ESSA Essential Secondary Science Assessment

5-449051-6

2009

Essential Secondary Science Assessment (ESSA)

Print your name here _____
(First name) (Last name)

First name
WRITE IN CAPITAL LETTERS

Last name
WRITE IN CAPITAL LETTERS

Print the name of your school here

WRITE IN CAPITAL LETTERS

School code Region code

1. Are you a boy or a girl?
   - ○ boy
   - ○ girl

2. How old are you today?
   - ○ 13 or younger
   - ○ 14
   - ○ 15 or older

3. Are you of Aboriginal or Torres Strait Islander origin?
   If of both Aboriginal and Torres Strait Islander origin, mark both 'yes' bubbles.
   - ○ no
   - ○ yes, Aboriginal
   - ○ yes, Torres Strait Islander

4. Do you speak a language other than English at home?
   - ○ yes
   - ○ no

5. Does your mother or father or caregiver speak a language other than English at home?
   - ○ yes
   - ○ no

   If you answered 'yes' to questions 4 or 5, then answer question 6.

6. How many years have you been at an Australian school?
   - ○ less than 1 year
   - ○ 1 to 3 years
   - ○ 3 to 7 years
   - ○ more than 7 years

INFORMATION BELOW TO BE COMPLETED BY TEACHERS ONLY

Teachers – please complete this section if this student received special provisions to complete parts of the test.
The student accessed the following special provisions:

○ Large print ○ Braille ○ Assistive technology ○ Oral sign support ○ Adjustable furniture
○ Separate supervision ○ Extra time ○ Scribe ○ Reader
○ Other (specify)

The student is **enrolled** in a Support Class: ○ no ○ yes ○ Sanctioned abandonment

Test practice items (approximately 8 minutes)

Part 1 – Extended response tasks (18 marks)

There are no practice items for Part 1, the extended response tasks. You do not need to refer to any of the articles in the magazine to complete Part 1.

Part 2 – Short response and multiple choice items (75 marks)

Each article in the magazine is linked to a group of test items in this book. As you work through Part 2, 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 you think is best and colour the 'bubble' next to it. If you want to change your response, rub it out thoroughly 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, number or show the order of events.

Practice items

Read ***Sea otters*** on page 2 of this test book or on the back cover of the magazine.

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

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A. Sea otters can keep warm because they

- ○ have thick fur
- ○ eat sea urchins
- ○ have a thick layer of blubber
- ○ can float on a bed of seaweed

B. In which ocean do we find sea otters?

Write your answer in the box below.

C. Which of the following animals are part of the sea otter's diet? Choose *yes* or *no* for each animal.

Animals	Yes	No
clam	○	○
crab	○	○
sea lion	○	○
shrimp	○	○

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

D. The energy to keep a sea otter warm comes from the cellular process called

- ○ digestion
- ○ respiration
- ○ conduction
- ○ combustion

E. The following events have happened in the history of the sea otters.
Place a number beside each event to show the correct order of these events.

- ☐ numbers of sea otters increased
- ☐ numbers decreased due to hunting
- ☐ otters become a protected species

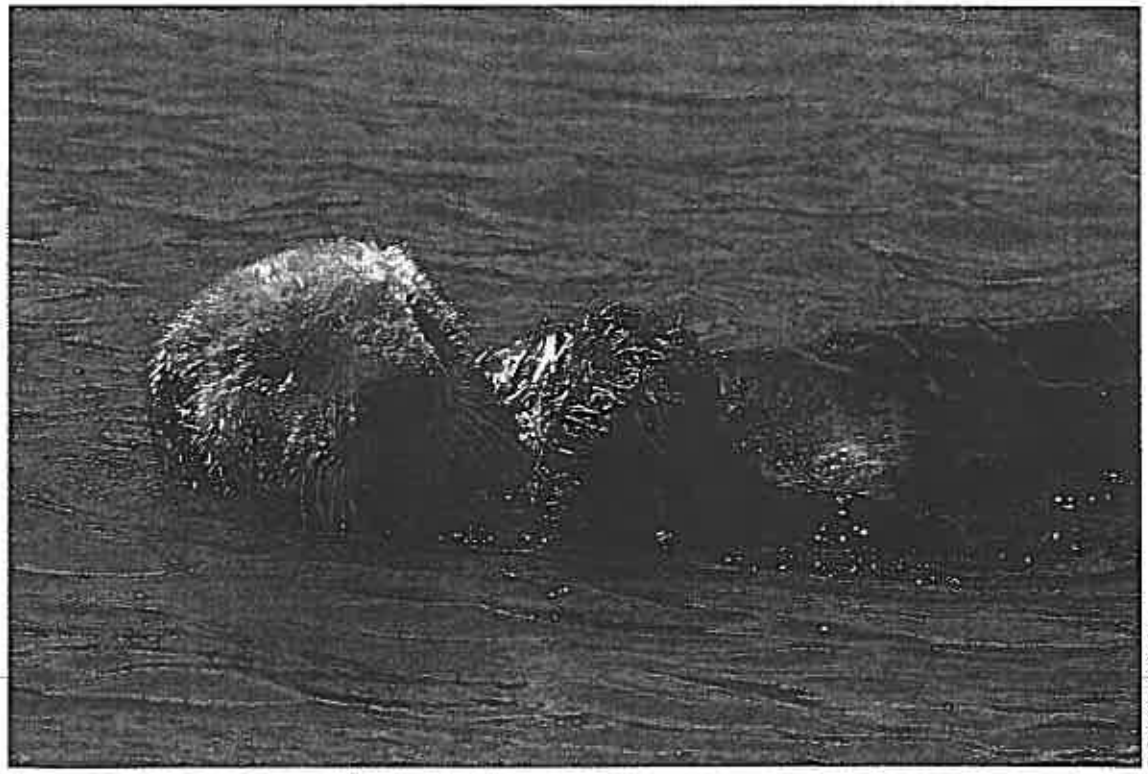
Sea otters

Sea otters live in the shallow coastal waters of the northern Pacific Ocean, along western Alaska.

Sea otters need a lot of energy to keep warm. A sea otter eats 25 percent of its body weight every day. Among the otters' favourite foods are crabs, sea urchins, clams, mussels and shrimp.

Unlike whales and sea lions, sea otters have no layer of blubber to insulate their bodies. Instead, they have only thick fur.

For 150 years, sea otters were hunted heavily for their fur and were nearly extinct by the early twentieth century. However, protection from hunting has allowed a steady recovery of their population.



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Part 1 – Extended response tasks (approximately 20 minutes)

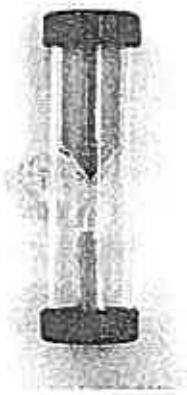
Complete all three tasks in Part 1. Make your responses as detailed and accurate as you can. You do not need the stimulus magazine for Part 1.

Task 1 – In the shower (6 marks)

Lily's house uses electricity to heat water for the shower.

Her mum bought a four-minute timer that sticks to the wall in the shower.

'Here you are, Lily. This timer will tell you when you've had enough time in the shower!'



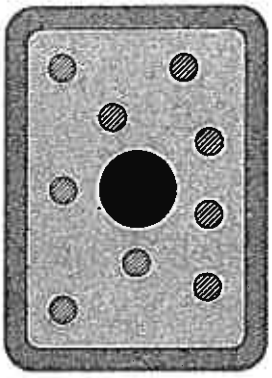
Four-minute shower timer

Which natural resources might be used when someone is having a warm shower?

How can reducing shower time benefit our environment? Explain your answer in as much detail as you can.

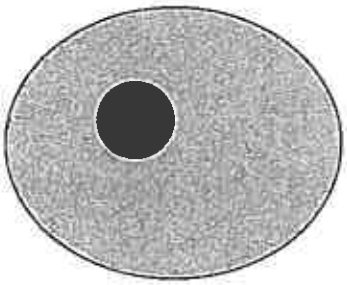
NA	0	1	2	3	4	5	6

Task 2 – Plants and animals (6 marks)



Plant cell

Key
- chloroplast
- nucleus
- cytoplasm



Animal cell

Complete the following sentences. Write one response in each box below.

Plant cells and animal cells are similar because they both have [ ]

Plant cells and animal cells are different because

plant cells have [ ] but animal cells don't.

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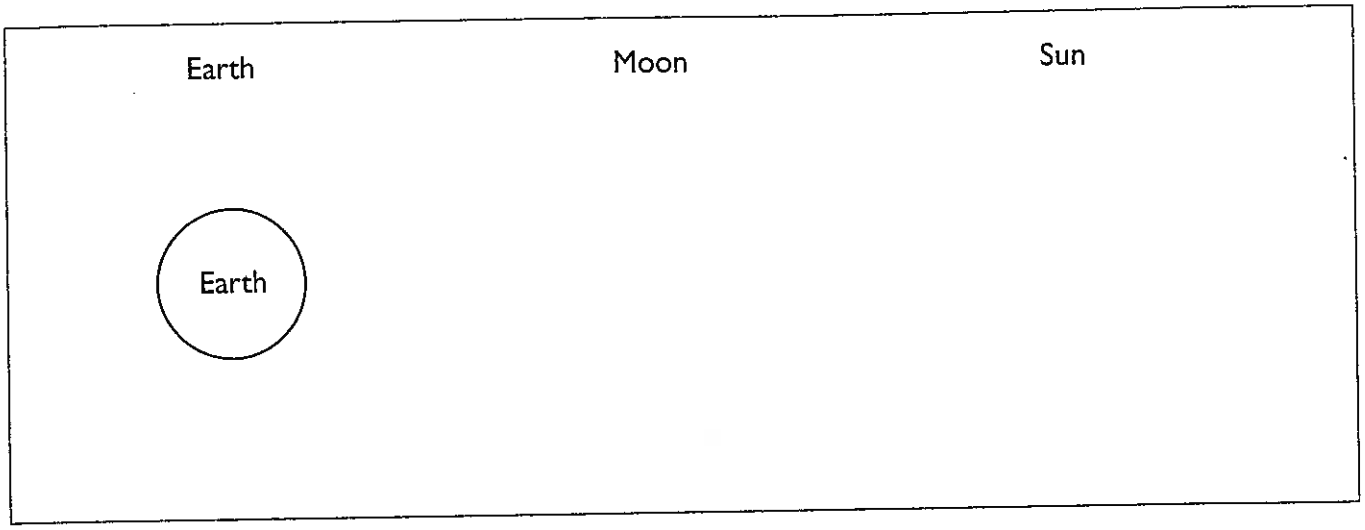
Why do plant cells need different structures from animal cells? Explain as fully as you can.

NA	0	1	2	3	4	5	6

Task 3 – Earth, Moon, Sun (6 marks)

In the box below, draw a labelled diagram to compare the sizes of Earth, our Moon and the Sun. (Earth has been drawn for you.)



Describe the movements of Earth and the Moon through space.

What causes these movements? Explain as fully as you can.

NA 0 1 2 3 4 5 6

Part 2 – Short response and multiple choice tasks (approximately 60 minutes)

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

Read ***Water cleaned by the Sun*** on page 2 of the magazine, then complete items 1 to 6.

1. Liquid water for drinking is classified as part of the

   - ○ atmosphere
   - ○ hydrosphere
   - ○ lithosphere

2. If the Mvura is used in countries without clean water then

   - ○ there will be a water shortage
   - ○ nobody will die because of dirty water
   - ○ bacteria that cause diseases will be wiped out
   - ○ fewer people will die from diseases caused by bacteria

3. If one litre of water weighs one kilogram, how much will a full Mvura weigh?

   - ○ about 150 g
   - ○ about 1.5 kg
   - ○ about 15 kg
   - ○ about 150 kg

4. Bacteria are examples of

   - ○ animals
   - ○ microorganisms
   - ○ plants
   - ○ substances

5. Name the process that bacteria use when they reproduce.

   - ○ cell division
   - ○ decomposition
   - ○ photosynthesis
   - ○ respiration

6. Which scientific understandings have been used in the design of the Mvura?

	Yes	No
The Sun is a source of energy.	○	○
People can carry water on their heads.	○	○
Water is made of hydrogen and oxygen.	○	○
Living things function in a small temperature range.	○	○

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Read ***Keys to the universe*** on page 3 of the magazine, then complete items 7 to 12.

7. Which of the following statements is a current description of our solar system?

- ○ All planets revolve around Earth.
- ○ All planets revolve around the Moon.
- ○ Earth is the centre of the solar system.
- ○ The Sun is the centre of the solar system.

8. Look at the photograph of Earth in the article.

The part of Earth in the photograph **must** be

- ○ facing towards the Sun
- ○ facing towards the Moon
- ○ facing away from the Sun
- ○ facing away from the Moon

9. Look at the photograph of the Moon in the article.

From Earth, the Moon would look like this

- ○ every day
- ○ once a week
- ○ a few days each month
- ○ once or twice each year

10. The telescope is an example of a

- ○ phenomenon
- ○ science
- ○ technology

11. Light can travel to Earth because

- ○ light is a form of energy
- ○ light travels extremely quickly
- ○ light can travel through very cold spaces
- ○ light can travel through spaces that do not contain matter

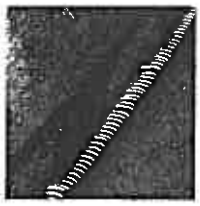
12. The main idea of the article is that

- ○ Galileo was an Italian astronomer
- ○ explanations in science can change
- ○ there will always be unanswered questions about science
- ○ an old telescope clearly shows the Sun, Moon and Earth

Read ***Biomimicry*** on pages 4 and 5 of the magazine, then complete items 13 to 17.

13. Which photograph in the article shows serrations?

O



O

O

O

14. The bullet train moves along its track because energy is changed from

- O heat to kinetic
- O kinetic to heat
- O electrical to kinetic
- O kinetic to electrical

15. The train's designers reduced the impact of the train on society by

- O increasing the train's speed
- O reducing the noise produced
- O making the train look like birds
- O using the design on aircraft and skating equipment

16. Using serrations on trains and aircraft is called a technology because

- O it uses a new idea
- O it is used on machines
- O it uses designs from nature
- O it is used to solve a problem

17. The article's title, 'Biomimicry', is most likely to mean

- O copying living things
- O sounding like an owl
- O making a very fast train
- O using science to solve a problem

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Read ***Separating a mixture*** on page 6 of the magazine, then complete items 18 to 23.

18. What equipment would be used for process A?

- ○ beaker and sieve
- ○ filter paper and filter funnel
- ○ bar magnet wrapped in paper
- ○ tripod stand and Bunsen burner

19. What is in mixture B?

- ○ sand and salt
- ○ sand and iron filings
- ○ sand, salt and pebbles
- ○ sand, salt and iron filings

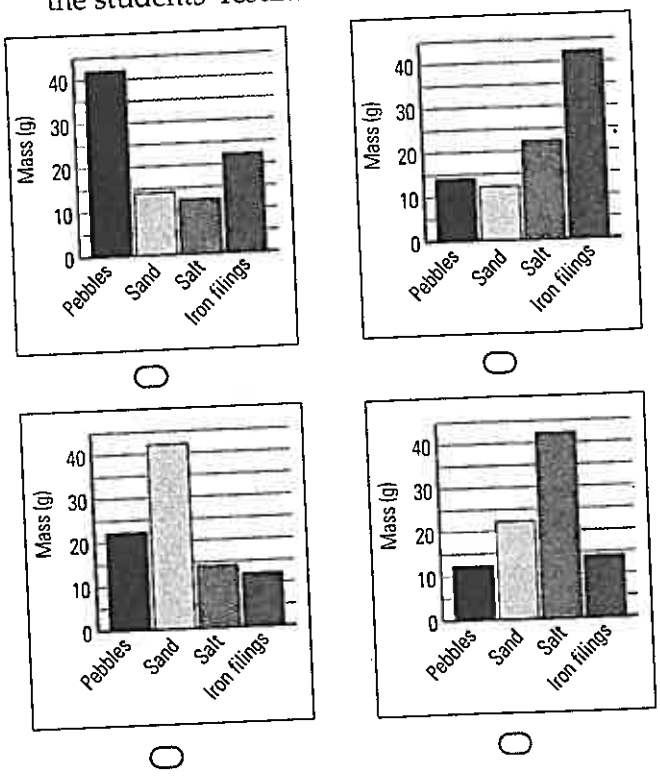
20. What is the name of process C?

- ○ condensation
- ○ evaporation
- ○ filtration
- ○ sedimentation

21. In the table of results in the article, what should be the heading of column D?

- ○ Length (mm)
- ○ Mass (g)
- ○ Temperature (°C)
- ○ Volume (mL)

22. Which column graph best represents the students' results in the table?



23. This table compares the actual mass of substances in the mixture and the masses that students measured.

Substance	Actual mass in mixture	Mass found by students
Pebbles	25	22
Sand	40	42
Salt	20	14
Iron filings	15	12

How could the procedure be improved to get closer to the actual values?

- ○ Use a different flow chart to solve this separation problem.
- ○ Perform the separation four times and take the average of the results.
- ○ Take a smaller sample of the mixture and perform the separation again.

Read ***The native cherry*** on page 7 of the magazine,
then complete items 24 to 29.

24. What is one use for the native cherry's sap?

- ○ valuable tonic
- ○ insect repellent
- ○ snake bite treatment

25. The native cherry is an example of a

- ○ consumer
- ○ decomposer
- ○ producer

26. The main function of the roots of a native cherry is to

- ○ make sugar
- ○ take in sugar
- ○ make oxygen and water
- ○ take in water and minerals

27. Order the parts of a plant below from the simplest (1) to the most complex (4).

- ☐ cells
- ☐ organs
- ☐ system
- ☐ tissues

28. What is a technology made from the **wood** of the native cherry?

- ○ spear thrower
- ○ insect repellent
- ○ sweet juicy fruit
- ○ snake bite treatment

29. If a bullroarer were used on the Moon, it would

- ○ not make sound
- ○ make a different sound
- ○ make the same sound as on Earth

Read ***Smelly grass clippings*** on page 8 of the magazine, then complete items 30 to 36.

30. In the article, what is the heading above the procedure?

- ○ What we did
- ○ What we found out
- ○ Graph of temperature in grass pile over time
- ○ What we thought

31. What was the highest temperature recorded by sensor 1?

Write your answer in the box below.

32. The students made their measurements using a temperature sensor and data logger.

What is one benefit of using these pieces of equipment?

- ○ Students won't get dirty.
- ○ They are examples of scientific technology.
- ○ Measurements can be presented as a graph.
- ○ Students can make continuous measurements.

33. Which statement correctly describes the trend in the graph?

- ○ The temperature of the pile decreases each day.
- ○ The temperature of the pile tends to rise and fall each day.
- ○ The temperature is usually lower in the middle of the pile than on the surface.

34. Which scientific process did the students do in the article?

- ○ devise a model
- ○ write a conclusion
- ○ evaluate an investigation
- ○ collect a set of observations

35. The students thought bacteria might cause the heat in the pile of grass clippings.

What could be used as a control in the investigation to remove the effect of bacteria?

- ○ a similar-sized pile of sawdust
- ○ a similar-sized pile of gum leaves
- ○ a pile of grass clippings twice the size
- ○ a similar-sized pile of sterilised grass clippings

36. What is an impact of the bacteria that break down and decay grass clippings?

- ○ Living things are harmed.
- ○ The environment is damaged.
- ○ Nutrients are returned to the soil.
- ○ The bacteria cause an outbreak of grass diseases.

Read ***Energy to go!*** on page 9 of the magazine,
then complete items 37 to 41.

37. Write **energy**, **force** or **mass** in the box beside the matching definition.

amount of matter ☐

causes changes ☐

pushes and pulls ☐

38. The main energy transformation occurring in the music speakers is

electrical	→	?

- ○ current
- ○ heat
- ○ light
- ○ sound

39. What has science helped to improve at many rock concerts?

Science has helped to improve ...	Yes	No
the words of the songs	○	○
the skills of performers in the band	○	○
the materials used to make the instruments	○	○
the amount of sound heard by the audience	○	○

40. Look at the photograph in the article.

You can make **observations** from the photograph about

- ○ electricity
- ○ heat
- ○ light
- ○ sound

41. When the band is performing, the total amount of energy

- ○ increases
- ○ decreases
- ○ stays the same

Read ***Building sandcastles*** on pages 10 and 11 of the magazine, then complete items 42 to 48.

42. Australian beach sand grains are very rounded because

- ○ they are crystals
- ○ they are tiny pieces of quartz
- ○ they have been rolled over and over by waves
- ○ they have been formed from ancient inland mountains

43. In this article, why is it helpful to compare Australian sand grains with marbles?

- ○ Sand grains are a model for marbles.
- ○ Marbles and sand grains are made of glass.
- ○ It is easy to imagine how difficult it would be to build with marbles.
- ○ Marbles are larger than sand grains so can be handled more easily.

44. What process moves sediments from the mountains to the sea after the rocks have been broken down?

- ○ erosion
- ○ rivers
- ○ rock cycle
- ○ weathering

45. Quartz is an example of

- ○ sand
- ○ a rock
- ○ a mineral
- ○ a fossil fuel

46. Igneous rocks form when

- ○ molten rock cools
- ○ rock is heated or compressed
- ○ pieces of rock are compressed and cemented together
- ○ water evaporates from mixtures of sand and broken rock

47. A scientist who studies igneous rocks and landforms would be a

- ○ chemist
- ○ biologist
- ○ physicist
- ○ geologist

48. Which elements are present in SiO_2?

- ○ silicon dioxide
- ○ silver and dioxide
- ○ silicon and oxygen
- ○ sulfur, iodine and oxygen

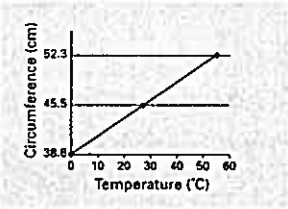
Read ***Cassandra's investigation*** on page 12 of the magazine, then complete items 49 to 55.

49. Which of Cassandra's diagrams shows the balloon that was at room temperature?

- ○ Balloon A
- ○ Balloon B
- ○ Balloon C

50. Which is the most accurate graph from Cassandra's investigation?

○



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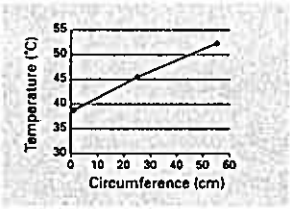

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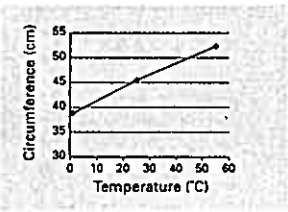

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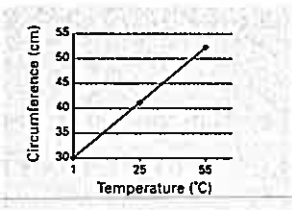


51. Cassandra's conclusion should

- ○ be a table containing her results
- ○ explain why her balloon leaked last winter
- ○ state whether her hypothesis was supported
- ○ summarise how she conducted her investigation

52. How could Cassandra improve the reliability of her results?

- ○ Use a more accurate thermometer.
- ○ Use different types of balloons.
- ○ Control the volume of water the balloons are spun in.
- ○ Take the measurements five times under the same conditions.

53. Compare Balloon A and Balloon C.

Which statements are correct?

	True	False
Balloon A has a larger volume.	○	○
Balloon A contains more particles.	○	○
The particles in Balloon A are larger.	○	○
The particles in Balloon A are further apart.	○	○

54. Compare the helium particles in the balloon at 1°C and the balloon at 55°C.

When the balloon is hotter, the particles

- ○ have no potential energy
- ○ have less total kinetic energy
- ○ have more total kinetic energy
- ○ have maximum potential energy

55. Why does a helium-filled balloon rise in the air?

- ○ Helium is less dense than air.
- ○ Helium has less mass than air.
- ○ Helium has less gravity than air.
- ○ Helium has less volume than air.

Read ***Nitrogen*** on page 13 of the magazine,
then complete items 56 to 61.

56. Nitrogen gas condenses at –196°C.

The '–' sign means that the measurement

- ○ is below 0
- ○ equals 196
- ○ is not accurate

57. °C is an example of a

- ○ chemical symbol
- ○ measuring device
- ○ quantity
- ○ unit

58. Vacuum flasks are used for storing nitrogen at temperatures at or below –196°C.

Most of the nitrogen stored in a vacuum flask will be in the form of a

- ○ gas
- ○ liquid
- ○ solid

59. What is the chemical symbol for nitrogen?

- ○ N
- ○ Na
- ○ Ne
- ○ Ni

60. Nitrogen is a

- ○ metallic element
- ○ metallic compound
- ○ non-metallic element
- ○ non-metallic compound

61. When the flask is opened and the temperature rises, the nitrogen changes from

- ○ gas to liquid
- ○ liquid to gas
- ○ solid to liquid
- ○ liquid to solid

Read ***Frog glue in surgery*** on page 14 of the magazine, then complete items 62 to 67.

62. Why does the frog make sticky liquid?

- ○ to let the frog lose its skin
- ○ to keep the frog's skin moist
- ○ to provide some food for ants
- ○ to protect the frog when attacked

63. A herpetologist is a scientist who

- ○ studies the environment
- ○ studies amphibians and reptiles
- ○ studies the chemicals that make glues

64. Which of the following are adaptations of the Holy Cross Frog?

Choose *yes* or *no* for each statement.

Is it an adaptation?	Yes	No
It lives underground.	○	○
It is an Australian frog.	○	○
It makes a sticky liquid on its skin.	○	○
It has to survive attacks by predators.	○	○

65. Frog glue might be particularly useful for joining bones and muscles.

Bones and muscles are parts of a human's

- ○ circulatory system
- ○ digestive system
- ○ nervous system
- ○ skeletal system

66. Why would scientists test the frog glue on sheep?

- ○ Human bones were too difficult to obtain.
- ○ To test if the glue was poisonous to humans
- ○ Hospitals would not let frogs into an operating theatre.
- ○ To see how the glue would cope when the sheep walked around

67. Order the steps in the scientific discovery of frog glue.

Write a number beside each step to show the correct order.

- ☐ Investigate properties of the glue.
- ☐ Develop a synthetic version of the glue.
- ☐ Observe the sticky secretion of the frog.
- ☐ Develop ideas for using the glue in surgery.

Read ***Galileo and ideas about friction*** on page 15 of the magazine, then complete items 68 to 75.

68. '5 kg' stands for

- ○ 5 grams
- ○ 5 joules
- ○ 5 kilograms
- ○ 5 kilojoules

69. The diagrams in the article model the student's computer simulation. They help to explain friction.

What is an advantage of using this kind of model?

- ○ The model can be built from wood.
- ○ Diagrams take less time than writing.
- ○ The diagrams are pictures that represent the idea.
- ○ The information cannot be communicated in words.

70. Which hypothesis is being tested in this investigation?

- ○ Friction increases the push required to keep a block of wood moving.
- ○ Friction increases the distance a block of wood will move before stopping.
- ○ Friction increases the speed at which a block of wood will move when it is pushed.

71. What is the independent variable that was changed in the student's investigation?

- ○ type of surface
- ○ mass of the box
- ○ speed of the box
- ○ strength of the push

72. In this scientific investigation, frictional force is largest when there is

- ○ no surface
- ○ a rough surface
- ○ a smooth surface
- ○ a smooth surface covered in oil

73. Which statement is correct?

When friction is present,

- ○ objects will move faster
- ○ objects will move slower
- ○ heavier objects can be moved
- ○ less effort is needed to move objects

74. In which of the following situations would a 5 kg block experience no friction?

- ○ falling through water
- ○ falling through the air
- ○ falling through a cloud
- ○ falling through a vacuum

75. An example of using friction in everyday life is

- ○ a ball falling when you drop it
- ○ weighing yourself on bathroom scales
- ○ wearing spiked shoes to play some sports
- ○ a balloon sticking to your hand when you rub the balloon with wool

Water cleaned by the Sun

Over one billion people around the world do not have access to clean healthy water and this leads to many deaths every year.

To help overcome the problem, Julie Frost from the University of New South Wales has designed a water purifier called 'Mvura'.

Mvura

'Mvura' means 'water' in the language of Zimbabwe

Mvura is made from:

- a plastic bag that holds about 15 litres of water
- a hard foam case around the plastic bag to make it easy to carry.

To clean the water, the plastic bag is spread out flat on the ground. Energy from the Sun heats the water to 65°C in about two hours. This is the temperature required to kill most harmful bacteria in water.

Mvura spread out to collect energy from the Sun

t adapted from an article in *The Helix*, a CSIRO magazine (www.csiro.au)
ages from J Frost

Keys to the universe

Here is an extract from a book called *George's secret key to the universe*. It was written by a famous British scientist named Stephen Hawking and his daughter Lucy Hawking.

In the story, a boy named George is talking with his adult neighbour, Eric.

'As you seem so interested in science, perhaps I could tell you a bit more about it ... Where shall we start? What would you like to know?' asked Eric.

George's mind was so full of questions that he found it hard to just pick one. Instead, he pointed at the metal tube. 'What's this?' he asked.

'Good choice, George, good choice,' said Eric happily. 'That's my telescope. It's a very old one – four hundred years ago it belonged to a man called Galileo. He lived in Italy and he loved looking at the sky at night. At that time, people believed that all the planets in our solar system went around Earth – they even thought our Sun orbited our planet.'

'But I know that's not true,' said George, putting his eye to the old telescope.

'Hang on a minute, George, while I get everything set up – I think you are going to like this,' Eric added.

Text: adapted from Hawking, L and Hawking, S. 2007. *George's secret key to the universe*. Random House, London

Biomimicry

Japan's bullet train is one of the fastest trains in the world. The train's designers needed to make the train run quietly at very high speeds.

A barking owl

The train's designers discovered that owls are the most silent of all birds when they fly.

Bullet trains

An owl's wing has many small serrations, or saw-toothed feathers along the edge of the wing. These serration feathers create small air currents that break up the air vibrations that produce noise.

So, to reduce the noise levels, serrations were cut into the connections between the train and the overhead electrical wires. This technology has also been applied to aircraft and to the caps and boots of professional skaters.

Edge of an owl's feather

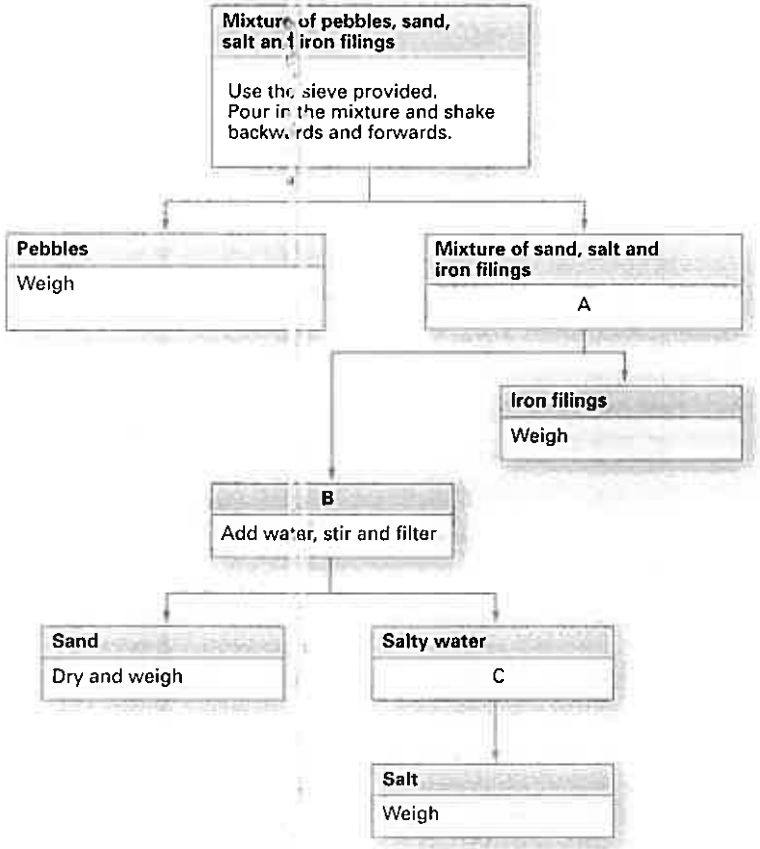
Another design feature inspired by birds is the train's nose cone. Computer modelling showed a shape like a kingfisher's beak is best for reducing the loud sonic boom that occurs when the train passes from a tunnel back into the open air.

A kingfisher

Separating a mixture

A group of students had a complex problem to solve. They had to find the mass of each substance in a mixture of small pebbles, sand, salt and iron filings.

They had the following flow chart to help them. However, this flow chart does not contain all the information they needed—the students had to work out the information represented by A, B, C and D in the flow chart.



The students' **table of results** is shown to the right.

Substance	D
Pebbles	22
Sand	42
Salt	14
Iron filings	12
Total mass obtained	90

The native cherry

The native cherry is an indigenous plant in Victoria, Queensland, New South Wales, Tasmania and South Australia. It is a small tree with tiny leaves and flowers.

The native cherry had many uses for Aboriginal people and later for European settlers. Here are some examples:

- The sweet juicy fruit was a springtime treat.
- Sap from the tree was a snake bite treatment.
- Stems were used to make spear throwers and bullroarers.
- Leaves were used to create smoke, which acted as an insect repellent.
- Twigs provided a valuable tonic for stopping infection in sores and cuts.

What is a bullroarer?

A bullroarer is made from a piece of wood that is oval-shaped, flat but slightly twisted. A string is attached at one end.

Holding the string, the bullroarer is whirled round and round at arm's length. As the bullroarer spins and twists on its axis, it makes a whirring sound which grows louder and louder the faster it swings.

To Australian Aboriginal people, the bullroarer was the voice of a great ancestral spirit – the voice of the Dreamtime. It was considered a sacred object. A bullroarer was hidden from sight and only used during initiation rites and other important ceremonies.

Text: adapted from www.dreamtime.asz.net and home.ubwin.com.au/~dwillamy
Image of native cherry © Allport Library and Museum of Fine Arts, State Library of Tasmania. *Native Cherry* by Ada Buder 1913.
Image of bullroarer from www.duchdigital.net

Smelly grass clippings

A pile of grass clippings feels warm after a few days. Where does the heat come from?

We decided to investigate.

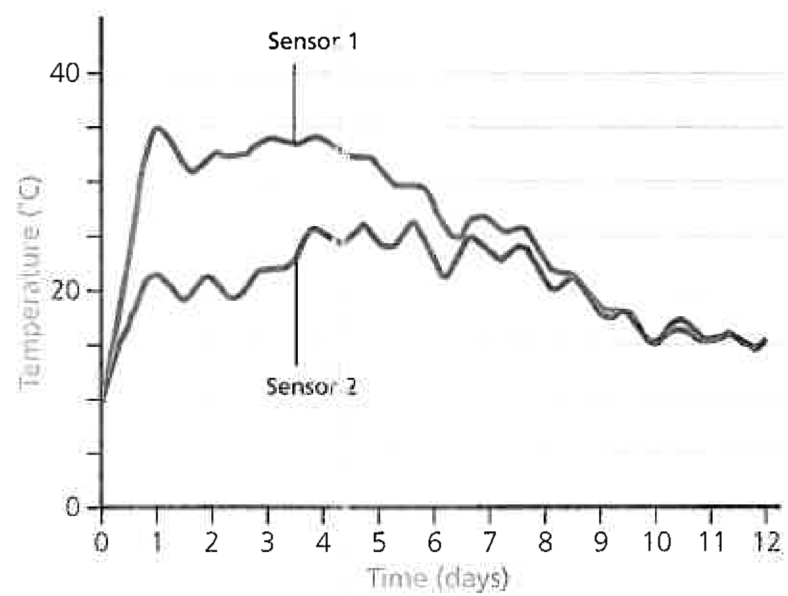
What we did

We cut the lawn and put the grass clippings in a pile. We put two temperature sensors into the grass pile. Sensor 1 was placed deep down in the middle of the pile and sensor 2 was placed near the surface of the pile. Data from these two sensors were collected by a data logger for almost two weeks.

What we found out

This graph shows the changing temperatures in the grass pile over a 12 day period.

Graph of temperature in grass pile over time



What we thought

At the end of the investigation, the grass pile smelt awful! We wondered, did bacteria make the grass pile become hot? Perhaps bacteria were causing the grass clippings to rot away.

Energy to go!

Have you heard someone say, 'I've got no energy left' or, 'He has enough energy to run a marathon' or, 'That activity is draining her of energy'? The word energy is used in many different ways.

What is energy?

For hundreds of years, scientists have been able to describe what energy does. However, energy was not as easy to define as force, mass or time, for example.

Scientists still find it tricky to define energy. Instead, they usually talk about changes in energy or changes between different forms of energy.

When you say, 'I've run out of energy', most people know what you mean. Of course, you haven't really run out of energy – your body just needs a boost of energy.

There are several forms of energy at a live rock concert. There are also examples of energy transformations.

Building sandcastles

Have you tried to build a sandcastle on an Australian beach? Did it fall down? Why can't you build a sandcastle like the beautiful ones you see in pictures?

Building sandcastles is not just about your skill with a bucket and spade. You need to have the right type of sand.

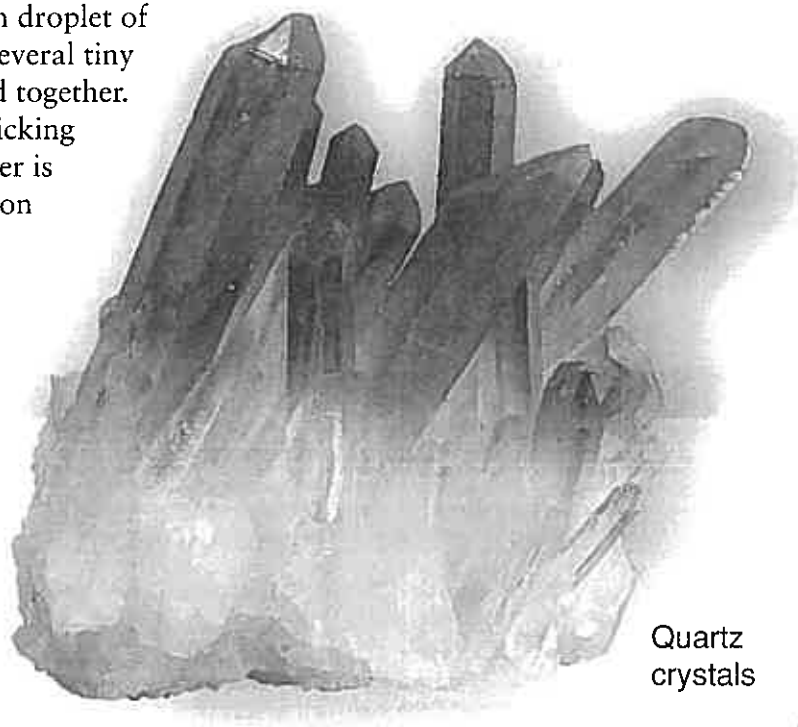
Sand grains are tiny pieces of quartz. These crystals are composed of a chemical called silicon dioxide (SiO_2).

Quartz crystals are very spiky and they are present in a variety of igneous rocks. Spiky sand grains are very good for building sandcastles.

Sand grains on Australian beaches are not spiky. Over millions of years, they have been moved from ancient inland mountains to the sea, where the waves roll them over and over on the shore. Australian sand grains tend to be very rounded. Imagine trying to make a castle with a large pile of small marbles.

To build a great sandcastle, you also need something to stick the sand grains together. While natural clay would be a very good 'glue', it is light and easily washes away from the sand grains as they are rolled on the beach.

That only leaves water to stick your sandcastle together. Each droplet of water holds several tiny grains of sand together. In fact, the sticking power of water is the main reason that you can build a castle from sand.



Quartz crystals

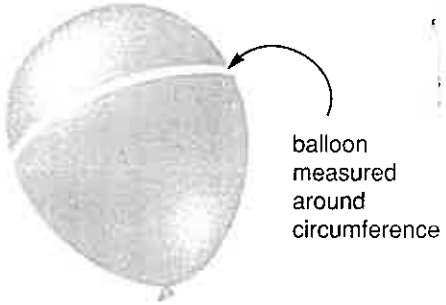
Cassandra's investigation

Cassandra really loves balloons.

Last winter, she got very upset when she walked home with a new helium balloon that seemed to be leaking because it got smaller.

After she was home for half an hour, she noticed that the balloon seemed to be back to its original size.

Cassandra decided to test if the temperature surrounding the balloon affected its size.



She used one balloon and measured around its circumference. The room temperature was 25°C.

Then she heated the balloon by spinning it in hot water (55°C) and measured its circumference.

Then she spun the balloon in ice water (1°C) and measured its circumference.

Here are Cassandra's results.

A

Circumference = 52.3 cm

B

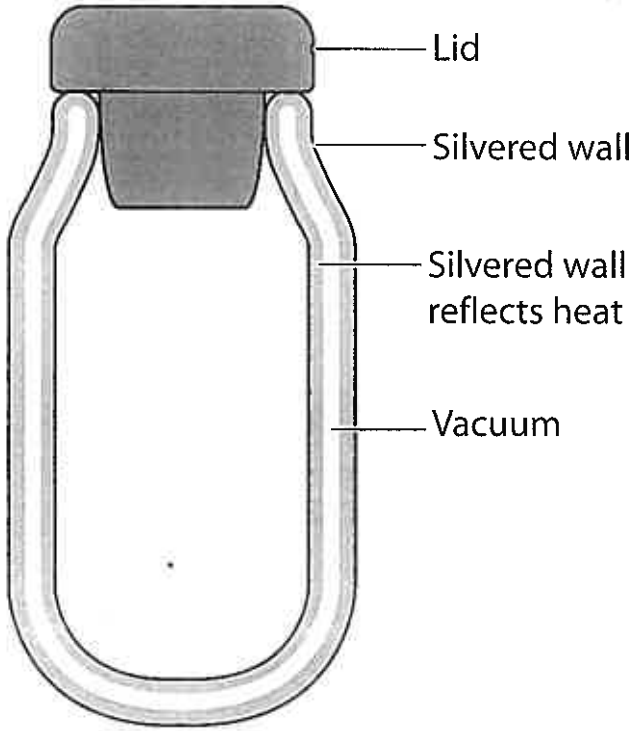
Circumference = 45.5 cm

C

Circumference = 38.8 cm

Nitrogen

Nitrogen gas condenses at –196°C.
The temperature in a laboratory is normally 25°C.
To keep nitrogen condensed, scientists place it in a vacuum flask.

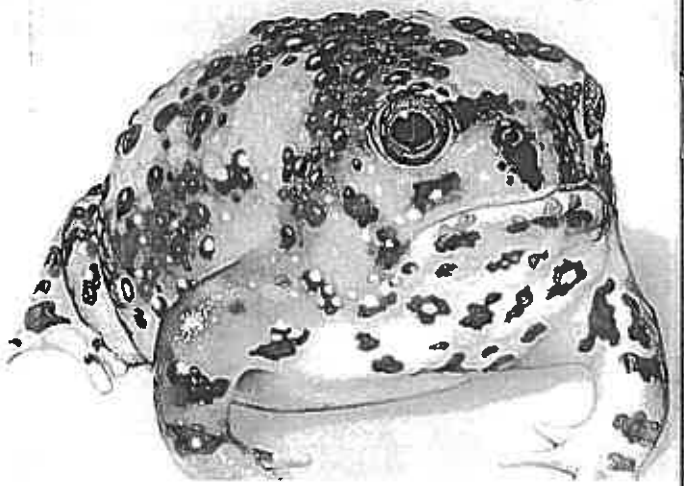


The structure of a vacuum flask

Frog glue in surgery

Australia's Holy Cross Frog (*Notaden bennetti*) is a small, brightly coloured frog which lives in dry areas of southern Queensland and northern New South Wales. It survives the arid conditions by living one metre underground and only coming out after heavy rain to find food and a mate.

To survive attacks by predators, such as ants, the frog releases a sticky liquid so that the predators stick to the frog's skin. The frog sheds its sticky skin each week and eats it, gaining nutrients from the trapped would-be predators.

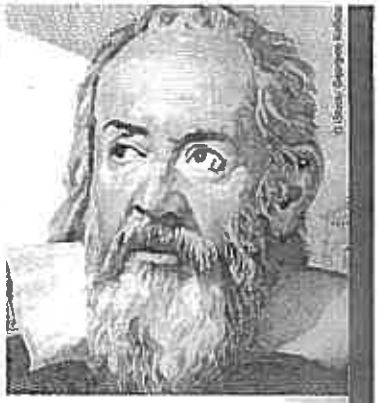


A herpetologist named Professor Mike Tyler of the University of Adelaide stumbled upon this interesting 'glue' during a field trip to study the frog. He got some of the extremely sticky liquid on his hands and could not wash it off with soap, water or petrol. He resorted to cutting it off with a knife.

Laboratory tests showed the glue breaks down slowly and sticks wood, cardboard, glass, plastics, metal, bone and skin. Frog glue was even tested to see if it could repair damaged knee tissue in sheep.

Then, Mike started working with doctors to see if the glue could be used during operations to repair torn tissue in the human knee and shoulder. Such uses could be worth millions of dollars. CSIRO scientists are working on a synthetic version of the glue to remove the need to get the liquid from living frogs.

Text adapted from *Cosmos* magazine. Image of Professor Tyler © University of Adelaide
Image of frog: www.anenvelopenaturearchive.com

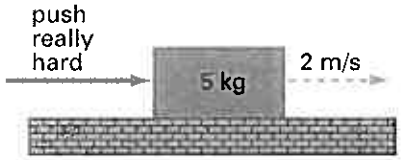


Galileo and ideas about friction

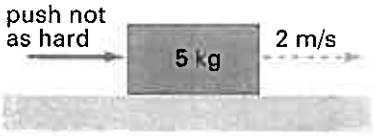
Galileo, an Italian scientist born in 1564, conducted a series of experiments and realised that the motion of objects is affected by an unseen force. This is the frictional force that acts between a surface and an object moving across it.

A student used a computer simulation to investigate Galileo's ideas about friction. He used the simulation because it would be difficult to control how a real block of wood moves in this investigation.

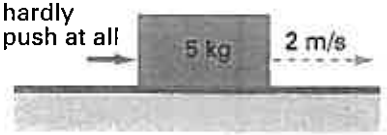
He drew a diagram to summarise each test in his investigation. Each diagram shows what he did to keep the block of wood moving at a constant speed of 2 m/s (metres per second).



rough surface



smooth surface



smooth surface
covered in oil

out in space
No friction!
Push it once to get it started
and then it will go forever.

Text adapted from csep10.phys.utk.edu and www.auburn.edu