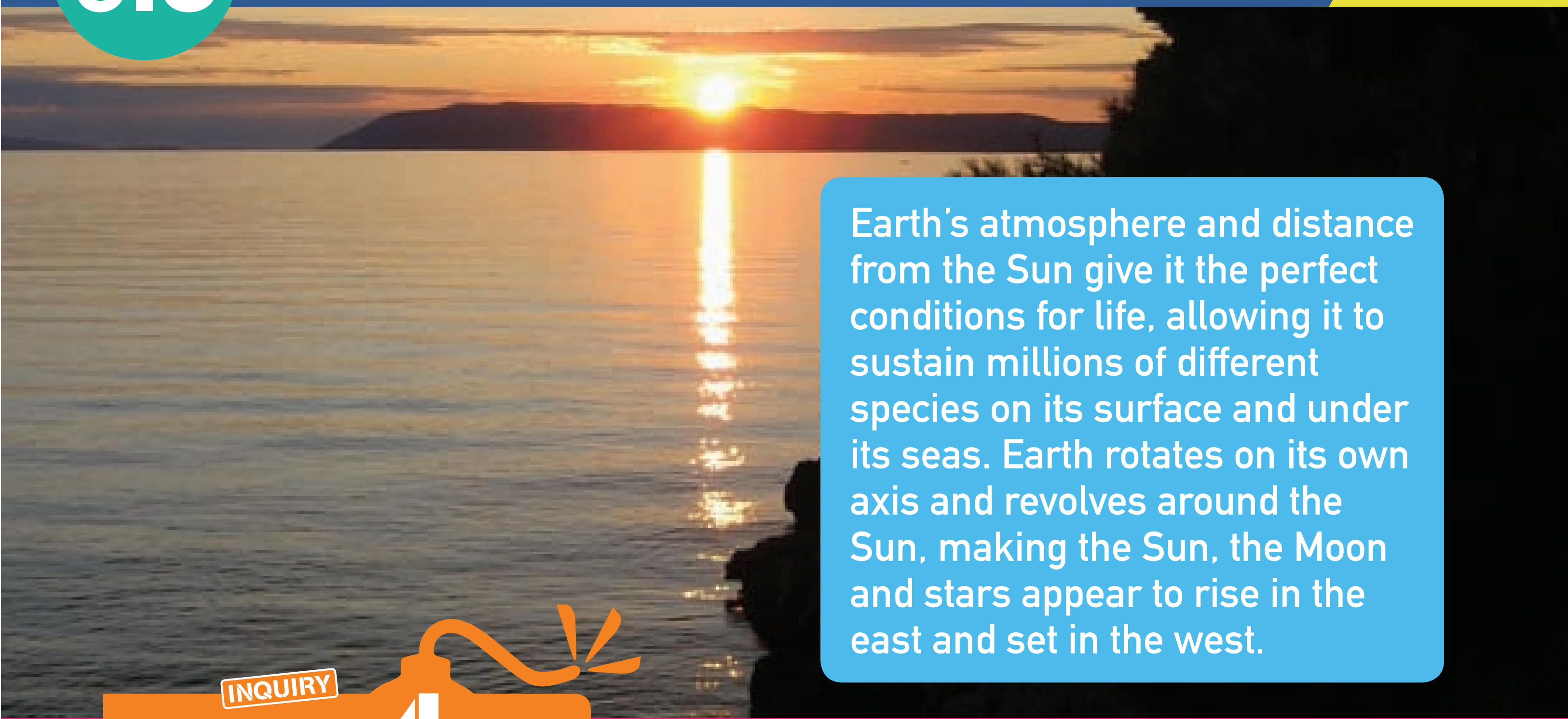
9.3 Earth



Earth's atmosphere and distance from the Sun give it the perfect conditions for life, allowing it to sustain millions of different species on its surface and under its seas. Earth rotates on its own axis and revolves around the Sun, making the Sun, the Moon and stars appear to rise in the east and set in the west.

INQUIRY **science 4 fun**

Make a sundial

Can a sundial tell the time accurately?

Yes

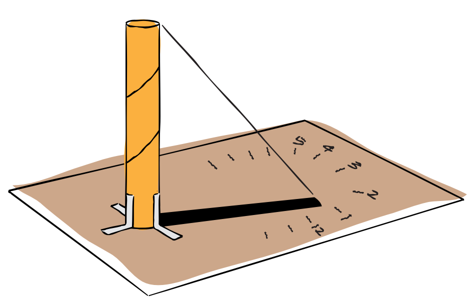
Collect this …

- sturdy sheet of cardboard or scrap timber
- sheet of A4 scrap paper
- sticky-tape
- felt-tip pen
- watch or clock
- compass (optional)

Do this …

1 Roll up the A4 sheet of paper lengthwise to form a cylinder.

2 Secure it to the sheet of cardboard with strips of sticky-tape so that it stands upright.



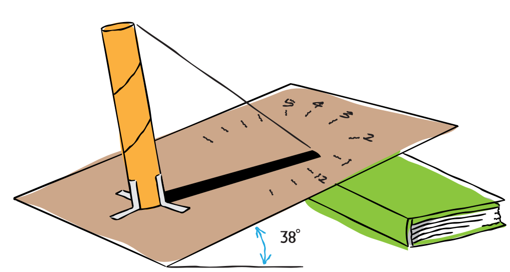
3 Place your sundial in a spot where it gets sunlight most of the day.

4 Every hour, use the felt-tip pen to mark where the shadow falls on the cardboard or timber sheet. Write the time next to its mark.

To make your sundial more accurate:

5 Use a compass to find exactly where north is.

6 Use an atlas or search the internet for the latitude of where you live. Melbourne, for example, is 38°S. Use a protractor to measure out this angle and tilt the base so that it slopes away from north at this angle.



Record this …

Describe what happened.
Explain how you could use your sundial to tell the time.

The Earth in space

Every day the Sun appears to rise in the east and set in the west, as do the Moon and stars. The Sun doesn't really move this way. Neither do the Moon or the stars. Instead, the Earth itself is spinning from west to east, making it appear that the Sun, Moon and stars move the other way. This can be seen in Figure 9.3.1.

Figure 9.3.1 Every five minutes another photograph was taken to produce this image of the Sun setting in the west.

Day and night

An imaginary line called the **axis** runs through the Earth from the north pole to the south pole. Earth rotates (spins) about this line, from west to east. The time taken for any planet to rotate about its axis is referred to as its **day**. Earth takes 24 hours to complete one rotation, and so one day on Earth is 24 hours. During this day, the Sun rises once in the east and sets once in the west.

As Figure 9.3.2 shows, at any time half of planet Earth is bathed in sunlight. This half experiences daylight. The other half is in the dark and so experiences night. As Earth rotates, some countries move into the light and others move out of it.

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9.6

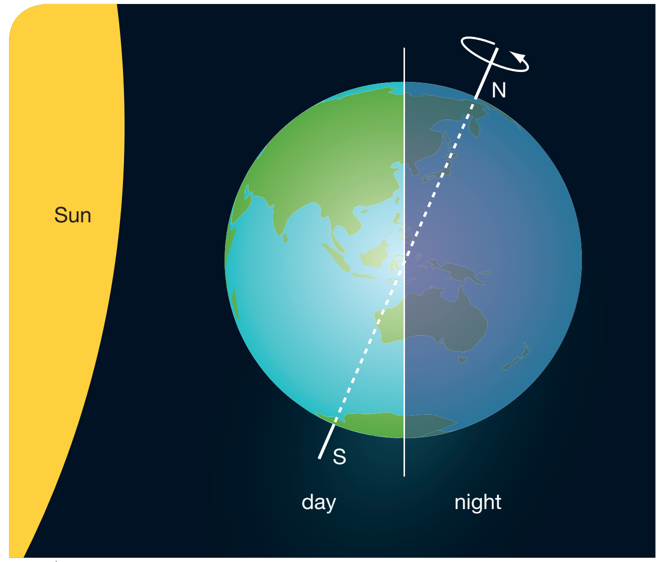

Figure 9.3.2 A day is the time it takes for Earth to spin around on its axis once completely. As Earth spins, only half is bathed in sunlight at any one time. This half experiences daylight. The dark half experiences night.

The year

Like all the other planets in the solar system, Earth orbits the Sun. It travels at an average speed of 108 000 km/h and takes $365\frac{1}{4}$ days to complete one **revolution** (one complete orbit). A complete orbit is shown in Figure 9.3.3. The time taken by a planet to revolve around the Sun is referred to as its **year**. For Earth, a year is $365\frac{1}{4}$ days. The quarter day makes setting up a calendar very difficult and so a calendar year is taken normally as 365 days. Every four years, however, the calendar needs to 'up' and an extra day (29 February) is added to make a **leap year** of 366 days.

9.7

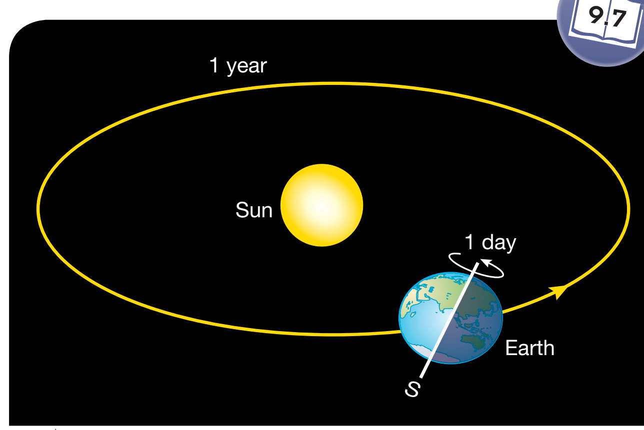

Figure 9.3.3 A year is the time it takes for Earth to completely revolve or orbit around the Sun. A day is the time it takes to rotate completely on its own axis.

Leap years

Every fourth year is not always a leap year. Use the following key to calculate whether a year is a leap year or not.

Can the year divided by 400?	If yes, then go to 2.
If not, can the year be divided by 100?	If yes, then go to 1.
If not, can the year be divided by 4?	If yes, then go to 2.
1	It's a normal year.
2	It's a leap year.

WORKED EXAMPLE
Identifying leap years

Problem

Is 2012 a leap year?

Solution

2012 ÷ 400 = 5.03 (cannot be divided by 400)

2012 ÷ 100 = 20.12 (cannot be divided by 100)

2012 ÷ 4 = 503

This is a whole number and so 2012 is a leap year.

Climate

The regions around the equator always point towards the Sun, and the sunlight that falls on them is bright and its heat is concentrated. This makes it hot all the time with very little variation between the seasons.

The north and south poles are always the coldest part of the planet. As Figure 9.3.4 shows, any sunlight that falls on them is almost parallel to the Earth's surface, spreading it over a large area. In their winters, the poles are pointed so far away from the Sun that it doesn't appear at all through the day. In contrast, there is day-long sunlight in the summer.

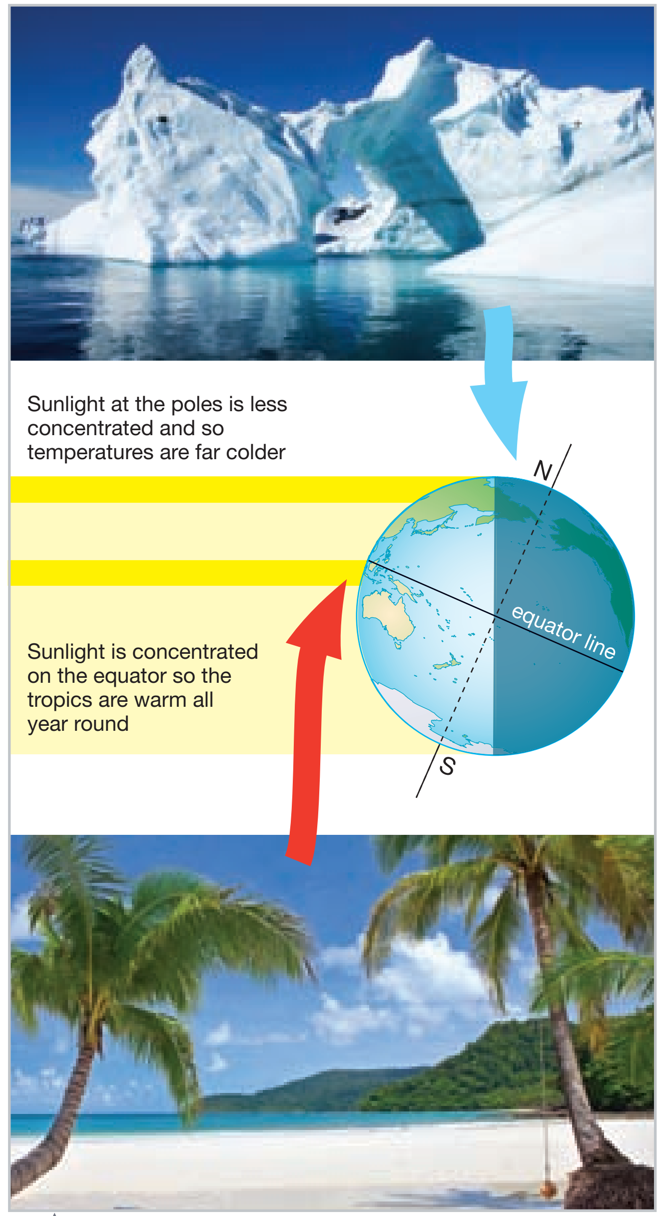

Figure 9.3.4 The Earth is spherical and so sunlight hits its different regions at different angles.

Australia is a huge continent that spreads from near the equator to the Southern Ocean. As a result, the country has a wide range of climates: far north Queensland, the Northern Territory and the Kimberley region of Western Australia are always hot, while Tasmania and southern Victoria are usually much cooler.

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Seasons

As Earth revolves around the Sun, its axis is not 'vertical' but is tilted at an angle of 23.5°. This tilt gives us our **seasons**. As Figure 9.3.5 shows, some parts of Earth point towards the Sun, exposing them more so the sunlight falling on them is more concentrated. These parts experience summer. Other parts of Earth are pointed away from the Sun. In these regions the sunlight is spread over a larger area. This results in lower temperatures and winter.

Earth exposes different parts of its surface to the Sun as it moves along its orbit. Australia experiences summer from December through to March because this is when the southern hemisphere is pointed towards the Sun. Meanwhile, the northern hemisphere is pointing away from the Sun and is experiencing winter. The situation reverses six months later.

In summer, Earth's tilt causes the Sun to be more vertical in the sky at noon than in winter. This causes:

- more hours of sunlight in summer than in winter
- the position on the horizon where the Sun rises and sets to change slightly each day
- short shadows in summer and long shadows at exactly the same time of day in winter. Architects and builders use this fact to control the amount of sunlight that enters a house. Eaves, verandas and pergolas block the vertical summer sun, keeping the house cool. However, the more angled winter sun can get underneath them and enter the house to keep it warm.

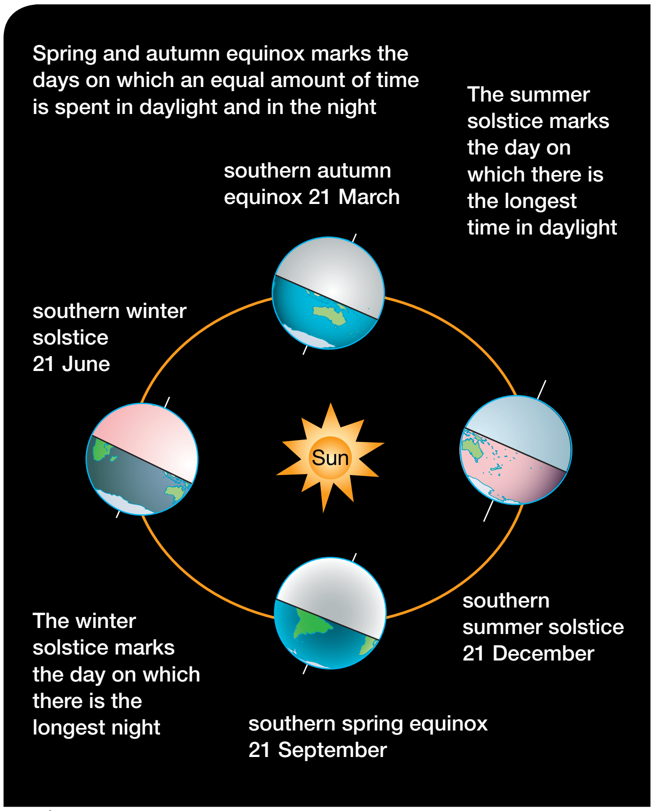


Figure 9.3.5 Earth's tilted axis causes sunlight to be more concentrated on some parts of Earth than others at different times of the year. This causes the seasons.

INQUIRY science 4 fun

Same but different

What happens when sunlight falls on Earth at an angle?

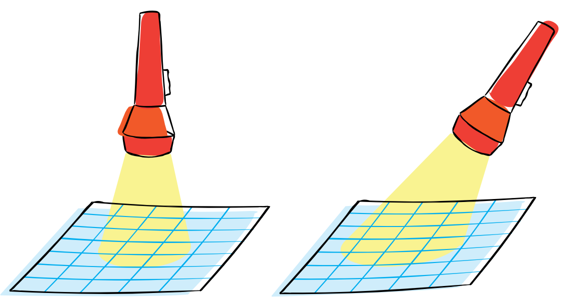
Yes

Collect this ...

- torch
- sheet of paper (preferably graph paper or with a grid)
- 30 cm ruler

Do this ...

1. Place the sheet of paper on the floor or on a desk or table.
2. Hold the torch 30 cm from the paper and shine its light directly onto the paper.
3. Trace around the 'pool'of light.
4. Repeat, but this time direct the torch so that its light falls on the paper at an angle.
5. Once again, trace around the 'pool' of light.



Record this ...

Describe what happened.
Explain why you think this happened.

9.3 Unit review

Remembering

1 **State** which of the following is correct. Earth spins from:

A north to south
B east to west
C south to north
D west to east

2 **Recall** the following terms by matching each with the correct number of days:

A year	365
A 'normal' calendar year	366
A leap year	365.25 or $365\frac{1}{4}$

Understanding

3 **Define** the following terms:

a 1 day
b 1 year
c 1 revolution.

4 **Describe** the problems that would be caused if our calendar year was taken as $365\frac{1}{4}$ and not 365 and 366 days.

5 **Explain** why tropical countries are located around the equator.

6 The equinox marks the time in the year that the length of day and night are exactly the same. **Predict**:

a how many equinoxes occur each year
b the seasons they occur in.

Applying

7 **Use** a sketch to help **define** the following terms:

a Earth's axis
b the equator
c the poles.

8 Some people only have a birthday every four years. **Identify** the date on which they were born.

9 The surface of Earth is moving at incredible speeds due to its spin. **Identify** the part(s) on Earth's surface that are:

a moving the fastest
b just turning on the spot.

10 **Calculate** whether the following years are/were leap years or not.

a 1896
b 1900
c 2225
d 2400.

11 **Use** the labels on the diagram shown in Figure 9.3.6 to **identify** the part(s) of Earth (A, B, C or D) experiencing:

a summer
b winter
c a day in which the Sun is always in the sky
d a day in which the Sun never appears.

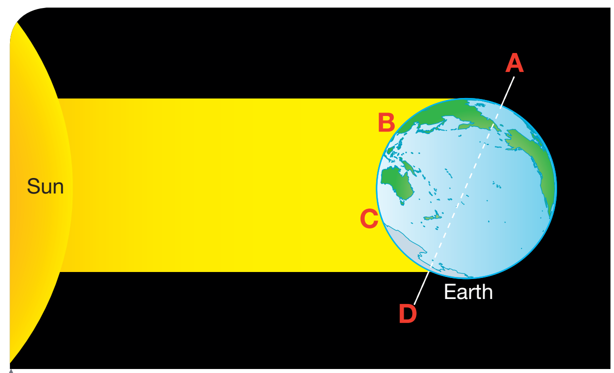


Figure 9.3.6

12 a **Use** Figure 9.3.5 to help to **predict** the season that Australia experienced on the following dates:

A 21 March
B 30 June
C New Year's Day, 1 January
D Anzac Day, 25 April

b **Identify** what season the northern hemisphere would be experiencing on the same dates.

13 We can only celebrate New Year's Eve at 12 midnight because our calendar years are rounded off at either 365 or 366 days. If we used $365\frac{1}{4}$ days for our calendar year, then New Year's celebrations would have to be celebrated at different times each year.

a **Calculate** how many hours there are in one quarter of a day.

b New Year's Eve was at 12 am this year. If the calendar year was $365\frac{1}{4}$ days long, then **calculate** the time it would occur:

i next year
ii the year after that.

c **Calculate** how many years would pass before New Year's Eve returned to 12 am.

d **Use** this example to **explain** why the length of a calendar year is rounded to 365 or 366 days.

Evaluating

14 China has no time zones, despite being a country as large as Australia. **Compare** what a day would be like in its east and in its west.

15 Russia has 11 time zones. **Propose** a reason why. (A map will help.)

16 **Predict** from the list below the set of results most likely obtained in the science4fun activity on page 349.

A Direct torch: 48 squares; angled torch: 64 squares
B Direct torch: 64 squares; angled torch: 48 squares
C Direct torch: 64 squares; angled torch: 64 squares
B Direct torch: 48 squares; angled torch: 48 squares

17 Not every 'turn-of-century' year is a leap year.

a **Calculate** whether the 'turn-of-century' years 1500, 1600, 1700 through to 2500 were/will be leap years or not.
b **Propose** a reason why most 'turn-of-century' years are not leap years.

18 **Propose** what would happen to the seasons if Earth's tilt suddenly changed to:

a 0° (no tilt at all)
b 45° (more than now)
c 10° (less than now).

Creating

19 Science fiction and horror authors have long been fascinated by the idea of endless days and endless nights. Imagine a planet that doesn't spin. On it, forms of life have evolved very differently from those found on Earth. Think of what may live on the dark side and light side of the planet. Just as important, think of the forms of life that couldn't possibly exist. **Create** a short story or a plotline for a blockbuster movie about:

a a creature from one side travelling into the other (light to dark or dark to light)
b a human landing on the planet and exploring both sides.

Inquiring

1 Design a model to show why day and night occur and how the seasons happen. A search of the internet might help you come up with ideas.

2 Not everyone experiences summer, autumn, winter and spring. For example, people in the far north of Australia instead talk about the wet and dry seasons. Research the seasons and calendars used by the Aboriginal and Torres Strait Islander peoples.

3 Search available resources such as textbooks, encyclopaedias and the internet to research:

a the times of sunrise and sunset over a week. Summarise what you find in a table
b the starting and finishing dates for the different seasons in different countries
c what UTC is and how all the world's clocks are based on it
d what the International Date Line is, where it is, and why it's needed
e how long a day and a year is on the other planets of the solar system
f whether other planets in the solar system experience seasons.

4 Find and compare the times for the rotation and orbits of the Earth, Sun and Moon.

5 Research how Al Battani calculated the length of the year in the tenth century.

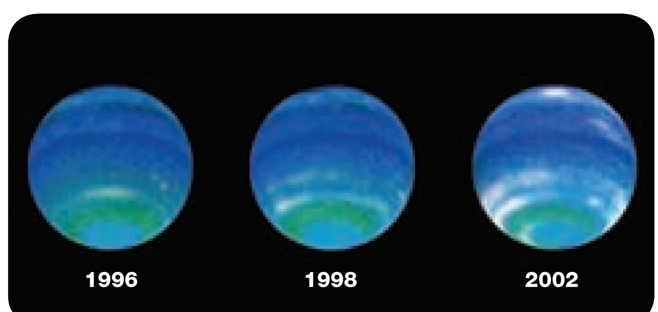


Figure 9.3.7 Neptune's axis tilts at 29° and should show seasons like Earth. However, Neptune's year is the same as 165 Earth years, so each season would be about 40 years long! The increasing white bands in these images are thought to mark the start of spring.

9.3 Practical activities

1 Day and night

Purpose

To model day and night on Earth.

Materials

- balloon
- string or cotton
- felt-tip pen
- access to a globe
- access to a bright light (such as a projector, spotlight, data projector or similar)

Procedure

1. Blow up your balloon and tie it off so that no gas can escape. This is your Earth, and its tied-off end represents the north pole.
2. Tie a length of string or cotton to the north pole.
3. Use the felt-tip pen to draw on the balloon the position of the equator, south pole and International Date Line.
4. Use the globe to check the shape and position of the major continents and copy them onto the balloon. Make sure you include Australia.
5. On Australia, write a large E on the east coast and a large W on the west coast.
6. Hang the balloon by the string in front of the bright light and slowly turn it from the 'west' (W) to 'east' (E) as shown in Figure 9.3.8.

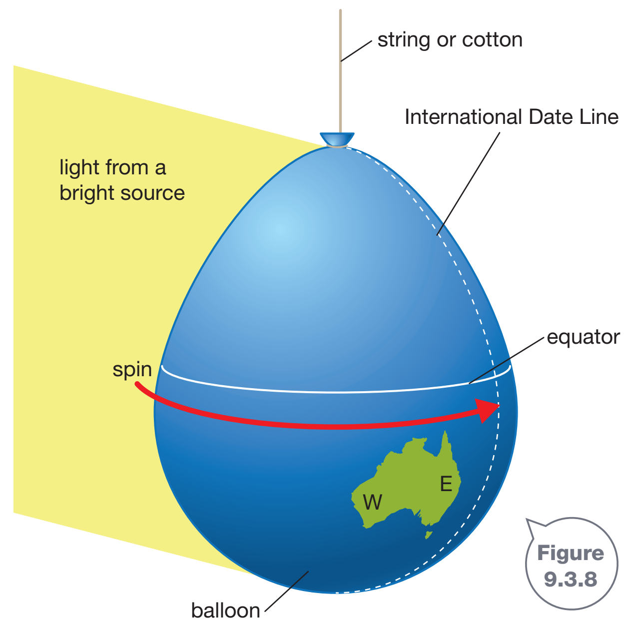


Figure 9.3.8

Discussion

1. The Sun rises in the east and sets in the west, but you rotated your 'Earth' in the opposite direction. **Explain** why there is a difference.
2. **Identify** which coast of Australia:
   a. first came into 'daylight'
   b. was the last to move into 'night'.
3. Perth is on a different time zone from Melbourne, Sydney and Brisbane, being two hours 'behind' them. **Use** your model to **explain** why different time zones are needed in Australia.
4. **Assess** how accurate this model is in showing Earth, its spin, and its day.

2 Angles make a difference

Purpose
To test whether the angle of sunlight affects the surface temperature on Earth.

Materials
- lamp (such as a microscope lamp)
- 2 thermometers
- 2 blocks of wood
- black plastic
- sticky-tape

Procedure
1. Cut out two small identically sized sheets of black plastic and tape them onto wooden blocks so that they make pockets.
2. Secure a thermometer in each pocket, ensuring that it is touching the plastic sheet. Tape the thermometer to the board to secure it.
3. Place the two blocks the same distance from the lamp. Figure 9.3.9 shows the set-up.
   - Block A: Lay one block flat on the desk so that the light from the lamp falls on it at an angle.
   - Block B: Use some books to chock up the other block so that it is at an angle to the desk and the light falls directly on it.
4. Turn on the lamp.

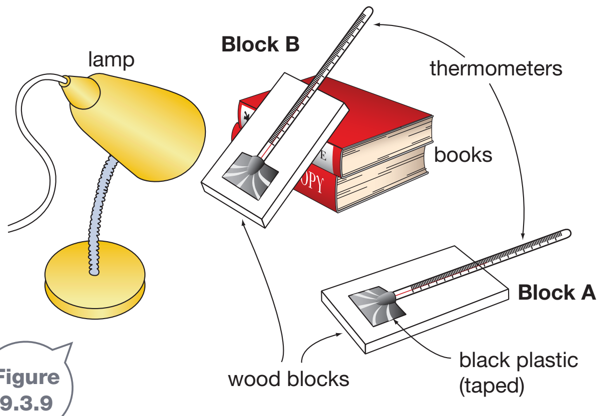


Figure 9.3.9

Results
1. Record the temperature of each thermometer every minute for at least five minutes.
2. Place your results in a table like the one shown below.

Time (min)	Block A	Block B
1		
2		
3		
4		
5		

Discussion
1. **Identify** which block (A or B) showed the greatest increase in temperature.
2. **Identify** which block (A or B) modelled the surface of the Earth in:
   a. far north Queensland
   b. southern Tasmania.
3. **Use** your results to **explain** why:
   a. the tropics are found near the equator
   b. icebergs are only found near the poles.