2.1 Plasma: the fourth state of matter

EXTENSION

Knowledge and understanding

L Literacy CCT Critical and creative thinking

There is a fourth state of matter called 'plasma' that is rare (uncommon) on Earth, but makes up 99% of the rest of the universe. Plasma is a special form of gas that only exists at temperatures above 6000°C. It is most commonly found within stars, including our Sun.

On Earth, plasma is:

- found in the superheated air surrounding a bolt of lightning
- found in the colourful auroras that are sometimes seen in the skies near the north and south poles
- occasionally found in intense factory fires and bushfires.

Plasma can be created artificially (made by people) by sparking electricity through a gas. Fluorescent tubes and neon advertising signs do this, and plasma is what produces their light. Plasma is produced in plasma TVs. It is produced in the arc welders used to join slabs of steel together. It is found in the superheated exhaust of rockets and in front of the heat shields of those rockets as they re-enter Earth's atmosphere.

Plasma is currently being investigated as a way of controlling the intense heat generated in nuclear fusion reactions. Nuclear reactors currently use a type of nuclear reaction known as fission to generate their power. They use non-renewable uranium and produce wastes that remain radioactive for many thousands of years. In contrast, a nuclear fusion reactor would have almost limitless (won't run out) fuel (water). It would generate even more power, and it would be 'clean', because it wouldn't produce any radioactive waste.

1 **State** the minimum temperature at which plasma exists. _____°C.

2 **Identify** whether plasma is a special type of solid, liquid or gas.

_____

3 **State** where plasma can be found:

(a) in stormy weather _____

(b) at shipbuilding yards _____

(c) in outer space _____

(d) in home entertainment devices _____

(e) in lights _____

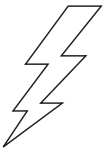
(f) around spacecraft _____

(g) in advertising _____

(h) near the north and south poles _____

superheated (n) to superheat; (v) to heat excessively. To heat a substance above the temperature where a change of state would usually occur.

bolt of lightning (n)



aurora (n) colourful bands of light in the sky caused by charged particles from the Sun

intense (adj) very powerful, strong

bushfire (n) an uncontrollable fire that occurs in the bush. Bushfires are common in Australia during summer.

artificially (adv) with the help of human beings or machines

neon advertising sign (n)

arc welder (n)

radioactive (adj) giving off radiation

limitless (adj) never ending

home entertainment devices (n) TVs, DVD players, home movie systems, etc.

2.1 EXTENSION

4 **Explain** why plasma is rare on Earth, but common in the rest of the universe.

HINT
What is Earth's average temperature?

5 Plasma is not found in house fires but is sometimes found in bushfires and factory fires. **Propose** a reason why.

HINT
What burns in a factory fire or in a bushfire?

6 Humans need to breathe oxygen to survive. **Predict** (suggest) whether it would be safe to breathe plasma made of oxygen.

7 **List** the disadvantages of nuclear power plants that use nuclear fission.

8 Currently, no nuclear power plants generate their power using fusion successfully. **Propose** a reason why not.

9 **List** the advantages of a nuclear power plant generating power using fusion.

2.2 Biodegradability

ADDITIONAL

Knowledge and understanding

L Literacy S Sustainability

Refer to the Learning Across the Curriculum in unit 2.1 in your student book to complete the following questions.

1 **Define** the term *biodegradable*.

2 **List** signs that indicate a substance is biodegradable.

3 **Classify** whether the following substances and objects are biodegradable or not by placing a tick in the correct column.

Substance or object	Biodegradable	Non-biodegradable
Autumn leaves	✔	
Pebbles		
Polystyrene cup		
Plastic fork		
A dead rat		
Fruit salad		
Glass bottle		
Woollen jumper		
Wooden log		
Lamb chop		

pebble (n) a small rounded stone usually shaped by water movement

4 You take your lunch to school. It contains an egg-and-salad roll wrapped in cling wrap, a muesli bar in a foil wrapper, an apple and a small plastic bottle of fruit juice. All of it is in a plastic container.

cling wrap (n)

(a) **List** all of the substances in your lunch that are biodegradable.

(b) **List** all of the substances that are non-biodegradable.

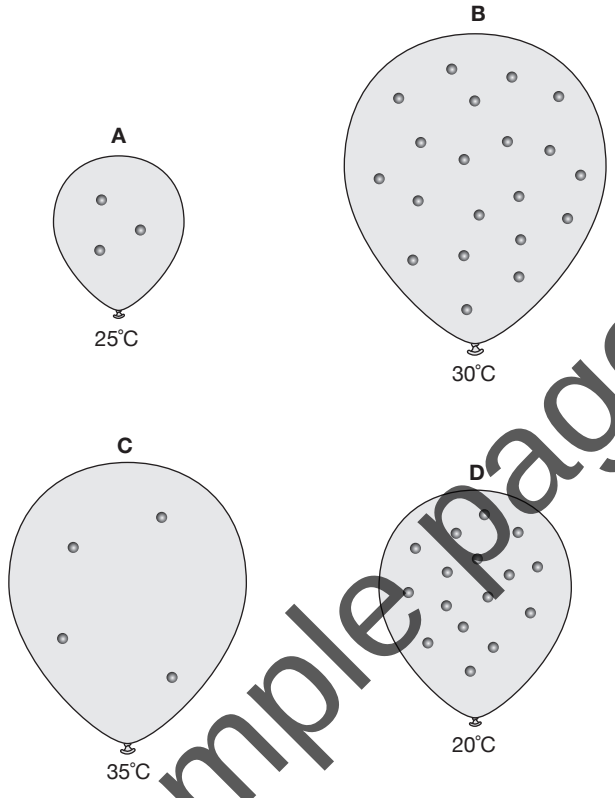
5 **Explain** why we all should recycle non-biodegradable substances.

6 **Describe** what our environment would be like if nothing was recycled.

Knowledge and understanding

N Numeracy **CCT Critical and creative thinking**

Four balloons were blown up to different sizes in different rooms of a house. The temperature of each room was different. The balloons are shown below.



Identify the balloon:

(a) in which the air particles would be moving the fastest _____

(b) in which the air particles would be moving the slowest _____

(c) in which the particles are furthest apart _____

(d) in which the particles are closest to each other _____

(e) that would be the heaviest _____

(f) that would be the lightest _____

(g) that has the most space/greatest volume _____

(h) that has the least space/smallest volume _____

(i) with the densest air _____

(j) with the least dense air. _____

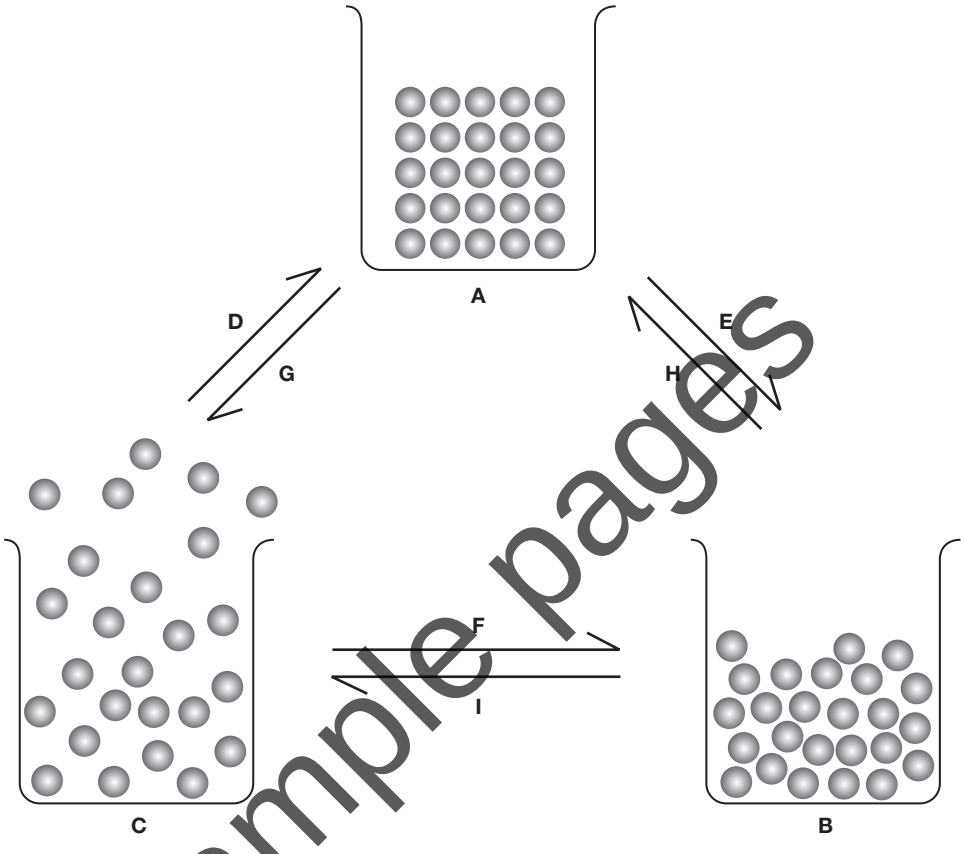
2.4 Changes of state

Knowledge and understanding

N Numeracy **CCT Critical and creative thinking**

LB 2.4 p.121

The three diagrams show the three main states of matter—solid, liquid and gas.



1 Identify which diagram (A, B or C) best represents a:

(a) solid _____

(b) liquid _____

(c) gas. _____

2 Identify which arrows in the diagrams represent the following changes of state:

(a) melting _____

(b) freezing _____

(c) evaporation _____

(d) condensation _____

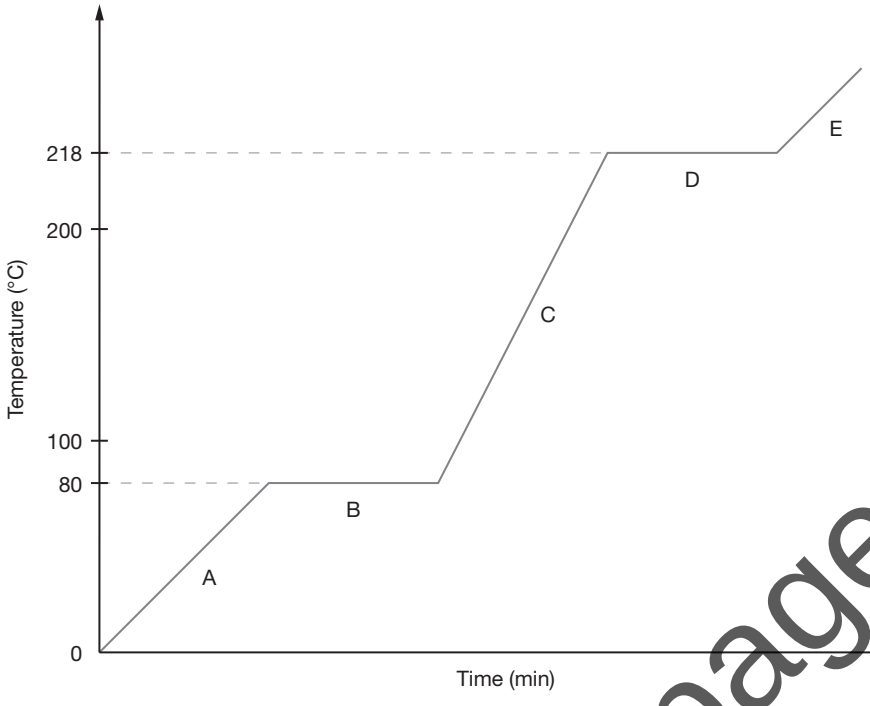
(e) sublimation _____

(f) deposition. _____

2.4

Naphthalene is a smelly chemical commonly used in mothballs. Some flakes of naphthalene were heated up until they melted and then boiled. The graph shows the important stages in this heating.

mothballs (n) small balls of chemicals, usually naphthalene, used to protect clothing from moths



3 **Identify** which section of the graph (A, B, C, D or E) best represents when naphthalene was:

(a) all gas _____

(b) in both gaseous and liquid states _____

(c) all liquid _____

(d) in both liquid and solid states _____

(e) all solid. _____

4 **Use** the graph to **predict** the melting point of naphthalene. Is it:

A 0°C?

B 80°C?

C 100°C?

D 218°C?

_____

5 **Use** the graph to **predict** the boiling point of naphthalene. Is it:

A 0°C?

B 80°C?

C 100°C?

D 218°C?

_____

2.5 Cooling curve

Working scientifically

N Numeracy

Students boiled salty water on a hotplate. They then removed the water from the hotplate and placed it in a freezer to cool. They measured its temperature every minute.

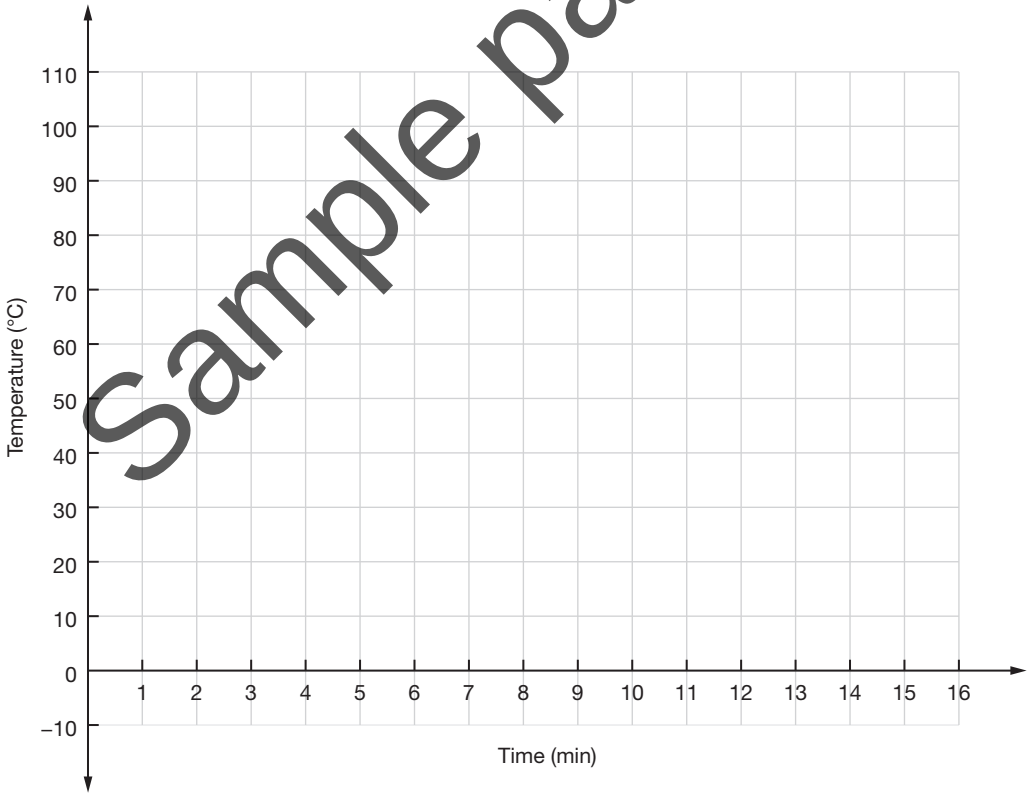
1 The measurements taken are shown in the table below. **Construct** a graph by plotting these values on the grid provided.

Time (minutes)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Temperature (°C)	104	103	102	91	82	70	59	51	40	28	20	11	2	–1	–4	–4	–4

2 **Use** your graph to estimate:

(a) the boiling point of salty water _____

(b) the freezing point of salty water. _____



2.6 Archimedes

Knowledge and understanding

L Literacy CCT Critical and creative thinking

LB 2.6 p.127

Archimedes lived from about 287 to 212 BCE. He was born in Syracuse, on the island of Sicily. Although it is now a part of Italy, Syracuse was then a colony of ancient Greece. Little is known about Archimedes' life and most of what we do know comes from stories written by ancient Roman historians long after his death.

Figure 2.6.1 Archimedes and King Hiero II

colony (n) an area of land that is controlled by another country

historian (n) someone who studies history

Myth or fact?

Syracuse at that time was constantly under threat from the expanding Roman Empire, and Archimedes invented machines that would help his city fight off any invasion.

However, it is now thought that some stories about these machines may have been propaganda (rumours) designed to scare off the Romans.

Archimedes and density

According to a Roman story, Archimedes worked out how to calculate the density of an irregular object. Density is the mass of an object divided by its volume. Hiero II, the king of Syracuse, suspected that his goldsmith had cheated him by substituting cheaper silver for gold in a wreath the king had commissioned to present to the ancient Greek gods.

Archimedes was given the task of determining whether the wreath was pure gold or not. He knew that if the wreath contained silver, then its density would be less than that of gold, and so he needed to measure both its mass and its volume. Mass could be easily measured using scales, but he wondered how he could measure the volume of such an irregularly shaped wreath. One way was to melt down the wreath, make it into a regular box-shaped prism, and then calculate its volume. This would, of course, have destroyed the wreath. He needed to find a non-destructive way of testing the wreath.

While pondering this question, Archimedes supposedly took a bath. On lowering himself in, he noticed that the water level rose. He instantly realised that the water rose by the same volume as his body. He could use the same method to measure the volume of the wreath! Excited by his discovery, Archimedes allegedly ran naked into the street shouting 'Eureka, eureka!'

goldsmith (n) someone who makes things from gold

substitute (v) to swap one thing for another thing

wreath (n) flowers, twigs or branches shaped to form a circle or ring (see illustration on page 24)

commission (v) to order something; to pay to have something done or made

determine (v) to find out or work out

supposedly (adv) we don't know whether the information that follows is true

allegedly (adv) we don't know whether the information that follows is true

eureka (v) a Greek word meaning 'I have found it'

ponder (v) to consider carefully; think about

1 **Propose** reasons why the wreath could not be melted down.

2 **Explain** what caused Archimedes to be so excited that he ran naked into the street.

3 Below are four possible interpretations for the words 'Eureka, eureka!' **Identify** which is the most likely meaning for the expression.

A 'The water's so cold, so cold!'

B 'I've found the answer, I've found the answer!'

C 'Down with the king, down with the king!'

D 'Hey look at me, I've got no clothes on!'

4 **Explain** what the term *non-destructive test* means.

5 **Propose** what a destructive test of the wreath would be.

6 Destructive tests would never be carried out in the following situations. For each situation, **propose** a reason why.

(a) testing the strength of the Sydney Harbour Bridge

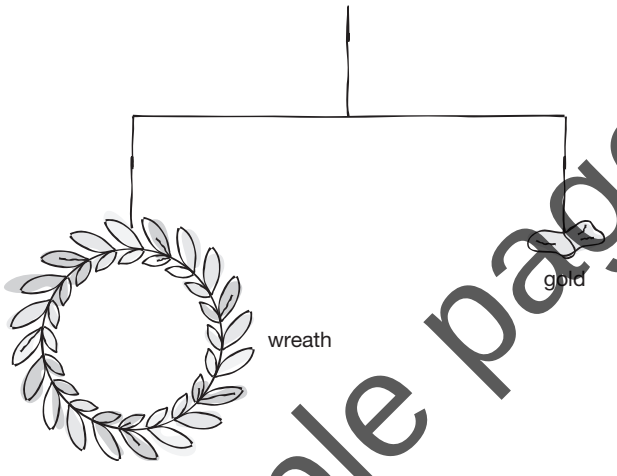
(b) testing the amount of chemical pollutants that will kill people

(c) testing the force in a punch that would cause brain injury

7 Many scientists do not believe all the stories about Archimedes, his inventions and discoveries. **Propose** two reasons why.

8 Many scientists do not believe that Archimedes used his 'bathtub' method to determine if the wreath was pure gold or not. Many suggest that he used apparatus like that shown below.

apparatus (n) equipment for a particular use, such as an experiment

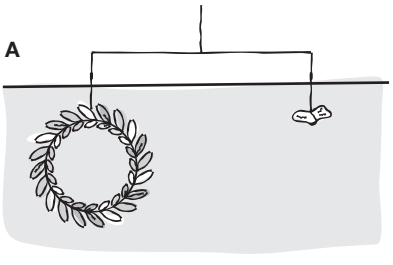


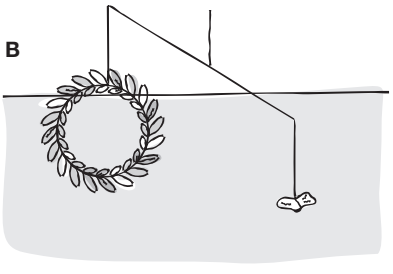
Diagrams A–C show three things that could happen once the apparatus was lowered into water, depending on the density of the wreath.

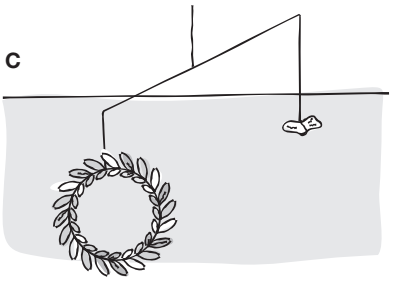
Situation A would occur if the wreath was made of pure gold. **Predict** which of the situations would probably occur if:

(a) the wreath was partly made of a less dense metal such as silver _____

(b) the wreath was partly made of a denser material such as platinum. _____







2.7 Density calculations

EXTENSION

Working scientifically

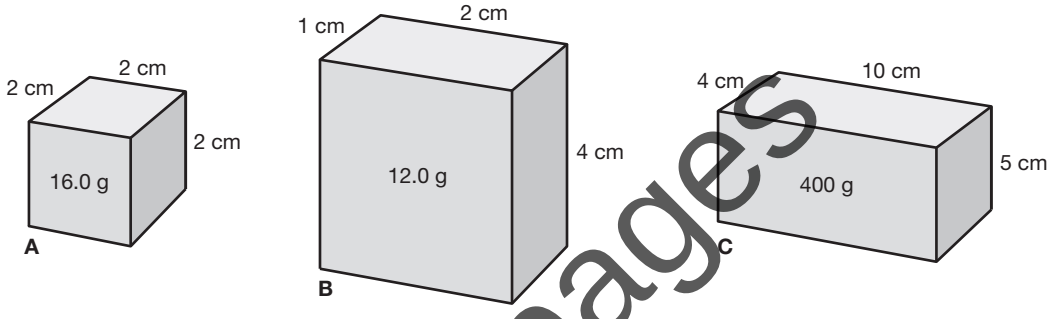
N Numeracy

If an object has a regular shape like a cube or a box, then you don't need to use a measuring cylinder to find its volume. You can use maths instead. The volume of a box can be calculated using the formula:

Volume = length × width × height

$V = lwh$

1 (a) Use the formula $V = lwh$ to **calculate** the volume of the rectangular prisms shown.



Prism A: $V =$ _____ cm^3

Prism B: $V =$ _____ cm^3

Prism C: $V =$ _____ cm^3

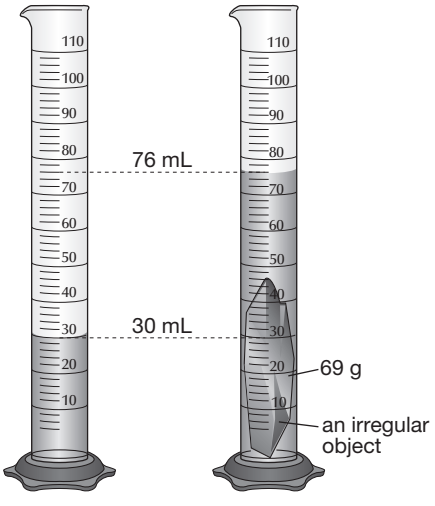
(b) Use the masses given for each of the prisms to **calculate** their densities.

Prism A: $d = \frac{m}{V}$ = _____ / _____ = _____ g/cm^3

Prism B: $d = \frac{m}{V}$ = _____ / _____ = _____ g/cm^3

Prism C: $d = \frac{m}{V}$ = _____ / _____ = _____ g/cm^3

2 (a) Calculate the volume of the irregular object shown that has been put inside a measuring cylinder containing some water.

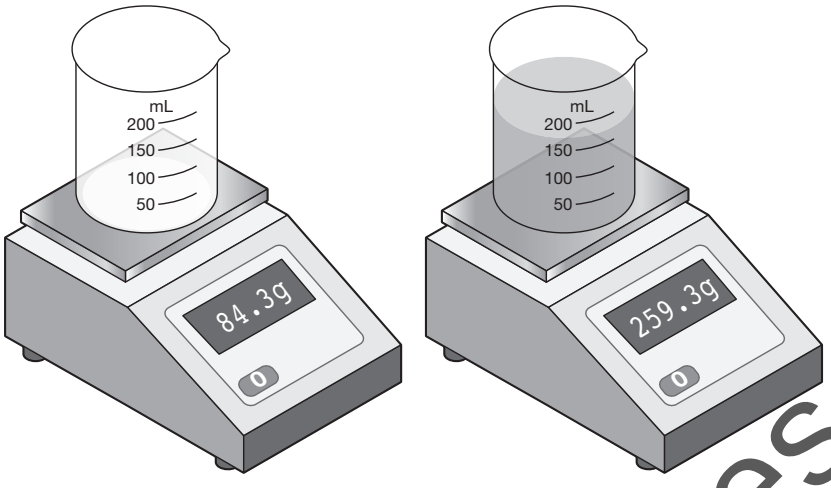


$V =$ _____ mL = _____ cm^3

(b) **Use** the mass given for the irregular object in part (a) to **calculate** its density.

Irregular shape: $d = \frac{m}{V}$ = _____ / _____ = _____ g/cm^3

3 The mass of an unknown liquid was determined by the method shown.



(a) **Use** this information in the diagram to **calculate** the density of the liquid.

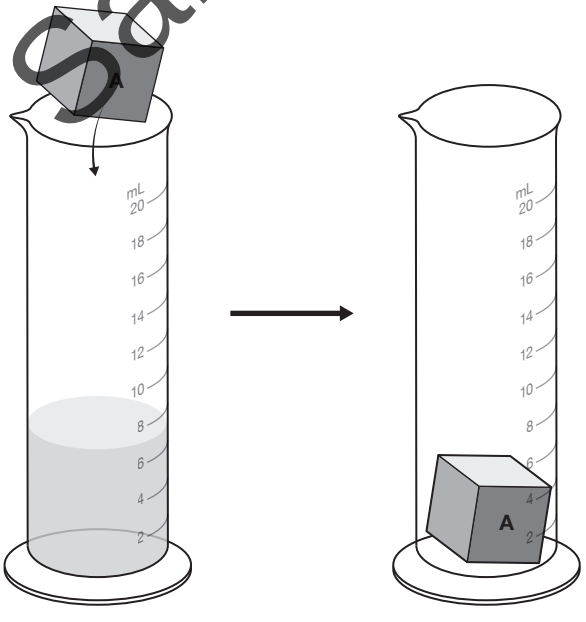
_____

_____

(b) From its density, **propose** what the unknown liquid is most likely to be.

_____

4 Prism A in question 1 was dropped into the measuring cylinder shown below. **Modify** the second measuring cylinder by marking the level the water should rise to.



2.8 Icebergs

Working scientifically

LB 2.8 p.128

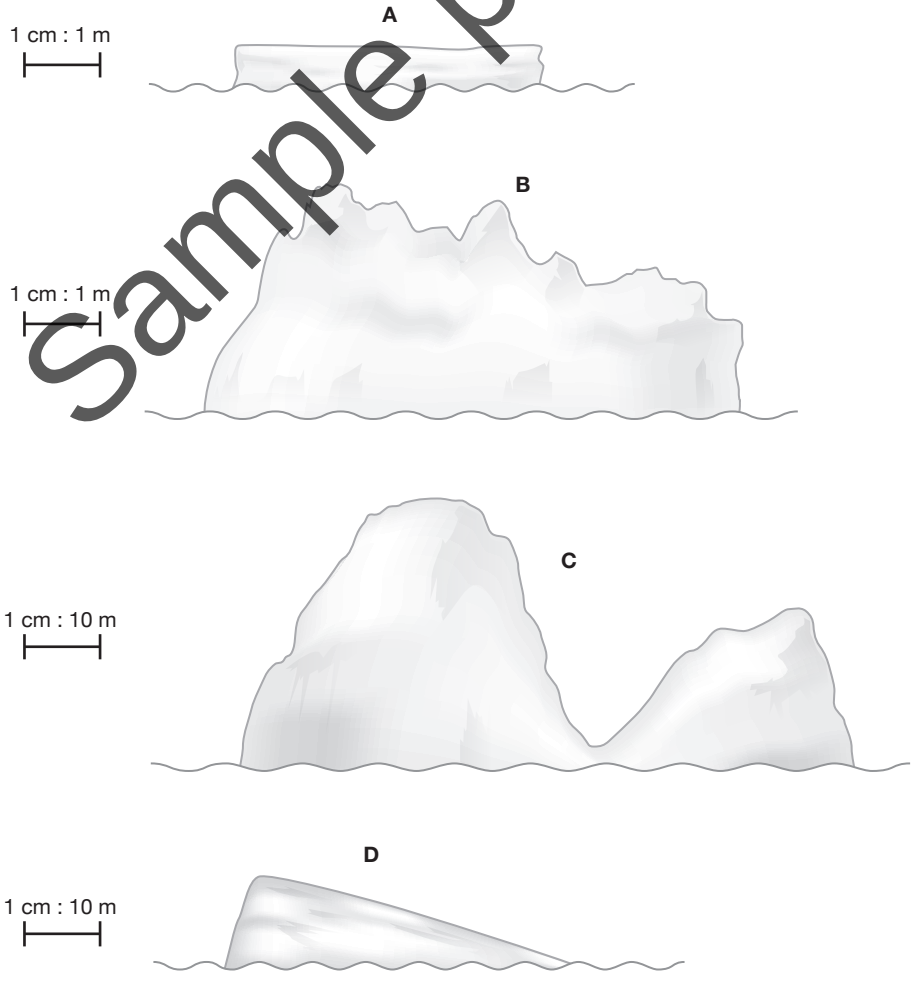
N Numeracy **CCT Critical and creative thinking**

Ice can form amazing shapes, from tiny snowflakes to gigantic icebergs.

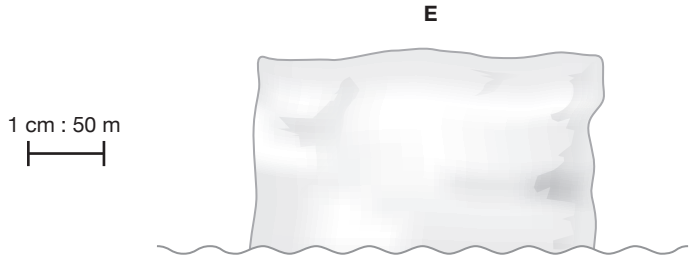
The following key uses shape to classify icebergs.

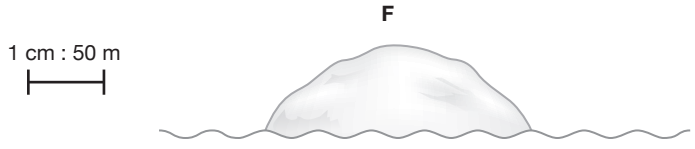
iceberg (n) a large piece of frozen water that moves around the ocean

Shape	Classification
Rounded top	Dome
Spires or peaks (uneven, jagged)	Pinnacle
One steep side, one side gently sloping	Wedge
An eroded (worn) canyon-like slot	Dry-dock
Flat top	Tabular (if its width is at least 5 times more than its height) Blocky (if its width is less than 5 times more than its height)



2.8





1 **Use** the key on page 27 to **classify** the icebergs shown.

(a) A = Tabular _____ **(b)** B = _____

(c) C = _____ **(d)** D = _____

(e) E = _____ **(f)** F = _____

2 The International Ice Patrol further classifies icebergs according to their size, as shown in the following table.

Category	Height (m)	Width (m)
Growler	Less than 1	Less than 5
Bergy Bit	1–5	5–15
Small	5–15	15–60
Medium	15–45	60–120
Large	45–75	120–200
Very Large	75 or more	200 or more

Use the scale beside each iceberg on pages 27 and 28 to **calculate** its height and width. **Write** the height (m) and width (m) of each iceberg on its diagram.

3 **Classify** each of the icebergs according to its size.

(a) A = _____ **(b)** B = _____

(c) C = _____ **(d)** D = _____

(e) E = _____ **(f)** F = _____

2.9 Icebergs and the First Fleet

EXTENSION

Knowledge and understanding

L Literacy CCT Critical and creative thinking

When the First Fleet landed in New South Wales in 1788, it carried enough food supplies for two years. After that time, people thought that the new settlement would be producing its own food and would be self-sufficient. By 1789, however, some foods were running out. Crops had failed in the poor soils around Sydney Cove, mice had eaten the grain, the harbour had been overfished, and kangaroos, wallabies and emus were staying away from the settlement and so could not be killed. Some food was produced at Rose Hill (Parramatta) and Norfolk Island, but not enough for the population of Sydney. Ships were sent to Indonesia and South Africa to collect food, but they took up to seven months to return.

settlement (n) an area of land where people live

self-sufficient (adj) not relying on someone else's help for food, fuel etc.

overfished (v) when too many fish have been caught, so it is difficult to catch more

food rations (n) a fixed amount of food given to people when there is not enough food

convict (n) a prisoner taken from England to New South Wales to work

A ship called HMS *Guardian* was sent from England with 1000 tonnes of livestock and grain on board to save Sydney. On Christmas Eve 1789, the ship moved close to an iceberg in the Southern Ocean to collect fresh water for the livestock and plants on board. That night, it struck the iceberg and started to sink. All the food for Sydney was thrown overboard to lighten the ship's load. HMS *Guardian* sailed slowly into Cape Town, South Africa. Nine weeks later, it was destroyed by a hurricane. Meanwhile, the people in the settlement of Sydney were placed on food rations and at least one convict died from starvation. The settlement had to wait until the arrival of the Second Fleet in 1790 for the next delivery of food.

1 **State** the year in which the First Fleet arrived in Australia. _____

2 **State** how long the food the First Fleet brought with them was supposed to last.

_____

3 **List** factors that caused the food shortage of the first years.

_____

_____

4 **Name** the places where farms were successfully producing food.

_____

5 **Explain** why HMS *Guardian* went so close to the iceberg that it eventually hit.

_____

6 **Outline** what happened to the ship after it hit the iceberg.

_____

_____

7 **State** how long the settlers in Sydney had to wait before another shipment of food arrived.

shipment (n) a load of goods or supplies sent on a ship

_____

2.10 Literacy review

Knowledge and understanding

L Literacy

jiggle (v) to move quickly backwards and forwards or up and down

enrich (v) to make something better

1 Use the following clues to **identify** the key terms form the chapter.

Clue	Word
Small particles	a t o m s
Jiggles about on the spot	v i b r a t e s
Cannot be compressed	i _ _ _ _ _ _ _ _ _ _ _ _ _
Air that is full of water vapour	h _ _ _ _
Breaks down naturally	b _ _ _ _ _ _ _ _ _ _ _ _
Made from rotted substances such as vegetables and used to enrich the soil in gardens	c _ _ _ _ _
A non-biodegradable substance	p _ _ _ _ _ _ _ _ _
Smell	o _ _ _ _
Another name for the three states that matter comes in	f _ _ _ _ _
Powered by water	h _ _ _ _ _ _ _ _
Fourth state of matter	p _ _ _ _ _
The particles that make up everything	m _ _ _ _ _
Motion that pushes pollen grains around	B _ _ _ _ _ _ _
A solid changes into a liquid	m _ _ _ _
A liquid changes into a gas	e _ _ _ _ _ _ _ _ _
Changes from liquid to gas, accompanied by lots of bubbles	b _ _ _ _
Changes from liquid to solid	f _ _ _ _ _ _
Dry ice doesn't melt but does this	s _ _ _ _ _ _ _
Appears on a mirror on a cold day	c _ _ _ _ _ _ _ _ _ _ _
Tiny droplets of water, often confused with water vapour	s _ _ _ _

2 Once you have identified the key terms in question 1, **identify** and highlight them in the wordfind below. They can be written in any direction, including diagonally.

V	S	N	G	S	M	A	S	L	A	B	S	G	I	N
K	I	B	O	Z	E	U	T	M	L	E	Q	N	B	U
S	S	B	Q	I	B	Z	S	O	T	Q	C	S	R	E
Y	F	H	R	L	T	A	E	A	M	O	S	L	O	N
V	E	U	I	A	L	A	R	E	M	S	E	I	W	E
H	K	M	A	P	T	O	S	P	R	R	S	O	N	R
T	E	I	M	O	P	E	R	N	M	E	A	B	I	Y
S	I	D	D	A	E	E	S	J	E	S	H	F	A	T
W	H	O	V	B	S	T	L	E	M	D	P	G	N	S
T	U	E	T	S	O	P	M	O	C	A	N	C	L	Y
R	G	K	I	S	T	E	A	M	P	M	B	O	T	L
E	L	B	A	D	A	R	G	E	D	O	I	B	C	O
L	L	H	Y	D	R	A	U	L	I	C	H	Q	Z	P
E	M	A	T	T	E	R	D	K	G	P	E	W	E	C
D	Z	D	Q	N	Z	Y	Z	F	B	Q	N	Z	Q	L