

# 6

# PART

## Part 6: Predictable phenomena

- Activity 6.1 Why does the moon change shape?
- Activity 6.2 What is the time?
- Activity 6.3 What causes the tides?
- Activity 6.4 Eclipses
- Activity 6.5 Using predictable phenomena to create calendars

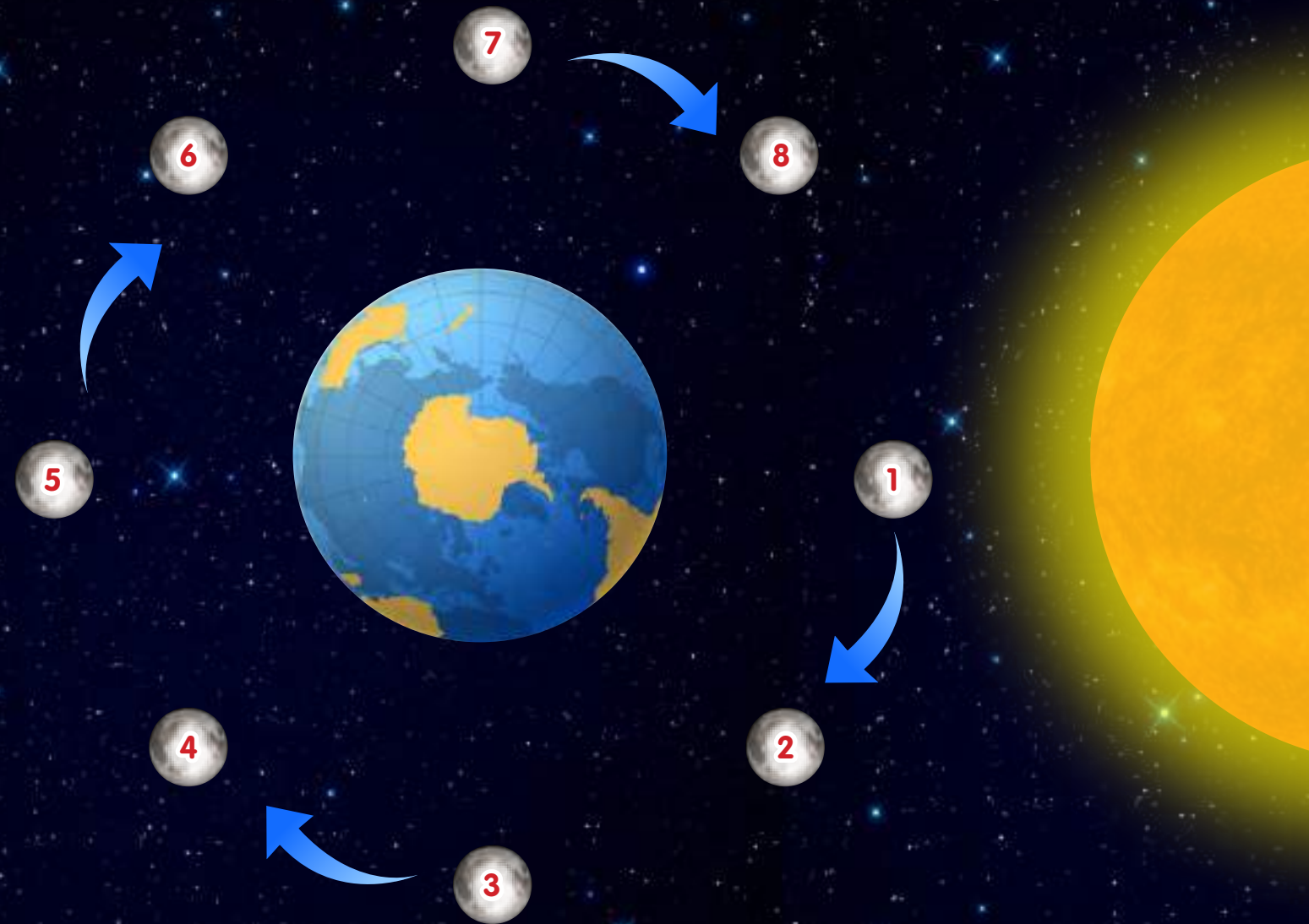
# Activity 6.1 Why does the moon change shape?

Activity type



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This diagram is what an astronaut would see in outer space if the spaceship was above the South Pole. The moon takes about 29 days to orbit the Earth in a clockwise direction. In that time the moon appears to change shape. Why does the moon change shape?



## Activity 6.1 Why does the moon change shape? Continued

### Modelling the phases of the moon

#### What to use:

##### Each GROUP will require:

- torch or desk lamp
- polystyrene ball painted black on one half and white on the other half
- drawing paper or digital camera/ mobile phone camera.

##### Each STUDENT will require:

- **Notebook.**

#### What to do:

##### Step 1

One student uses a torch or desk lamp to simulate the sun shining from the centre of the solar system.

##### Step 2

A second student acts as the observer from the southern hemisphere of Earth holding a camera, or pencil and pad.

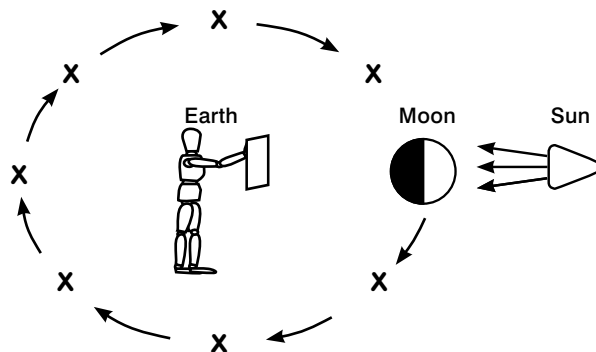
##### Step 3

A third student holds the moon between the observer student (Earth) and the sun, ensuring that the white half of the moon always faces the sun.



##### Step 4

The observer student now draws or photographs the moon from this position.



##### Step 5

Now move the moon 45° around the circle in a clockwise direction, ensuring the moon keeps the white half facing the sun. Take an observation.

##### Step 6

Keep moving the moon around the observer student each 45° until observations have been taken for all eight locations.

##### Step 7

Include the photos or drawings in your **Notebook** to complete the table. Label your images using the terms shown in the *Order of the phases*.

#### Discussion:

Explain why the moon appears to change shape as it orbits the Earth.

### ORDER OF THE PHASES



New moon



Waxing Crescent



First Quarter



Waxing Gibbous



Full moon



Waning Gibbous



Third Quarter



Waning Crescent



New moon



## Activity 6.1 Why does the moon change shape? Continued

### Recording the phases of the moon

#### What to use:

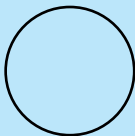
Each STUDENT will require:

- **Notebook**
- camera or pencil.

#### What to do:

##### Step 1

Draw a table like the following in your **Notebook**. Make sure you include enough rows for a month of observations.

Date	Moon	Name of phase
		

##### Step 2

Observe the moon each night and photograph or draw a diagram of the shape that is illuminated. Find out the name of that phase and record it in the table too.

#### Discussion:



After your first week of observations, can you predict when the next full moon will be? Write down your prediction and wait to see if you are correct.

For the next month your task is to observe and draw the phases of the moon.

THE  
MOON  
ILLUSION

When the moon is close to the horizon it appears a lot larger than when it is higher in the sky. The cause of this illusion is not fully understood, however the current theories suggest foreground objects on the horizon trick the brain into thinking that the more distant objects (like the moon) are larger.

Still not sure? Try this out: hold your hand out at arm's length and cover the rising full moon with your thumb - it should be about the size of your thumbnail. Do this again later on when the moon is higher in the sky - it should still be about the size of your thumbnail.

## Activity 6.1 Why does the moon change shape? Continued

### Cut and paste

#### What to use:

Each STUDENT will require:











































- Activity sheet 6.1 Waxing and waning
- scissors, glue.

#### What to do:

##### Step 1

Cut and paste images and labels to correctly show the phases of the moon seen from the Southern Hemisphere.

What can the phase of the moon tell us about the relative locations of the Earth, moon and the sun?

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						
						
						
						
						
						

Could you work out the date if you knew what the moon phase was going to be?

## ONCE IN A BLUE MOON

Since the mid 20th Century the term blue moon has been used to refer to the second full moon in a calendar month. As the moon cycles through its phases approximately every 29 days, the only way there could be two full moons in a calendar month would be if there was a full moon at the start of the month.

In 1999 there were two blue moons by this definition. One in January and one in March as there was no full moon in February because it had 28 days. This will occur again in 2018.

Traditionally a blue moon was linked with the number of full moons in a season. As a season is three months long, normally one would expect three full moons. When there were four full moons in a season the third was referred to as the blue moon.

These moons are blue in name only. Very rarely is the moon actually blue. Particles in the atmosphere about one micron (1000th of a millimetre) in diameter emitted from volcanoes or bushfires can act like a colour filter and tinge the moon blue.

### Solve the crime

#### What to use:

Each STUDENT will require:

- Activity sheet 6.1 The Mystery of the Missing Sundial.

#### What to do:

##### Step 1

Working with other students in your group, use your knowledge of the phases of the moon to solve the crime of the missing sundial.



Click here to test your understanding of the phases of the moon.



# Activity 6.2 What is the time?



## Sundial

### What to use:

Each GROUP will require:

- **Activity sheet 6.2 Sundial**
- drinking straw or wooden skewer
- heavy cardboard
- scissors
- sticky tape
- protractor, ruler
- compass to locate north.

### What to do:

#### Step 1

Cut a rectangle of cardboard the same size as the sundial templates.

#### Step 2

Sticky tape the templates to both sides of the cardboard.

#### Step 3

Make a hole through the sundial to accommodate the drinking straw or wooden skewer.

#### Step 4

Look on the next page to determine your latitude. Your sundial needs to be at an angle of 90 degrees minus your latitude. Use a protractor to make some wedges at that angle. Tape the wedges to the back of the sundial.

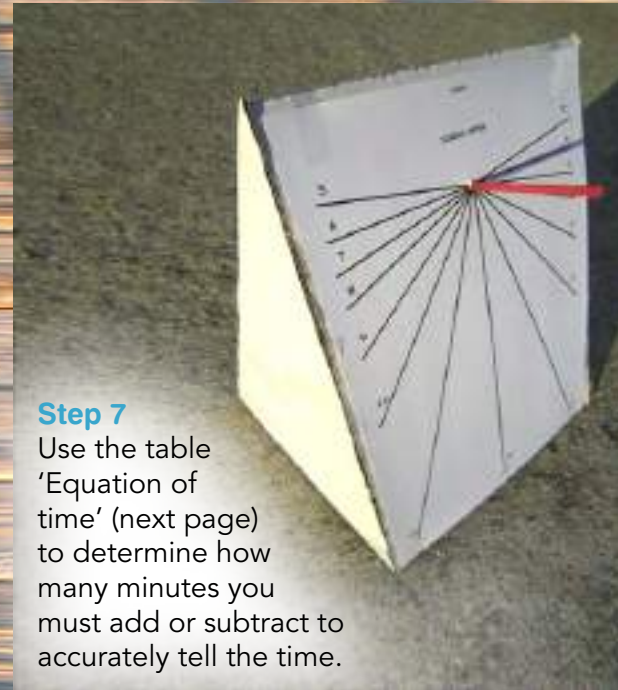
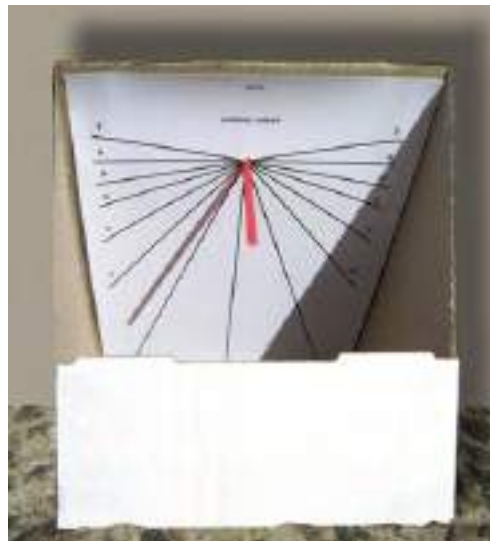


#### Step 5

Place the sundial in a sunny position with the 12 facing south.

#### Step 6

The shadow of the straw or skewer will tell you the time. In winter the sun is low in the sky and you will read the sundial from the lower template.



#### Step 7

Use the table 'Equation of time' (next page) to determine how many minutes you must add or subtract to accurately tell the time.



This sundial has been made for Canberra.

**Before the invention of clocks people used the position of the sun in the sky to tell the time. When the sun was at the highest point in the sky it was midday.**

**Sundials use the shadows cast by the sun to measure the time. They can come in many different forms. You might even have one in your garden!**



## Activity 6.2 What is the time? Continued

# EQUATION OF TIME

	5th	15th	25th
January	-5	-9	-12
February	-14	-14	-13
March	-12	-9	-6
April	-3	0	+2
May	+3	+4	+3
June	+2	0	-2
July	-4	-6	-6
August	-6	-5	-2
September	+1	+5	+8
October	+11	+14	+16
November	+16	+15	+13
December	+10	+5	0

As the sun's path changes during the year a sundial's accuracy can vary.

Use the table on the left to adjust the time on your sundial. For example, if your sundial indicates 1.00pm on 15 March, then the correct time is 12.51pm (1.00 minus 9 minutes).

You will also need to add one hour during daylight saving.

City	Latitude in degrees south
Adelaide	35°
Alice Springs	24°
Brisbane	27°
Canberra	35°
Darwin	12°
Hobart	43°
Melbourne	38°
Perth	32°
Sydney	34°
Townsville	19°

Use this table to determine the tilt for your sundial.

For example a sundial for Canberra (35 degrees south of the equator) is tilted 35 degrees from the vertical or 55 degrees from the ground.



# Activity 6.3 What causes the tides?

Activity type



DOWNLOAD e-NOTEBOOK



Galileo originally thought the tides were caused by the Earth's movement around the sun. Just like water sloshes in a bucket when you carry it, he thought the tides he observed in the Mediterranean 'sloshed' due to the momentum of the Earth.



Click here to test your understanding of the phases of the moon.

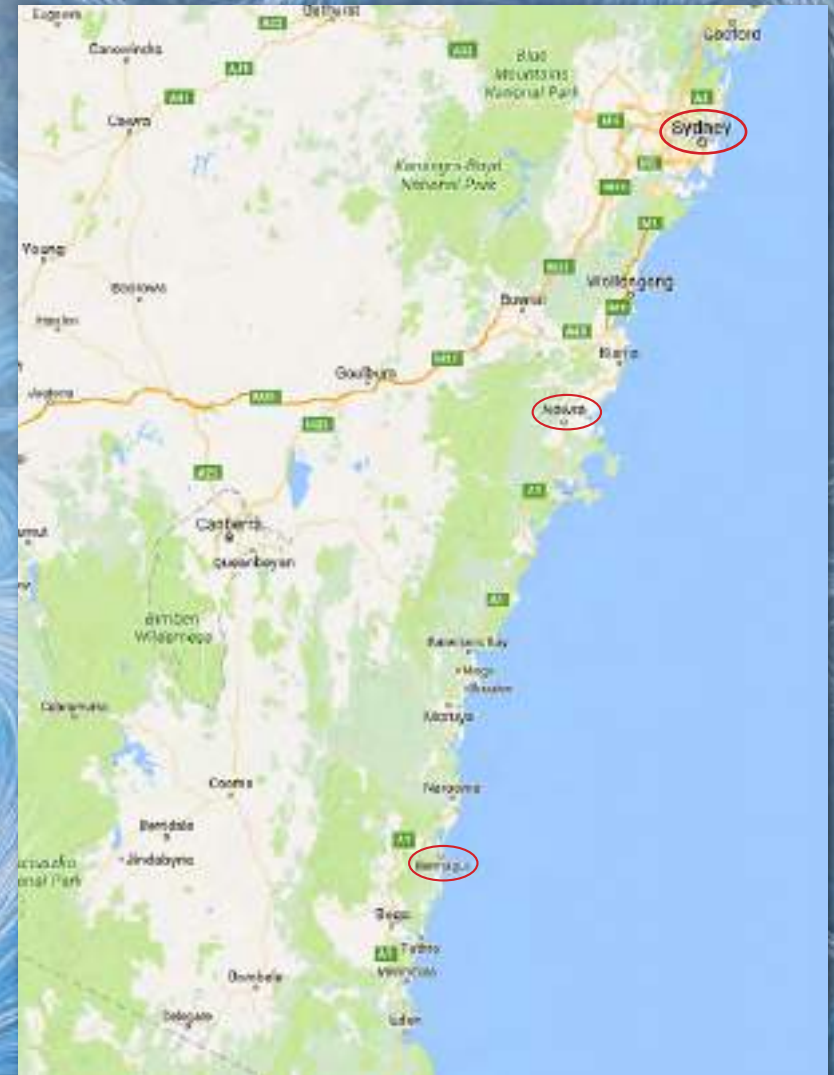


## Activity 6.3 What causes the tides? Continued

Sailors navigating into bays and harbours need to predict how deep the water will be as it may be too shallow for their vessel at low tide.

Depending on location and the type of fish you want to catch it is best to go fishing at a particular tide. Low tides make fishing around rocks or reefs easier as the water is shallower. Fishing on either side of a low or high tide when the water is changing direction can mean you pick up fish moving to new areas.

Why is it important to know when high and low tide will be?



Map showing Sydney, Nowra and Bermagui



## Activity 6.3 What causes the tides? Continued

### NSW tide chart

Date	Sydney (Fort Dennison)		Nowra (Shoalhaven River)		Bermagui (Bermagui Bridge)	
	High	Low	High	Low	High	Low
1st January 2013	10:27am 11:07pm	4:04am 5:00pm	12:37pm 6:24am 7:20pm		11:12am 11:52pm	4:49am 5:45pm
2nd January 2013	11:06am 11:52pm	4:48am 5:39pm	1:27am 1:16pm 7:08am 7:59pm		11:51am	5:33am 6:24pm
3rd January 2013	11:49am	5:37am 6:20pm	2:12am 1:59pm 7:57am 8:40pm		0:32am 12:34pm	6:23am 7:05pm



### Using a tide chart

#### What to do:

Use the NSW tide chart to answer the following questions in your **Notebook**.

- Propose a reason why we usually see two low tides and two high tides each day.
- Look at the data from the 1st of January, 2013.
  - What is the time difference between the second high tide in Sydney and the high tide in Nowra?
  - Can you propose a reason for this difference?
  - There was only one high tide in Nowra on the 1st of January, 2013. Why do you think this is the case?
- Look at the data from Sydney. What is the approximate time difference between:
  - The two high tides on the 1st of January?
  - The two low tides on the 2nd of January?
  - The morning high tide and morning low tide on the 3rd of January?

- Look at the data for the 3rd of January and compare it to that on the 2nd of January. How much later in the day is:
  - The first high tide in Sydney?
  - The first high tide in Nowra?
  - The second high tide in Bermagui?
  - The first low tide in Sydney?
  - The first low tide in Nowra?
  - The first low tide in Bermagui?
- Assuming the pattern stays the same, predict the time of the first high and low tides for the 4th of January.

Date	Sydney (Fort Dennison)		Nowra (Shoalhaven River)		Bermagui (Bermagui Bridge)	
	High	Low	High	Low	High	Low
4th January 2013						

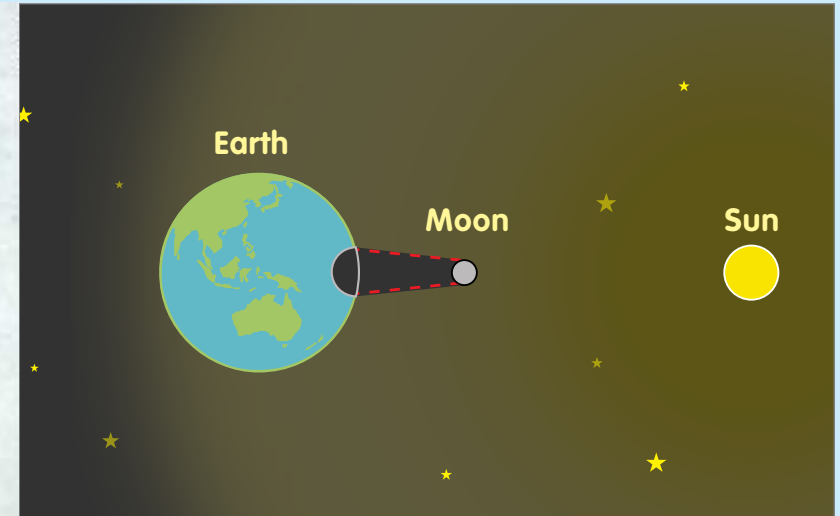


# Activity 6.4 Eclipses



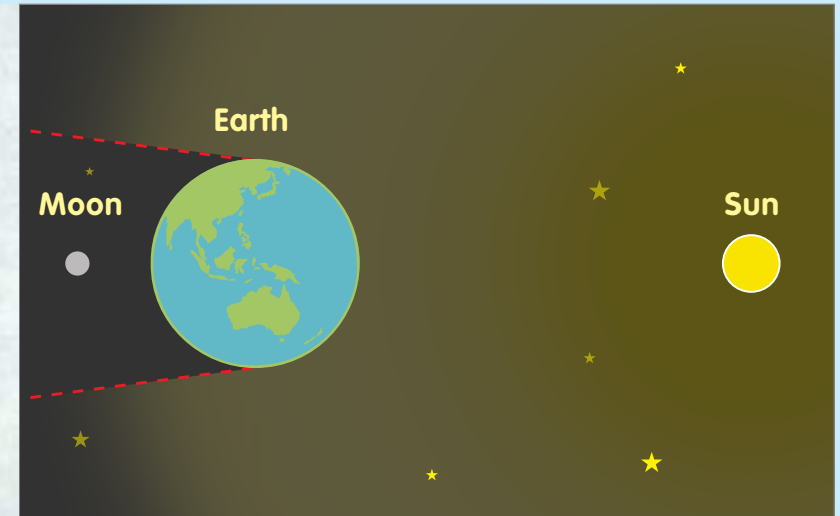
## SOLAR ECLIPSE

A solar eclipse occurs when the moon blocks out the light from the sun.



## LUNAR ECLIPSE

A lunar eclipse occurs when the Earth blocks the sun's light from being reflected by the moon.



Click here to learn more about eclipses. (Your teacher will give you the Scootle Student login PIN to access the resources.)

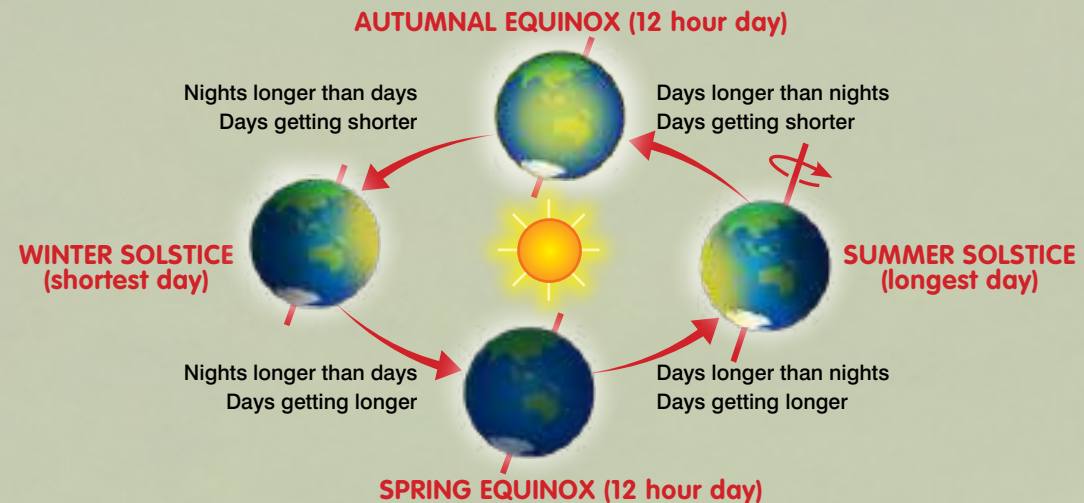
# Activity 6.5 Using predictable phenomena to create calendars



Different cultures have used predictable phenomena such as the phases of the moon, eclipses and the position of stars in the night sky to create calendars to know when to hunt a particular animal or when to plant or harvest crops.

In the southern hemisphere the summer solstice is the day when the sun is furthestmost south at noon (generally 21st January). The winter solstice is the day when the sun is furthestmost north at noon (generally 21st June). These mark the days with the longest and shortest daylight hours. Equinoxes are the dates halfway between the solstices, when each day has an equal amount of light and dark.

## Southern Hemisphere Solstices and Equinoxes (viewed from above the Earth's orbital plane)



## STONEHENGE

Stonehenge is located on the Salisbury Plane in Wiltshire, England. The site dates back to around 4000 BCE. While a lot of mystery still remains about its purpose it appears it was constructed to mark the solstices and equinoxes.

The arrangement of the stones at Stonehenge allowed the ancient Britons to mark the solstices and equinoxes, as when the sun rose on these days, it was aligned with particular stones.

This is what Stonehenge might have looked like in 2400 BCE. At dawn on the summer solstice, the rays of the sun would have shone straight through what are called the "slaughter stones" to strike the "altar stone" in the centre.



## Activity 6.5 Using predictable phenomena to create calendars Continued



### THE EGYPTIANS

The earliest Egyptian calendar was based on the moon's cycles, but later the Egyptians realized that the star Sirius in Canis Major, which we call Sirius, rose next to the sun at sunrise every 365 days. This corresponded with the start of the annual flooding of the Nile. Based on this knowledge, they devised a 365 day calendar that seems to have begun around 4200 BCE.

#### Why does Easter change date every year?

The date of Easter is the first Sunday after the first full moon after the March equinox.

#### Why does Ramadan change date every year?

Ramadan is the ninth month of the Islamic calendar. The Islamic calendar is a lunar calendar, with new months beginning when the first crescent of a new moon appears. As this calendar is 354 days, rather than 365 days, Ramadan will move through the months.





## Activity 6.5 Using predictable phenomena to create calendars Continued

### AUSTRALIAN INDIGENOUS CALENDARS

#### Wurdi Youang

Wurdi Youang is a site in Victoria thought to have been built by the Wathaurung people. The cultural significance of the site has been lost, however new studies have shown that the arrangement of the boulders appears to be linked with the solstices and the equinoxes. From the position where the photograph was taken, the boulders show the position of the setting sun at different times of year.

The site has not been accurately dated but is thought to be thousands of years old and may predate Stonehenge.



#### Making a calendar

##### What to use:

Each PAIR will require:

- Activity sheet 6.5 Circular calendar.

##### What to do:

###### Step 1

Add some of the events to your calendar that occur on an annual cycle - holidays, sport, special events, birthdays etc.

###### Step 2

Mark the seasons on your calendar.

###### Step 3

Add the solstices and equinoxes.



Click here to learn about Australian Indigenous calendars.



# 6

## PART

The sun shines on one side of the moon and the other side is in shadow. The moon takes 29 days to orbit the Earth. As the moon moves around us it goes through phases. When the moon is gaining in illumination each night it is **waxing**. When it is losing illumination it is **waning**.

When the moon is between the sun and the Earth we call it a **new moon**. It appears to us as a dark circle, however we usually cannot see it because it is daytime. As the moon orbits further we see it change into various phases – **waxing crescent** (sliver of the moon illuminated on left side), **first quarter**, **waxing gibbous**, **full moon**, **waning gibbous**, **third quarter**, **waning crescent** (sliver of the moon illuminated on right side), and **new moon** again.

If two full moons occur in a calendar month the second full moon is called a **blue moon**.

Before the invention of clocks people used the position of the sun in the sky to tell the time. When the sun was at the **highest point in the sky** it was **midday**. **Sundials** use the **shadows** cast by the sun to measure the **time**.

Due to the gravity of the moon Earth's oceans bulge out on the side facing the moon and also on the opposite side of Earth. This causes **high tides**. When the sun, Earth and moon are in a straight line the tides are the highest and are called **spring tides** (or king tides). This occurs during new moons and full moons. When the sun, Earth and moon make a right angle to each other the bulges are less extreme and the high tide is called a **neap tide**.

A **solar eclipse** occurs when the moon blocks out the light from the sun.

A **lunar eclipse** occurs when the Earth blocks the sun's light from being reflected by the moon.

In **temperate parts** of Australia we experience four **seasons**; **spring**, **summer**, **autumn** and **winter**. Each season is three months long with spring beginning on the 1st September.

In **tropical** parts of Australia we experience two seasons; the **Wet Season** (October/November to March/April) and the rest of the year is the **Dry Season**.

The day with the most daylight hours is the **Summer Solstice** on 21st December. The day with the least daylight hours is the **Winter Solstice** on 21st June. **Equinoxes** are the days when the number of hours of daylight equals the hours of nighttime.

