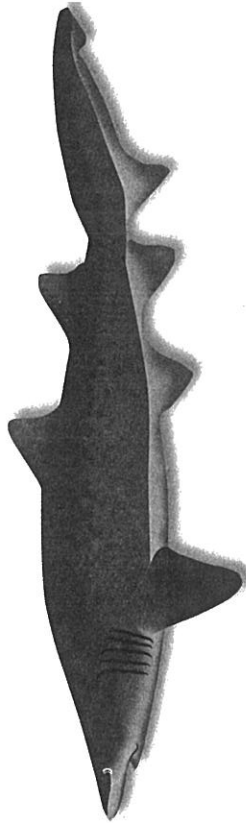


# Grey Nurse Shark

The Grey Nurse Shark, *Carcharias taurus*, became the first protected shark in the world when the NSW Government declared it a protected species in 1984. It is believed that there could be as few as 300 remaining on the east coast, making the Grey Nurse Shark Australia's most endangered species.

The species has a large, rather stout body. It is bronze in colour with a pale underside and brownish spots on its upper body and tail fin. Adult sharks grow to a length of 3.6 metres.



The breeding of Grey Nurse Sharks is quite unusual. They give birth to live young. Mating occurs in autumn. The young are born after a nine month gestation period. Towards the end of the gestation period, the more fully developed embryos eat the less developed embryos as well as the unfertilised eggs within the female shark. As a result only one or two pups are produced from each litter.

## Short response and multiple choice practice

Each article in the magazine is linked to a group of test items in this book. As you work through the test, read the article in the magazine and then complete the related short response and multiple choice tasks. Some test items use information located in the article. However, many items require you to use your own scientific knowledge, understanding and skills.

For multiple choice items, choose the response that you think is best and colour the 'bubble' next to it. If you want to change your response, rub it out thoroughly and then colour in the 'bubble' beside your new response.

For short response items, write your own response in the space provided in the test book. You may need to write a word, complete a diagram or show the order of events.

### Practice items

Read GREY NURSE SHARK on the opposite page.

Use information from the article to complete items A to C.

A. What colour is the Grey Nurse Shark?

- blue  
 grey  
 brown  
 bronze

B. When was the Grey Nurse Shark declared a protected species in NSW?

Write your answer in the box below.

C. Which of the following statements about Grey Nurse Sharks are true? Choose *true* or *false* for each statement. Colour the bubbles in the table to show your responses.

Statement	True	False
Grey Nurse Sharks' young are called 'kittens'.	<input type="radio"/>	<input type="radio"/>
Grey Nurse Sharks lay their eggs in nests of sand.	<input type="radio"/>	<input type="radio"/>
Grey Nurse Sharks produce only one or two young each litter.	<input type="radio"/>	<input type="radio"/>
Grey Nurse Sharks are born after a nine-month gestation period.	<input type="radio"/>	<input type="radio"/>

Use your own knowledge, understanding and skills to complete items D and E.

D. The following are events in the shark's breeding cycle.

Place a number beside each event to show the correct sequence.

birth  
 mating  
 gestation

E. The Grey Nurse Shark is

- a fish  
 a reptile  
 a mammal  
 an amphibian

## Part 1 – Extended response tasks

Complete all three tasks in Part 1. Make your responses as detailed and accurate as you can.

### 1 – Rusting investigation

Observations about the test tubes shown on the next page to complete the results table below.

tube	Treatment	Observation after three days
	Water heated	
	Water heated; oil added	
	Not heated; no oil added	
	Not heated; oil added	

conclusion for this investigation, including a discussion of whether this was a fair test.

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A group of students performed an investigation to study what affects the chemical reaction called rusting. Their hypothesis was that air and water are needed for rusting. They decided to test this using the procedure below.

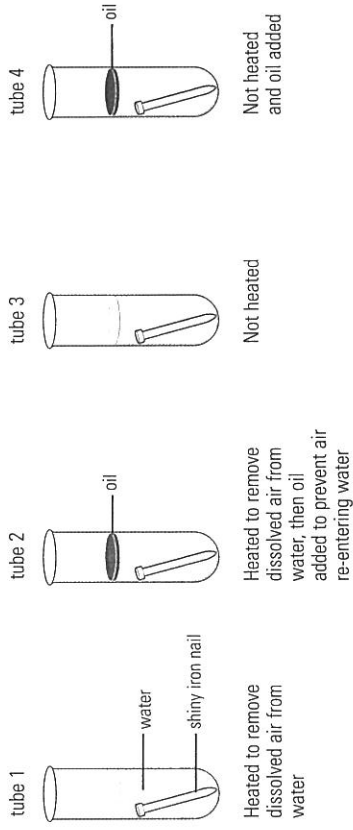
Their teacher advised them that heating water would remove air and that pouring oil onto water would stop air from dissolving back into it.

**Hypothesis:** that air and water are needed for rusting

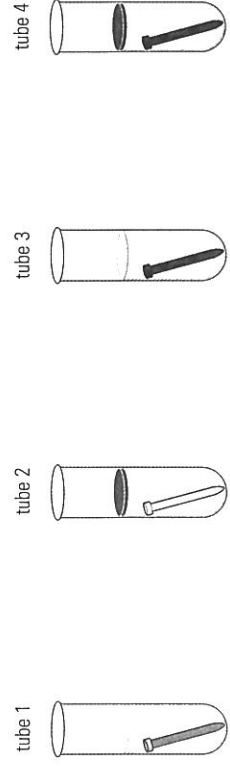
**Procedure:**

1. Place an identical shiny iron nail in each of four test tubes.
2. Add 10 mL of water to each test tube to cover the nail.
3. Heat the water in test tubes 1 and 2 until almost boiling.
4. Pour oil onto the surface of the water in test tubes 2 and 4.
5. Leave all test tubes on the bench for three days.

#### At the beginning of the investigation



#### After three days



## 2 – Hot air ballooning

Hot air balloons are the simplest flying machines. They have been used by passengers since the 1790s. Modern hot air balloons are usually made of nylon. The air inside is heated using a gas burner. The best time for flying is in the cool early morning.

Explain what happens when the air inside the balloon is heated.

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Why does this happen. Use your knowledge and understanding of particle theory to support your response.

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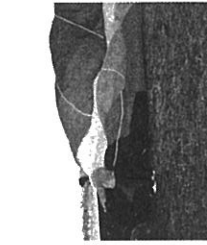
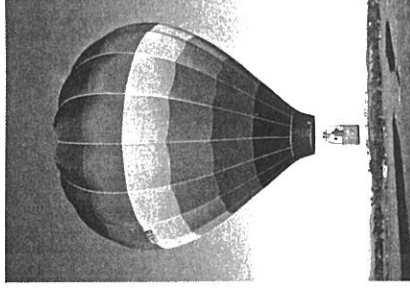
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The crew blow hot air into the balloon



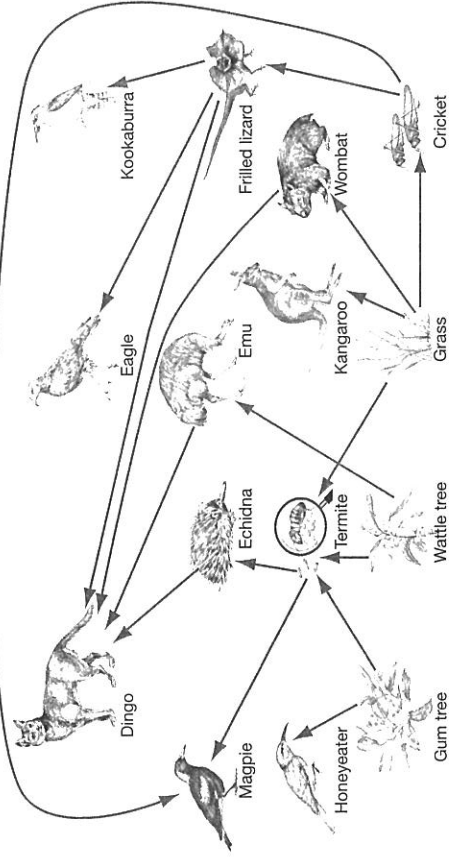
The crew blow hot air into the balloon



Hot air balloons aloft



## Task 3 – A grassland food web



Scientists create models of real-world situations so that they can help explain relationships and make predictions. Food webs are models of the interactions between producers, consumers and decomposers in ecosystems.

The diagram shows a food web in an Australian grassland. Use it to complete the following table.

Organisms that eat termites

Organisms that are eaten by termites

Suppose that all the termites disappeared from the grassland ecosystem.

Predict the impact of the loss of termites on the other organisms in this ecosystem. In your response, consider the limitations or problems in using this model of the ecosystem.

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## 2 – Hot air ballooning

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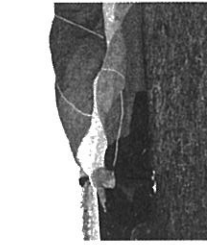
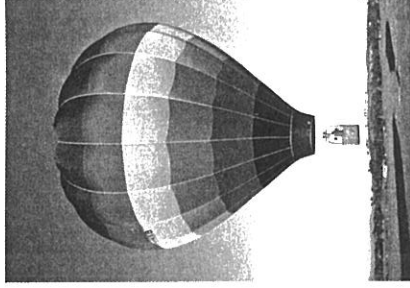
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The crew blow hot air into the balloon



The crew blow hot air into the balloon



Hot air balloons aloft



## Part 2 – Short response and multiple choice tasks

Use the stimulus magazine to complete all the items in Part 2.

Read *The world's most poisonous sting*ers on page 2 of the magazine, then complete items 1 to 4.

Which two Australian states would it always be safe to swim free from these stingers?

- Queensland and New South Wales
- Western Australia and Queensland
- South Australia and New South Wales
- Western Australia and Northern Territory

What is the role of the scientists mentioned in article?

- to kill all stingers in tropical waters
- to find out more about stingers and their stings
- to collect money to treat and prevent symptoms of stinger stings
- to make laws to stop anyone from swimming during stinger season

3. In the photograph, the fully-grown Box Jellyfish is shown as

- life size
- larger than life size
- smaller than life size

4. Box Jellyfish and Irukandji are classified into a group of animals called Cubozoa.

- What is the most likely reason that they are grouped together?
- Both kill humans.
  - Both chase and catch their prey.
  - Both have a bell shape and stinging tentacles.
  - Both are found in tropical waters in Australia.

Read *Star trails in the midnight sky* on page 4 of the magazine, then complete items 9 to 16.

9. What colour is the star Antares?

- white
- yellow
- blue-white
- red-orange

10. How many times brighter is Fomalhaut than Alpha Centauri?

- 2 times
- 10 times
- 20 times
- 200 times

11. Planets leave thicker, brighter trails in photographs than stars.

The photograph that most clearly shows a planet is

- Photograph 1
- Photograph 2
- Photograph 3

12. Scientists who study the planets and stars are called

- astronomers
- biologists
- ecologists
- physicists

13. The stars have left images of curved trails in the photographs because

- the stars orbit Earth
- Earth orbits the Sun
- Earth spins on its axis
- the stars spin on an axis

14. Why is a light-year used as the unit to measure distances between stars?

- Space is always expanding.
- A light-year is a very precise unit.
- Distances between stars are huge.

15. Which of the following is located beyond our solar system?

- Jupiter
- the Sun
- Antares
- the asteroid belt

16. Most of the space between Alpha Centauri and the Sun is

- air
- vacuum
- helium gas
- dust particles

Read *Investigating growth of seeds* on page 3 of the magazine, then complete items 5 to 8.

Which variable in Daniel's investigation did purposely change?

- type of seeds
- amount of water
- amount of growth
- time in microwave oven

Notify one trend shown by Daniel's results. Microwaving seeds for 10 seconds will kill them.

Microwaving seeds for more than 10 seconds will increase their growth rate. Microwaving seeds up to 5 seconds will increase the amount of growth over 10 days.

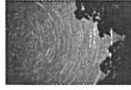
Microwaving seeds up to 5 seconds will decrease the amount of growth over 10 days.

7. To measure average growth, Daniel probably made measurements of the

- width of plant stems
- length of plant stems
- number of plant roots
- number of plant leaves

8. Daniel did not place one group of seeds in the microwave oven because

- he did not have enough time
- he was using the leftover seeds
- he needed to make sure he had enough seeds growing
- he wanted to see if the seeds grow without microwaving



Read *Using the Southern Cross to tell time* on page 5 of the magazine, then complete items 17 to 20.

Why can the Southern Cross be used to tell time?

- a 24 hour period,
- it spins on its axis
- it changes its shape
- it changes its brightness
- it seems to turn around a point

Why is it necessary to make corrections to clock time each month?

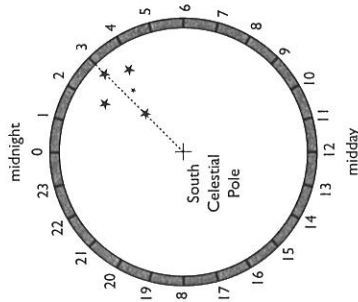
- Earth is spinning on its axis.
- Earth is in a different position around the Sun.
- The Sun is constantly moving about the galaxy.
- The stars are constantly rotating about the South Celestial Pole.

19. How long does it take Earth to travel around the Sun?

- 1 day
- 28 days
- 365 days

20. What is the time shown by the Southern Cross in this diagram if it is 1 March?

- 1 am
- 3 am
- 5 am



Read *In the kitchen* on page 7 of the magazine, then complete items 25 to 32.

25. From the article, which metallic material is the poorest conductor of heat?

Write your answer in the box below.

26. Which was the dependent variable that Alex measured in the activity in the article?

- heat source
- amount of water heated
- type of thermometer used
- time taken to heat the water

27. How could Alex improve the reliability of her results?

- Use new saucepans for the investigation.
- Repeat the investigation with 1 L of water.
- Use a Bunsen burner instead of a stove ring.
- Carry out five trials under the same conditions.

28. What is the chemical symbol for copper?

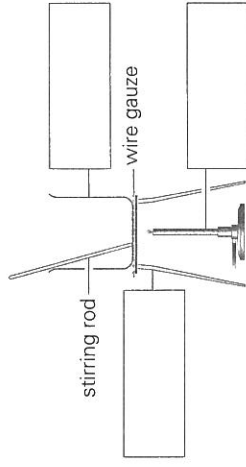
- Co
- Cp
- Cr
- Cu

29. Heat is an example of

- air
- matter
- energy
- pressure

30. At school, Alex investigated the heating of water using the following apparatus. Only some items in the diagram have been labelled.

Write labels in the boxes provided to complete the diagram.



31. What is happening to the particles of water as the water is heated?

- They are getting bigger.
- They are getting smaller.
- They are moving more slowly.
- They are moving more quickly.

32. Alex found that she could not heat the water above 100°C.

The best explanation is that, at 100°C,

- water particles chemically react
- water particles take up less space
- water particles turn into different particles
- water particles absorb enough energy to break free from one another

Read *Going batty* on page 6 of the magazine, then complete items 21 to 24.

Why are bats described as being nocturnal?

- They sleep in the dark.
- They are most active at night.
- They hibernate in winter months.
- They hang upside down by their claws.

Why are bats classified as microorganisms unicellular organisms multicellular organisms

23. Which term correctly describes a Little Red Flying Fox?

- producer
- consumer
- decomposer

24. A colony of 100 000 microbats may eat between 200 and 400 tonnes of insects each year.

Microbats are a natural resource that would be of most benefit to

- miners
- farmers
- scientists
- conservationists

Read **Froth flotation** on page 8 of the magazine, then complete items 33 to 37.



Write the steps for processing zinc in the correct order. Write a number in each box to indicate the correct order.

Ore is crushed.

Air is bubbled through.

Water and oil are added.

Zinc minerals are skimmed off.

The invention of froth flotation was an important new technology because it was invented by an Australian it was invented over 100 years ago it made it easier to find zinc ore in the earth it made it easier to separate zinc minerals from other materials

Iron and many other useful materials are obtained from the ground by mining. From a scientific viewpoint, a disadvantage of mining is that mining uses up natural resources zinc is combined with lead and silver many people are employed in the mining industry a lot of money is earned from the sale of mined resources

Another use of the froth flotation method could be separating salt from sea water separating different colours in inks separating scrap iron from scrap aluminium separating small floating particles from water

Write which statements below are correct? Choose *true* or *false* for each statement.

Statement	true	false
Minerals are made of rocks.	<input type="checkbox"/>	<input type="checkbox"/>
Rocks contain a mixture of chemicals.	<input type="checkbox"/>	<input type="checkbox"/>
Minerals can be elements or compounds.	<input type="checkbox"/>	<input type="checkbox"/>
Zinc ore is a made resource from Earth's crust.	<input type="checkbox"/>	<input type="checkbox"/>

Read **Fog busters** on page 9 of the magazine, then complete items 38 to 44.



38. XeroCoat stops fog forming on glasses because it

- spreads out the water
- forms the water into droplets
- allows more light to pass through
- bounces the light in different directions

39. Light is

- a kind of matter
- a form of energy
- a chemical reaction
- a substance needed by organisms

40. Which process causes fog to form on a mirror?

- melting
- freezing
- condensing
- evaporating

41. XeroCoat is a technology that can improve eye glass lenses by making them

- less visible
- easier to see through
- more difficult to scratch
- more comfortable to wear

42. Silica is best described as

- a rock
- a mixture
- an element
- a compound

43. When a mirror fogs up, the change of state can be shown as

- liquid → gas
- gas → liquid
- liquid → solid
- solid → liquid

44. The development of XeroCoat will benefit society by

- making driving safer
- being a new invention
- finding a new use for sand
- preventing water from forming droplets

Read *Frass-shooting caterpillars* on page 10 of the magazine, then complete items 45 to 50.

Read *Earth's moving magnetic pole* on page 11 of the magazine, then complete items 51 to 54.

Which paragraph provides an outline of the experimental procedure?

- 3
- 4
- 6
- 7

Which of the following statements is an observation?

- 14 out of 17 caterpillars were eaten.
- The smell of real poo attracts the predators.
- Wasps consider caterpillars to be a juicy meal.
- There are three possible reasons for poo shooting.

Food chain from the article is

- leaf → caterpillar → wasp
- wasp → caterpillar → leaf
- caterpillar → wasp → leaf
- wasp → leaf → caterpillar

Which of the following best describes the poo-shooting behaviour of this caterpillar?

- an adaptation
- an innovation
- an investigation
- a biotechnology

49. The hypothesis that frass ejection is used for protection by silver-spotted skipper caterpillars is

- proved by the results in the article
- supported by the results in the article
- disproved by the results in the article
- unsupported by the results in the article

50. In Martha's experiment, which variables did she keep the same and which variables did she change?

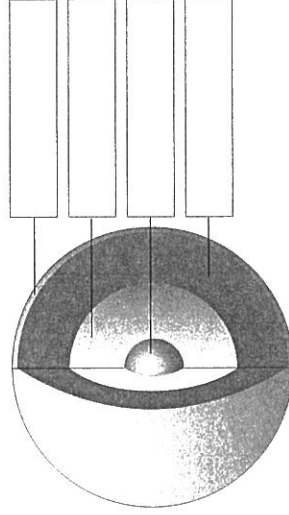
Choose *same* or *changed* for each variable below.

Variable	same	changed
type of leaves	<input type="radio"/>	<input type="radio"/>
size of pellets	<input type="radio"/>	<input type="radio"/>
smell of pellets	<input type="radio"/>	<input type="radio"/>
colour of pellets	<input type="radio"/>	<input type="radio"/>
number of caterpillars	<input type="radio"/>	<input type="radio"/>

51. The location of the north magnetic pole in 1994 was

- 70° N 96° W
- 96° N 70° W
- 79° N 105° W
- 105° N 79° W

52. Label this diagram of the structure of Earth.

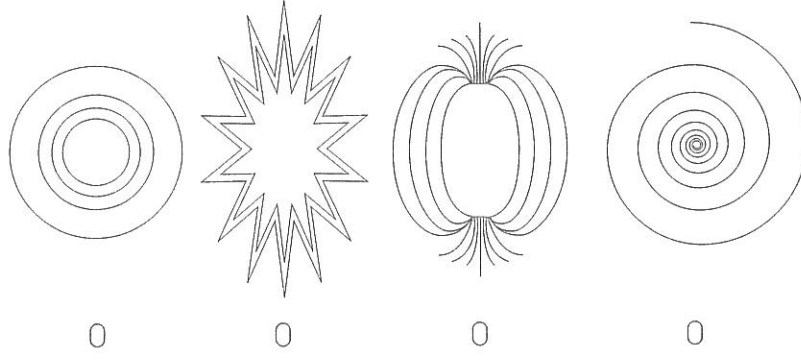


53. Scientists often draw lines around a magnet to show its magnetic field.

This is an example of

- a model
- a theory
- a hypothesis
- an explanation

54. Which of these diagrams best illustrates the magnetic field around Earth?



Read **Meteorites from Mars** on pages 12 and 13 of the magazine, then complete items 55 to 62.

59. Meteorite collisions often leave pure iron fragments. Iron is an example of a
- metallic element
  - metallic compound
  - non-metallic element
  - non-metallic compound
60. What causes a meteorite to heat up as it enters Earth's atmosphere?
- oxygen in the atmosphere
  - gravity pulling on the meteorite
  - gas bubbles inside the meteorite escaping
  - friction between the meteorite and air particles
61. How old is the material that makes up ALH84001?
- 23 years
  - 31 years
  - 13 000 years
  - about 2 billion years
62. Where do most asteroids occur in the solar system?
- between Mars and Earth
  - between Earth and Venus
  - between Mars and Jupiter
  - between Earth and the Moon

Read **Bodies and bugs** on page 14 of the magazine, then complete items 63 to 68.

63. Why do insects need to moult?
- to replace their worn-out skin
  - their outer skin prevents them growing so that entomologists know how old they are
  - to change the colour of their skin as they get older
64. Which unit should be written on the graph axis labelled *Length*?
- m
  - km
  - nm
  - mm
65. What evidence would indicate that a body had been dead for seven days?
- the presence of eggs and larvae
  - the presence of eggs and adult flies
  - the presence of eggs, pupae and adult flies
  - the presence of larvae, pupae and adult flies

66. Using the scale, what is the actual length of the maggot in the photograph?
- 1 mm
  - 4 mm
  - 6 mm
  - 60 mm
67. How much will the maggot in the photograph increase in length before it becomes a pupa?
- 4 mm
  - 10 mm
  - 12 mm
  - 16 mm
68. Which of the following is a scientific skill that is useful for a crime investigator?
- photographing maggots
  - identifying insects such as green flies
  - finding corpses that have been dead for many days

an article illustrates reasons for society to support scientific research that scientific arguments are different from legal ones that improvements in technology impact on science the advantage of using models in science to explain phenomena y are some scientists not convinced that there was life on Mars? They have never believed life existed on Mars. They need more evidence to support the theory. The photographs of fossils in meteorites are fakes. at is a meteorite? pose the best definition. a rounded brick an object that travels in space a rock from space that falls to Earth a type of rock that comes from Mars at evidence is used to support the claim that ALH84001 came from Mars? the mineral content of the meteorite the grey-green colour of the meteorite the gas bubbles found in the meteorite the black glass fusion crust of the meteorite



Read *Cumulonimbus clouds and thunderstorms* on page 15 of the magazine, then complete items 69 to 75.

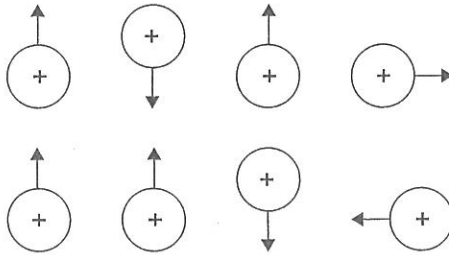
Which piece of equipment is used to measure air temperature?

- stopwatch
- thermometer
- spring balance
- measuring cylinder

What is the gas that makes up most of Earth's atmosphere?

- ozone
- oxygen
- nitrogen
- carbon dioxide

What will usually happen when two positive charges are placed near each other?



72. A weather satellite in space can photograph lightning but cannot record the sound of thunder because

- thunder travels to the ground
- light has more energy than sound
- clouds stop sound from going into space
- there are not enough particles in space to transfer sound

73. Friction causes the static electricity in lightning.

What is friction?

- a contact force
- a magnetic force
- a gravitational force
- an electrostatic force

74. Compared with particles in water vapour, the particles in liquid water have

- less kinetic energy
- more kinetic energy
- less chemical energy
- more chemical energy

75. Which of the following statements about convection currents is true?

- Convection currents only occur in gases.
- Convection currents cause water vapour to condense.
- Convection currents move energy from cold matter to warmer matter.
- Convection currents move energy from warm matter to colder matter.

## ESSA 2007 student survey

We would like to know what you think about this science test and about learning science. This survey is not a test and there are no right or wrong answers. Your responses will be kept confidential so please answer as honestly as you can.

	1	2	3	4
	strongly disagree	disagree	agree	strongly agree
<b>ABOUT THE TEST</b>				
1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The test was about what I learn in science class.				
2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The test was more difficult than I expected.				
3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The test was different from the science tests I do at school.				
4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The test was much longer than any other tests I do at school.				
5	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoyed reading the stimulus magazine.				
6	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think the extended response tasks were the hardest part of the test.				
7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoyed doing the test.				
<b>ABOUT SCIENCE LESSONS</b>				
8	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Literacy is important in learning science.				
9	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is important that all students learn science in Years 7–10.				
10	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science is the hardest subject that I learn.				
11	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In primary school, I enjoyed lessons that were about science.				
12	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In secondary school, I enjoy science lessons.				
<b>ABOUT SCIENCE</b>				
13	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am interested in science.				
14	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science helps me to make decisions about things in my life.				
15	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I know about many careers that are based on science.				
16	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want to study a science subject in Years 11 and 12.				
17	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science impacts on many aspects of my everyday life.				
18	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Protecting the environment for the future is my responsibility.				
19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science provides information about today's important issues.				
20	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science helps me to understand the world around me.				

# The world's most poisonous stingers

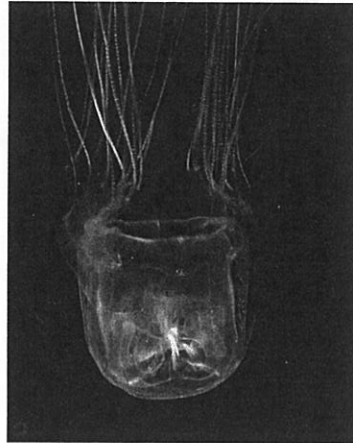
It is stinger season in the tropical waters of northern Australia from August to June each year.

Stingers are almost invisible killers that float just offshore. The two most dangerous examples in Australia are the Box Jellyfish and the Irukandji. They are studied by scientists at the Tropical Australian Stinger Research Unit at James Cook University in Queensland.

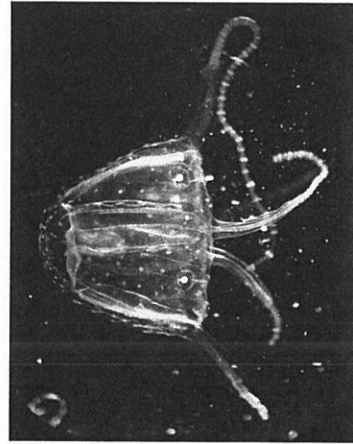


Distribution

Distribution of Box Jellyfish and Irukandji



The **Box Jellyfish** can grow to 38 cm in diameter and it can have tentacles up to 4 m long.



The **Irukandji** can grow to 2.5 cm in diameter and it can have tentacles up to 1 m long.

Treatment for stings by Box Jellyfish and Irukandji should begin immediately. Call 000 for help.

Wash the affected area with household vinegar and seek medical assistance.

# Investigating growth of seeds

Daniel was investigating factors that affect the growth of seeds. He used the Internet and found out that beans grow better if the bean seeds are placed inside a microwave oven that is switched on for 10 seconds.

Daniel designed an investigation to test this idea.

- He selected 24 seeds and divided them into six groups of four seeds.
- He did not put one group of four seeds into the microwave oven. He placed the other groups into a microwave oven for different amounts of time.
- Then he placed all the seeds into a plastic tray on top of wet cotton wool.
- He placed the tray onto the window sill and made observations every day. He made sure that the cotton wool stayed damp.

Daniel's results are shown in the table below.

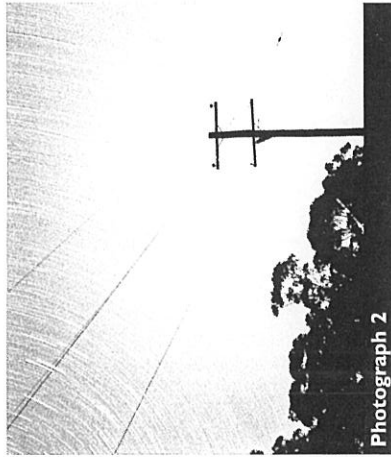
Growth of microwaved seeds

Time in microwave oven (s)	Average growth after 10 days (mm)
0*	10
2	12
5	14
10	9
12	3
15	no growth

\* not placed in microwave oven

# STAR TRAILS

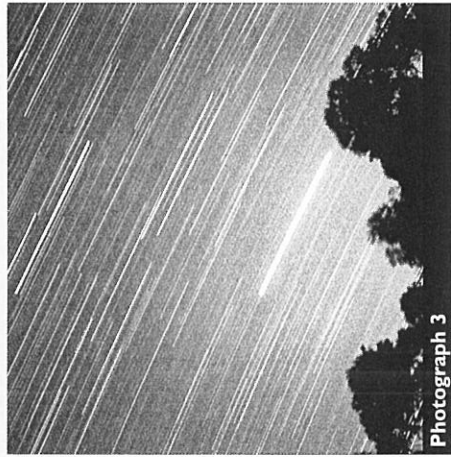
in the midnight sky



Photograph 2



Photograph 1

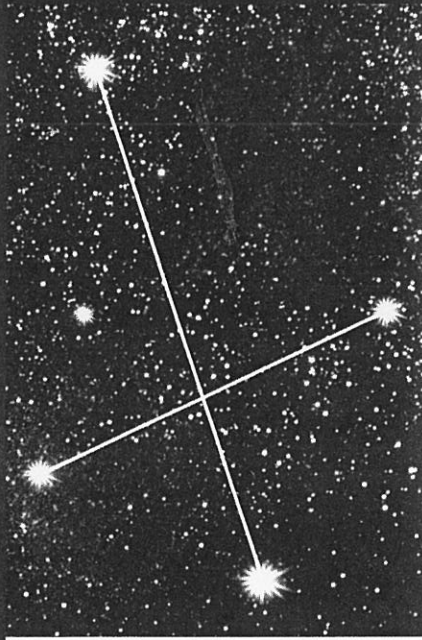


Photograph 3

These photographs were taken near the rural town of Bulahdelah in NSW. They were all taken around midnight in the same week. There had been a bushfire near the township and this caused a red glow in the sky.

Table of some well-known stars

STAR NAME	DISTANCE IN LIGHT-YEARS	COLOUR	BRIGHTNESS
Sun	0	yellow	1
Alpha Centauri	4.4	yellow	2
Rigel	773	blue-white	700000
Antares	604	red-orange	3500
Fomalhaut	25.1	white	20
Canopus	313	yellow-white	0.001



Evelyn Crawford, a Barkinji Elder from Brewarrina, used the Southern Cross for telling the time at night when working in cattle camps as a drover: 'You'd say, "Wake me when the Cross turns over ... Wake me when the tail is this way ... or that way ... or when the bright star is over 'ere ..." And you'd draw it on the ground. You could tell every two hours by it.'



## Time from the Southern Cross

The Southern Cross is not always upright as you see it on the Australian flag. It appears to rotate around the South Celestial Pole. In 24 hours it will lie on one side, be upside down and lie on the other side before returning to an upright position. Because the Southern Cross appears to rotate around the South Celestial Pole like a clock, it is possible to determine the time of night from its position.

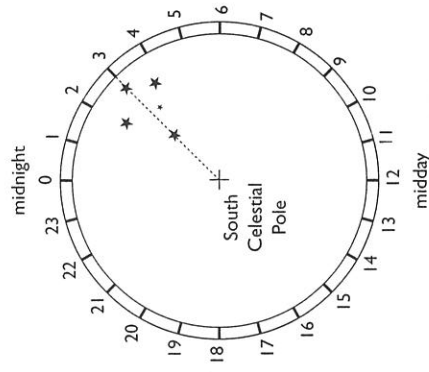
The night of 1 April is the best night of the year to use the Southern Cross to tell the time.

### The Southern Cross

Imagine the Southern Cross to be the hour hand of a 24 hour clock. The South Celestial Pole is the centre of the clock. Thus, at 0/2400 hours (midnight) the Cross is directly above the Pole. At 600 hours (6 am) the Cross is to the right of the Pole. At 1800 hours (6 pm) the Cross is directly to the left of the Pole.

You can use this method any time of the year but there is a correction to make if the date is not 1 April. Firstly read the time off the Southern Cross. Next deduct 2 hours from that time for each month after 1 April.

(Note: These times are for Eastern Standard Time in NSW.)



On 1 April, wherever the Southern Cross points on this clock is the correct time.

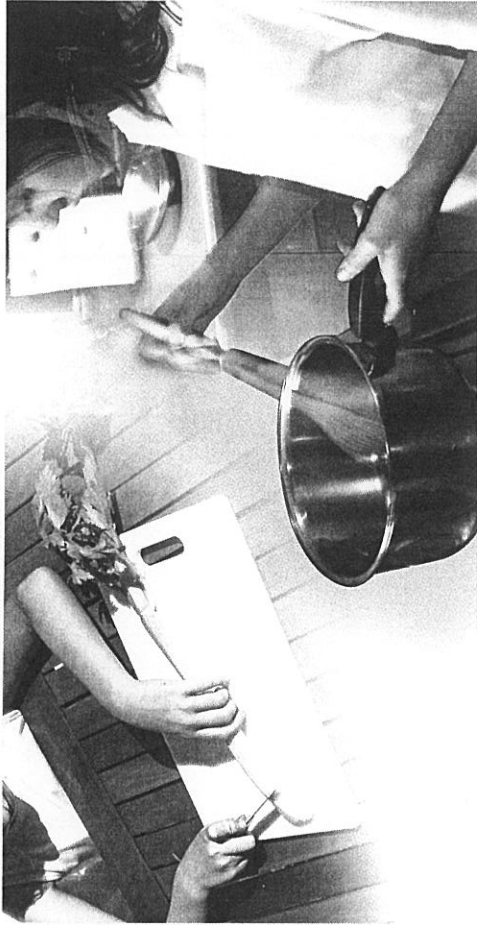


Bats are the only mammals that can fly. As mammals, they have fur, or hair-covered bodies, and the females produce milk to feed their young. Bats are nocturnal, that is, they are most active at night. During the day, they sleep and rest in their roosts. At night they fly into darkness to search for food.

There are over 80 different species of bats in Australia. Bats are divided into two main groups, commonly called the megabats and the microbats.

	Megabats	Microbats
<b>Food source</b>	fruit, blossom, nectar, pollen	insects and other small animals
<b>Senses used to find food</b>	sight, smell	hearing by listening to echoes
<b>Where they roost</b>	branches of trees	hollows in old trees, caves, buildings, burrows
<b>Number of claws on their forelimbs</b>	two	one
<b>Main predators</b>	carpet pythons, goannas, sea eagles, Powerful Owl	cats, spotted pythons, goannas, large frogs, owls
<b>Conservation threats – bats vulnerable to</b>	loss of feeding areas due to forestry activities, clearing of native vegetation, land degradation from agriculture	loss of tree hollows and feeding grounds due to forestry activities, land clearing for agriculture and housing, land degradation
<b>Example</b>	Little Red Flying Fox ( <i>Pteropus scapulatus</i> )	Inland Forest Bat ( <i>Vespardelus baverstocki</i> )

# In the kitchen



Alex's mum said that her copper saucepan was the quickest to heat water.

Alex decided to test this claim using four saucepans made of different materials. She wanted to know which saucepan material will transfer heat to water most quickly.

The saucepans she used were undamaged and had the same size, thickness and shape. She used the same heat source and the same thermometer. For each test she heated 500 mL of water.

Alex's results are shown in the table below.

Saucepan material	Copper	Aluminium	Glass	Stainless steel
Time (in seconds) to heat 500 mL of water from 15°C to 100°C	100	120	200	150

# Froth flotation

Australian history is crowded with great discoveries!

The discovery of a large zinc, lead and silver mineral deposit at Broken Hill in 1883 was a great boost to our country's economy.

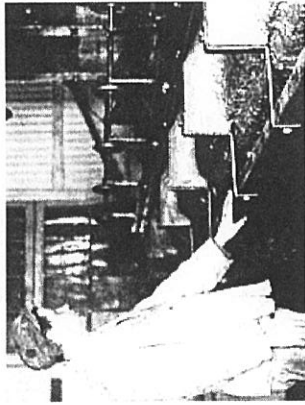
However, until the early 1900s, much of the mined zinc ore was wasted because it could not be efficiently separated from the other minerals and waste rock.

Then workers at Broken Hill, including a manager named Guillaume Delprat and a foreman named James Lyster, solved the problem.

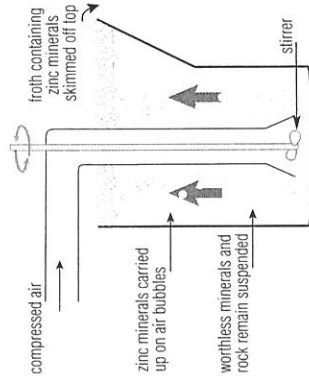
They discovered that, after the mined rock was crushed, they could add water to make a pulp. Then they added some oil and bubbled air through the mixture. The zinc minerals tended to stick to the bubbles, which floated to the surface where they could be skimmed off as froth. The waste rock sank to the bottom.

This process to separate zinc mineral from waste rock is known as froth flotation. It is now used worldwide.

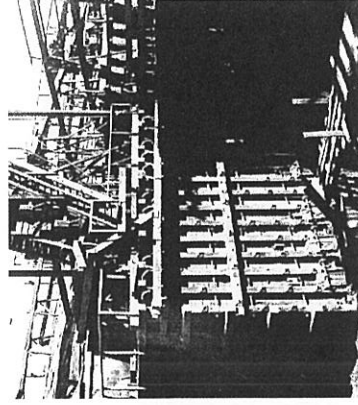
Since the 1950s, froth flotation has also been used in many other industries, including sewage treatment and water purification.



Froth flotation to separate zinc minerals



Froth flotation process



Froth flotation plant

# Fog Busters

If you've worn goggles for skiing or swimming, you've probably been annoyed by the way they can fog up. Or maybe fog on mirrors or windows bothers you.

Fog forms when water vapour in warm moist air forms tiny water droplets on a smooth cool surface. Instead of letting light through, the droplets tend to bounce light in different directions. This makes it hard to see through the glass.



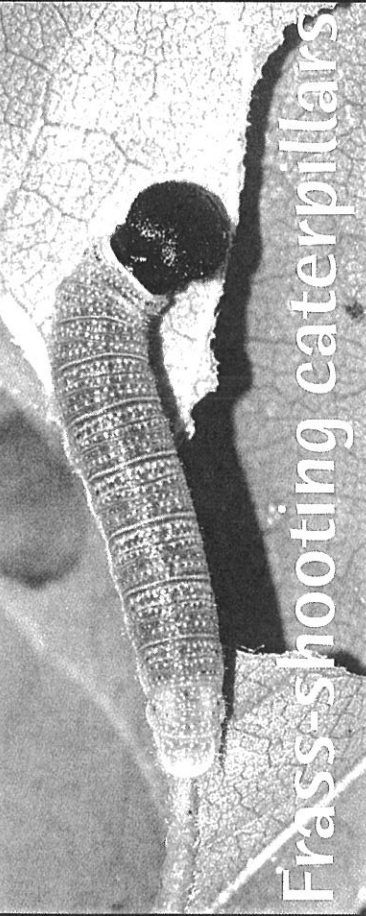
But Australian physicists Michael Harvey and Paul Meredith have invented a new, permanent, multi-purpose coating that will prevent your eye glasses, car windscreen or bathroom mirror from ever fogging up again. The new coating is called XeroCoat.

To make XeroCoat, the physicists use a material called silica (or silicon dioxide). Silica is found in many kinds of rock and it is the main chemical in sand and glass.

Because XeroCoat is silica glass, it makes a transparent, smooth, hard coating. Indeed, XeroCoat is a very thin film of nano-porous silica; this means that the coating is a thin layer of glass full of very tiny invisible holes.

When exposed to warm moist air, the coating attracts water. Instead of beading into rounded droplets, the water gets sucked into the holes all over the surface. This spreads out the water and the resulting water film doesn't bounce light around in the same way that droplets do. You can still see clearly through the glass.

So in two to five years, you might be shopping for improved eye glasses or ski goggles or riding around in a car with a windscreen that resists fogging and reduces glare. It'd be a new window on the world, thanks to materials research!

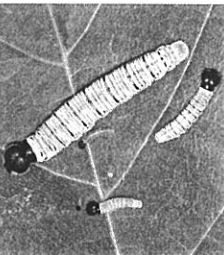


# Frass-shooting caterpillars

Martha Weiss, from Georgetown University (USA), has been investigating the unusual ability of some caterpillars to launch their poo into the air at high speed.

Caterpillars are the larvae of butterflies and moths. They are often found eating leaves in trees. Martha has found 17 families of moths and caterpillars that practise 'frass ejection', or poo-shooting. Martha studied one caterpillar in particular, the caterpillar of the silver-spotted skipper.

A close examination revealed how the caterpillars fire their poo. The caterpillar has a comb located above its anus that acts like the latch on a mouse trap. First the caterpillar excretes a poo pellet. An increase in blood pressure around the anus triggers the 'latch', launching the poo pellet a distance of up to 1.53 metres and at a speed of up to 1.3 metres per second.



Martha investigated three possible reasons for frass ejection: hygiene, lack of space and protection. The results of her study suggest that protection seems to be the answer.

Some insects, such as wasps, consider caterpillars to be a juicy meal and hunt them by the smell of their poo. By firing their poo a good distance away from their shelter, caterpillars protect themselves from being eaten.

To test her theory about frass ejection being related to protection, Martha placed caterpillar poo on leaves that had caterpillars on them. She found that 14 out of 17 caterpillars were eaten. She also placed glass pellets that resembled caterpillar poo on another set of leaves that had caterpillars on them. On these leaves, only 3 of the 17 caterpillars were eaten.

So, it seems that the smell of the real poo is what is attracting the predators.



1 Images of Martha Weiss, from Georgetown University (USA), has been investigating the unusual ability of some caterpillars to launch their poo into the air at high speed. 2 Caterpillars are the larvae of butterflies and moths. They are often found eating leaves in trees. Martha has found 17 families of moths and caterpillars that practise 'frass ejection', or poo-shooting. Martha studied one caterpillar in particular, the caterpillar of the silver-spotted skipper. 3 A close examination revealed how the caterpillars fire their poo. The caterpillar has a comb located above its anus that acts like the latch on a mouse trap. First the caterpillar excretes a poo pellet. An increase in blood pressure around the anus triggers the 'latch', launching the poo pellet a distance of up to 1.53 metres and at a speed of up to 1.3 metres per second. 4 Martha investigated three possible reasons for frass ejection: hygiene, lack of space and protection. The results of her study suggest that protection seems to be the answer. 5 Some insects, such as wasps, consider caterpillars to be a juicy meal and hunt them by the smell of their poo. By firing their poo a good distance away from their shelter, caterpillars protect themselves from being eaten. 6 To test her theory about frass ejection being related to protection, Martha placed caterpillar poo on leaves that had caterpillars on them. She found that 14 out of 17 caterpillars were eaten. She also placed glass pellets that resembled caterpillar poo on another set of leaves that had caterpillars on them. On these leaves, only 3 of the 17 caterpillars were eaten. 7 So, it seems that the smell of the real poo is what is attracting the predators.

Text: adapted from an article in *The Helix*, a magazine of CSIRO's Double Helix Science Club ([www.csiro.au/helix](http://www.csiro.au/helix)). Large caterpillar image © [www.butterflynature.com](http://www.butterflynature.com) (Ludy Burris). Images of Martha Weiss, small caterpillar and wasp © <http://bioresources.gov.au> (Ludy Burris).

# Earth's moving magnetic pole

Our planet's magnetic field is in a constant state of change, say researchers who are beginning to understand how Earth's magnetic field behaves and why.

Every few years, scientist Larry Newitt of the Geological Survey of Canada goes hunting. He grabs his gloves, parka, a fancy compass and flies over the Canadian arctic.

He is searching for Earth's north magnetic pole. At the moment, it's located in northern Canada.

Scientists have long known that the magnetic pole moves. In 1831, James Ross located the pole for the first time (at 70°N 96°W). No-one returned until the next century. In 1904, Roald Amundsen found the pole again and discovered that it had moved at least 50 km.

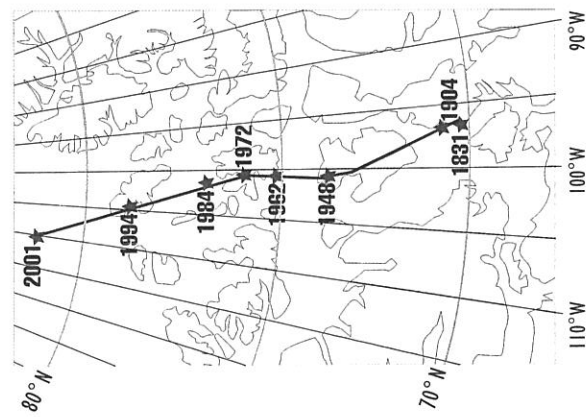
During the 20th century, the pole kept moving north at an average speed of 10 km per year. Newitt claims that over recent years the pole's movement has accelerated to 40 km per year. At this rate, it will exit North America and reach Siberia in a few decades.

## Earth's structure and the magnetic field

To understand what's happening, we have to take a trip to the centre of Earth where the magnetic field is produced.

At the heart of our planet lies a solid iron ball, about as hot as the surface of the Sun. Researchers call this the inner core. The inner core is 70% as wide as the Moon. It spins at its own rate, faster than the earth above it. It is surrounded by a very deep layer of liquid iron known as the outer core.

Earth's magnetic field comes from the liquid outer core, which is an electrically conducting fluid in constant motion. The liquid outer core has huge whirlpool currents powered by Earth's rotation. It is these complex motions that generate our planet's magnetism.



The movement of Earth's north magnetic pole across the Canadian arctic, 1831–2001

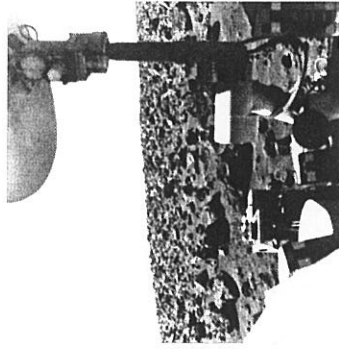


Roald Amundsen

# Meteorites

About 24 000 meteorites have been discovered on Earth. Surprisingly, 34 have been identified as originating from the planet Mars. One of these is called ALH84001.

ALH84001 was found in 1984 in Antarctica by a meteorite-hunting expedition from the USA. ALH84001 weighed about 1.93 kilograms and was shaped like a rounded brick. It was partly covered with black glass. The glass, called fusion crust, forms on all meteorites as they fall through Earth's atmosphere. When cracked open, ALH84001 was found to be made of tiny grey-green crystals. Scientists believe that ALH84001 fell to Earth 13 000 years ago.



Viking 1 on Mars

## How do scientists know that some meteorites come from Mars?

Scientists study the composition of gases found in bubbles within meteorites. Using a spectroscope, scientists discovered that the gases in some meteorites are the same as the gases in the Martian atmosphere, as analysed by Viking 1 spacecraft in 1976. Meteorites that contain bubbles of Martian air come from Mars.



Scientists collect meteorites in Antarctica



The meteorite called ALH84001

# from Mars

## How did these meteorites come to Earth?

Scientists think these meteorites were formed in a collision between an asteroid and Mars. Apart from making a huge crater, rocks were thrown up at great speed. The rocks travelled so fast that they escaped the gravitational force of Mars and travelled into space. Eventually, these rocks were captured by Earth's gravity and fell as meteorites.



This impact crater on Mars is 10 km across

## Life on Mars?

According to some scientists, examination of ALH84001 using an electron microscope reveals fossil evidence of tiny bacteria – ones much smaller than those on Earth. These scientists suggest that tiny bacteria existed on Mars two billion years ago.

However, other scientists are not convinced.



Is this a fossilised Martian microorganism?



Are these worm-like structures fossilised Martian bacteria?

# Bodies and bugs

When crime investigators need to know how long a body has been dead, they can look at the bugs that have begun to set up home in the corpse. By far the most important bugs for this are insects, especially metallic green flies.

Adult flies can arrive within a few minutes of death. They lay their eggs on the corpse, often on wounds and bruises, to provide a source of food for their young. Specialist forensic entomologists can identify the flies and use knowledge of their life cycle to accurately estimate the time of death of the body.

The white eggs, which are sausage-shaped and about 2 millimetres in length, are usually laid in clumps. When the eggs hatch, the young are called larvae. Green fly larvae, or maggots, are white and cone-shaped.

The maggots use a pair of hooks in their mouths to attach themselves to their food. They must shed their skin to grow. This is called moulting and they do this three times while they are maggots.

The third time a larva moults, its skin contracts and forms a hard capsule or case. The case covers the newly-moulted insect inside. The insect is now called a pupa. A few days later, the pupa case cracks open and the adult fly climbs out.

An adult green fly is about 16 millimetres long. It doesn't fly much for a day or two while its body hardens. Then adult flies mate. They might travel for kilometres to find another site to lay their eggs.



Scale:  
1 mm

The photograph shows a maggot under a microscope.

## Green fly life cycle and growth at 27°C

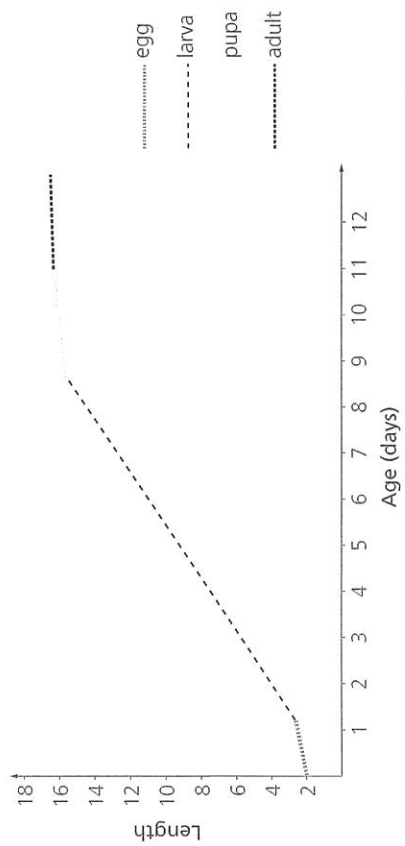


Image of maggot from iStock.

# Cumulonimbus clouds and thunderstorms

In summer after a very hot day, fierce thunderstorms often occur in the late afternoon.

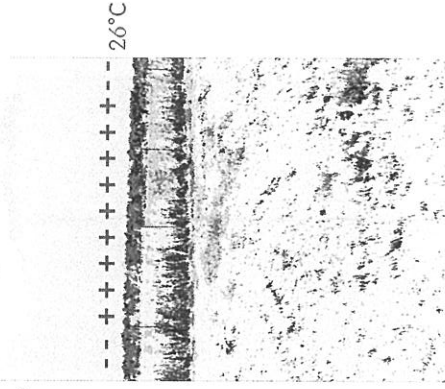
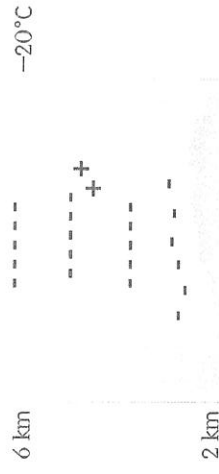
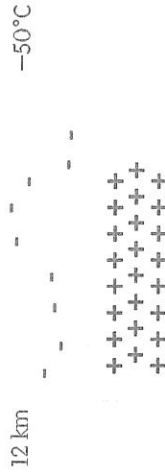
During the day, warm moist air near the ground is heated. The air above remains colder. Under these conditions, strong convection currents force the air at ground level to rise. As water vapour rises, it condenses into water droplets. Heat is released during condensation, which increases convection. This results in a towering cumulonimbus cloud. Such clouds can contain millions of tonnes of water and can grow to a height of 15 km in 30 minutes.

However, the cause of lightning in a thunderstorm is still not completely understood. Scientists believe that water droplets, ice crystals and hailstones inside a cumulonimbus cloud collide violently because of strong air currents. Friction then causes static electricity.

Positive charges build up at the top of a cloud and negative ones build up at the bottom. The ground underneath is positively charged. The difference between charges increases until lightning sparks across the gap.

The lightning travels at 40 000 km per second. It can generate 100 million volts of electricity. The air in the lightning path is heated to around 30 000°C. This temperature is so hot that air expands violently, like popcorn, and produces sound waves.

The amount of energy stored by a cumulonimbus cloud is so huge that it is of the same scale as a small atomic bomb.



The electrical nature of a cumulonimbus cloud