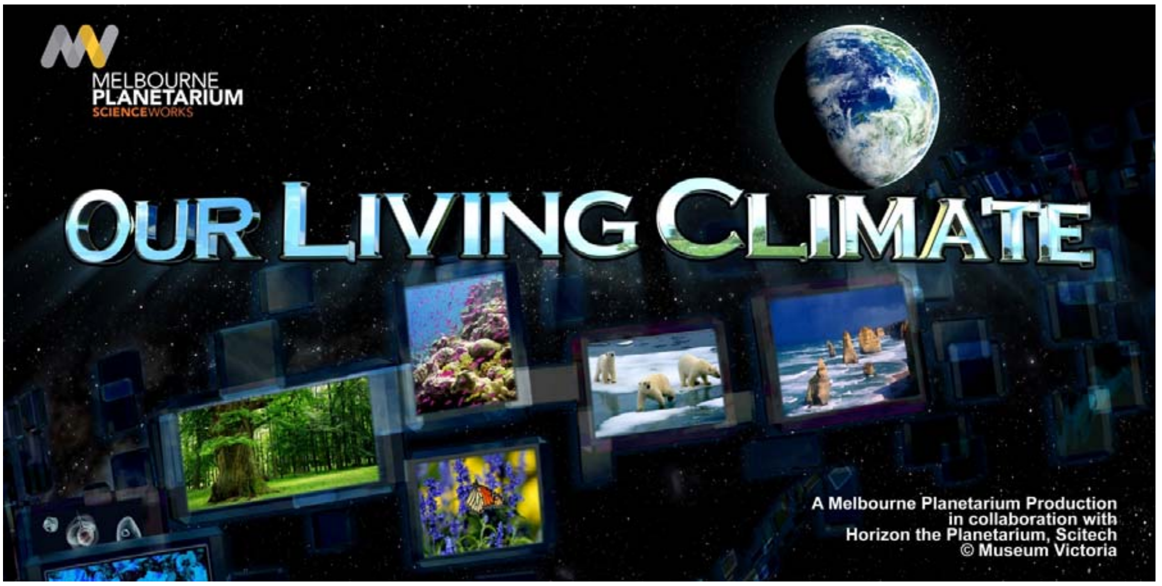

Melbourne Planetarium education kit

Acknowledgements

This education kit is based on materials developed by Museum Victoria Program Coordinators and other educators.

The support of the Department of Education and Early Childhood Development is acknowledged.

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SCIENCEWORKS

Victoria
The Place To Be

Contents

Teacher notes

Visiting Melbourne Planetarium at Scienceworks

Planetarium shows consist of a 25 minute presentation in a domed theatre. They are followed by a 10 minute practical guide to 'What's in the sky tonight?'

If the planetarium show is your first programmed activity at Scienceworks, it is important that you arrive about 30 minutes before the show's starting time. This allows time to process payment and store lunches, and for our staff to address your students before proceeding to the planetarium.

Information about the Planetarium show*: Our Living Climate*

Our Living Climate is suitable for students from year 5 – 10 and general audiences.

It looks at the climate of the Earth and explores the following themes:

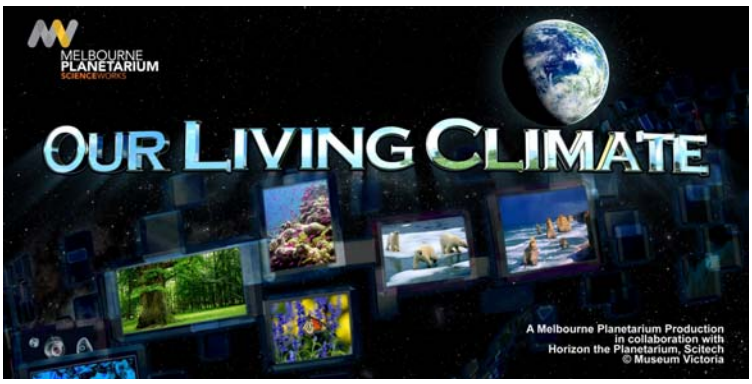
- The Earth's climate is a complex system that has changed over time
- The Earth's atmosphere sustains life and has been built by life
- There are important similarities and differences between Earth and other planets.

The show is in documentary style, using a number of visual techniques to engage the audience and to support the learning themes. It begins with a comparison between the Earth and its nearest neighbours – our Moon and the planet Venus – highlighting the delicate atmospheric balance required to support life.

Next we are immersed in the story of the Earth's climate, travelling through time to view the interactions between life and climate at various stages in the planet's evolution – a mass extinction event, an ice age and the industrial revolution.

We are left with an understanding of how scientists can study constant climate change and how we humans have an opportunity to impact the climate for better or worse. *Our Living Climate* – the greatest scientific challenge of our time.

It is recommended that students are familiar with vocabulary in the *Word list* (pages 5 & 6) and have completed *Activity 1: Climate timeline* before seeing this show.



Our Living Climate was produced by Melbourne Planetarium at Scienceworks, in collaboration with Horizon the Planetarium, SciTech.

Curriculum links

This table shows the links between the school-based activities in this kit and the domains of the Victorian Essential Learning Standards.

VELS **Victorian Essential Leaning Standards →** **School-based education activities**		**Physical, Personal & Social Learning**				**Discipline-based Learning**						**Interdisciplinary Learning**			
		Health & Physical Education	Interpersonal Development	Personal Learning	Civics & Citizenship	The Arts	English	Languages other than English	Humanities	Mathematics	Science	Communication	Design, Creativity & Technology	Information & Communication	Thinking
Activity 1	Climate timeline		•							•	•				•
Activity 2	Rainfall, weather & climate		•			•				•	•		•		•
Activity 3	Make your own greenhouse			•						•	•			•	
Activity 4	Seasons on other planets		•	•			•				•	•			•
Activity 5	Life on Mars versus life on Earth		•	•	•						•	•			•
Activity 6	Wish you were here			•		•	•		•		•	•	•	•	

Word list

Adaptation	Through the process of evolution, organisms that have genetic traits that better suit their environment are more likely to pass on those traits (as they will be more successful at reproducing). Over time the population will have traits that are 'adapted' to the environment.
Atmosphere	The envelope of gases that surround a celestial body. The Earth's atmosphere retains heat from the Sun, and helps to maintain a hospitable climate. The Moon has no atmosphere.
Carbon Dioxide	Carbon dioxide is a molecule made of one carbon and two oxygen atoms. Humans use oxygen from the air when they breathe in and expel carbon dioxide when they breathe out. Plants do the reverse during the day – they take in carbon dioxide and release oxygen.
Climate	The climate of a region refers to the total conditions over a long period of time (often decades or centuries). These conditions include rainfall, temperature, atmospheric pressure and humidity.
DNA	(Deoxyribonucleic acid). One of the 'building blocks of life', the DNA molecules of living organisms contain their genetic information.
Earths Axis	An axis is an imaginary line about which an object rotates. On Earth, the imaginary line joins the North and South Poles.
Ecosystem	A contained system where the animals, plants and environment are interconnected and dependent on each other.
Evolution	The biological process, first described by Charles Darwin, whereby changes occur in a population through random variations from one generation to the next.
Fossil Fuels	Fuels created from organic remains under high pressure for long periods of time. Such 'fossil fuels' (e.g. coal, oil, natural gas) have a high carbon concentration, as did the living things from which they originated.
Genetics	The study of traits passed on from one generation of living things to the next.
Greenhouse Effect	The process where a planet, like the Earth, traps heat from the Sun in its atmosphere, similarly to a greenhouse trapping heat for plants. Molecules of Methane, Carbon Dioxide and Water are responsible for most of the effect on Earth. The higher the levels of these molecules, the stronger the greenhouse effect will be.
Ice Age	A long period of time when the temperature of large areas of the Earth drops and becomes covered with ice sheets.

Magnetic Field	A magnetic field is an invisible area in which objects are subject to a magnetic force. The Earth's magnetic field surrounds the planet and helps to stop the Sun's dangerous radiation from reaching the surface.
Mammals	A class of animals whose young are fed by the mother's mammary glands. All mammals other than the Australian monotremes (platypi and echidnas) give birth to live young.
Mass extinction	Refers to an event that results in the extinction of a large number of species at once, or over a short amount of time.
Molecule	A group of elements that are bonded together, e.g. water is a molecule of one oxygen atom and two hydrogen atoms.
Nebular cloud	The collection of gas and dust that came together because of the force of gravity to form the Sun and the Solar System.
Orbit	An orbit is the path that one (celestial) body makes when moving around another. The path the Earth takes around the Sun is called its orbit. This orbit is nearly circular. Changes in the orbit's shape can affect the Earth's climate.
Primate	An order (a biological grouping) of specific mammals, containing monkeys, lemurs, and apes, or hominoids. Humans are classified as primates (part of the hominoid family).
Surface Temperature	The surface temperature of a planet is the temperature at ground level.
Volcanic	Processes that happen in and around volcanoes.
Weather	Weather refers to the everyday changes in conditions in an area, e.g. whether it is raining, sunny, hot or cold. Weather changes constantly, as opposed to climate, which is the pattern of weather over a long period.

Internet resources

Melbourne Planetarium
http://museumvictoria.com.au/planetarium/

The Eight Planets
http://www.nineplanets.org/

NASA Solar System Exploration
http://solarsystem.nasa.gov/index.cfm

NASA education materials
http://education.nasa.gov/home/index.html

Geological Time Chart
http://www.bgs.ac.uk/education/britstrat/home.html

NASA Earth Observatory
http://earthobservatory.nasa.gov/

Introduction to climate
http://www.ucar.edu/learn/1_2_1.htm

Earth Day Footprint Quiz
http://www.ecofoot.org/

Bureau of Meteorology Climate Information
http://www.bom.gov.au/climate/

Activity 1: Climate timeline

Background information

This activity underpins the students' knowledge of key climate concepts and provides a visual representation of the changes that have occurred in the Earth's climate.

The daily variations that we call weather tend towards certain average values, and it is the combination of these long-term conditions that defines climate. Climate also changes, but much more slowly and (mostly) predictably. For example, we cannot say with any certainty what the temperature will be in Melbourne on the 30 June this year, but we can be fairly confident that it will be colder than the 30 December.

When we look at the way the climate has changed throughout the history of the Earth, it can be very difficult to get our heads around the numbers involved. For example:

- Dinosaurs became extinct 65 million years ago.
- *Homo sapiens* (humans) appeared only 100,000 years ago.

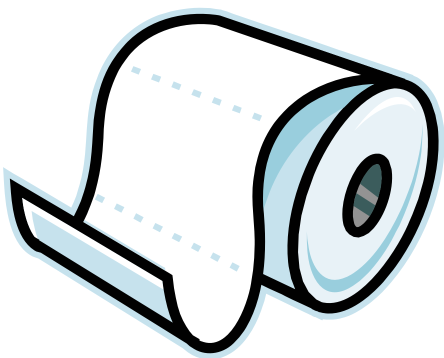
In this activity, students will watch then discuss short interviews with scientists. Transcripts of these are provided on pages 13-14.

They will then construct a 'toilet paper timeline' to help visualise and understand how the climate has changed over time. The 'Key dates in Earth's history' list gives you some key dates, and pre-calculated distances along the timeline. You can choose to give younger students a selection of dates from the list. You may wish to include a scale calculation for more advanced students (see below).

What you need

This task may be done as a class activity, or in smaller groups. Each group will need:

- Several toilet paper rolls
  (to make a total length of at least 50 metres)
- Post-it notes
- Coloured markers
- Ruler
- Tape measure
- Access to a long space to lay out the toilet roll (eg. a hall, gym or long hallway)



What to do

Part A: Introduction and discussion

1. Ask the students to discuss what they understand by the word *climate*.
2. Show the students the interviews, which deal with
    a. One particular mass extinction event, driven by climate
    b. Why we believe the climate is currently changing
    c. How scientists measure changes in the climate over time
3. Use the interviews to prompt discussion on the topic of climate. The following questions may be a guide:
   Has the climate always changed?
   How do we know the climate is changing?
   Can you name any big climate events in history?
4. Inform students that they will be creating their own timeline of climate change.

Part B: The toilet paper timeline

1. Before you begin, choose some dates from the *Key dates in Earth's history* list (see p 10). The number will depend on the year level of your students.
2. Give students a copy of the list you have chosen, and explain that they are going to use it to form a timeline of Earth's history.
3. Explain that each centimetre of toilet paper represents 1 million years of Earth's history. Therefore, if the sheets of your toilet paper are 11 cm long, each sheet will represent 11 million years. If your sheets are 10.5 cm long, they will represent 10.5 million years – the scale in the table on pages 10-11.

   For older students: Rather than using the pre-scaled values, you may wish your students to use the *Calculating Scale Worksheet* (see page 12) to calculate their own scale for the timeline.

   For younger students: Calculations may be simpler if you use a toilet roll and tape measure (scale 1cm to 1 million years) rather than counting toilet paper sheets as units.
4. Move students to the area you will use to construct the timeline.
5. Have students unroll the toilet paper a few metres and place a post-it note marked 'NOW' on the end. All the other events will be measured from here.
6. Have students unroll the toilet paper, marking other events with the post-it notes as they go. Use tape to join a second roll to the end if necessary.

   For events over a long period of time, note the start and end points.
7. At the end of the exercise, the toilet roll should be completely unrolled and students should be able to see a few key things:
    a. Most of human history has taken place in a very short time.
    b. The Earth's climate has changed over time.
    c. The Earth has experienced a number of major events, including mass extinctions, changes in continent positions and ice ages.

Key dates in Earth's history

This table lists key events in the Earth's climate history, and records how many years ago the events happened. The last two columns are the scaled values of time, based on one 10.5 cm toilet paper sheet = 10.5 million years. Be sure to check the length of a sheet on your own toilet paper and adjust the figures accordingly! (Alternatively, use a tape measure instead of counting sheets).

Note that precise calculations for additional centimetres of toilet paper (last column) should only be used for 'recent' events, as the exact dates for many events in the distant past are not known.

Example using toilet paper with sheets that are 10.5 cm long: If we mark the end of the roll as 'Now', then to place a marker for 'Ice forms on Antarctica' we need to count three sheets and measure 4cm along the next sheet.

Time of event:	Description of event:	Measuring from the 'now' marker, how many sheets ago did the event happen?	How many additional millimetres or centimetres along the next sheet?
0 years ago	Current time.	0	0
10,000 years ago:	Recorded human history begins.	0	0.1mm
18,000 years ago:	Peak of last glacial period.	0	0.2mm
65,000 years ago:	Evidence of humans living in Australia	0	0.6mm
100,000 years ago:	First *Homo sapiens* appears.	0	1mm
1.7 million years ago:	The ancestors to *Homo sapiens* develop the ability to use controlled fire.	0	2cm
3.5 million years ago:	First human-like creatures appear, in Africa.	0	3cm
27.8 million years ago:	Fish Canyon Tuff Eruption. Volcanic winter lasting several years.	2	7cm
35.5 million years ago:	Ice forms on Antarctica.	3	4cm
65 million years ago:	Age of Dinosaurs ends, with mass extinction of 70% of all living things, probably because of climate changes caused by a meteorite collision.	6	2cm
70 million years ago:	The Himalayas begin forming. They are responsible for increased global rainfall.	6	7cm

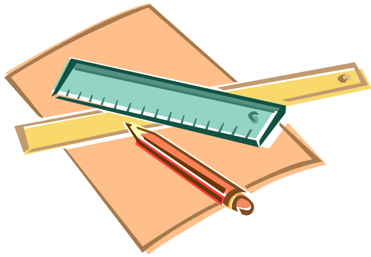
Time of event:	Description of event:	Sheets of toilet paper
150 million years ago:	Supercontinent Pangaea broken up; modern oceans formed; continents drifting apart	14
245 million years ago:	Age of Dinosaurs begins.	23
250 million years ago:	Mass extinction of 90% of life in the oceans and 70% of life on land.	24
350-250 million years ago:	Large parts of the Earth's land surface are covered with glaciers.	33 - 24
0.5 billion years ago:	First land plants with inner vessels.	48
0.6 billion years ago:	Ozone layer starts offering protection, allowing land-based organisms to develop.	57
0.65 billion years ago:	First living things with more than one cell appear	62
0.85-0.65 billion years ago:	Cryogenian Ice-Age	81 -62
1 billion years ago:	Iron formations in the earth that collect oxygen become 'saturated' and can hold no more, so free oxygen can now stay in the atmosphere.	95
1.9 billion years ago:	First cells with nuclei appear in oceans.	181
2 billion years ago:	Eukaryotic photosynthesis begins, much more efficient than Prokaryotic	190
2.7-2.3 billion years ago:	Huronian Ice Age (hypothesised)	257 - 219
2.4 billion years ago:	Oceans contain significant amounts of oxygen.	229
2.72 billion years ago:	First fossil record of a Stromatolite.	259
3.25 billion years ago:	Photosynthesis begins in oceans.	310
3.5 billion years ago:	First life appears in oceans.	333
3.7 billion years ago:	Earth's crust solidified.	352
5 billion years ago:	Earth is formed, along with the other planets	476

Calculating scale worksheet

Introduction

To calculate where to place the event on the timeline, you need to convert the number of years ago the event happened to a distance that you can plot on the toilet-paper timeline. This worksheet takes you through the steps to do this, using the following scale:

1cm = 1 million years



This means that if your toilet paper sheets are 10 cm long, each one represents 10 million years of Earth's history. If the sheets are 15 cm long, each one represents 15 million years of Earth's history.

What to do:

1. Measure the length of one sheet of toilet paper. Write down how many centimetres it is:

   Length of one sheet of toilet paper = ________________ cm

2. Calculate how may million years one sheet represents:

   ________________ cm x 1 million years = ______________ years per sheet
   (length of one sheet)

3. For each event calculate how many 'sheets ago' it took place and write on the list of events. Use this calculation:

$$\frac{\text{Number of years ago}}{\text{Number of years per sheet}} = \text{Number of sheets}$$

An Example: If your sheets are 10.5 cm long, representing 10.5 million years, then the extinction of the dinosaurs can be represented as follows ……

$$\frac{\text{65 million years}}{\text{10.5 million years per sheet}} = \text{6.2 sheets ago}$$

= 6 sheets + 0.2 X 10.5cm

= 6 sheets + 2.1 cm ago

Interview Transcripts

Interview 1: Prof. Guang Shi talking about the Permian extinction - Video file1

Question	Answer
Who are you?	I'm Professor Guang Shi, Professor of Earth Sciences at Deakin University. My interest has been in biodiversity and in how biodiversity evolved and particularly the end-Permian mass extinction 250 million years ago.
What was the biggest mass extinction in Earth's history?	This mass extinction is the largest in Earth's history. It actually wiped out about over 90% of animal species in the oceans and more than 70% of species on land.
What caused this extinction?	For over three decades now scientists have been puzzled by the mechanism behind this Great Dying in the Earth's history. There has now been increasing evidence pointing towards climate change. It appears to be that if you trace and link up all the geological evidence, climate change appears to be the ultimate mechanism but may have been triggered by severe volcanism in Siberia. So you actually have climate change, volcanism and some other environmental factors working together in a process of linked environmental change. This led to the development of very hostile and stressful conditions for life.
What can we learn from this event?	Climate change played a major role. From that perspective, this analogy from the end-Permian mass extinction could be used as a very important lesson and perspective for understanding how our modern ecosystem will change in the face of global climate change.

Interview 2: Tas Van Ommen talking about Ice Cores - Video file 2

Question	Answer
Who are you?	I'm Tas Van Ommen. I work for the Australian Antarctic Division and I lead the Ice Cores Project there.
What is an Ice Core?	Ice cores are valuable sources of past climate information. They're basically cylinders of ice that we drill out of the Antarctic ice sheet. They contain information on the climate that gets deposited with the layers of snow that fall on the continent year by year. These layers carry with them all sorts of information about the atmosphere and its contaminants over time By analysing ice cores, we learn a great deal about the processes that control the climate. We learn how it's changed in the past and how ice ages have come and gone.

What do Ice cores tell us about past atmospheres?	One of the most valuable indicators we get from ice cores comes in the form of tiny bubbles of past atmosphere that get trapped between the snow flakes as the ice builds up on the continent. We can bring the ice cores back to the laboratory, crack open the bubbles which are like tiny time capsules of past atmosphere and analyse them to determine past levels of greenhouse gases. What we find is really startling. The carbon dioxide levels over the past 800,000 years track the temperature record incredibly closely, showing that there is a tight link between CO_2 and climate.
How do we date Ice cores?	If you look at an ice core you can not visibly see the layers of annual snow. However, in almost all of the measurements we make, you can actually detect and count these layers to date the ice core in much the same way that you can count tree rings.

Interview 3: Prof. David Karoly discussing recent climate change - Video file 3

Question	Answer
Who are you?	My name is David Karoly. I'm a professor here in the School of Earth Sciences at the University of Melbourne. I do a lot of work on climate change research and was heavily involved in the fourth assessment report of the Intergovernmental Panel on Climate Change that was released in 2007.
What has been observed in the climate in the 20th century?	There is ample evidence that temperatures have increased substantially globally and regionally in the twentieth century and the magnitude of that – about seven or eight tenths of a degree over the last hundred years – is very large compared with any other century-time scale change.
How do we get evidence for past temperatures?	When we compare that to temperature changes over the last 1000 years or 2000 years we can't get direct thermometer evidence. We have to look at other evidence like changes in temperatures that we can infer from tree rings, from ice cores, from coral records or other evidence of temperature changes – even documentary records from people living in different areas around the world.
What do we learn from this evidence?	What we find is that the magnitude of temperature variations in the 20th century – seven or eight tenths of a degree – is more than double the temperature changes in any period over the last 1000 or 2000 years and the rate of warming is much greater. There is evidence of a cool period called the 'Little Ice Age' primarily in Europe around the 18th century and also of a mediaeval warm period, but the temperature variations in those periods were much smaller than we've seen in the twentieth century – smaller by at least a factor of two.

Activity 2: Rainfall, weather and climate

Background information

This activity reinforces students' understanding of precipitation (rainfall) as a basic component of weather and climate.

At the end of this activity students will

- Understand how hot and cold atmospheric layers create rain through a short teacher demonstration,
- Gain insight into how rainfall is measured by building their own rain gauge and taking measurements,
- Investigate the difference between weather and climate by comparing weather observations with long term averages.

Rain is an integral part of the Earth's weather, and the measurement of rainfall over long periods adds to our understanding of changing climate. In the atmosphere, water vapour condenses on dust and other particles in the air. This causes clouds and eventually rain. In the teacher demonstration below we create water vapour in a jar, and allow it to condense on small indentations on the jar's lid to mimic the creation of rainfall in the atmosphere.

Teacher demonstration

What you need

- Glass jar with a metal lid
- Hammer and nail
- Boiling (or near boiling) water
- A few cubes of ice, enough water to cover the lid and a pinch of salt

What to do

1. Ask your students what needs to happen to make rain? Instruct them to write a paragraph or draw a picture to explain.
2. Using the hammer and nail, make five small indentations in the top of the jar lid (be careful not to punch through the lid).
3. Pour the boiling water into the jar (about ¼ to ⅓ full)
4. Place the lid upside down on top of the jar (but make sure the air cannot escape).
5. Place the ice, a pinch of salt and a small amount of water into the lid.
6. Watch what happens. Ask your students to record what they see.
7. As the steam cools near the lid, water vapour forms. After a few minutes 'rain drops' fall from the lid.
8. Ask students to compare what they saw in the experiment to what they wrote down before the demonstration. Has their explanation changed? How was the experiment similar to the way rain forms in the real world?
9. As a group, draw a diagram explaining the process of rain formation.

Make a rain gauge worksheet

What you need

- Glass jar (or drinking glass) with vertical sides and a flat bottom
- Ruler
- Permanent marker
- Sticky tape
- Cardboard
- Scissors

What to do

1. Draw a rectangle on a piece of cardboard. Your rectangle should be 2cm wide and 10cm long (see figure 1).
2. Cut out the rectangle.
3. Using your ruler, mark the distance along the edge at regular intervals (say every 5mm). Make sure the bottom edge is 0cm.
4. Line up the cardboard ruler next to the jar, making sure the bottom of the ruler is at the very base of the jar.
5. Tape the ruler to the jar.

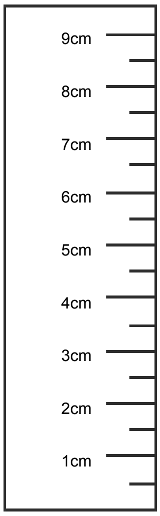


Figure 1

A rain gauge for dry areas

For areas that receive only a few millimetres of rain in each downpour, it is a good idea to make a rain gauge that magnifies the scale of measurements on the side of the jar. It is then much easier to measure small amounts of rain.

What you need

- An empty glass jar, with vertical sides and a flat bottom
- A plastic kitchen funnel, somewhat wider than the jar
- Masking tape for marking measurements

What to do

1. Measure the area of the top of the funnel and the area of the bottom of the jar. Work out how many times larger the area of the top of the funnel is compared with the area of the bottom of the jar. (Ideally 4 or 5 times is best, so choose your jar and funnel with this ratio in mind).
2. Mark a scale of measurements in millimetres on the masking tape, magnifying the scale according to the ratio calculated above. If, for example, the area of your funnel is 4 times larger than the area of your jar, mark and label the first millimetre on your scale of measurements 4 mm up from the bottom of the jar. Mark and label the second millimetre on your scale 8 mm up from the bottom of the jar, and so on.
3. Stick the masking tape to the outside of the jar (0 mm at the bottom of the jar). Cover the masking tape with clear tape so that it is waterproof.
4. Secure the funnel in the top of the jar with two pieces of masking tape, so that it can be easily removed to empty the jar.

To use your rain gauge:

1. To take effective measurements, you should place your rain gauge outside, away from trees and buildings. You may wish to place it inside an open-topped box so that it is not knocked over by wind or curious animals.

2. Draw a table like the one shown below (or make a table in a spreadsheet program).

Date	Time	Rainfall (mm)	Cloud cover (Full, half, slight or clear)

3. Record measurements at the same time each day for a month.
Remember to empty your rain gauge each day.

4. Record your measurements in the table.

5. At the end of the month, add up all the rainfall values, and count the total number of observations you made. Use the formula below to calculate the average (mean) rainfall per recording over the month.

Average rainfall per recording = Sum of all the rainfall values / Number of recordings = ______________ mm

6. In your table find the highest rainfall value and the lowest rainfall value you recorded and write these below.

Highest rainfall = _____________ mm   Lowest rainfall = _______________mm

7. The Bureau of Meteorology has rainfall observations like these recorded over long periods. Compare your values to the Monthly Climate Statistics Reference Sheet (see page 18), which lists some of these rainfall statistics for Melbourne for each month of the year.

8. Using the Monthly Climate Statistics Reference Sheet, find the long term records for the month you have taken measurements for and write the values below.

The average long-term rainfall for _____________ *(month)* is ____________ *(amount)* mm

The highest daily rainfall for _______________ *(month)* is _____________ *(amount)* mm

Questions

1. Did you record more or less rainfall than average? How did your highest rainfall compare with the highest daily rainfall recorded by the Bureau of Meteorology?
2. How did your average rainfall compare with the highest average rainfall?
How did it compare with the lowest average rainfall?
3. What differences would you expect to see in rainfall at different times of the year?
4. Are average values or daily values better for predicting weather? Explain.

Monthly Climate Statistics Reference Sheet for Melbourne (Rainfall)

Reproduced from the Bureau of Meteorology (http://www.bom.gov.au/climate/averages/tables/cw_086071_All.shtml)

Statistics for other Australian sites may be obtained from http://www.bom.gov.au/climate/averages/tables/ca_site_file_names.shtml.

Current as at 07 May 2009 02:33:17 EST

Site: 'MELBOURNE REGIONAL OFFICE' [086071]; Records start date: 1855; Last Record: 2009

Latitude: 37.81 Degrees South; Longitude: 144.97 Degrees East; Elevation: 31 m; State: VIC

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December
Average (Mean) rainfall (mm)	47.6	47.3	50.2	57.3	56.2	49.2	47.7	50.2	57.9	66.2	59.5	59.2
Highest daily rainfall (mm)	108	113.4	90.2	80	51.2	44.2	74.4	54.4	58.7	61	72.6	99.6
Date of Highest daily rainfall	29-Jan-63	3-Feb-05	5-Mar-19	23-Apr-60	15-May-74	22-Jun-04	12 Jul 1891	17 Aug 1881	23-Sep-16	21-Oct-53	21-Nov-54	4-Dec-54
Highest average rainfall over a month (mm)	176	238.2	190.7	195	142.5	116.8	178.4	110.8	201.6	193.3	206.1	197.4
Year of Highest rainfall	1963	1972	1911	1960	1942	1991	1891	1939	1916	1869	1954	1993
Lowest average rainfall over a month (mm)	0.3	0.5	3.7	0	3.8	8	9.4	12.4	12	7.5	6.5	1.7
Year of Lowest rainfall	1932	1965	1934	1923	1934	1858	1979	1903	2008	1914	1895	1972
Median monthly rainfall (mm)	37	32	38.6	49.6	55.2	42.7	45.4	49.2	52.6	67.3	53	51.5
Average (Mean) number of days of rain	8.3	7.4	9.3	11.4	13.9	14.1	15.1	15.6	14.7	14.1	11.7	10.4
Average (Mean) number of days of more than 1mm of rain	5.6	5	6.1	8	9.7	9.5	9.8	10.5	10.4	10.3	8.3	7.2
Average (Mean) number of days of more than 10mm of rain	1.4	1.4	1.5	1.6	1.4	1.1	1	0.9	1.5	1.8	1.8	1.6
Average (Mean) number of days of more than 25mm of rain	0.5	0.4	0.4	0.4	0.2	0.1	0.1	0.1	0.2	0.3	0.3	0.5

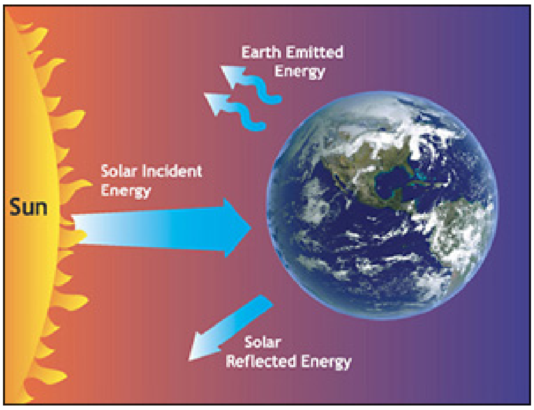
Activity 3: Make your own greenhouse

In this activity, students will build and investigate their own greenhouse.

Background information

Think about a patch of dirt in the open Sun. As the Sun warms the dirt, the temperature increases, and the dirt releases heat and moisture into the atmosphere. Gardeners use greenhouses made of glass to trap heat and moisture inside, keeping temperature and humidity levels higher inside than outside, helping plants to grow.

Without the layers of the Earth's atmosphere to create a similar greenhouse effect, all the heat from the Sun would simply be reflected back into space and lost. The greenhouse effect is essential for life on Earth; however, certain chemicals called greenhouse gases can change the thickness and composition of our atmosphere, which can affect how much heat is trapped.



CREDIT: NASA

Venus has a thick atmosphere, with large amounts of sulphur and carbon dioxide. This means that Venus has a much stronger greenhouse effect than Earth. The surface of Venus is over 400°C and the air pressure is 90 times that of Earth.

The colour of a planet (its albedo) can also affect the greenhouse effect. Lighter colours are better at reflecting heat. Darker colours absorb more heat.

In this activity your students will model a greenhouse environment. They will use cling film (to simulate the Earth's atmosphere) and bubble wrap (to simulate the effect of a thicker atmosphere, like Venus) to compare the difference in temperature between these environments.

What you need

Each group will need:

- A copy of the *Record Keeping* Worksheet (page 22)
- A medium clear glass jar or plastic bottle
- Cling wrap to cover the jar or bottle
- Bubble wrap to cover the jar or bottle
- Small thermometer (must fit inside the jar)
- Damp dirt (enough to cover the bottom of the jar three times)
- Rubber band
- Graph paper

What to do

1. Ask the students what they understand about the terms greenhouse and greenhouse effect. Have they ever been inside a greenhouse?
2. Divide the students into small groups of around three or four. Give each group a set of activity materials. Each group steps through the following procedure:
    a. Place a small layer of dirt on the bottom of the jar.
    b. Place the thermometer into the dirt and place in the sun.
    c. Record the temperature every minute for 10 minutes. Record the temperature on the table provided in the *Record Keeping Worksheet*.
    d. Replace the dirt in the jar.
    e. Cover the top of the jar with the cling wrap and secure with a rubber band.
    f. Repeat step c.
    g. Remove the cling wrap and replace the dirt again.
    h. Cover the top of the jar with the bubble wrap and secure with a rubber band.
    i. Repeat step c.
3. Using graph paper, plot the temperature versus time for each model. Use different colours and label each model so you can tell them apart.

Questions

1. In which situation did the temperature increase fastest: open air, cling wrap or bubble wrap? Is this what you expected?
2. Why do the covered jars become hotter? How is this similar to the greenhouse effect on Earth?
3. Venus' atmosphere is much thicker than that of Earth. Would you expect it to be hotter? Why?

Extension (Optional)

Carbon dioxide is one of the most important greenhouse gases. Have students research the main parts of the carbon cycle online. Some good resources are:

Carbon cycle interactive games:
http://www.windows.ucar.edu/earth/climate/carbon_cycle.html
http://epa.gov/climatechange/kids/carbon_cycle_version2.html

Articles:
http://www.eo.ucar.edu/kids/green/cycles6.htm
http://earthobservatory.nasa.gov/Features/CarbonCycle/carbon_cycle4.php

After researching the carbon cycle, ask students to write a short story entitled 'A day in the life of a carbon atom'. Their story should discuss what happens at key points in the carbon cycle.

Worksheet – Record Keeping

Greenhouse Type	Time (min)	Temperature (°C)	Greenhouse Type	Time (min)	Temperature (°C)	Greenhouse Type	Time (min)	Temperature (°C)
Open	0		**Cling Wrap**	0		**Bubble Wrap**	0	
Open	1		**Cling Wrap**	1		**Bubble Wrap**	1	
Open	2		**Cling Wrap**	2		**Bubble Wrap**	2	
Open	3		**Cling Wrap**	3		**Bubble Wrap**	3	
Open	4		**Cling Wrap**	4		**Bubble Wrap**	4	
Open	5		**Cling Wrap**	5		**Bubble Wrap**	5	
Open	6		**Cling Wrap**	6		**Bubble Wrap**	6	
Open	7		**Cling Wrap**	7		**Bubble Wrap**	7	
Open	8		**Cling Wrap**	8		**Bubble Wrap**	8	
Open	9		**Cling Wrap**	9		**Bubble Wrap**	9	
Open	10		**Cling Wrap**	10		**Bubble Wrap**	10	

Activity 4: Seasons on other planets

Background information

There are a number of factors that cause the seasons on other planets. These include the distance of the planets from the Sun, their rotation time and their axial tilt.

This activity provides students with background information on planetary seasons. Each student is asked to read and make notes about each planet.

The class then plays a guessing game to reinforce this information.

What you need

- Information sheet *Seasons on other planets*
- Information sheet *Planet information*

What to do

1. Introduce the idea of the game to students.
2. Hand out the worksheets and allow students time to read them.
3. Ask the students to make notes about the important features of each planet as they are reading.
4. Choose three students to come up the front (with their notes). Sit them facing their classmates with their backs to the board. Instruct them not to turn around.
5. Behind each student, write the name of a planet on the board.
6. The students up the front then take turns at asking questions of their classmates, until they can guess what planet they are. They should only ask questions with a yes/no answer – for example: Am I hotter than Earth? Am I made of gas? Do I have a thick atmosphere?. If the answer is 'yes' they can ask another question. If the answer is 'no' the next student has a chance to guess.
7. Continue until all students have guessed their planet.

Optional

Older students can complete the planet activity outlined in the following link:

http://museumvictoria.com.au/pages/3812/Activities/Seasons-on-other-planets.pdf

Seasons on other planets

Information sheet

The seasons on the planets of the Solar System are largely a reflection of the size of the difference between the maximum and minimum temperatures on each planet. This difference is caused by the combined influence of a number of factors:

1. The distance of the planet from the Sun

If a planet is close to the Sun (e.g. Mercury), the influence of the Sun's rays will be much greater than on planets far away (e.g. dwarf planet Pluto). The Earth is quite close to the Sun, so the Sun has a large influence on temperatures on Earth.

2. The rotation time of the planet

Planets that have a long rotation time (eg. Mercury) have a much longer daytime and night-time than planets with a short rotation time (eg. Jupiter). If the Sun is in the sky for a long time, that half of the planet will tend to become much hotter than if the Sun is in the sky for a short time. Similarly, long nights will cause much lower temperatures than short nights, as the half of the planet in darkness will have longer to cool down. The average daytime and night-time on Earth is quite short, so our rotation time has only limited influence on maximum and minimum temperatures.

3. The composition and density of the planet's atmosphere

Planets with dense atmospheres (e.g. Venus) will have little variation in temperature, as the atmosphere moderates heat gain and loss. Temperatures on planets with no atmosphere, or a very thin atmosphere (e.g. Mercury) are not subject to this moderating influence. The Earth's atmosphere is of medium density – it filters the Sun's heat that comes through to the surface during the day and helps to retain heat when the Sun goes down.

4. The axial tilt of the planet

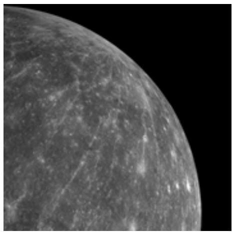
If the axis of a planet has a moderate tilt (e.g. Earth, Mars), or a large tilt (Uranus, Pluto) there will be a big seasonal variation in the length of day and night, especially at higher latitudes. For planets that are close to the Sun, this will cause a marked seasonal difference between temperatures in the two hemispheres.

Earth's tilt of 23.5 degrees causes locations close to the poles to have around six months of daytime and six months of night-time. When the South Pole is tilted towards the Sun, it is the Southern summer with continuous daylight, and when the South Pole is tilted away from the Sun, it is the southern winter with continuous night time.

5. The orbital eccentricity of the planet

The more elliptical the orbit of a planet, the more variation there will tend to be in temperature as the planet revolves around the Sun. When the planet's orbit takes it nearer the Sun, it will receive more heat than when it is further away. Mercury has a quite elliptical orbit, while Earth's orbit is almost circular.

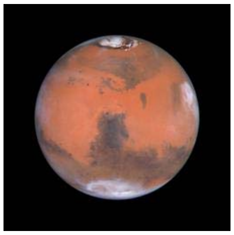
Planet information



CREDIT: NASA

Mercury is the closest planet to the Sun. Its climate varies considerably throughout its year because it moves in a highly elliptical path. This means that at times it is much closer to the Sun than at other times. It does not have any atmosphere and has no protection from the Sun. During the day it gets really hot and during the night it gets really cold. Mercury has no tilt, so its seasons are caused by its highly elliptical path around the Sun.

Venus is the second closest planet to the Sun. Its orbit does not cause the seasons because it is nearly circular. It has a tilt of only three degrees (in the opposite direction to the other planets) so temperatures across the planet do not vary much throughout a Venus year. The climate on this planet is always hot because it is relatively close to the Sun and has a thick atmosphere that keeps temperatures stable. You could say that Venus hardly has any seasons at all.



CREDIT: NASA

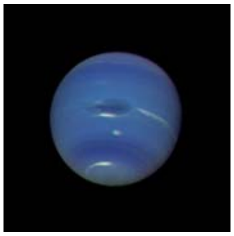
Mars is the fourth closest planet to our Sun. This planet can be considered to have only two seasons (summer and winter) that vary greatly in temperature. The planet's elliptical path and its significant tilt produce the seasons. The fact that Mars has a very thin atmosphere also contributes to the extreme temperature variations.

Jupiter has a tilt of only three degrees and has a very thick atmosphere (being one of the gas giants). Its path around the Sun is elliptical, so you might expect the temperature to vary along its orbit. However, it is very far from the Sun, so the temperature change is small. Jupiter is always very cold. The very thick atmosphere keeps the cold temperatures very stable. You could say that Jupiter does not have any seasons.

CREDIT: NASA

Saturn is one of the gas giants. It has a tilt as well as an elliptical path around the Sun. However, since it is very far away from the Sun, it is always very cold and its thick atmosphere keeps it that way.

Uranus has an elliptical orbit but is a long way from the Sun so it experiences extremely cold conditions all year round. It has a very thick atmosphere (being another of the gas giants) and so the temperature remains very cold throughout its year. It has a tilt of about 98 degrees, practically spinning on its side. Its daytime lasts for half of its year and night time for the other half.



CREDIT: NASA

Neptune's orbit is nearly circular, and it has a tilt of about 28 degrees. However, Neptune is far away from the Sun, so temperatures are always extremely cold. Its atmosphere is very thick and keeps the climate icy cold.

Pluto (a dwarf planet) is very far from the Sun so temperatures are always extremely cold. Even though its path around the Sun is very elliptical, and its atmosphere is extremely thin, the distance from the Sun makes it extremely cold all the time.

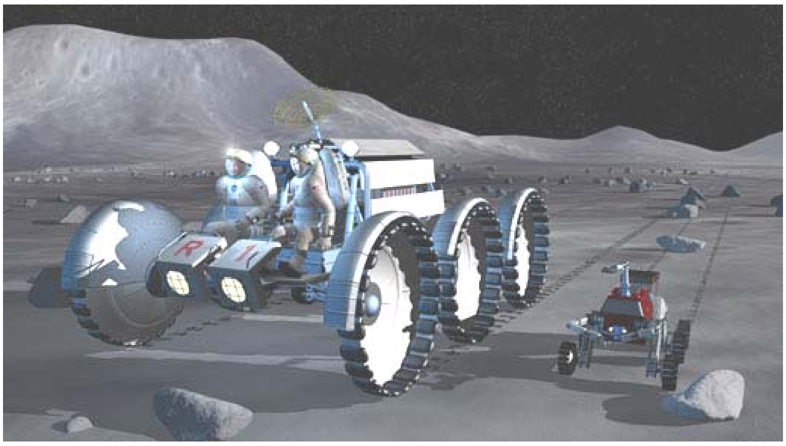
Activity 5: Life on Mars versus life on Earth

Background information

In 2004, The United States Government announced plans to return humans to the Moon, and to eventually send humans to Mars. This was quite a change in policy, as NASA's Solar System exploration has only been done by robotic missions since the 1970s.

As you might expect, this plan has many supporters and critics.

In this activity, students will consider this issue from the point of view of a government policy advisor. They will brainstorm and discuss the issue using the six-thinking hats method (developed by Dr Edward de Bono).



CREDIT: NASA

What you need

- Photocopies of Worksheet: *Six thinking hats.* You may wish to enlarge these to A3 size, so students have more space to write.
- Access to resources for students' own research.

What to do

1. Begin the session by posing the following scenario:

   'NASA and many other international space agencies and governments intend to cooperate to send humans to the Moon to live, conduct experiments and help plan for other missions to Mars and beyond.

   Sending humans to the Moon offers a great opportunity for advances in science and technology. However, many argue that the amount of money required for this project would be much better spent on sustainable technology here on Earth, to combat issues such as water shortages, poverty and climate issues.

   The Australian Government has been asked to join this group and provide money and research to help send humans to the Moon. It is your group's job to advise the government:

   Should we send people to live on the Moon, or should we spend the money on much needed projects on Earth?'

2. Divide the students into groups of four.
3. Ask the groups to write down all the information they need to research to make a decision. They may want to allocate different research topics to different group members.
4. Allow students the time to research the scenario, using library or online resources.
5. With research in hand, gather the students back into their groups.
6. Hand out the worksheets; explain the six-thinking-hats method and what each colour represents.
7. Starting with the white hat, groups should spend the time indicated in Table 1, discussing and writing down notes under each hat on the worksheet. The teacher should keep time, and encourage groups to stay focused on the particular hat.
8. After the students have worked through the six-hats, have each group present their findings (Blue Hat) and their reasoning to the rest of the class.
9. Discuss whether the thinking hats process changed their mind about the topic.

Thinking hat colour	**Suggested time**
White Hat:	10 min
Red Hat:	5 min
Black Hat:	7 min
Yellow Hat:	7 min
Green Hat:	5 min
Blue Hat:	5 min

Table 1: Suggested time interval to be spent on brainstorming for each thinking hat colour

Worksheet: Six thinking hats

What is your key issue statement or question?

White hat:

List the information, facts and figures about the issue.

Red hat:

What are your opinions and feelings about the issue?

Black hat:

What are your criticisms, judgments and negatives about the issue?

Yellow hat:

What are the positive aspects of the issue?

Green hat:

What are the alternatives or new ideas relating to the issue?

Blue hat: Conclusion

Based on all of the issues and ideas, what do you think is the best response to the question?

Activity 6: Wish you were here

Background information

In this activity, students will investigate the different climatic regions on Earth, and the ways in which humans live in a range of these environments. They will research information on a particular climatic region and create a digital movie, highlighting what you would need to live in that climate.

What you need

- Map of the world
- Internet access
- Computers with Windows Movie Maker installed (standard on most XP and Vista machines)
- Information about different environments (online, or library references)
- Movie planning worksheet and Windows Movie Maker instruction sheet.

What to do

1. Using the world map as a guide, choose examples of different environments/climatic regions (e.g. desert, rainforest, polar region, large city). As a group, discuss the characteristics of that environment (temperature, rainfall, noise etc) and whether you would have to live differently there.

2. Inform students that they will be creating a movie about the climate in a chosen part of the world. They should imagine that it's their job to encourage people to move to that area. Information about the climate and environment, and what they would need to survive should be included.

3. Place the students in groups of no more than four. You can ask each group to choose a place on the map, or you can assign one to them.

4. Give each group a copy of the *Movie planning worksheet* and the *Windows movie maker instruction sheet.*

5. To create their movie, each group should go through the following steps:

   a. Research their chosen destination's climate:

   Allow students time in the library or online to collate some key facts about their chosen environment. Ask them to consider what sort of information they would need if they were going to live in that place.

   b. Use the movie planning worksheet to plan their movie:

   The movie should be no longer than five minutes.

c. Collect images showing the climate of their chosen environment:

Two good websites for free images are: http://pics.tech4learning.com/ and http://gimp-savvy.com/PHOTO-ARCHIVE/ . Remind the students that they should acknowledge the source of the images.

d. Write a short narration:

The narration should communicate the main points about the environment and relate to the images being used.

e. Import images into Movie Maker and produce the clip, adding a voice-over:

To do this they will need access to Movie Maker and the instructions.

f. Share their movie with the rest of the class, and discuss:

Did students find the movies a useful way to learn about climate? Did it encourage them to want to visit any of the places when they are older? What do they think is the best place to live and why? What is the worst place to live, and why? How will climate change affect the way that humans live in various parts of the world?

Movie planning worksheet

Questions

1. The main messages we want people to understand are:

   a. ____

   b. ____

2. Use the table below to draw an idea of the images you need (on the left) and write what your narrator will say (on the right). Think carefully about the order of the images and the length of time spent on each image.

Draw your images (stick figures are OK)	**Write down the words that go with each image**
(time:________sec)	
(time:________sec)	
(time:________sec)	
(time:________sec)	
(time:________sec)	

3. Follow the instructions on the *Windows movie maker instruction sheet* to create your movie. Your movie should be no longer than 5 minutes.

Windows movie maker[1] instruction sheet

You can create clips using Windows Movie Maker. It usually comes free and installed with Windows XP or Windows Vista. On a PC, Movie Maker is the movie making program and Movie Player is the program used for playing videos.

Using Windows Movie Maker to import pictures and create a timeline

1. Download the pictures you wish to include in your movie and save them to a folder on your computer. You should note where you copied the images from, so that you can place credits in your movie.
2. Click on "**Start**" at the bottom of the PC and click on the **Windows Media Maker** icon which should open the program.
3. Go to Movie Tasks on the left hand side, then to "**Import**", then click on "**pictures**".
4. Locate folder with digital images and click on first image. Click "Ctrl + A" and then "all" to select all. Click "**Import**" so that all the photos appear on the photoboard.
5. Go to **Tools**, then **Options**, then **Advanced** and choose picture duration at 5 seconds; the transition should be set at 1 second. Click "OK".
6. Click on the first slide and then "Ctrl + A" to select all. Drag the photos down to the storyboard.
7. The movie will appear in the "storyboard". Play it by clicking the large arrow in the animation.
8. If you want to show full screen, click "view" and then full screen.

Adding credits, transitions and titles

1. Go to Movie Tasks on the left hand side and then to "**Edit movie**".
2. From here you can click on **"view video transitions"** to drag and drop transitions into your storyboard.
3. You can click on "**make titles or credits"** to add opening titles or end credits to your movie.

Adding a narration

1. Your movie will need a narration or text but not both. It is advisable to write a script first to get the best possible narration.
2. Go into "**Tools**" and select "**Narrate Timeline**" or click on the microphone icon above the storyboard. Make sure you click on "**audio device**" to select the microphone.
3. Ensure that your microphone into your computer is working. Then click on "**Start Narration**" and **stop** when necessary.

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[1] These instructions are adapted from the Museum Victoria "Earth Quest" Education Kit, used with the permission of Garry Hoban, Associate Professor of Science Education and Teacher Education, University of Wollongong, Australia.

4. Make sure you save and name the file.
5. In order to make your images and narration line up perfectly, you may need to adjust your timeline (see below).

Making your static images suit the narration

1. Click on the relevant photo in the storyboard and then click “Ctrl + C” to copy and “Ctrl + V” as many times as you need to keep the static image on the screen to fit with the storyboard.
2. Use the arrows on the bottom right hand side of the computer to find the images that you want to copy and do the same as above.
3. You can rewind the storyboard with “Ctrl + Q” and play the storyboard with “Ctrl + W”.
4. You can delete any unwanted photos by clicking on them and pressing Delete.

Saving the animation

1. You can save the project by clicking under “Publish to this computer” or “save to this computer” under the Finish Movie heading. This saves the movie as a .wmv (window media video) file which allows it to be shared, and opened by other computers.
2. Chose a movie location to suit your needs. You may be best to save it to ‘**my computer**’. It must be saved as a .wmv to be uploaded to a web site or shared with others. If you just “save” under the FILE menu within Movie Maker it becomes a .WMMV file which cannot be transferred or uploaded.