Student Worksheet

Before people had clocks, they had special words, which could be used to demonstrate the regular predictable progression of time during the day. For example, breakfast time is earlier than lunchtime.

Write down these words and share them with others. See if you can order them in correct sequence during one day.

Rough notes

In correct sequence.

_____

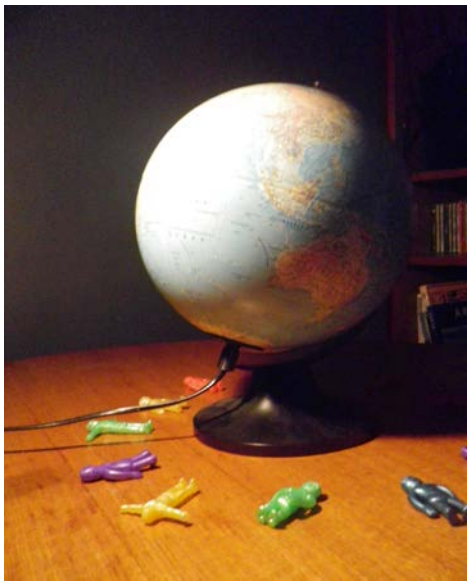
_____

_____

_____

Day & Night – Teacher's Notes

Teacher Demonstration



Evening falls in Western Australia

In a darkened room or storage cupboard, a bright light such as a torch or desk lamp can demonstrate how the Sun shines on a spinning Earth bringing daylight and dark.

Materials

- A globe, basketball or balloon with Australia drawn on it
- A bright light source
- Small stick men from the Reject or $2.00 shop or cut out paper people or even coloured pencils to represent people.

Method

1. Set up the equipment
2. Ask a student to spin the Earth/globe/basketball or balloon clockwise looking downwards from the North Pole
3. Arrange the varied people either on the surface of the globe or on the desk below

4. Describe the illumination on the globe as it rotates completely representing one day
5. Ask students what time of day each "person" would observe.

Aboriginal Time – Teacher's Notes

How people in the past divided up the day depended on their lifestyle.

Nomadic people followed food sources and their day did not have regular intervals as they had to respond immediately to any opportunities and challenges provided by Nature.

Agrarian communities were more settled but still had need only of general divisions or information from bells or singing the call to the faithful from the minaret, if nearby. Looking after domestic animals and planting crops provided their own times and calendar.

City people had greater need for organised time as trade depends on people being in the same place at the same time. People needed to be organized. Towns would have bells that rang out the times of religious services; town criers called out the daytime hours and night watchmen called out night hours. 10 o'clock and all is well .

Aboriginal Time - Teacher's Notes

In the not too distant past, after about 70,000 years ago our ancestors lived in sub-Saharan Africa. As the Ice Age finished they moved north to populate the rest of the World.

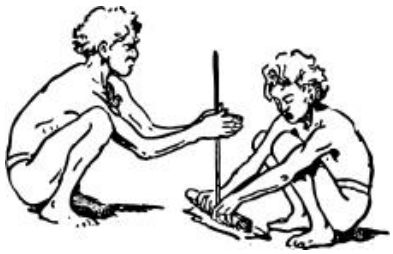
One group moved quickly and arrived here in Australia about 50,000 years ago to be followed by two later waves before sea level rose and cut off the continent. These were the ancestors of all present Aboriginal Australians. It is said they lived in the Deamtime.

A wanjina or ancestor spirit

Aboriginal people had to keep moving so that they did not exhaust local food and water supplies. They lived a sustainable existence. They travelled in small family groups of perhaps five adults and six children and followed a Hunter atherer lifestyle. The men hunted large game such as kangaroo and emu whilst the women hunted small game such as lizards, gathered seeds and fruit and looked after the children. They wore simple skin clothes and carried only a few tools. They didn't wander about but cleverly followed routes they knew would bring them seasonal food and water. These routes (Song lines) were described in songs and stories, which they passed on to their children. They had no permanent settlements or written language. Until recently Aboriginal people in Australia followed such an apparently simple but actually very efficient lifestyle. It was the only way to survive in such a vast resource-poor land as ours.

The Aboriginal dreamtime starts with dark night. The spirits put fire in the sky to warm the first men and women but it was a weak fire and they didn't feel much heat. Then fire is cunningly stolen to bring daylight to Earth. A story from Melville Island tells how the first man Purnukapali lit the first torch from this fire and his sister, Wurupranala, who later became the sun, carried it during the day.

Aboriginal Time - Teacher's Notes



Words common to most Aboriginal languages suggests that 24 hours could be broken into:

Pre dawn	Daybreak	Morning	Midday
Daytime	Late afternoon	Just before sunset	Sunset
Middle of the night		Nighttime	

Since they did not carry clocks, how did people know when it is daybreak? The sun rises over the horizon.

How did they know when it is midday? The sun was at its highest or directly overhead. Their shadow stopped growing smaller and pointed in the opposite direction.

How did they know it was sunset? The sun appeared to go down over the horizon.

Some groups could mark the passing of time at night by the movement of constellations through the sky.

Why do you think that early Aboriginal people did not need to break the day into smaller fractions such as hours and minutes? They travelled in small groups and rarely met up with others. They did not need to tell the time as they reacted to whatever their travels and Nature brought them.

At what time of day would an early Aboriginal person go hunting game? Anytime they were hungry and wanted meat.

At what time would an Aboriginal family eat roast kangaroo? Anytime after it had been caught and cooked.

At what time of day would an Aboriginal family next eat roast kangaroo? Anytime after the first kangaroo had been eaten and the next kangaroo had been caught and cooked.

Name _____

Aboriginal Time – Student Worksheet

Aboriginal history starts in the Dreamtime when ancestor spirits lived in the sky.

A story from Melville Island tells how the first man, Purnukapali lit the first torch from a fire given by the ancestor spirits. It was carried during the day by his sister Wurupranala, who later became the sun. Words common to most Aboriginal languages suggests that 24 hours could be broken into:

A wanjina or ancestor spirit

Pre dawn, daybreak, morning, midday, daytime, late afternoon, just before sunset, sunset, middle of the night and nighttime.

Since they did not carry clocks, how did people know when it is daybreak?

_____

How did they know when it is midday? _____

_____

How did they know it was sunset?

_____

Name _____

Aboriginal Time - Student Worksheet

Some groups could mark the passing of time at night by the movement of constellations through the sky.

Why do you think that early Aboriginal people did not need to break the day into smaller fractions such as hours and minutes?

_____

_____

At what time of day would an early Aboriginal person go hunting game?

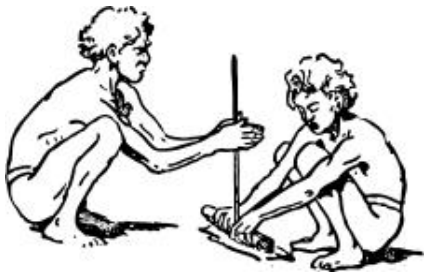
_____

At what time would an Aboriginal family eat roast kangaroo?

_____

At what time of day would an Aboriginal family next eat roast kangaroo?

_____



Day V Night - Teacher's Notes

Directed Discussion

(see Aboriginal Time for further information)

Other groups left Africa and traveled on to populate Europe, Asia and finally the Americas. They too were initially hunter gatherers. For most hunter-gatherer people and later for early farming people, day and night were considered opposites. Daytime was considered good because you could see to find food and water and you could see to defend yourself against attack. Night was a time of dark and fear, of unseen predators and evil spirits.

Some believed that there was constant struggle between the forces of day and night. The concept of one "day" lasting through light and dark did not exist

Europeans still use dark, black or night to describe evil and uncertainty and white or bright to represent good. In old fashioned cowboy movies the "goodies" wore white hats and the "baddies" wore black. Ask students to find examples of this use in present stories.

Black hearted, a shining light in the school community, fair maiden, dark thoughts, dark deeds are not seen in the light of day, bright students win prizes, in the dark recesses of your mind, ghosts and vampires walk at night but are burned by the light of the sun, let's shine some light on the problem, you are a ray of sunshine! And more.

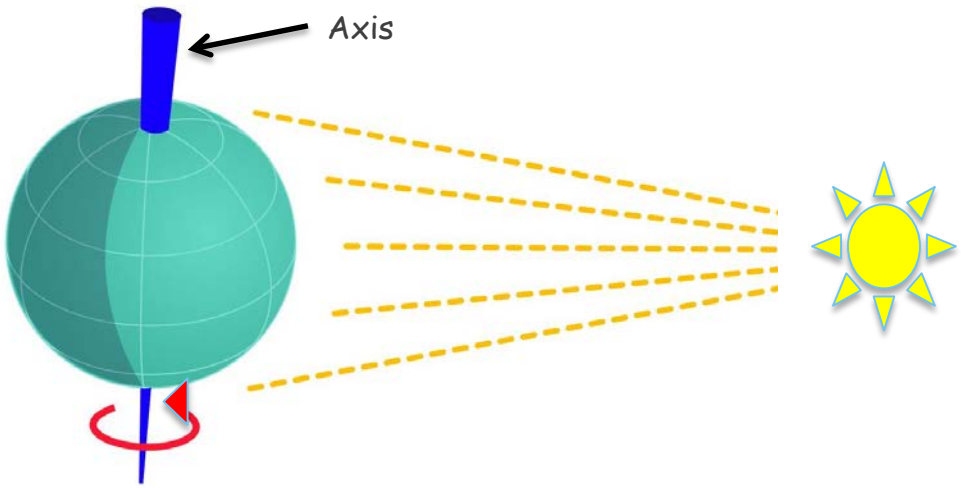
Time Vocabulary - Teacher's Notes

Short Class Discussion

You may wish to discuss with your students whether we should still use the expressions sunrise and sunset, as they are misleading.

Should we instead use "Earthrise" and "Earth set" for first light and last light?

Light from the sun illuminates the side of the Earth facing it. As the planet spins on its axis part of the surface moves away from the Sun and becomes dark.



Midday Around the World - Teacher's Notes

This activity is designed to assist students with their understanding of the rotation of the Earth.

Materials

- The attached map cut into 24 pieces
- A powerful torch

Method:

1. Copy the map of the world, attached, with the equator marked on it as large as possible (at least A3).
2. Cut the map in N/S strips of 24 (approximately equal) pieces.
3. Assemble students in a circle facing outwards with their strip of map in the correct sequence and with the equator at the same height.
4. Ask one student to shine a torch at the equator of the student nearest them (they are not to move for this activity).
5. Ask students to shuffle in their circle anticlockwise.
6. Students should call out when they think it is midday at their location (the torch is shining directly on their equator).

Before clocks and watches were common, some cities would rely on bells or flags to indicate specific hours. Both Edinburg in Scotland and Fremantle in WA fired a cannon to indicate one o'clock and both ports sometimes a ball on a high pole was also "dropped" to alert sailors entering the port to adjust their timepieces.

12 Hours - Teacher's Notes

We have 12 hours of daylight and twelve hours of night at the equator.

When people settled into agriculture and towns appeared measurements had to become uniform to control fair trade, develop technology and collect taxes. Early Assyrian and Egyptian people used their thumbs and the three joints each in their four fingers to count.

Numbered joints

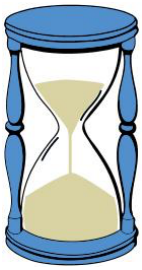
Thumb counting to five

This resulted in a numerical system based on the (sacred) number 12, as compared to the present decimal system based on 10. (Some teachers may even remember that prior to the arrival of decimal coinage there were 12 pennies to one shilling and twelve inches in one foot).
Sundials broke the day into twelve sections for those who needed it.

Most people just rose at ***dawn***, worked until ***breakfast*** (which was the first meal of the day and broke the night's fasting), returned to work only to stop about ***midday*** for a meal and then worked on until ***sunset*** when they went home for their evening meal. The nighttime wasn't broken up into sections. Sailors estimated time at night by watching the stars.

12 Hours - Teacher's Notes

The advanced T bar sundial developed in Egypt and shown in some tomb paintings was calibrated to divide the period between sunrise and sunset into 12 hours. Since Egypt is close to the equator throughout the year the days are of almost equal length. Elsewhere the tilt of the Earth's axis resulted in longer summer hours and shorter winter hours. At night, time was estimated by movement of significant stars or by using a water clock or sand hourglass.



Although in ancient Greece about 140BC it was suggested that night and day should be divided into 24 hours of equal length most people still managed with hours that varied in length with the seasons until mechanical clocks appeared in the Middle Ages. Many early clocks only had an hour hand. Ordinary people estimated the time of day by the Sun or by church bells ringing for service.

Timely Fractions – Teacher's Notes

Most modern people divide one rotation of the Earth into

- Day and night
- Hours
- Minutes
- Seconds

This is a great opportunity to have student considered the Mathematics involved in this.

What fraction of one hour is one minute? 1/60

What fraction of one minute is one second? 1/60

What fraction of one minute is 30 seconds? 1/2

How many minutes are there in one and a half hours?
90 minutes

How many minutes would you have to wait if lunch is at 12noon and the clock reads 11.40am? 20 minutes

What fraction of one hour is this? 1/3

If a one hour game of sport is divided into four quarters, how long must each quarter last? $\frac{1}{4}$ of an hour or 15 minutes

What date is your birthday?

What is today's date?

Name _____

Timely Fractions - Student Worksheet

What fraction of one hour is one minute? _____

What fraction of one minute is one second? _____

What fraction of one minute is 30 seconds? _____

How many minutes are there in one and a half hours?

_____

How many minutes would you have to wait if lunch is at 12noon and the clock reads 11.40am?

_____

What fraction of one hour is this? _____

If a one hour game of sport is divided into four quarters, how long must each quarter last?

_____

<u>Days and Months mnemonic</u>

30 days has September, April, June and November.
All the rest have 31, excepting February alone, which has but 28 days clear and 29 on each Leap Year.

What date is your birthday? _____

What is today's date? _____

Book of Hours - Teacher's Notes

In Medieval times people read their "Book of Hours". They were used across society and contained prayers and psalms and other daily and seasonal devotions. Since they were often the only book in the household, they also had an alphabet so they could be used to teach children to read. They were often given by a husband to his wife as a marriage gift and were passed down through generations. Rich people had books full of illustrations and often the major initial letters were heavily illuminated.

Divide daylight hours amongst the class and ask them to produce a small illuminated picture indicating what activities should be carried out at that time. E.g. 12o'clock eating. These can be progressively organised along a wall to represent the passing of the hours of daylight.
Rich people could afford beeswax candles to measure the passing of hours. When Henry XIII had a son he gave a very large donation to the church for candles to mark the passing of the hours. The child died at two months. Town criers walked through cities calling out the passing of the hours when clocks were rare.

Name _____

Book of Hours - Student Worksheet

In Medieval times people read their "Book of Hours". They were used across society and contained prayers and psalms and other daily and seasonal devotions. Since they were often the only book in the household, they also had an alphabet so they could be used to teach children to read.

Draw a picture below to represent the hour you have been given by your teacher.

Relative Time Graph - Teacher's Notes

Ptolemy divided degrees of latitude into 60 smaller (more minute) parts. He called these "partes minutae primae" and then these into even more minute parts "partes minutae secondae". This is why we call them "minutes" and "seconds". Again, the general public did not use these smaller subdivisions until the development of mechanical clocks. Medieval town clocks often had only an hour hand. Artisans such as smiths, engineers and pharmacists could estimate time using rhymes and prayers in much the same way that one second can be roughly measured by saying "One Mississippi" or one chimpanzeeses".

This brings us to the idea that one day can be divided into 24 hours, which can each be divided into 60 minutes, which can each be divided into 60 seconds. To create uniformity across the Earth, the new definition of a second is taken as the time taken for 9,192,631,770 energy transitions of a cesium atom. This not only allows for UTC (Co-ordinated Universal Time – in French) it also allows for the addition of "leap" seconds to permit greater accuracy and agree with astronomical time. Eight times in every ten years a minute has 61 seconds.

Relative timescales

Materials

- Graph paper or the worksheet provided
- Three different coloured pencils

Method

We are going to see the differences in size of the units we use to measure one day.

1. Each small square on the graph paper is two seconds

Relative Time Graph - Teacher's Notes

2. Colour in 1 second in green in the square at the bottom left corner of the graph paper. What fraction of the square will it be? $\frac{1}{2}$

3. Label this "1 second".
   How many 1 seconds are there in a minute? 60
   Do you think we can fit one minute of seconds into this graph paper? Students write in their best guess.
   How many squares would we need to fill in for one minute? Half of 60 = 30squares.

4. We shall colour one minute worth of seconds in red. (remember to include the first second)

5. Label this "1 minute".
   Did the minute of seconds fit into the graph paper? Yes, easily.
   Is a second larger or smaller than a minute? Smaller
   What fraction of a minute is a second? 1/60
   How many minutes make an hour? 60 minutes
   Do you think you will be able to fill in an hour of seconds onto this graph paper? Explain your answer. Yes because there is room for six of these red blocks on the graph paper.

6. Outline this 1 hour block in blue

Guess how many seconds there are in 1 hour

a. 6 seconds (1/10 minute)
b. 60 seconds (1 minute)
c. 360 seconds (6X60 seconds)
d. 3,600 seconds (60X60 seconds)

Can we fit a day into this graph? No because a day has 24 hours and there

isn't room for 24 blue blocks.
Why do we have a minute hand (and sometimes a second hand) on clocks and watches? To accurately measure time for things which take less than one hour

To boil an egg = 3minutes - Too little it is runny – too long it turns into rubber!
Year 3 to run 100m ~16seconds (Teacher might take a little longer)
To measure heart rate 70 to 110 beats per minute

Name _____

Relative Time Graph - Student Worksheet

We are going to see the differences in size of the units we use to measure one day.

Name _____

Relative Time Graph - Student Worksheet

Method

1. Each small square on the graph paper is two seconds

2. Colour in 1 second in green in the square at the bottom left corner of the graph paper. What fraction of the square will it be? _____

3. Label this '1 second'.
   How many 1 seconds are there in a minute? _____
   Do you think we can fit one minute of seconds into this graph paper? _____
   How many squares would we need to fill in for one minute?
   _____

4. We shall colour one minute worth of seconds in red (remember to include the first second).

5. Label this '1 minute'.
   Did the minute of seconds fit into the graph paper? _____
   Is a second larger or smaller than a minute? _____
   What fraction of a minute is a second? _____
   How many minutes make an hour? _____
   Do you think you will be able to fill in an hour of seconds onto this graph paper? Explain your answer.

_____

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Relative Time Graph - Student Worksheet

6. Outline a 1 hour block in blue

Guess how many seconds there are in 1 hour.

a. 6 seconds (1/10 minute)
b. 60 seconds (1 minute)
c. 360 seconds (6X60 seconds)
d. 3,600 seconds (60X60 seconds)

Can we fit a day into this graph? _____

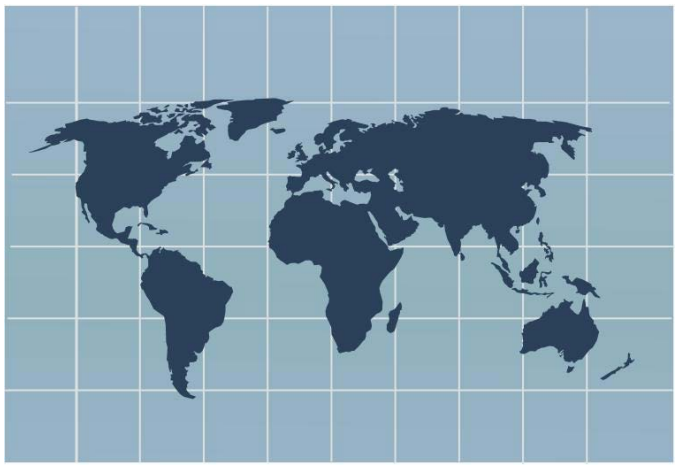
Why do we have a minute hand (and sometimes a second hand) on clocks and watches?

_____

_____

_____

Time Zones - Teacher's Notes



If students have access to iPads or you have a Smart Board or data projector with Internet access, visit timeanddate.com and click on the time zone interactive map.

1. Students may be surprised to see how economics and politics have created time zones around the world which are not 24 vertical strips as might be expected. They will see that WA stretches across its time zone.
2. The International dateline is not a straight line running North to South but zigzags about to include and exclude national boundaries.
3. Daylight saving affects some countries and not others
4. Western Australia stretches across a whole zone. The west coast of our state is almost in the next time zone. (this will cause some problems when they make their sundials as the solar time on the dial may be different from the zone time).

Traditionally time was calculated as a deviation from GMT, Greenwich Mean Time. Greenwich lies close to London on the River Thames. It was a great seafaring center and so time was calculated from a spot near the Royal Observatory there. You can stand with one foot officially in the Eastern Hemisphere and the other in the Western Hemisphere. A recent more

accurate estimation involves not only solar observations but also atomic clocks spaced round the globe. This is known as UTC or Coordinated Universal Time (in the original French Temps Universal Coordonné) UTC times can be seen across the base of the map and can be used to estimate time differences around the world. If students know the location of a city on the map, they can click on the red dot to check their answer. If not they or you can type the location into the space above the map.

If it is noon (12 am) at Greenwich, what time is it in:

Perth WA (or their own town)	12 + 8 = 20h or 8pm
Adelaide SA	12 + 9 = 21h or 9pm
Sydney NSW	12 + 11 = 23h or 11pm
Washington USA	12 – 5 = 7h or 7am

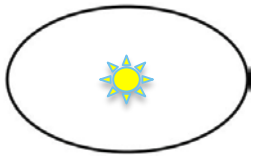
Students may be encouraged to name the nearest city close to where relatives may be. They can then count the difference in time between where they live and where their relatives live.

If your granny lives in Rome in Italy, is this a good time to call her on the telephone from school? Usually not as it is too early in the morning!

Solar & Sidereal Day - Teacher's Notes

We say that it takes 1 day for the Earth to rotate so that the Sun appears in the same spot in the sky. We also say that 1 day is always broken into 24 hours of even length. This is known as a **SOLAR DAY**.

BUT



In reality, the Earth does not travel in a circle round the Sun. It travels in an elliptical orbit at different speeds affected by the Sun's gravity. The average day length in this case is 23.93 hours because some "days" are longer than others. If we want one year to mean one complete revolution of the Earth round the Sun so that it will appear in exactly the same spot in the sky, we have to add about 4 minutes to every year.

Solar day = Sidereal day + 4seconds

Student Demonstration

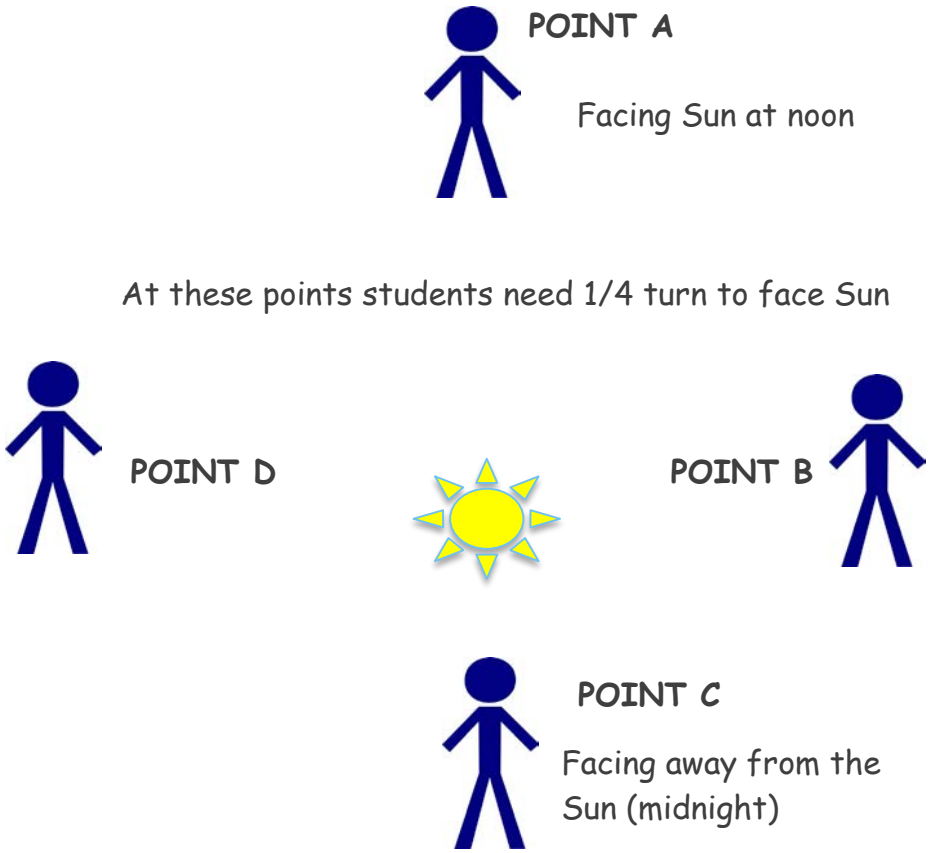
Materials

- 1 teacher to model the Sun
- 1 student to model the Earth

Method

1. The teacher is the Sun (of course!) shining their light all around.
2. Ask the student to face you. It is noon or midday at Point A of the Earth's yearly revolution of the Sun. Every time the student rotates to indicate one day they should be facing the same way. Sometimes it is a good idea to ask them to pick a spot behind you in the classroom and make sure they end up facing that spot.
3. Ask the student to complete one rotation on their axis to indicate one day. They will be facing you. It is noon.

4. Ask the student to continue rotating on their axis but make a quarter revolution of you to Point B. By the time they are a quarter of the way round they will find that at the point that was "noon" they are no longer facing you but are 90° turned away from you. (one quarter of a revolution). It will take them a quarter more of a revolution's to be facing you for noon . These days will be longer.
5. Half way along their revolution



AND

Because the Earth is a slightly flattened sphere, the speed of rotation at the equator has to be very much faster than at the poles. We hurtle round

our axis at hundreds of kilometers in one day. Why do we not get spun off at this great speed? That is because the "spin off" force is only one three thousandths as strong as the much greater force of gravity.

Investigating Shadows – Teacher's Notes

The following activities are best done outside but some can also be done in a classroom if the weather is inclement. Reducing the number of light sources in the room will make shadows more apparent. Students will be investigating their own shadows.

Materials

- Sunny day
- Chalk
- Ruler
- Hard smooth surface such as concrete and an uneven surface such as grass or brick.
- A brush or hose to remove chalk marks
- Ruler

Observations

In Science we observe and (where possible) measure.
Find a partner and find out if:

1. Tall people always have longer shadows than small people? Only if they stand together at the same spot and the same time. If the tall person stands farther away from the light source their shadow will become smaller.
2. Your shadows always lie in the one direction? At the same time in the same place – Yes. Your shadow will swing around your feet progressively during the day.
3. You can cross your shadow with your partner. Impossible unless you use different light sources.
4. You can step away from your shadow. Not possible without some obstruction (something else could block the lower part of their shadow)

Investigating Shadows – Teacher's Notes

5. With the sun or a light at your back, find a way to change the shape of your shadow. Change your bodies orientation to the light or change the shape of your body.
6. Can you play shadow tag? No, unless you stand in line with the sun or light source directly behind you.

List the ways your shadow are the same as you and different to you.

Same	Different
More or less the same shape if you stand square on to the light. Your shadow moves when you move and stops when you stop. Your shadow moves in the same direction as you do (unless there is another light source)	Only occur when there is strong light source Multiple light sources give multiple shadows from one person Your shadow is a different length to you. If you turn sideways your shadow changes shape.

Discuss:

Does your shadow remain if the light goes out? No. Light is needed to create a shadow.

Will a red torch cast a red shadow? No

Will a red balloon cast a red shadow? No

Will a red light give a red balloon a red shadow? No

Do the edges of a shadow become crisper or fuzzier with distance from light source? Fuzzier (because some light will bend).

Why can you have multiple shadows in the classroom but only one outside? Inside a classroom there are many lights causing many shadows. Outside the sun casts shadows.

Name _____

Investigating Shadows – Student Worksheet

In Science we observe and (where possible) measure.

Find a partner and find out if:

1. Tall people always have longer shadows than small people?

_____

2. Your shadows always lie in the one direction?

_____

3. You can cross your shadows with your partner.

_____

4. You can step away from your shadow.

_____

5. With the sun or a light at your back, find a way to change the shape of your shadow.

_____

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Name _____

Investigating Shadows – Student Worksheet

6. Can you play shadow tag?

_____

List the ways your shadow are the same as you and different to you.

Same (Compare)	Different (Contrast)

Discuss:

Does your shadow remain if the light goes out.
Will a red torch cast a red shadow?
Will a red balloon cast a red shadow?
Will a red light give a red balloon a red shadow?

Name _____

Investigating Shadows – Student Worksheet

Do the edges of a shadow become crisper or fuzzier with distance from light source?

Why can you have multiple shadows in the classroom but only one outside?

Shadow Graph - Teacher's Notes

For this activity, students, in pairs go outside and measure the height of each other's shadow an hour apart. They need to be standing on exactly the same spot facing south every time. South can be found using an App, a compass or map of the school. They enter their own data in the table provided and draw a bar or column graph of the results.

Precision and accuracy

You may wish to discuss with students the degree of accuracy, which would make the data acceptable. Using a standard ruler, students can only accurately measure to millimeters. Although in secondary school they are encouraged to measure to two decimal places, this equipment is limiting. In the third column students can comment on anything else that they notice about their shadow.

Materials

- Worksheet
- Ruler or measuring tape
- Pen or pencil

Why can't you measure the length of your own shadow? Because the moment you move down to measure it, it changes shape.

Note: If climate or class members make measurements difficult, the data below can be used. (The average height for a Year 3 student is 127mm)

Shadow Graph - Teacher's Notes

Observations

Time	Length in mm	Comment
8.30am	130	The shadow is to my right and is longer than my height
9.30am	125	The shadow is becoming shorter and seems to be moving to my left (towards the south)
10.30am	115	The shadow has become even shorter
11.30am	105	The shadow lies directly in front of me (due south)
12.30pm	114	The shadow is becoming longer and is moving towards the east.
1.30pm	124	The shadow continues to lengthen and turn east
2.30 pm	130	The shadow is longer than me and is further to the east

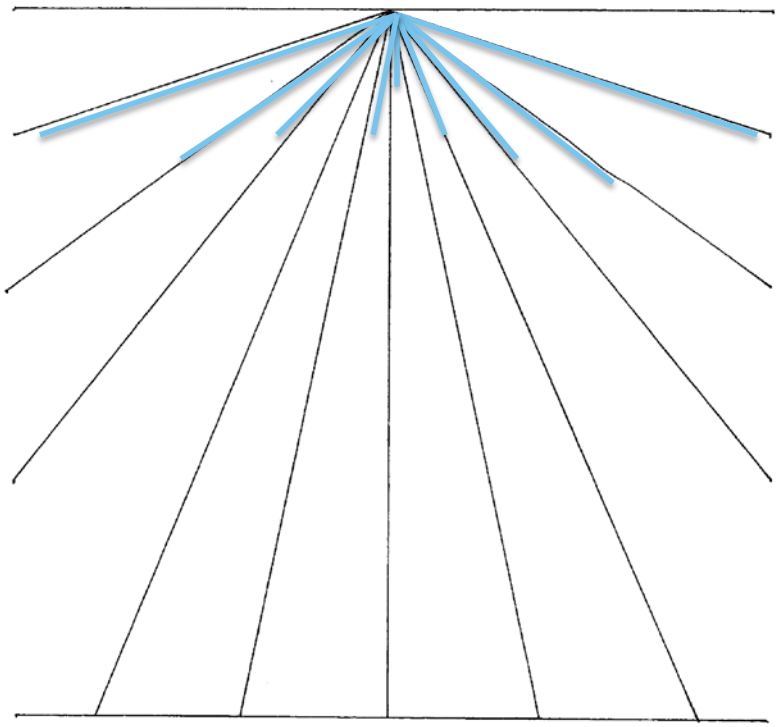
If measurements are scaled by 1/10 then the bars can fit into the graph sheet. Provided.

Extension

Students might wish to use this diagram to display both the change in length and direction of the shadow. A suitably scaled line could be drawn on the appropriate ray.

Please Note: The shadow moves anticlockwise in the Southern Hemisphere.

Shadow Graph – Teacher's Notes



Name _____

Shadow Graph - Student Worksheet

Today you will be working with a partner to measure your shadows.
Why can't you measure the length of your own shadow?

_____

Time	Length in mm	Comment

Name _____

Shadow Graph – Student Worksheet

Title of graph _____

Shadows & Art – Teacher's Notes

Silhouettes (shadow profiles) were very popular before photographs were invented. This drawing shows a frame used by professional silhouette artists. The head is magnified because it is some distance from the light source but close to the frame.

White paper stuck on a wall and a strong desk light or torch for illumination can produce a good silhouette. Someone else traces the profile of the sitter in pencil. The silhouette is then cut out and placed on a backing card of a different colour. Traditionally the head is a darker tone than the background. Students can mount these as a display and challenge others to guess which silhouette represents whom.

The **Brocken specter** is caused by a climber's magnified shadow falling on low-lying clouds. It is often surrounded by a rainbow effect and is deeply scary! It only happens when the person is illuminated from behind. It appears to stalk the viewer.

Whiteout occurs when snowfall, dust or fog diffuses light and there are no shadows. The horizon disappears from view. Depth and distance are impossible to estimate. In Canada people have been lost in their back gardens and had to literally feel their way to their own back door. In Europe climbers have walked off cliffs. Most people settle down and wait until it passes. This has caused some traffic accidents on motorways when cars have crashed into those already halted.

In Australia this used to happen during dust storms.

Nodal Sundial - Teacher's Notes

Ancient people noticed that shadows thrown by the Sun moved in regular and predictable ways. They used this to make sundials.

Almost noon at midsummer

The nodal sundial measures 12 solar hours of different lengths. It was used for general timekeeping and for religious ceremonies. We shall be experimenting to find out how accurate it is.

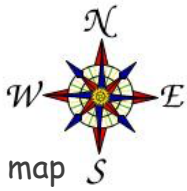
Common Misconceptions

A. Sundials show the movement of shadows cast by the sun clockwise. This only happens in the northern hemisphere. Shadow movement south of the equator is anticlockwise. The word clockwise was coined in the northern hemisphere because movement of the clock's hands are the same as the movement of shadows on a sundial

B. There is a common misconception that stele (needles of rock) such as Cleopatra's needle originally from the banks of the Nile River in Egypt were used to estimate time. They were usually only memorial rocks. Although the Solarium Augusti in Rome may have functioned to tell the time as well as celebrating the birthday of Caesar Augustus.

Nodal Sundial - Teacher's Notes

Materials



- This worksheet
- A blob of Blu-Tack, plasticine or play dough
- A pencil (nodus) and ruler
- A magnetic compass, phone compass app or school map
- Classroom clock, watch or mobile phone clock

Method

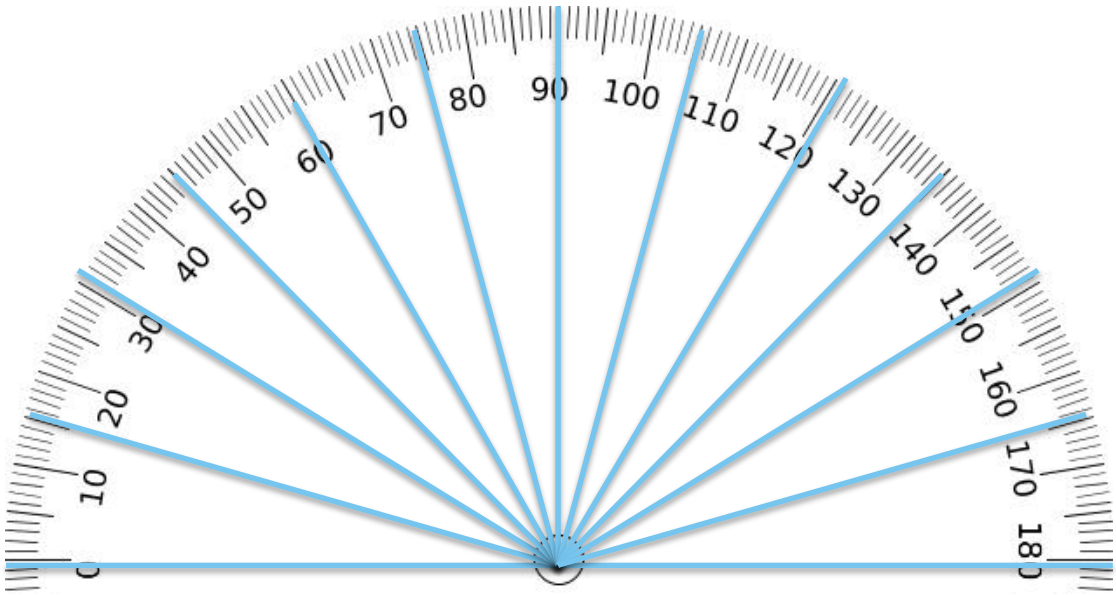
1. Select a dry sunny day if possible. (If unfortunately this activity has to be done when it is raining or overcast then you will need a strong torch. Once the dial has been drawn and nodus attached, switch off classroom lights and arc the torch over the dial in an east to west direction).
2. With pencil and ruler draw a straight line between 0 and 180 on the paper protractor on your worksheet. This line must always lie east to west.

The ancient people used 12 hours in one day so we need to divide the paper into 12 parts of equal size. Night and day were considered antagonistic.

3. Start at zero and measure in units of 15 degrees. Look clockwise round the circle until you see 15 and then join that point to the cross in the middle of the base. You will have made the first section.
4. For every section you will need to add another 15 until you reach 180. Draw lines from these numbers to the cross.

Q What numbers will we need to use? 0, 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, 165 then 180.

Nodal Sundial - Teacher's Notes



5. Mark these on the worksheet and draw in the sections from the number to the central cross using a pencil and ruler. This is easiest if a "step by step" instruction process is used. These mark where solar hours should fall on the sundial if they were of equal length. (They are not).

6. Using Blu-Tack or plasticine set your pencil upright on the cross.

7. Take your sundial outside, align the horizontal line east to west. If you are using a magnetic compass it needs to be kept away from metal and power lines. Phone apps use satellite information not magnetism. Most school maps have "North" at the top. Mark where the shadow falls on each standard (UTC) hour.

Horus was God of the Sky in Ancient Egypt. The pharaoh represented him in life.

Nodal Sundial - Teacher's Notes

Q How accurate is your sundial? It is not very accurate because solar hours vary in length.

This Assyrian king needs a nodal sundial. What things would he use it for?
Setting times for:
Organising religious and social control.
Meetings, meals, working hours, prayers, religious activities,
ceremonies, changing of guard

Brain Strain

In Western Australia in February, daylight lasts $13^1/_2$ standard hours.

In summer will Ancient Egyptian solar hours be longer or shorter than our standard hours?

Egyptian solar hours will be longer because they only had twelve. At that time of year there was a longer period of daylight to be divided into 12. In winter when there is less than 12 standard hours of daylight then the reverse would apply

Why do you think that modern people need a more accurate measure of time than the solar hour? Any reasonable answer that involves organising many more people to work. How could you organise education for 300 students and 25 teachers together if they all arrived and left at different times? Advanced technologies require more accuracy to get a good result.

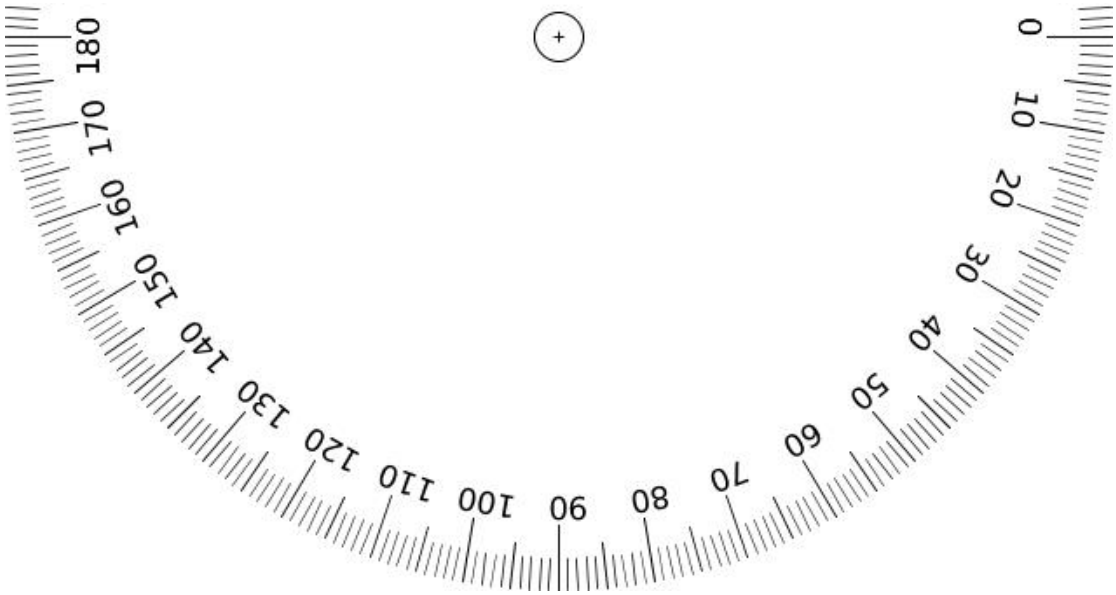
Nodal Sundial - Teacher's Notes

Name four things in your home that tell the time. Clocks, watches, mobile phones, laptops, televisions, fridges, microwaves and cookers.

Name _____

Nodal Sundial – Student Worksheet

Nodal sundials show ***solar hours.***



Ancient Egyptians and Assyrians divided the daylight into 12 solar hours of equal length. We will divide the protractor above into 12 equal sections of 15 "degrees" or units radiating from the cross.

Name _____

Nodal Sundial – Student Worksheet

What numbers will we need to use? _____

_____

Mark these on the worksheet and draw in the sections from the number to the central cross using a pencil and ruler.

Using Blu-Tack or plasticine set your pencil upright on the cross.

Take your sundial outside, align the horizontal line east to west (your teacher will help you) and mark where the shadow falls on each hour.

Horus was God of the Sky in Ancient Egypt. The pharaoh represented him in life.

Q How accurate is your sundial?

_____

Name _____

Nodal Sundial – Student Worksheet

This Assyrian king needs a nodal sundial. What things would he use it for?

_____

_____

_____

_____

Brain Strain

In Western Australia in February, daylight lasts $13^1/_2$ standard hours.

Will Ancient Egyptian solar hours be longer or shorter than our standard hours?

Egyptian solar hours will be _____

because _____.

Name _____

Nodal Sundial - Student Worksheet

Why do you think that modern people need a more accurate measure of time than the solar hour?

_____

_____

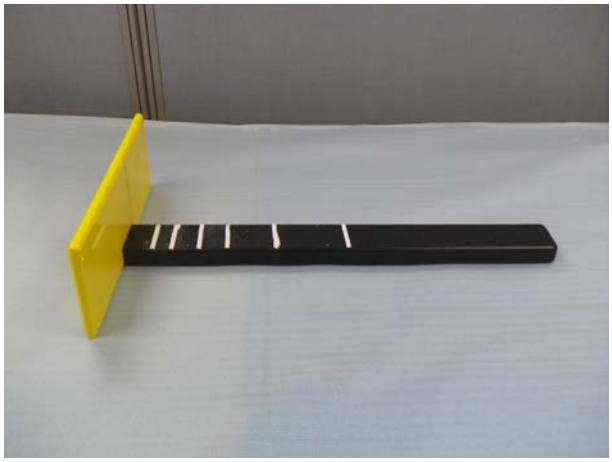
_____

Name four things in your home which tell the time

1. _____
2. _____
3. _____
4. _____

T Bar Sundial - Teacher's Notes

Solar hours are estimated by dividing daylight by twelve.



Paintings of T bar sundials were found on tomb walls in the pyramids. They were made of wood, would have been inexpensive to make and light enough to carry about on worksites. They were used by Egyptian work overseers to measure out the working hours of slaves and peasants. Hours were marked by holes drilled on the position of the shadow on the long arm. Only six marks were necessary as at midday when the sun was overhead, there was no shadow. The sundial was reversed at midday to measure the shadow as it moved over to the other side. These measured twelve solar hours which are of different lengths at different times of the year.

A copy can be made of cardboard or thick paper. A ruler makes a good pattern for the long arm.

Materials

- A ruler and pencil
- Cardboard (old boxes are great)
- Scissors
- Masking tape or sticky tape
- Pencil or chalk
- A magnetic compass, mobile phone compass app or a school map to estimate an east to west direction.

T Bar Sundial - Teacher's Notes

Method

1. Use your ruler to outline a strip of card about 20cm long and cut it out.
2. Cut out a 5cm square of cardboard and stick it onto the end of the strip so that it covers the last 5cm of the strip.
3. Then fold it at right angles to a T shape so it looks like the photograph above.
4. Set it with the T running east to west.
5. Using a standard clock mark the hourly divisions along the long arm

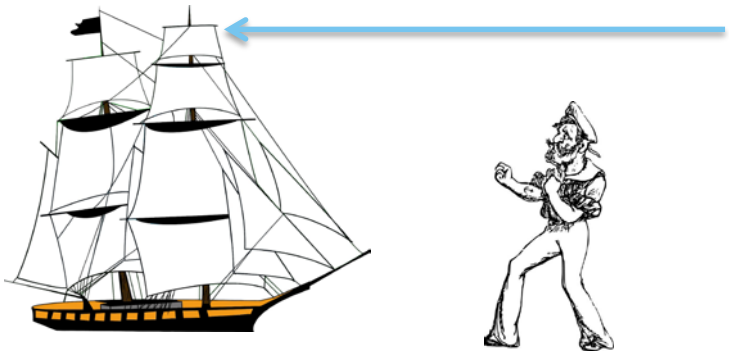
What is a solar hour? One twelfth of daylight on that day
What does your sundial measure? The movement of a shadow along the bar
What are the advantages of this over the stone or clay nodal sundial? It is easier and cheaper to make and is easier to carry around
What is the smallest fraction of one hour that you can measure accurately using this? Early in the day and late at night you can measure quarter hours but near noon only half hours because the hour marks are so close together.

Extra for experts

On sailing ships fresh water was kept in wooden casks and often drinking it could be a health hazard. In Royal Navy ships captains had casks of rum for drinking. The officers drank tots neat and the sailors had watered rum. The addition of alcohol made the water safer to drink.

Using what we have just learned, why would sea captains wait until the sun was over the topmost yardarm to break out the rum ration and let the sailors stand easy on deck? The ship's yardarm was used like the T bar to tell the time. On the North Atlantic in summer the sun would "cross" over this at about 11am when half the working day was already over. This way, if the sailors became drunk and difficult to handle they would only have to be

controlled until dark when everything quieted down. "Oh what shall we do with the drunken sailor?"



Topmost yardarm

Yardarms are horizontal spars from which sails are set

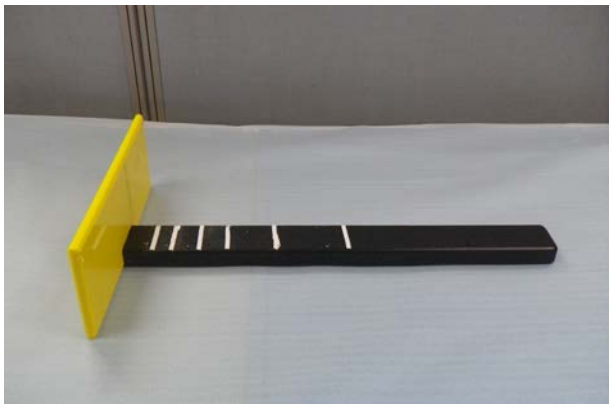
Students may know the sea shanty "What shall we do with the drunken sailor". It was used to keep sailors pulling or walking ropes in unison.

Chorus: Hoorah! And up she rises [three times, appears before each verse]
Early in the morning.
What shall we do with a drunken sailor? [three times]
Early in the morning.
Put him in the long-boat and make him bail her.
Early in the morning.
What shall we do with a drunken soldier?
Early in the morning.
Put him in the guardroom till he gets sober.
Early in the morning.

Name _____

T Bar Sundial - Student Worksheet

Solar hours are estimated by dividing daylight by twelve.



Paintings of T bar sundials were found on tomb walls in the pyramids. They were made of wood, would have been inexpensive to make and light enough to carry about.

Draw your T bar solar measuring stick below to half scale when you have finished working with it.

What is a solar hour? _____

What does your sundial measure? _____

_____

Name _____

T Bar Sundial - Student Worksheet

What are the advantages of this over the stone or clay nodal sundial?

_____

What is the smallest fraction of one hour that you can measure accurately using this?

_____

_____

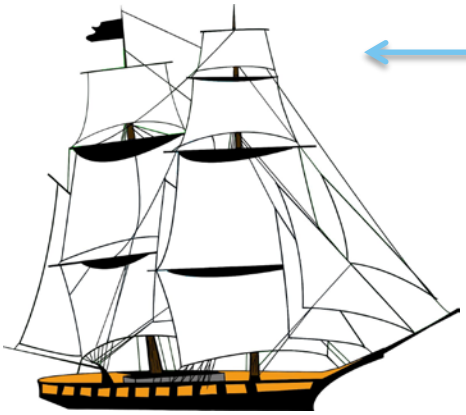
Extra for experts

On sailing ships fresh water was kept in wooden casks and often drinking it could be a health hazard. In Royal Navy ships captains had casks of rum for drinking. The officers drank tots neat and the sailors had watered rum. The addition of alcohol made the water safer to drink.

Using what we have just learned, why would sea captains wait until the sun was over the topmost yardarm to break out the rum ration and let the sailors stand easy on deck?

Name _____

T Bar Sundial - Student Worksheet



Topmost yardarm

Yardarms are horizontal spars from which sails are set

_____

_____

_____

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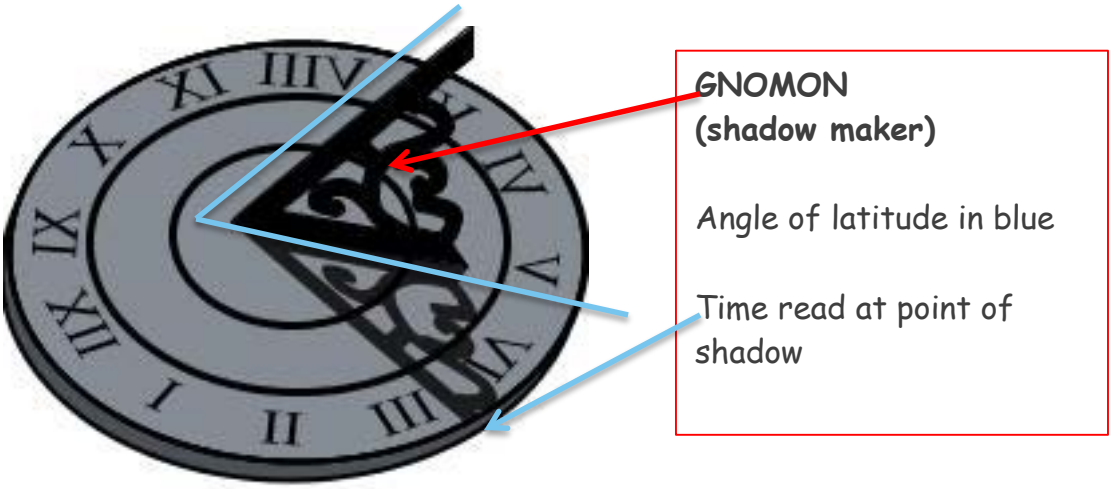
Gnomon Sundial - Teacher's Notes



Arab philosophers of 9th and 10th centuries were amongst the first advanced scientists and mathematicians in Europe. They discovered that using a gnomon, a triangular shadow maker, would indicate hours of exactly the same length of standard time, no matter what time of year it was. The angle between its base and top has to be the same as the latitude of the location in which it is used. This is because when it points south it lies parallel to the Earth's axis of rotation.
These became very popular in Renaissance times in Europe and the concept of a single standard hour made scientific measurements more reliable. Some sundials were placed on walls.

Sundials were often ornate and had mottos such as:

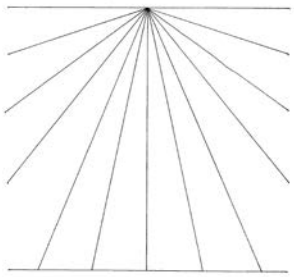
- Tempus fugit (Time flies – Latin)
- Tak tint o time ere time be tent (Pay attention to time or time will be lost - Scots)
- Let others tell of storms and showers. I only tell of sunny hours (Anon)

Gnomon Sundial - Teacher's Notes

Materials

- Worksheet for sundial base
- Spare paper for gnomon
- Protractor
- Glue or sticky tape
- Scissors
- Atlas or Internet access to find your latitude

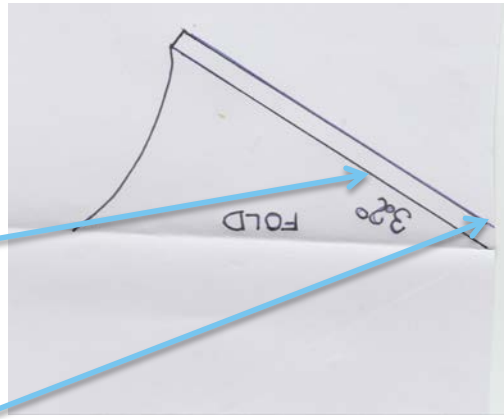
E.g.	Broome	20.3°S
	Perth	32°S
	Kalgoorlie	30.7°S
	Albany	35°S



Sundial base

- Prepared gnomon (Shadow triangle for your school's latitude)

To prepare your gnomon



Fold a sheet of paper in half. The fold will be the top of the gnomon and will be used to reinforce it.
With the protractor, measure your school's latitude (in this case 32°S) away from the fold then draw that line about 9cm long.
Draw another line about 1cm below this to make the flaps that will stick onto the base in the worksheet.
Leaving the paper folded cut round the outside of the gnomon.
Fold out the flaps to attach to the prepared base in the student worksheet.
The gnomon should be attached with the fold running down to the north or origin of the rays on the base

Gnomon Sundial - Teacher's Notes

Method

1. Before class prepare photocopies of the correct gnomon for your school.
2. Ask students to cut out the gnomon, fold back the flaps and stick it onto the base with the fold pointing downwards towards the origin of the rays in the base.
3. Take the sundial outside and align it so that the gnomon points down towards the west
4. Read the time

Observations

What time did your sundial read? Dependent on time

What time is it according to your watch, clock or mobile? There will usually be a difference.

Why is there a difference? The dial tells solar time. Our watches etc. give standard time according to standard agreed time zones.

Both Perth and Kalgoorlie are in the same time zone but their sundials read noon at different times. Why would a Kalgoorlie sundial read noon much earlier than the Perth one? Kalgoorlie lies east of Perth. It faces the Sun much earlier then Perth. The overhead Sun at noon will happen earlier there.

Does the moving Sun rise and set? No, The Earth rotates so that particular places approach the Sun and then roll away from the Sun .

What fractions of a sundial hour can you accurately read? Quarters of a sundial hour.

One thousand years ago, what would our ancestors have used a sundial for?

To organise people to come together for church services, meals, meetings, trading times.

To estimate distances when travelling on land or sea.

To organise people to come together at the same time for working parties

Gnomon Sundial - Teacher's Notes

Extension

Write a short letter to a friend organising a meeting using information from a sundial

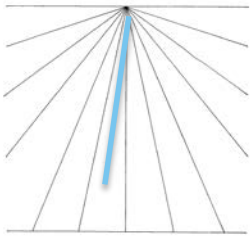
Dear _____

We must meet at _____ o'clock to_____

because _____

Look on the sundial. Set out when the shadow fall looks like this below.

Student draws a coloured line at the time agreed.
This would be for 5.15pm.
(The shadow moves anticlockwise).



Your good friend _____

Gnomon Sundial - Teacher's Notes

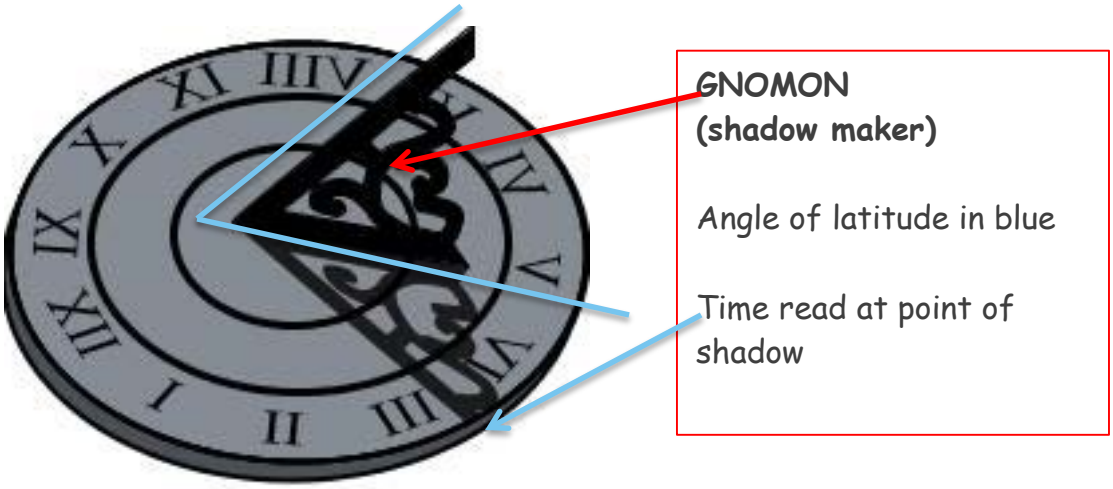
Cottesloe Sundial - An advanced gnomon sundial

The Cottesloe sundial was built in 1993. It is based on 18th century sundials popular in Jaipur in India. The parallel triangular gnomons throw shadows onto engraved plates which curve on either side of them permitting accurate time to be read throughout the year. Curved lines are engraved on the plates permit adjustment to WA standard time.

An Earth Science excursion here permits students to not only visit the sundial but also to look at ancient and recent fossils on the beach and in the dunes.

Name _____

Gnomon Sundials – Student Worksheet



Arab philosophers of 9th and 10th centuries were amongst the first advanced scientists and mathematicians in Europe. They discovered that using a gnomon, a triangular shadow maker, would indicate hours of exactly the same length of standard time, no matter what time of year it was.

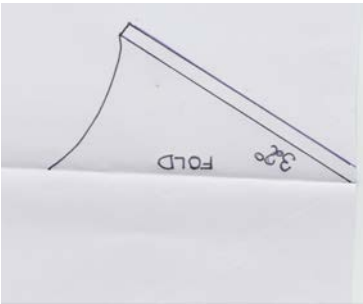
Sundials were often ornate and had mottos such as:

- Tempus fugit (Time flies – Latin)
- Let others tell of storms and showers. I only tell of sunny hours (Anon)

To prepare your gnomon

Fold a sheet of paper in half. The fold will be the top of the gnomon and will be used to reinforce it.

With the protractor, measure your

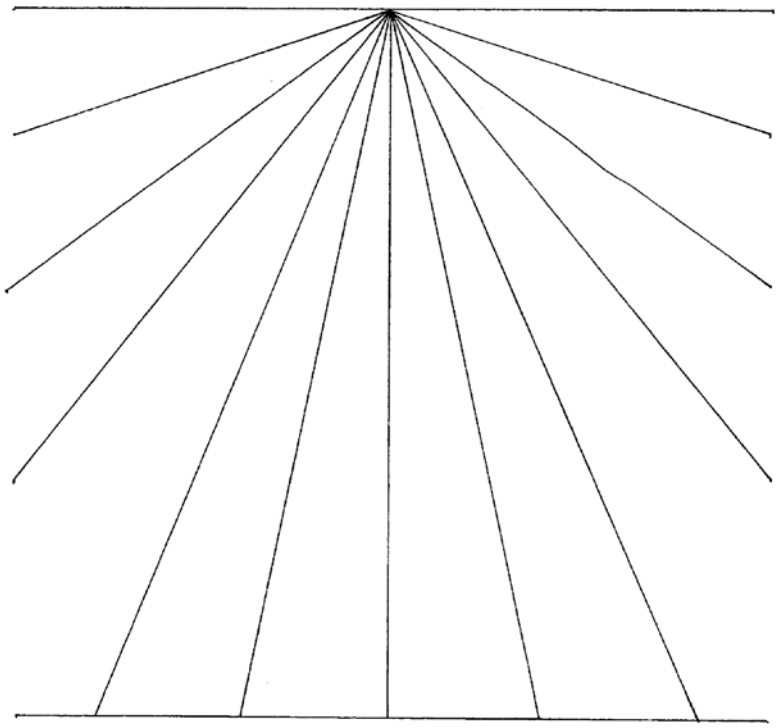


Name _____

Gnomon Sundials – Student Worksheet

school's latitude (in this case 32°S) away from the fold then draw that line about 9cm long.
Draw another line about 1cm below this to make the flaps that will stick onto the base in the worksheet.
Leaving the paper folded cut round the outside of the gnomon.
Fold out the flaps to attach to the prepared base below.
The gnomon should be attached with the fold running down to the north or origin of the rays on the base.

The base of the sundial



Name _____

Gnomon Sundials - Student Worksheet

Observations

What time did your sundial read? _____

What time is it according to your watch, clock or mobile?

_____

Why is there a difference? _____

Both Perth and Kalgoorlie are in the same time zone but their sundials read noon at different times. Why would a Kalgoorlie sundial read noon much earlier than the Perth one?

_____

Does the moving Sun rise and set? _____

What fractions of a sundial hour can you accurately read on this sundial?

_____

One thousand years ago, what would our ancestors have used a sundial for?

_____

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Gnomon Sundials – Student Worksheet

Extension

Write a short letter to a friend organising a meeting using information from a sundial.

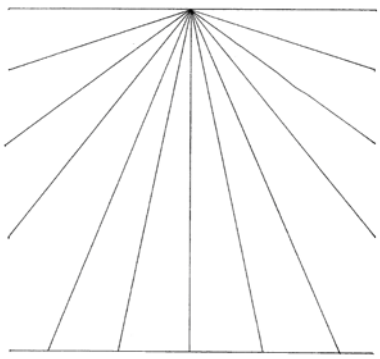
Dear _____

We must meet at _____ o'clock

to_____

because _____.

Look on the sundial. Set out when the shadow fall looks like this.



Your good friend _____

Name _____

Gnomon Sundials – Student Worksheet

The Cottesloe Sundial

The Cottesloe sundial was built in 1993. It is based on 18th century sundials popular in Jaipur in India. The parallel triangular gnomons throw shadows onto engraved plates which curve on either side of them permitting accurate time to be read through the year. Curved lines are engraved on the plates to permit adjustment to WA standard time.

Name _____

Digital and Analogue Time - PPP

In class we have experimented and found that light energy comes from the Sun and that the Earth spins round on its axis once every 24 hours so different parts of the globe face the sun at different times. We made sundials and found that solar time differs from standard time because of artificial time zones. We use WST (Western Standard Time).

Because our modern lifestyle is complex, we have many things that measure time so that we can boil a 3 minute egg, meet a friend for play at 4 o'clock and get to school on time.

Please help your student to find four things that tell the time in your home, what kind of power they need and what they are usually used for.

Analog clock

igital clock

Time	Analog or digital	Power	Use

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Digital and Analogue Time - PPP

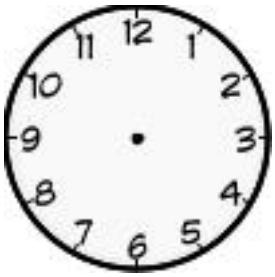


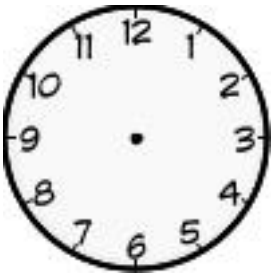
What is the time on each clock?

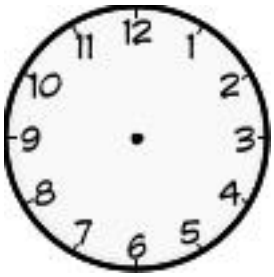
_____ and _____ and _____

Can you tell if the clock reading is am or pm?

Important school times

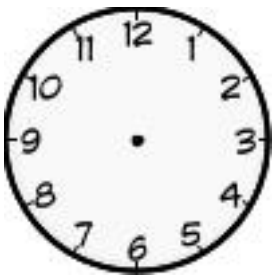

START


LUNCH


CLOSE

What time does your school start?
What time do you eat lunch?
What time does your school close?

Put these times on the clock faces above.



What is your favourite time at home?
Why?

_____

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Getting the Right Perspective - Teacher's Notes

Our sun is the star that lies at the center of our solar system.
The Earth is one of eight planets that orbit the Sun.
The moon is one of many natural satellites that orbit the planets.

Some Cultural Background

Our ancestors used the sun to estimate time during daylight and the phases of the moon to note the passing of months. Sun and moon were worshipped as powerful deities. In Western Australia Aboriginal people believed that the moon was Kidili, who was castrated for attempting to rape the first women on Earth. The women fled into the sky to become the Pleiades constellation (Seven sisters). The Celts thought the moon was the goddess Arianrhod (Silver wheel).

Our solar system formed out of a cloud of nebular dust from an exploded large star about 4.6 billion years ago. Static electricity first bound these dust particles into clumps. Gravity then pulled most of them together towards the center of the swirling disc to form a large ball. The remainder became the solar disc from which planets, moons, meteorites and asteroids formed. The rocky planets and asteroid belt circle that sun and further out lies the gassy planets. They all rotate on their axes and orbit the sun.

The Sun like all stars creates its own energy (heat, light, radioactivity and other forms of radiation). It is a rotating ball of gas and plasma and it contains 99.8% of all the mass in the solar system. Its diameter is roughly 109 times that of the Earth and you could fit almost one million Earths inside it. Because it is gas and plasma, when it rotates the equator spins faster than the poles and different parts spin at different rates.
The stars we see in the sky lie outside our solar system and some have their own solar systems of planets rotating round them.

Getting the Right Perspective - Teacher's Notes

The Earth is a rocky planet that orbits round the Sun. It depends on the Sun for heat and light. It rotates once every 24 hours and orbits the sun every year. One orbit takes approximately 365.25 rotations. Leap year adjustments (February 29th) every fourth year, try to make up for the difference but every so often an extra minute is added or lost to the year and all clocks are adjusted. Even such small differences build up over time. We now all use the Gregorian calendar. To keep things in synch, Pope Gregory ordered that 10 days be dropped from the then Julian calendar. Peasants revolted because they thought that meant they had lost 10 days of their lives!

The moon is a natural satellite of the Earth. It was formed about 4.5 billion years ago when a large body possibly the size of Mars crashed into the Earth re-melting its surface and throwing some material into space to create the moon. We have evidence of this from differing oxygen isotope ratios. The moon makes one rotation every month as it makes one orbit of the Earth. This means that the same side of the moon is always facing Earth. With the Earth, it also orbits the Sun. Like the Earth it does not make its own energy but depends on the Sun for heat and light.

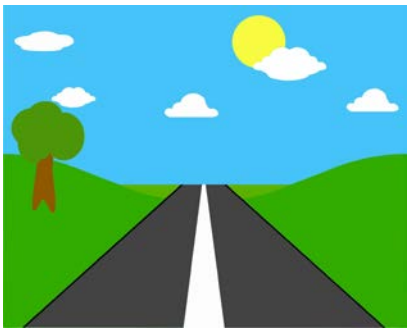
Student misconception 1

The Sun and Moon are the same size because they look the same size in the sky.

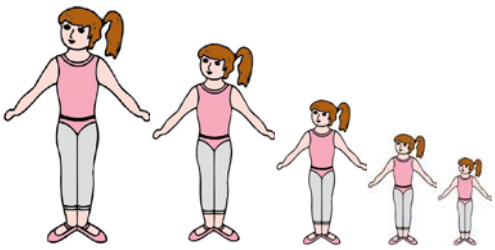
The Sun's diameter is about 400 times greater than the moon's. It is also 400 times farther away. They only seem the same because of perspective. As things move away they appear to become smaller. Artists, to give the impression of depth in two dimensional paintings and drawings, have used this "trick of the eye". They call it perspective.

Getting the Right Perspective - Teacher's Notes

This picture was drawn to show a straight road "disappearing" into the distance.



Does the road really get narrower? No
Do things actually shrink when they move away? No. Distance makes things appear smaller.
This artist's trick of making things seem far away by drawing them smaller is called **PERSPECTIVE**.



Materials

- Pairs of students.
- A ruler for each pair
- An open space such as the school oval or long corridor

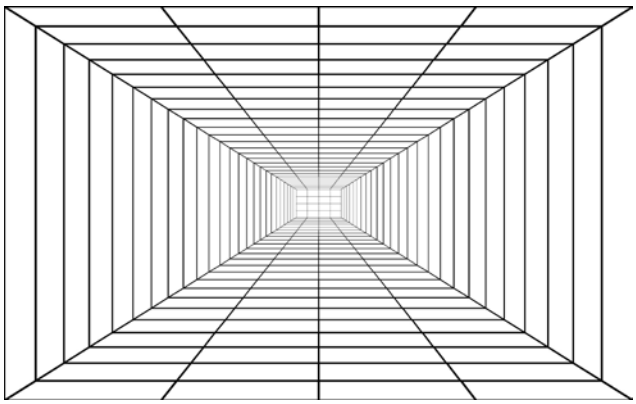
Method

1. Students form two lines with pairs facing each other
2. One student remains on the line and holds a ruler vertically at arms length. They will measure the apparent height of their partner

against the ruler.

3. The other students start walking forwards counting each step.
4. When the walking student appears to be the same height as the ruler the standing students shouts for them to stop.
5. Exchange roles and re-test.

Take a ruler and a partner out onto the oval. Find out how far away your partner has to walk until they ***seem*** as tall as the ruler.
How many steps did it take? X steps
Exchange roles and re-test. How many steps did your partner take? X steps
Did students appear to grow smaller when they moved away? Yes
Compare your results with those of the class. Did everyone take the same number of steps? No
Why would this be? You will find that results vary, as students will be of different heights and have different strides.
The size a person ***appears*** is due to their original size and to the distance from the viewer.



Perspective grid

Use the grid to draw a stick figure getting proportionally smaller to demonstrate perspective.
(Advertisements for beds and furniture often use small actors to make the goods seem large and space lavish. Show homes have smaller scale furniture to make the rooms look big.)

Name _____

Getting the Right Perspective – Student Worksheet

An artist drew this to show a straight road "disappearing" into the distance.

Does the road really get narrower? _____

Do things actually shrink when they move away? _____

Take a ruler and a partner out onto the oval. Find out how far away your partner has to walk until they ***seem*** as tall as the ruler.

How many steps did it take? _____

Exchange roles and re-test. How many steps did your partner take? _____

Did students appear to grow smaller when they moved away?

_____

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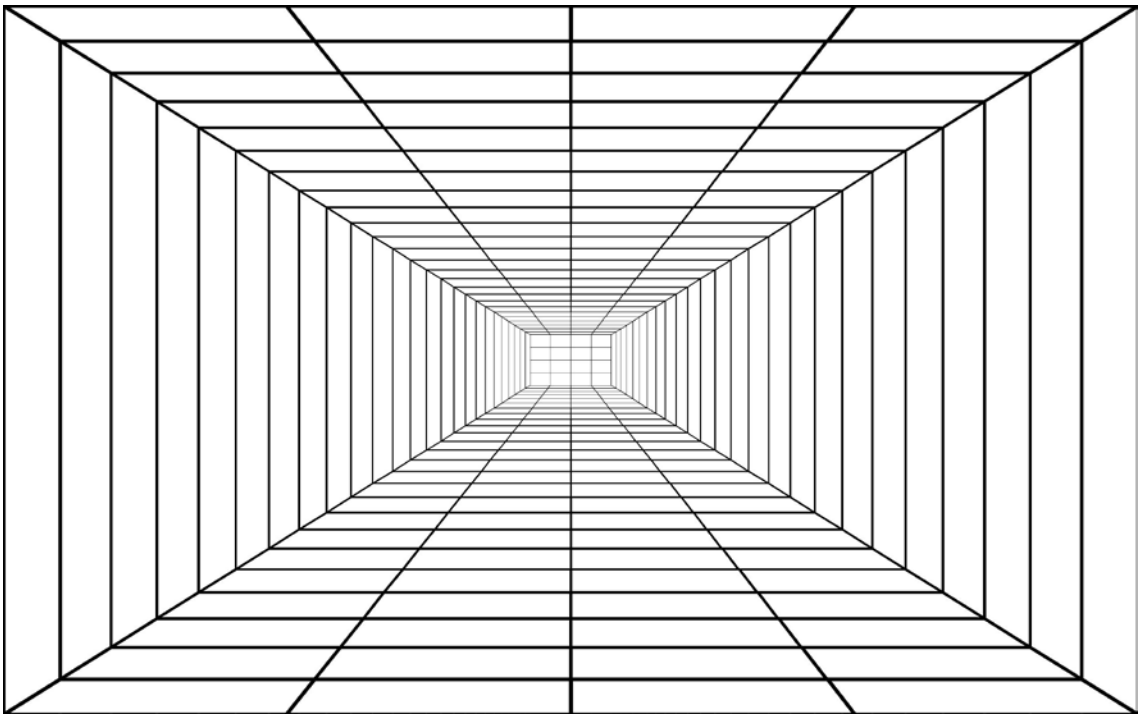
Getting the Right Perspective – Student Worksheet

Compare your results with those of the class. Did everyone take the same number of steps? Explain your answer.

_____

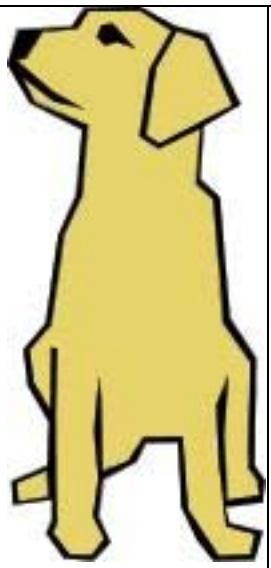
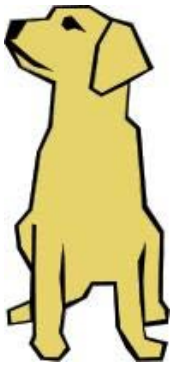
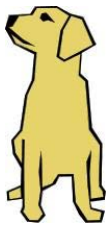
_____

This apparent decrease in size with distance is known as perspective. This grid helps keep drawings in correct proportion. Use the grid to make a person appear to move into the distance. Start by drawing a stick figure in the largest rectangle and repeat three times into three inner rectangles.



Modelling to Scale – Teacher's Notes

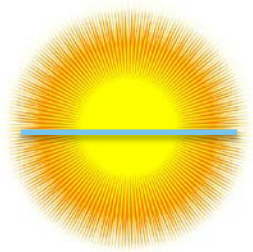
A scale model is a copy that keeps the proportions but not the size of the original. The scale is the number of times the copy has to be magnified or reduced to be equal to the original.

			
Original	Scale 1:2	Scale 1:3	Scale 1:?

What is the scale of the drawing on the right? 1/4

It is difficult to make an accurately scaled model of Earth, Sun and moon because the sun is very, very large in comparison to the Earth and moon. The diameter of the sun is almost 109 times bigger than the diameter of the Earth. Draw the Earth on the same (1;1) scale as the sun. The blue line is the diameter of the sun. Students could make a very, very tiny dot with a very sharp pencil on the right side of the table on the next page.

Modelling to Scale - Teacher's Notes

	.
Sun	Earth

If you drew the Earth as a circle with a diameter of 1cm, what size would the diameter of the sun be? 109cm.

Guess how many sheets of A4 paper you would need to stick together to draw the Sun at this scale? 20. You would need to stick together a block of 4 sheets by 5 sheets.

There is an excellent Prezi presentation, which will convince your students of the scaling problems at:
Prezi.com/hmx8hma62m2z/scale-model-of-earthsunmoon/

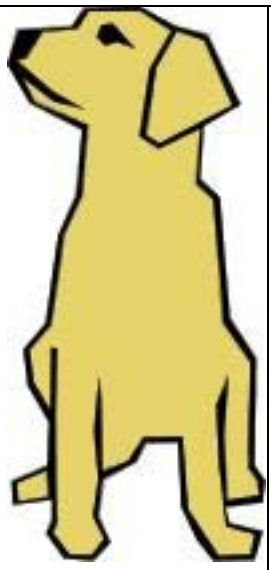
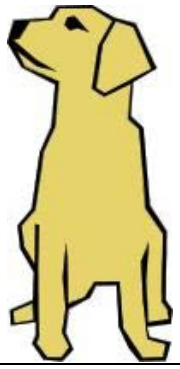
Some data

Diameter of Sun	1.392 million km (You could fit almost 109 Earths inside it)
Distance of Sun to Earth	150 million km (107 Earth diameters)
Diameter of Earth	12,742 km
Diameter of Moon	3,476 km
Distance of Earth to Moon	384,400 km (30 Earth diameters)
Space shuttle orbit	350km (it can't fly to the moon but is already in space)

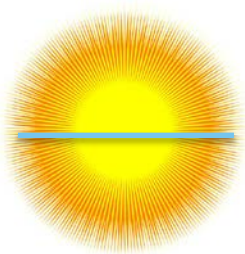
Name _____

Modelling to Scale - Student Worksheet

A scale model is a copy that keeps the proportions but not the size of the original. What is the scale of the drawing in the right column?

			
Original 1:1	Scale 1:2	Scale 1:3	Scale 1:____

It is difficult to make an accurately scaled model of Earth, Sun and Moon because the Sun is very, very large in comparison to the Earth and Moon. The diameter of the Sun (the blue line across the sun) is almost 109 times bigger than the diameter of the Earth. Draw the Earth to the same scale on the right.

Sun 	Earth

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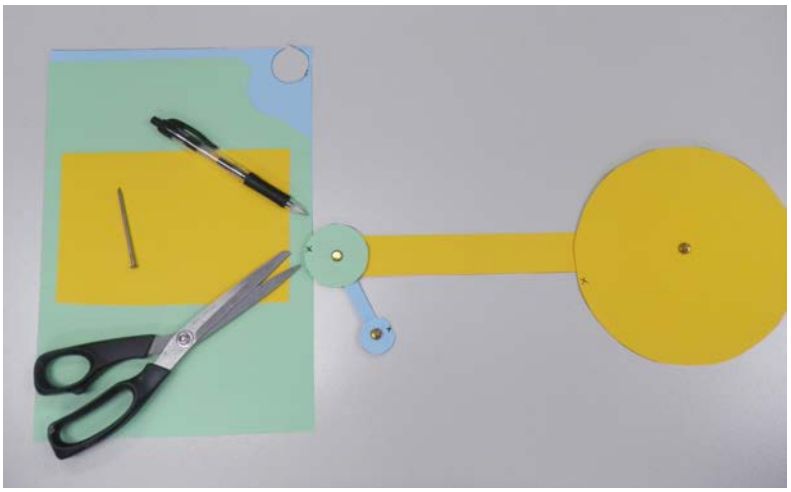
Name _____

Modelling to Scale – Student Worksheet

If you drew the Earth as a circle with a diameter of 1cm, what size would the diameter of the sun have to be? _____

Guess how many sheets of A4 paper you would need to stick together to draw the Sun at this scale?

_____



Why can't we make this model to scale? _____

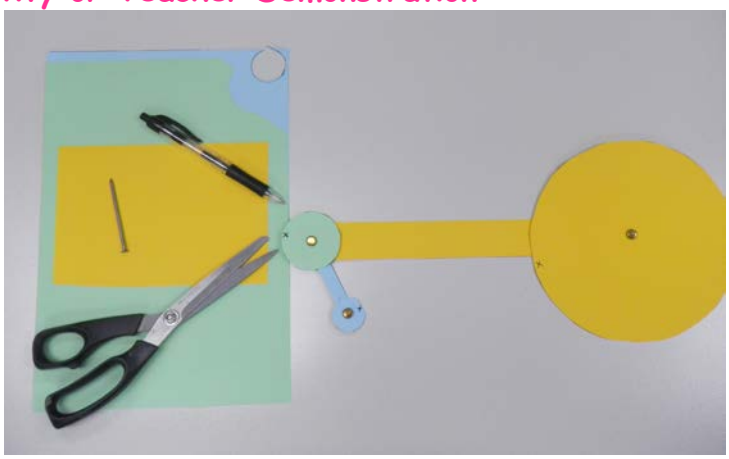
_____

This model will however display how the moon moves round the Earth and the Earth and Moon move round the Sun.

Student Misconception 2 - Rotation and revolution are the same

It is often easier to use **rotation** for turning or spinning about an axis and **orbiting** for taking a path around a sun or planet. Roughly the Earth rotates on its axis once every day and orbits the sun once every year. The moon rotates once every 28 days and orbits the Earth every 28 days. In each case the smaller object orbits round the nearest larger object.

Rotation and Orbit Model (Not to scale)
Student Activity or Teacher Demonstration



Materials per group

- Three sheets of coloured paper or card. Alternatively paint the paper after it has been cut.
- Pen
- Scissors
- Three split pins
- A nail or pin to pierce paper

Method

1. One student traces and then cuts out the largest circle possible from one sheet of paper or card. I found a side plate (from the staffroom) made a good-sized circle for A4 paper. This circle represents our Sun. They then cut a long thin strip from what remains.
2. The second student cuts out a much smaller circle (using a cup) from another coloured sheet to represent the Earth, our planet.
3. The third student cuts a very small circle of another colour to represent the Moon. They also cut a strip that will permit the moon to circle the Earth and not touch the sun.

Why can't we make this model to scale? If we tried to make this to scale we would require a great deal of cardboard and it would need to cover a very large area.

This model will however display the relative movements of the sun, Earth and Moon.

Earth and Moon

4. Start by making holes at the center of your Earth and Moon and join the short strip to the centers of the Earth and Moon with split pins.
5. Rotate the Earth, once for every day and orbit the moon round it so that one orbit takes 28 days.
6. As the Moon orbits, rotate it on its axis. Its rotation takes just as long as it takes to orbit round the Earth. That is the reason that the same side of the moon is always facing Earth.

Earth, Sun and Moon

7. Now join the Earth to the Sun with the longer strip and split pins
8. The Earth orbits round the Sun every 365 days.

The Sun is so big it could not travel between the Earth and the moon.

Our solar system is whirling round the center of the Milky Way galaxy which itself is travelling round a galactic central point. Nothing is stationary.

Orbit and Rotation Using Students as Models

This activity is only recommended for students who follow directions in an orderly manner or a single group of three chosen students can be used to demonstrate first to minimise disruption. I have never managed more than four "months" without students collapsing in fits of giggles or being "spun out". If it is performed at the beginning of the session, recovery time needs to be factored in.
Group students into threes in an open space. One represents the Sun, another the Earth and the third the Moon. You may have to count the days loudly to keep all students acting together.

1. **Moon rotates once as it orbits round the Earth in 28 days**
   (1 lunar month on Earth)

The Earth has to evenly rotate 28 times as the Moon makes one complete rotation. The moon must slowly turn to complete one rotation as it makes one orbit of the Earth. Students should be able to see that the Moon always keeps its face towards the Earth.

2. **Earth rotates 365 times as it orbits round the Sun. The Sun rotates on its axis while that happens**

One student is nominated as the sun. They rotate on the spot. (Of course different parts of the sun move round at different speeds however even the wobbliest or flexible student would soon get in a twist if they tried that). I have once used a student with a hula-hoop to represent the differences in movement of the sun's surface as it rotates.

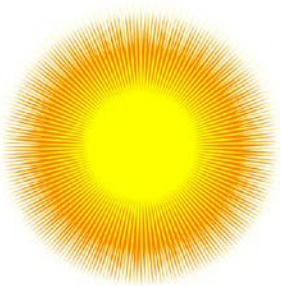
If the student who represents the Earth takes one step sideways during each revolution, that can represent 1 day's orbital movement round the sun.

3. **Getting all the moving parts/people working together.**

Start the Earth rotating, then the Moon orbits the Earth making one rotation per lunar month. Finally start the Earth and Moon on their trip round the Sun with the Moon orbiting the Earth and the Earth orbiting the Sun. All three rotate on their axes.

This pattern of wheels within wheels is the reason that Newton and other early scientists referred to the Judeo-Christian God as "The divine watchmaker" because interlocking rotating cogs worked inside old watches. Some tried to make machines that copied this movement but very accurate observations were needed to make the machines accurate.

Interestingly, the colour of the Sun is actually white. Most people draw or paint it as yellow, perhaps because it is less painful to glimpse at dawn and dusk when the greater thickness of atmosphere it's light travels through gives it a yellowish red tinge.



Worship the Sun - Teacher's Notes

In ancient times (our ancestors worshipped the Sun and the Moon. The Egyptian pharaohs' were said to be the Sun made flesh on Earth and they wore a solar disc in their headdress to signify this. Their Sun god was called Ra and was said to have brought the Earth to life by speaking the names of all living things. Ancient Egyptians noticed that as the position of the sun changed so did the seasons and the behaviors of animals and the life cycles of plants.
The early Celts worshipped the Moon because they noticed that as the moon changes the behaviors of animals changed. She was called Arianrhod meaning silver wheel. From Crete to Ireland she was known as the mother goddess.
For Western Australian Aboriginal people the moon was called Kidili. He was castrated for trying to rape the first women who escaped into the sky to become the Pleiadese constellation also known as the seven sisters. Perhaps Year 3 is a bit early for that story?

Students are asked to make a poster, which will persuade ancient people to worship either the Sun or the Moon.

(**HINT**: Use few words and few colours)

Marking key

Title is clear and bold	1 mark
Major image/picture is eye catching	2 marks
Reasons for worship (At least 2)	2 marks
On time and named	2 marks

Students may be asked to mark each other's efforts but overseen by their teacher.

Name _____

Worship the Sun - Student Worksheet

Worship the sun or it will be forever night!

In ancient times (our ancestors worshipped the Sun and the Moon. The Egyptian pharaohs' were said to be the Sun made flesh on Earth and they wore a solar disc in their headdress to signify this. Their Sun god was called a and was said to have brought the Earth to life by speaking the names of all living things. Ancient Egyptians noticed that as the position of the Sun changed so did the seasons and the behaviors of animals and the life cycles of plants.

You are asked to make a poster, which would have persuaded ancient people to worship either the Sun or the Moon.

(HINT Use few words and few colours)

Marking key

Title is clear and bold	1 mark
Major image/picture is eye catching	2 marks
Reasons for worship (At least 2)	2 marks
On time and named	2 marks