assignments in Junior Science

book 8

Energy and matter

CHRIS GREEF
SUADA BILALI

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Junior Science

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This title was commissioned by Jennifer Gough and project management was by Piper Print Media.

Chris Greef completed his schooling in Europe before doing a Bachelor of Science and Dip.Ed. at the University of Sydney. Most of his teaching career has been spent in inner city schools in Sydney, which encouraged innovative ways of teaching and learning, and engaging students from many diverse backgrounds. In the early 1990s, he returned to Sydney University to undertake a Masters of Education while working as a Science literacy consultant for the Write-it-Right Project; these studies and experiences reinforced the idea that explicit and scaffolded teaching allows all students to succeed and highlighted the importance of learning and manipulating scientific language. Chris has written a series of books for Blake Education and reviewed several science books.

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Printed in Australia by Ligare Book Printer

Blake EDUCATION
Better ways to learn

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ISBN 978 1 92209 083 6

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Introduction

Each book in the *Assignments in Junior Science* series provides a selection of work sheets covering one or two major topics. The work sheets are generally self-contained, supplying the information necessary for students to formulate answers. As students work through these activities, they will interpret and analyse data including text, tables, graphs and diagrams; and organise and represent data in a variety of formats. They will also utilise basic scientific skills such as working with formulas, completing calculations, making generalisations and explaining what they have discovered. The activities incorporate a range of theoretical and practical scientific skills, and also involve the development of literacy skills.

Contents

 ISBN 978 1 92209 083 6

Energy what?

1 Read the following introduction to energy and cross out the incorrect verb form.

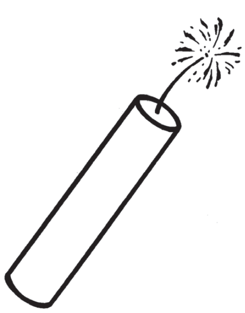
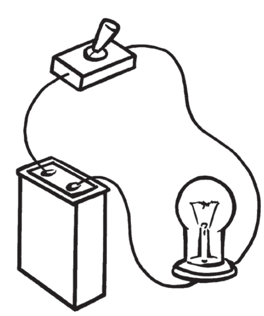
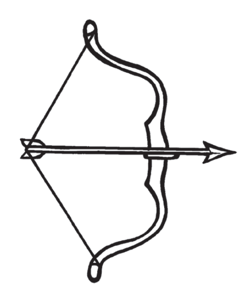
Energy *[can have / did have]* many different meanings. People *[need / needs]* energy to run. They *[need / needed]* energy to *[keep / kept]* their houses warm. They *[need / needed]* energy to cook. Plants *[need /needs]* energy to make food. Animals *[ate / eat]* plants to get their energy. Appliances and machines *[change / changes]* energy into useful forms.

But what *[has / is]* energy really? Energy *[is / are]* the ability to do work. Energy *[make / makes]* things happen. Energy *[caused / causes]* changes.

There *[are / is]* two groups of energy types: Energy in action *[has been called / is called]* moving energy and stored energy *[are called / is called]* potential energy.

Then there *[are / is]* many different energy forms. Chemical energy *[is / was]* the energy inside chemicals; a burning match *[could release / released]* it. Elastic energy *[are / is]* inside a stretched, compressed or twisted object; *[let go / let's go]* of the object and the energy *[became / becomes]* visible. Electric energy *[has / is]* what electrons *[are / have]* as they *[race / raced]* through a wire. Gravitational energy *[can be / is]* the energy that objects *[are / have]* when they *[are / were]* high up; let the object fall and the energy *[became / becomes]* obvious. Heat energy *[is travelling / travels]* away from hot objects. Light energy *[can travel/ travels]* away from bright objects, it *[can even travel / can even have travelled]* through some materials. Kinetic energy or mechanical energy *[is / was]* the energy that any moving thing *[had / has]*, such as a speeding car or a kicked ball or a falling feather. Nuclear energy *[can be kept / is kept]* inside the nucleus of an atom; in a nuclear reactor that nucleus *[is changed / are changed]* and then huge amounts of energy *[are released / is released]*. Sound energy *[can be carried / is carried]* from particle to particle as music *[came / comes]* to your ears.

2 Look at each diagram. In the first box, state which type of energy is illustrated. In the lower box, state the energy group. One example has been done for you.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potential			

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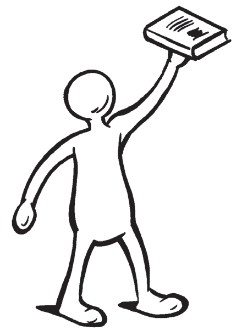
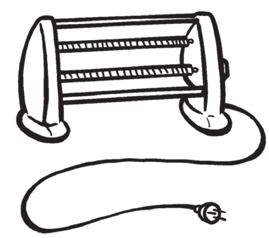
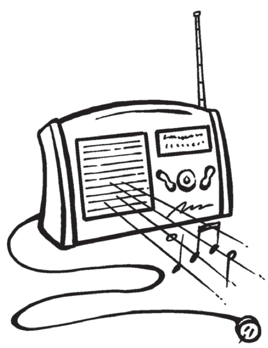
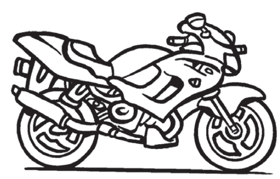
Energy what?

3 Machines and appliances change one energy form into others. Under each illustration, write the used energy form and then list the produced energy forms. One example has been done for you.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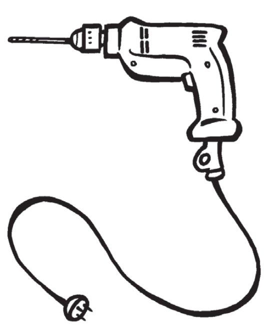
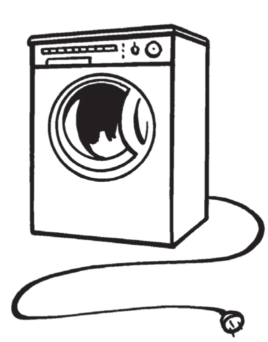
heat			

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Types of energy

There are two groups of energy forms: moving energy or energy in action and potential or stored energy. The potential energy needs to be triggered; then it could change into moving energy, which travels away.

Then there are many energy forms, such as chemical energy, elastic energy, electric energy, gravitational energy, heat energy, light energy, mechanical energy, nuclear energy and sound energy.

1 Draw straight lines with a ruler to match each energy form with its correct definition. Then in the last column, write 'moving' or 'potential' to show which energy group it belongs to.

Energy form
a Chemical
b Elastic
c Electric
d Gravitational
e Heat
f Kinetic
g Light
h Nuclear
i Sound

Definition	Energy group
Electrons travelling through a conductor	
Energy in objects being held up high	
Energy stored in a stretched or compressed material	
Energy stored inside molecules	
Energy stored inside the nucleus of atoms	
Infra-red waves travelling away from hot objects	
Light waves travelling away from coloured objects	
Sound waves travelling through matter	
Things that are moving	

2 List all the energy forms from question 1 under the correct energy group.

Moving	Potential

3 State the correct energy form and energy group for each of the following situations.

Situation	Energy form	Energy group
A set spring in a wind-up clock		
An inflated balloon		
The water in a hydro-electric dam		
A running dog		
A bright tube light		
Uranium for a nuclear reactor		
The red head of a match		
The glowing bars of a radiator		
A fired starting gun at a running race		

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Types of energy

4 Many appliances in your home convert one form of energy to other forms of energy. For each energy converter, state the initial energy form (i.e. the energy going into the appliance) and the final energy forms (i.e. the energy coming out of the appliance). Note that in most appliances, more than one final energy form is produced.

Energy converter	Initial energy form	Final energy forms
Light bulb		
Television set		
Kettle		
Electric drill		
Gas stove		
Electric stove		
Food mixer		
Petrol lawnmower		
Hand lawnmower		
Electric lawnmower		
A plucked guitar string		
Exploding fire works		

5 List five appliances that produce unwanted (wasted) forms of energy as well as wanted forms of energy. Write the energy forms which are wanted and the ones which are not. One example has been done for you.

Appliance	Wanted energy form	Wasted energy form
Radio	*Sound*	*Heat*

6 List the five sense organs of humans. Underline the biggest sense organ. Circle the most important one.

____

7 State which sense organ in the human body can pick up the following moving energy forms.

a Light energy from the Sun _______________

b Sound energy from a car _______________

c Heat energy from the Sun _______________

d Chemical energy from a deodorant _______________

e Movement energy from a shaking head _______________

f Movement energy from wind _______________

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What goes up must come down

1 When you throw a ball high up into the air, it soon comes back down again.

a State which form of energy is relevant for each situation.

Situation	Your arm muscles	The ball moves upwards.	The ball is high up.	The ball falls back down.	The ball bounces on the ground.
Form of energy					

b Note that scientists usually refer to mechanical energy simply as kinetic energy and gravitational potential energy as potential energy. Rewrite the row for the Form of energy using these scientific terms.

Situation	Your arm muscles	The ball moves upwards.	The ball is high up.	The ball falls back down.	The ball bounces on the ground.
Form of energy					

How much energy do you think is involved in throwing a ball up into the air? Energy is measured in joules (J). One joule of energy is needed to lift 100 g (for example, a small exercise book) up by 1 m (about the height of a table). In our ball-throwing example, all the energy comes from the muscles in your arm, say 100 J. This energy is given to the ball: as it leaves your hand, the ball has kinetic energy worth 100 J. But as the ball rises, it slows down. Therefore its kinetic energy also decreases. But as the ball rises, it goes higher. So it also receives potential energy which is increasing.

When the ball comes to a stop at its highest point, it has no kinetic energy, only potential energy. As the ball falls back to the ground again, its kinetic energy increases while its potential energy decreases. Just before hitting the ground, the ball has minimum gravitational energy, and maximum kinetic energy. At impact, this kinetic energy is converted into sound and elastic energies.

2 Think about the energy forms of the ball-throwing example.

a When does the ball have maximum kinetic energy?________________________________

b When does the ball have zero kinetic energy?________________________________

c When does the ball have maximum potential energy?________________________________

d When does the ball have zero potential energy?________________________________

It is possible to calculate the amount of energy a moving object has. Its kinetic energy (KE) depends on its mass (m) and its velocity (v):

$\text{KE} = \frac{1}{2} mv^2$ (Note that v^2 means $v \times v$.)

When a person with a mass of 50 kg jogs at a speed of 2 m/s, they have kinetic energy worth $\frac{1}{2} \times 50 \times 2 \times 2 = 100$ J. That is, $\text{KE} = \frac{1}{2} mv^2 = \frac{1}{2} \times 50\text{ kg} \times 2\text{ m/s} \times 2\text{ m/s} = 100$ J.

3 **a** Find your kinetic energy if you were racing at a speed of 10 m/s – that is, you run 100 m in 10 s.

____

b Calculate the kinetic energy of a small car (mass = 1 000 kg) travelling at a speed of 20 m/s, which is approximately 70 km/h.

____

We can also find the energy stored in an object at a certain height. This potential energy depends on the object's mass, gravity and the height the object is at: PE = mgh. Note that on Earth, g has the approximate value of 10.

4 **a** Find your potential energy when you stand on a 100 m high building.

____

b Calculate the potential energy of a small car with mass 1 000 kg if it was on a 10 m high block of units.

____

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Heat conduction – a recount

1 Read the passage below and correct the thirty spelling mistakes.

Michael thoght it wood be fun and a huge help to his parents if he made soup befor they got home. He choped the vegetables and aded them to the stock just as his mother did. He went to the drow and choose a large metle spoon to mix the soup. He desided to leave the spoon in the soop for when he needed to stir it.

When the soup started to boil, he piked up the spoon to give it a stirr, but to his surprize it had became too hot to handle and he imediately dropped it. 'Why did the spoon get so hot?' he thought to himself. Michael went to the draw to choose another spone. He decided to choose the wooden spoon instead of the glass one or the plastic one. Michael decided to leeve the wooden spoon in the soup to sea if it would get hot, but it didn't.

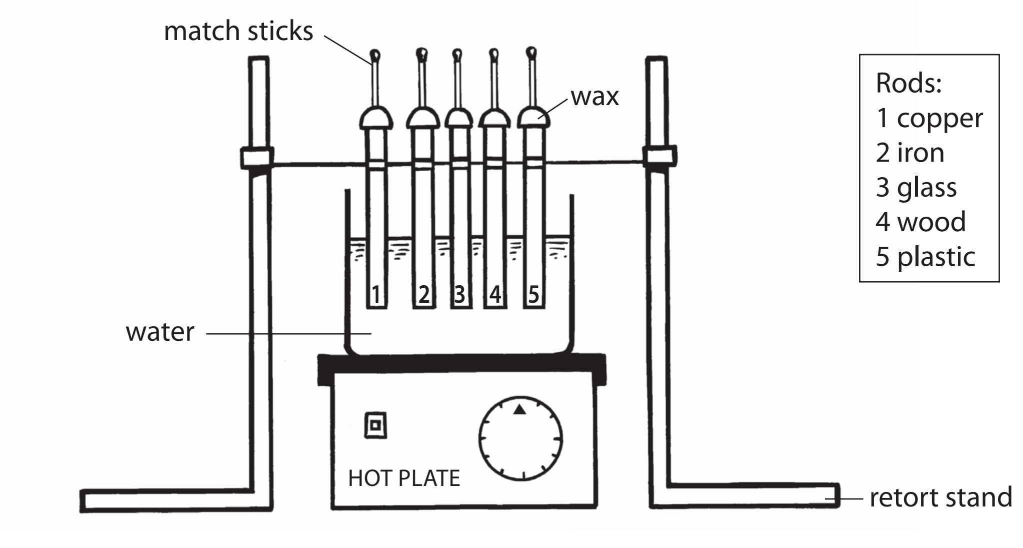
He went to school the next day and asked his teacher about what had happened. She explained that the metal spoon got hot because the heat from the boiling soup transfered into the metal. 'Heat travels easily through some metals. Metals are good conduktors of heat,' she said.

Non-metal substances like the woulden spoon are poor conductors of heat. Poor conductors of heat are called insulaters. They do not allow heet to pass throogh them.

Michael decided to design an experement to test how long it takes for heat to travell through different substances. He chose five diferent materials: copper, iron, glass, would and plastik. He let the experiment run four 20 minutes.

Below is a diagramme of how he set up his experiment and his results after the ixperiment.

Diagram of the experiment Michael set up



Results

Material	Time it took for match to fall (min)
Copper	8.00
Iron	11.5
Glass	20 +
Wood	20 +
Plastic	20 +

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Heat conduction – a recount

2 How did Michael set up the experiment? Describe what he did.

____

____

____

____

____

____

3 What do Michael's results show? Are his results consistent with the soup incident?

____

____

____

4 Outline how Michael's experiment was a fair test.

____

____

5 What could Michael do to improve his experiment – for example, to make his experiment more reliable?

____

6 From Michael's results, list the conductors and the insulators.

Conductors:____

Insulators:____

7 When we do not want heat to travel through an item, we use insulators to cover the object; for example, putting a wooden handle on a saucepan. Even air cavities in our house walls act as insulators – air is one of the best insulators. Substances that contain lots of air are poor conductors; therefore they become good insulating materials. List at least ten things around your home that are used as insulators.

____

____

8 From Michael's experiment, it is clear that metals are good conductors of heat. Do you think that all metals transfer heat at the same rate? Give reasons for your opinion. Is there anything in Michael's experiment that can help you answer this question?

____

____

____

9 Design an experiment that you could perform to answer question 8. Include a labelled diagram in the method you write. Remember to make the experiment a fair test. Use these headings in your experiment: Aim, Equipment, Safety considerations, Method, Results, Conclusion.

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A convection mix-up

You may have noticed during a shower or bath that steam rises to the ceiling and then down towards the floor, it begins to move in a circular motion. If you have ever boiled water with tea leaves in it, the tea leaves also move in a circular motion. The circular movement of particles in air and water is called **convection current**.

When you boil water, the heat energy at the bottom of the pan causes the water to move up to the surface. The water moves across the surface then down again on the sides. This is repeated continuously for as long as the water is heated.

Convection currents occur because the water at the bottom of the beaker expands as it is heated. It then floats to the top where it begins to cool. As more water rises, it moves the cooler water to the side. The cooler water then sinks to the bottom. This continues for as long as the water is heated.

1 Below is an experiment a science class performed and wrote up. Unfortunately, the experiment is completely out of order. Your task is to rewrite the experiment and draw the diagram in your workbook in the correct order for a procedure text. Make sure you arrange each statement under the correct heading.

Conclusion

Convection currents

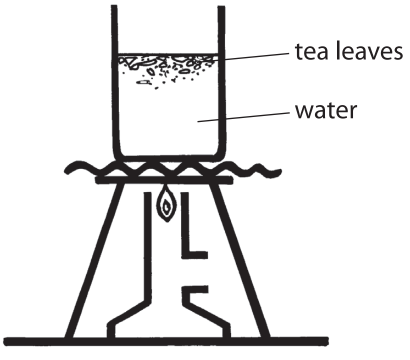
Heading

20 tea leaves, 250 mL beaker, Bunsen burner, tripod, wire gauze, heatproof mat

Results

The tea leaves moved in a circular motion. The tea leaves floated to the top, then across the top and then to the bottom, only to rise to the top again.

1. Set up the experiment as shown in the diagram.



2. Add the tea leaves to the water.
3. Turn on the burner and observe the leaves.

To observe convection currents in water

Method

Aim

Convection currents are created in heated water. As the water becomes hotter, tea leaves show how water moves in a circular motion.

Equipment

2 In the box at the right, draw a diagram to show how the tea leaves moved in the water. Use arrows to indicate the direction of movement.

3 Why did the tea leaves move in a circular motion?

____

____

____

4 Where around you would you find convection currents?

____

____

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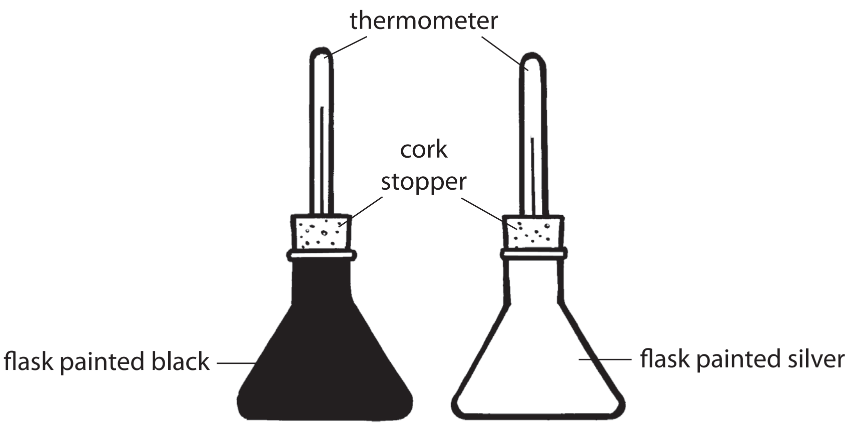
Heat radiation

Don't you just love the warmth of the Sun on your skin on a sunny day? The heat energy from the Sun travels through space, which is a vacuum, to reach Earth. In space there are no particles to conduct the heat energy. The heat travels to Earth by another method, called **radiation**.

Heat radiation travels to Earth as electromagnetic waves, which are invisible to the human eye. Infra-red waves are an example of electromagnetic waves. We cannot see these waves, but we can feel their effects. Objects on Earth can also radiate heat; for example, when you sit near a heater or an open fire you can feel the heat radiating towards you. When infra-red waves hit an object, some of the heat energy is absorbed (taken in) and some is reflected (bounced back) from its surface. This absorption or reflection can happen at different rates – depending on the object.

A group of students carried out two different experiments to test heat emission (heat given out) and heat absorption (heat taken in). They wanted to find out which colours radiate more heat energy and which absorb more heat energy. Their experiments are outlined below.

Experiment 1



A conical flask was painted black and another was painted silver. Each flask was filled with 100 mL of hot water at the same temperature. A cork with a thermometer then sealed the flask. The two flasks were positioned in the same area and the temperature was recorded every minute for 20 minutes.

Results

The temperature at the start of the experiment for both flasks was 85°C. After one minute, the temperature dropped by 1°C for the black flask but remained the same for the silver flask. At two and three minutes into the experiment, the silver flask measured 84.5°C and then 84°C. The black flask on the other hand measured 83.5°C and then 82°C. For the next five minutes, the temperature of the water in the black flask dropped to 81.5, 80, 78, 76.5 and 75°C consecutively. In the silver flask, the water dropped to 83.5, 83, 82, 82, and 81°C. By the ninth minute, they were both 1°C less. Over the next 5 minutes, each conical flask lost quite a bit of heat: The black flask read 73, 71.5, 70, 69.5 and 69. The silver flask was 79.5, 79, 78, 77.5 and 77. After sixteen minutes, the silver flask had dropped to 76°C and the black flask to 66°C.

The next three minutes saw the silver flask drop to 75, 74.5, and 73. It dropped a further 2°C for the twentieth minute. The black flask on the other hand dropped to 65, 63 and 61 and by the twentieth minute it too dropped a further 2°C.

1 Complete the Results table for experiment 1. Label the rows and include the correct units.

Results

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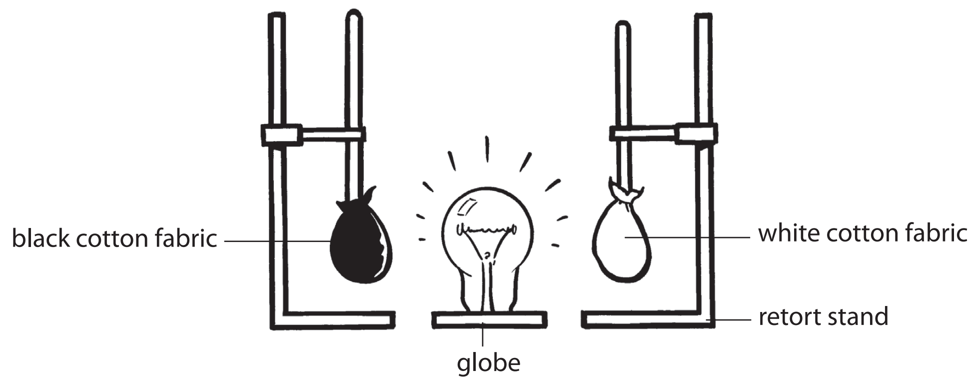
Experiment 2

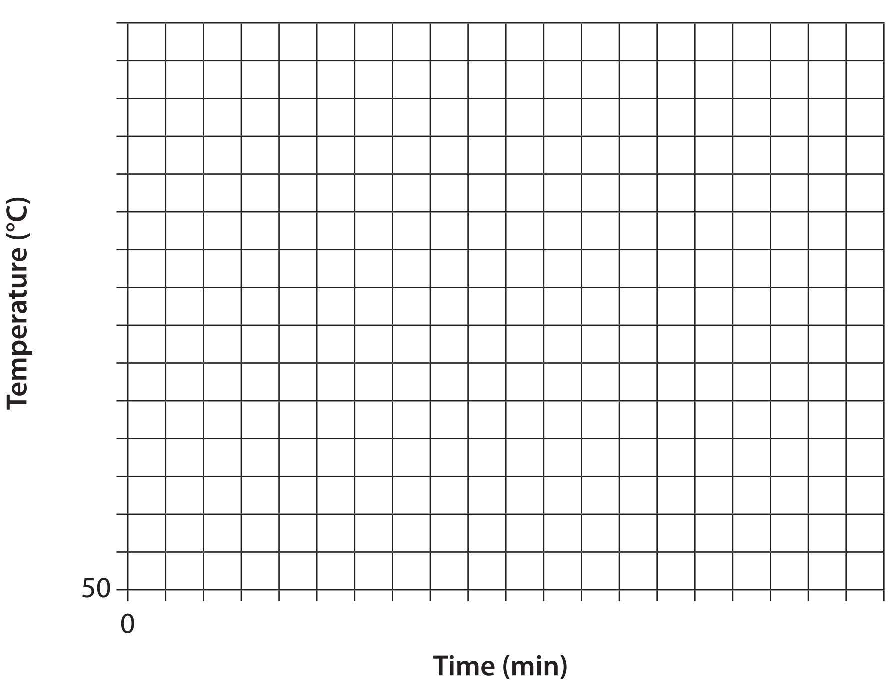


Some black cotton fabric and some white cotton fabric were each cut to a size of 2 cm × 2 cm. The pieces of fabric were wrapped around the bulbs of two separate thermometers. The thermometers were clamped and placed 10 cm from a light globe so that the globe was positioned in the centre. The light globe was switched on and the temperature of each thermometer was recorded every minute for 10 minutes.

Results

Time (min)	0	1	2	3	4	5	6	7	8	9	10
Black fabric Temp. (°C)	23	24	25.5	26	27	27.5	29	30	32	34.5	36
White fabric Temp. (°C)	23	23.5	24	24	24.5	24.5	25	26	27	27.5	28

2 Draw line graphs for the results in experiment 1. Use one colour to show the black flask results and a different colour to show the silver flask results. Don't forget to include a title and a key.



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Heat radiation

3 From your graph, what should the results be at fifteen minutes for experiment 1? Add the answers to your table in question 1.

4 Draw line graphs for the results in experiment 2. Use one colour to show the black fabric results and a different colour to show the white fabric results.

5 **a** Which experiment demonstrated heat emission?

____

b Which experiment demonstrated heat absorption?

____

6 From your graphs:

a which colour emits heat more quickly?

____

b which colour absorbs more heat?

____

7 Which experiment models each situation described below – experiment 1 or experiment 2?

a A black car sitting in the hot sun heated up more than a white car.______

b In summer, cricketers tend to wear light coloured clothing.______

c After 10 minutes of sitting in the bath, the warm water had cooled down.______

8 What do you think would happen in experiment 2 if the thermometers were moved twice the distance away from the globe?

____

9 List the variables that were controlled for experiments 1 and 2. That is, which things were kept the same?

Experiment 1: ____

Experiment 2: ____

10 Complete the table by identifying the independent and dependent variables for both experiments. That is, what did you alter on purpose and what did you then measure?

	Experiment 1	Experiment 2
Independent variable		
Dependent variable		

11 Why was a globe used in experiment 2?

____

12 Using the results and graphs, summarise the students' findings in two sentences.

____

____

____

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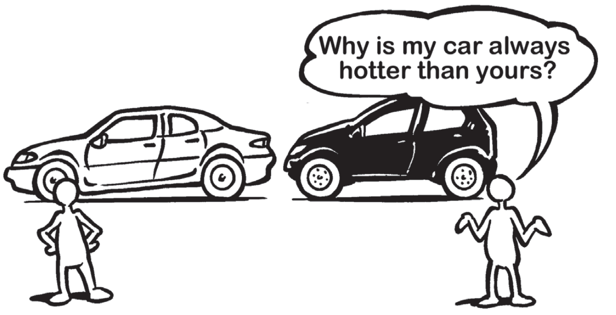
Problems too hot to handle!

Problem 1: Do darker colours absorb more or less heat than lighter colours?

a Describe the problem. That is, what are you trying to find out?



b State a hypothesis for this problem. That is, what could the solution be?

c Write an aim for this problem. That is, what are you trying to do or find out?

d Describe how you would solve this problem. Include a labelled diagram.

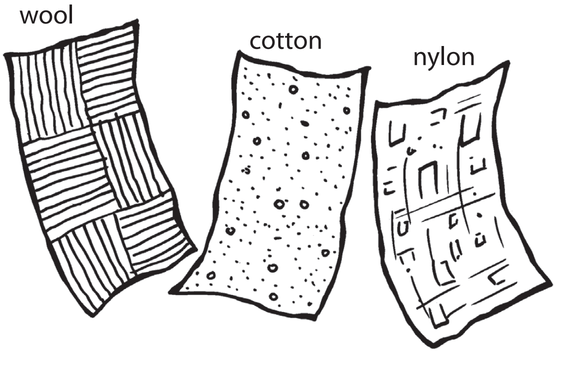
e List the variables you would control. That is, what would you keep the same?

f Identify the independent variable. That is, what do you change on purpose?

g Identify the dependent variable. That is, what would you measure?

Problem 2: Which type of cloth makes the best insulator: wool, cotton or nylon?

a Describe the problem.



b State a hypothesis for this problem.

Problems too hot to handle!

c Write an aim for this problem.

d Describe how you would solve this problem. Include a labelled diagram.

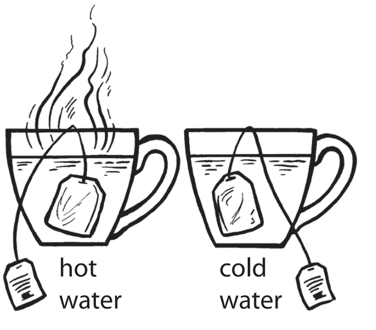
e List the controlled variables.

f Identify the independent variable.

g Identify the dependent variable.

Problem 3: Is the flavour of tea leaves released faster by hot water or cold water?

a Describe the problem.



b State a hypothesis for this problem.

c Write an aim for this problem.

d Describe how you would solve this problem. Include a labelled diagram.

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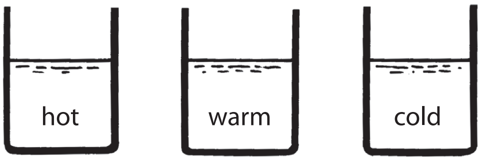
e List the controlled variables.

f Identify the independent variable.

g Identify the dependent variable.

Problem 4: **Which temperature of water will freeze the fastest – hot, warm or cold?**

a Describe the problem.



b State a hypothesis for this problem.

c Write an aim for this problem.

d Describe how you would solve this problem. Include a labelled diagram.

e List the controlled variables.

f Identify the independent variable.

g Identify the dependent variable.

Extension – Describe three more problems that you are curious about and would like to investigate.

ISBN 978 1 92209 083 6

The three laws of thermodynamics

The term thermodynamics comes from the Greek language; thermo has to do with heat, a form of energy, and dynamics refers to movement. So thermodynamics is about how heat energy moves. Three important laws of thermodynamics were developed in the mid 19th century and the early 20th century.

The first law of thermodynamics: Conservation of energy

Energy changes from one form to another, it cannot be created or destroyed. Energy is always conserved. The total amount of energy in the universe stays constant.

When a bar heater gives off heat and also some light, these forms of energy have come from another energy form: electric energy. Neither the heat nor the light were created.

Einstein's famous equation $E = mc^2$ broadened this law. The total amount of energy and matter in the universe stays the same. Therefore, people are able to change some matter into huge amounts of energy, like in a nuclear reactor. In this case, the energy did not come from another form of energy, it came from matter. The law of conservation of energy is only true when the amount of matter stays the same, which is most of the time.

The second law of thermodynamics: Entropy

The word **entropy** means messiness or disorder. Energy systems increase their entropy; that is, they become more and more messy. Look at your bedroom – after a few days, it can look really untidy. Its entropy has increased. If everything in your room ends up on the floor, the potential energy (here gravitational potential energy) has become less. Over time there is more entropy – that is, more chaos, more disorder, more mess – less orderliness and less potential energy.

Furthermore, heat travels from hotter objects to colder ones in order to make everything equally warm. Then it is no longer an ordered system, where heat would be 'over here' and cold would be 'over there'.

The third law of thermodynamics: Absolute zero

All particles of matter have stopped moving when they reach a temperature called absolute zero. Absolute zero is 0 K (Kelvin) or -273°C. At 0 K, gases have practically no volume.

Answer the comprehension questions, writing full sentences which contain the question as well as the answer.

On the lines

1 What language does the term **thermodynamics** come from?

____

2 What is moving in the laws of thermodynamics?

____

3 Does the amount of energy in the universe increase or decrease?

____

4 Does the amount of entropy in the universe increase or decrease?

____

5 What is all matter made of?

____

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The three laws of thermodynamics

Between the lines

6 How old is the earliest law?

7 How old is the youngest law?

8 What is the difference between the law of conservation of energy and the famous equation from Einstein?

9 What does the term **conservation** mean?

10 Does your room have more entropy or energy in the morning? What about the evening?

11 Which is colder: 0 K or 0°C?

Beyond the lines

12 Think of two other terms that contain 'therm'.

13 Suggest why so many scientific terms are based on Greek or Latin words.

14 List five forms of energy.

15 What is the unit of measurement for energy?

16 What is Einstein's famous equation, and what do the symbols in it stand for?

17 What has to happen to increase order in your bedroom?

18 What is the boiling point of water in degrees Celsius and in Kelvin?

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Things here, there and everywhere

We are all surrounded by many things and it would take a very long time to list them all.

1 Think about the different things that surround you throughout the week. List 24 of these things.

____

____

____

____

The things you listed all look, feel, smell and even taste different. We call these differences physical properties. Therefore a physical property of a thing (that is, a substance) is a feature or characteristic that can be used to describe it.

2 In the table below, separate the things you listed in question 1 into two groups. Name your groups.

Group 1:	Group 2:

3 What property did you use to separate the two groups?______________________________

A scientific way of grouping things can be based on their state of matter: solid, liquid or gas. The table below lists some of the properties of solids, liquids and gases.

Properties	Solids	Liquids	Gases
Fixed shape	Yes, they do not take the shape of their container.	No, they take the shape of their container.	No, they take the shape of their container.
Fixed volume	Yes, their volumes do not change.	Yes, their volumes do not change.	No, they fill any available space.
Compressibility	No, they cannot be pushed together.	No, they cannot be compressed.	Yes, they can be compressed.
Diffusion	No, they cannot move and mix.	Yes, they move and mix slowly.	Yes, they move and mix quickly.

4 Use the information in the table above to help you classify your 24 items into the groups solids, liquids and gases.

Solids	Liquids	Gases

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Things here, there and everywhere

In summary, everything around you is matter. There are three states of matter: solids, liquids and gases. Matter is everything that has mass and takes up space.

5 Do all the items in your list:

a take up space?______

b have mass? (That is, can they be weighed using a balance or scale?)______

6 List the properties that can be used to distinguish the items in each pair.

a Water and soft drink______

b Sugar and sand grains______

c Salt and pepper______

d Tennis ball and golf ball______

e Cork stopper and rubber stopper______

f Drawing pin and pin______

7 Write the meaning of each word in the table. Then use each word in a sentence that shows you understand its meaning.

Word	Meaning	Sentence
Diffuse		
Compressed		
Distinguish		
Matter		
Properties		
Fixed		
Similar		

8 Unjumble the sentences.

a similar properties can be grouped together. Substances with

______

b anything Matter is that takes has mass. up space and

______

c compressed. Gases easily can be

______

d fixed and a cannot be Solids have compressed. shape

______

e is example and can an be Air compressed. of a gas

______

f Water is a the shape of its liquid that takes container.

______

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Reports on substances

1 The table below provides information about four different substances. Choose one substance to write a report about.

Information	Water	Oxygen gas	Iron	Milk
Melting point (°C)	0	-219	1 536	-1
Boiling point (°C)	100	-183	2 861	101
State of matter*	Liquid	Gas	Solid	Liquid
Colour	Clear	Clear	Silver, shiny	White, opaque
Weight of 1 L	1.0 kg	1.5 g	7.8 kg	1.1 kg
Mixture?	No	No	No	Yes
Conductor of electricity?	Poor	No	Good	Poor
Conductor of heat?	Poor	Poor	Good	Poor
Pure substance?	Yes	Yes	Yes	No
Source	Rivers, rain	Plants	Iron ores	Cows
Occurrence	Oceans, lakes, ice	Air	Ground	Cows
Chemical symbol	H_2O	O_2	Fe	---
Renewable?	Yes	Yes	No	Yes
Recyclable?	Yes	Yes	Yes	No
Use 1	Living things need it, as well as food.	Living things respire with it.	Cars, bridges, nails (strength!)	First food for calves
Use 2	Many engines are cooled with it.	Burning of things like wood, coal.	In steel: sinks, cutlery	Nutritious drink for people
Comment 1	70% of a human body is water.	Cell respiration releases energy.	Iron is strong but heavy.	Popular drink for children
Comment 2	97% water on Earth is salt water (a mixture).	Burning is also called combustion.	Iron goes rusty easily; it needs to be protected.	Made into cheese, yoghurt, curd, ice cream

* Note: State of matter is taken as state of matter at room temperature (20°C).

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Reports on substances

2 **Collecting information into a scaffold**

Before you start writing your report, you need to collect relevant information into a scaffold. Each box in the scaffold represents one paragraph about a particular aspect. The first scaffold about water with five aspects – one for each paragraph – has been outlined below. The first and second information boxes in the scaffold have been started.

Use the scaffold below the exampe to collect relevant information about the substance you chose.

Example scaffold

Aspect	Information about water
a Classification	*Pure substance; State of matter: liquid*
b Properties	*Melting point 0°C, Boiling point 100°C*
c Production	
d Uses	
e Comments	

Your scaffold

Aspect	Information about:
a	
b	
c	
d	
e	

3 **Ordering your notes**

When you have finished collecting information into your scaffold, number the notes you made in the information column to show the order in which you will write your paragraph sentences.

4 **Writing a report**

Use the ordered information to write the paragraphs about the substance in your workbook.
Remember:

- each paragraph will have the name of the substance near the front
- many sentences will start with the name of the substance or 'It'
- use describing words (adjectives) and linking verbs (like 'has' and 'is').

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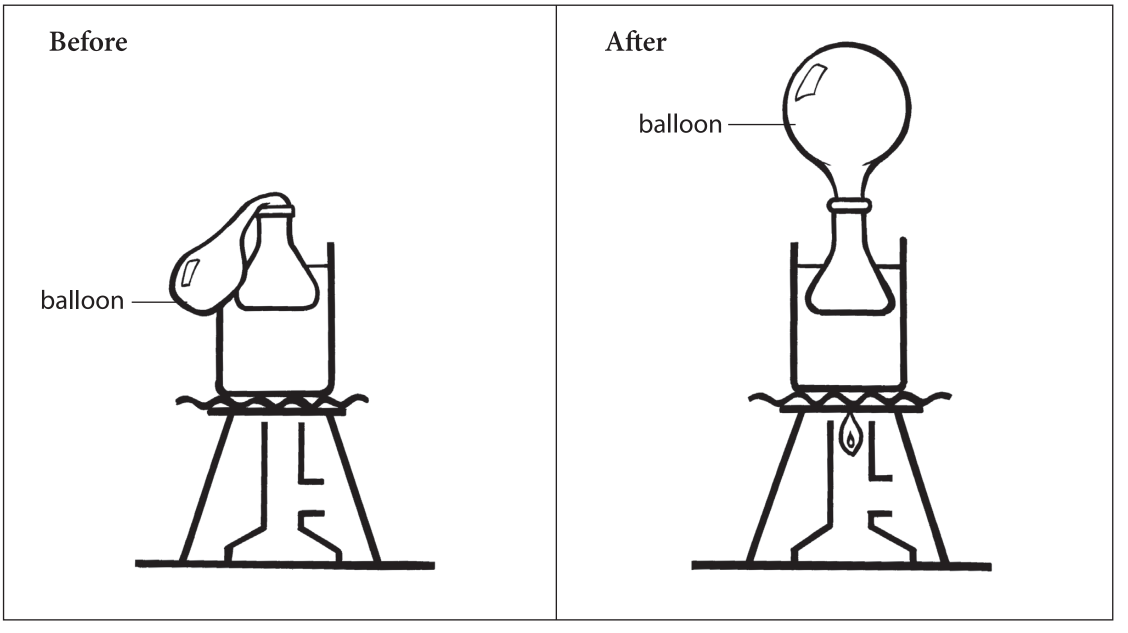
Watch me expand

When a solid, liquid or gas is heated, its particles vibrate or move more rapidly and push each other further apart.

1 The diagrams below show three separate experiments in which a gas, a liquid and a solid are heated. Use the diagrams to help you complete the procedure for each experiment. You need to write the aim, the steps involved in setting up the experiment, the results that you observed and then a conclusion for each experiment.

Experiment 1



Aim – what are you trying to do?

____

Equipment – what things do you need?

____

____

Method – what are the steps involved?

____

____

____

Results – what did you observe?

____

____

Conclusion – what have you learnt?

____

____

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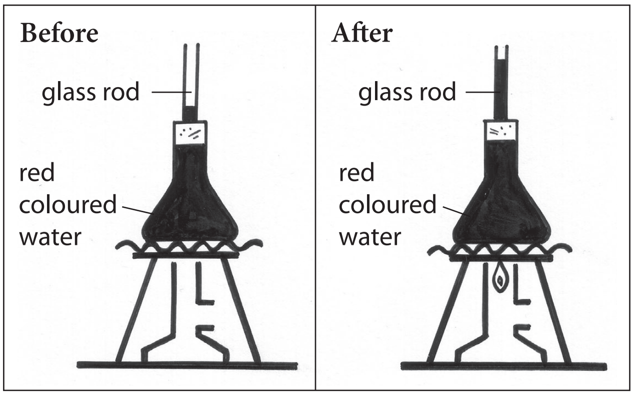
Watch me expand

Experiment 2



Aim: ______________________________

____

Equipment: ______________________________

____

____

Method: ______________________________

____

____

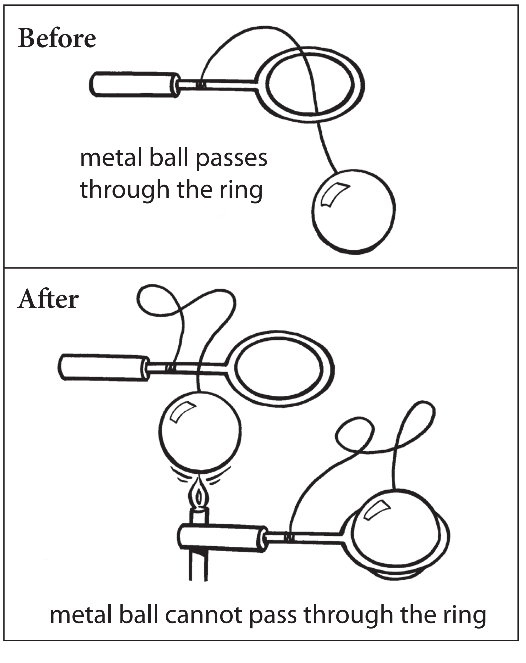
Results: ______________________________

____

Conclusion: ______________________________

____

Experiment 3



Aim: ______________________________

____

Equipment: ______________________________

____

____

Method: ______________________________

____

____

____

____

____

Results: ______________________________

____

Conclusion: ______________________________

____

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Watch me expand

2 a What does **contract** mean? Find out and write a definition.

____

b The experiments clearly show that solids, liquids and gases expand. Can they be contracted?______

c How could you use each experiment to show contraction? Record your ideas in the table.

How to show contraction		
Experiment 1	**Experiment 2**	**Experiment 3**

d Cross out the incorrect terms to make the statements true.

In order to make solids, liquids and gases expand, [heating / cooling] is required. This causes the particles to move [more slowly / faster]. To make solids, liquids and gases contract, [heating / cooling] is required. This causes the particles to move [more slowly / faster].

e From your observations, which state of matter expanded the most? Justify your answer.

____

____

People deal with expanding and contracting solids, liquids and gases every day and use their knowledge to design and build new things. For example, when new bridges are built, expansion gaps must be included, so the bridge does not buckle when it expands in hot weather. Thermometers contain a liquid, either mercury or coloured alcohol, in a bulb connected to a narrow tube. When the temperature rises, the level of the liquid rises as well. Another example is a hot air balloon – it is filled with gas and when the gas is heated, it expands. The expanded air becomes less dense than the colder air, making the balloon rise to great heights.

3 List at least three other examples where expansion and contraction are involved.

____

____

____

____

4 Describe at least two situations where you have noticed solids, liquids and gases around you behaving differently on a cold day or a warm day.

____

____

____

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The particle theory of matter

1 Each state of matter has certain properties, and these properties can be explained by how the particles of matter are behaving. Write the name of the correct state of matter beside each property. Then draw lines to join the properties with the corresponding behaviour of the particles. Note that some properties and behaviours appear more than once. One example has been done for you.

State	Property of state
liquid	**a** Are slightly bigger on heating
	b Can be compressed easily
	c Can be compressed slightly
	d Can be poured
	e Can be poured
	f Cannot be compressed
	g Cannot be poured
	h Fill the container at the bottom
	i Fill the container completely
	j Expand a lot when heated
	k Expand a little when heated
	l Have a constant shape
	m Have constant volume
	n Have constant volume
	o Take on the shape of the container
	p Take on the shape of the container

Behaviour of particles
• Particles are far apart from each other
• Particles are not attracted to each other and move freely
• Particles are not attracted to each other and move freely
• Particles are not attracted to each other and move freely
• Particles are strongly attracted to each other
• Particles don't move freely
• Particles have no spaces between them
• Particles have tiny spaces between them
• Particles move around each other and are attracted to each other
• Particles move faster but still touch each other often
• Particles move freely
• Particles move freely but touch each other
• Particles move much faster
• Particles touch each other
• Particles touch each other
• Particles vibrate more and take up more space

2 The properties of the states of matter can be explained by the behaviour of the particles. This is called the Particle model of matter or the Kinetic model of matter – what the particles do determines what happens to the state. In your workbook, write five complete sentences for each state of matter. In each sentence, include the name of the state, what the property is and how the particles cause this. Here is one example: *Gases can be compressed easily, because their particles are far apart from each other.*

3 **Quick quiz!**

a Which states of matter have mass?

b Which states of matter take up space?

c Which states of matter take the shape of the container?

d Which states of matter do not fill the container completely?

e Which states of matter expand slightly on heating?

f Which states of matter have constant volume?

g Which states of matter can be poured, and are called fluids?

h Which states of matter can be compressed slightly, if at all?

i Which states of matter are made up of particles?

j In which states of matter are the particles moving?

k In which states of matter are the particles attracted to each other?

l In which states of matter are there no spaces between particles?

m In which states of matter do the particles touch each other?

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Investigating the three states of matter 13a

1 What are solids, liquids and gases like? What are the properties of the three states of matter? Draw a tick for true or a cross for false in each cell of the table below.

Property	Solids	Liquids	Gases
Can be weighed			
Have mass			
Occupy space			
Have a fixed shape			
Have a constant volume			
Can be compressed easily			
Expand when heated			
Expand a lot when heated			
Contract when cooled			
Fill the full space of the container			
Take the shape of the container			
Get hot when compressed quickly			

2 Use the information in the table above to write summary sentences about the shared properties of the three states of matter. The first sentence has been started for you.

All states of matter ______________________________

____

____

____

____

____

____

3 Now write sentences about the properties that only one state of matter has. The first sentence has been started for you.

Only gases ______________________________

____

____

____

____

____

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Investigating the three states of matter 13b

The particles that make up matter behave in certain ways: they are attracted to each other, they have a certain distance between each other and they move or vibrate. The behaviour of particles is described in the table below.

Aspect	Behaviour of particles
Attraction	Particles are attracted to each other or not. Some are attracted to each other so strongly that they can't even move. Others have no attraction at all.
Distance	Some particles are very close to each other, while others are far away from each other.
Movement	Particles move around or they don't. Some move freely while others slide around each other.
Vibration	Particles vibrate in their position or don't, but they are not moving around.

4 Refer to the above table to help you complete the table below, about the behaviour of the particles in solids, liquids and gases. Choose from the terms in the word bank.

Word bank

- Close together
- Far apart
- Flying fast
- No
- No
- None
- Sliding around
- Strong
- Very close
- Very strong
- Vibrating
- Yes

Aspect	Particles in a solid	Particles in a liquid	Particles in a gas
Attraction			
Movement			
Vibration			
Distance			

5 Refer to the table above to help you answer the questions.

a Why are the particles so far apart from each other in gases?

____

b Why do the particles in liquids touch each other?

____

c Why don't the particles in a solid move?

____

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Is air really there?

A Science class was learning about air. The teacher said that air is a gas and has the same properties as any other gas.

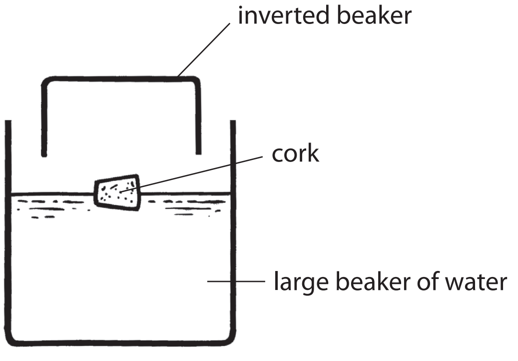
Answer the following questions in your workbook.

1 List three properties of air that make it a gas.

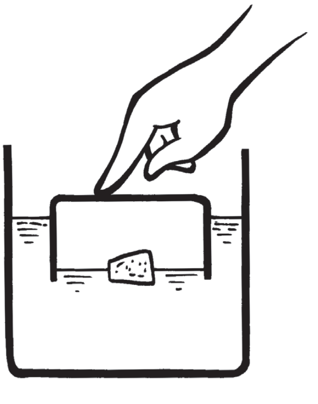
The class was asked to design an experiment to prove that air is a real substance, even though it cannot be seen. The designs and results of group 1 and group 2 are shown below. Study the diagrams carefully, then answer the questions that follow.

Group 1

Experimental set up:

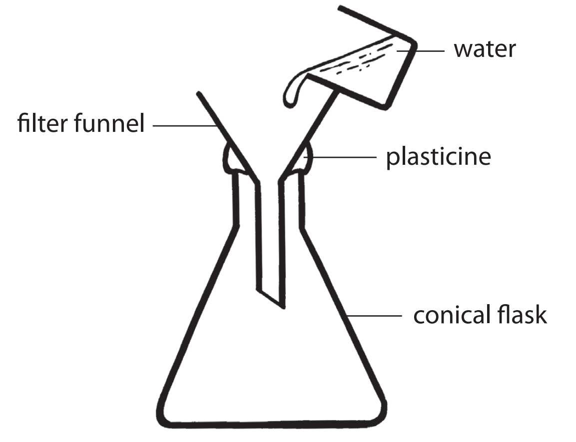


Experimental results:

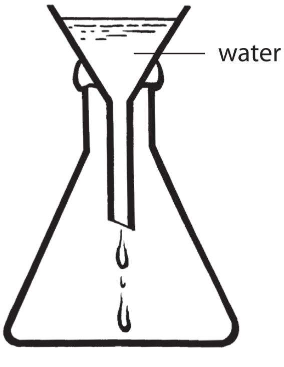


Group 2

Experimental set up:



Experimental results:



2 Describe how group 1 set up their experiment.

3 Describe what group 2 did.

4 Explain why the inverted beaker that group 1 used didn't fill up with water.

5 In group 2's experiment, explain why the water in the filter funnel didn't run out into the conical flask.

6 Explain why the plasticine was placed over the opening of the conical flask.

7 State whether both groups proved that air is really there.

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Particles and their energies

Matter is made up of particles and these particles have energy. When particles move slowly, they have only a small amount of kinetic (or mechanical) energy. When they move or vibrate faster, their kinetic energy increases. Cold substances have less heat energy, while hot substances have more heat energy.

1 Complete the following table about the types and amounts of energy that belong to the particles. Use the following terms for each column and repeat them as often as you need to.
Amount of kinetic energy: *Very little, Little, Some, Much, Very much*.
Amount of heat energy: *Less, Medium, More*.

Particles in matter	Amount of kinetic energy	Amount of heat energy
Cool gas		
Cool liquid		
Cool solid		
Warm gas		
Warm liquid		
Warm solid		
Hot gas		
Hot liquid		
Hot solid		

At a specific temperature, say at a room temperature of 20°C, some matter is solid, other matter is liquid and still other matter is gaseous. Let's assume that the substances all have the same amount of heat energy at this temperature. But how much kinetic energy do the particles in each substance have? (Let's assume that the particles have the same mass.)

2 Which type has the higher amount of kinetic energy:

a particles in a gas or particles in a liquid at the same temperature?____________________

b particles in a solid or particles in a liquid at the same temperature?____________________

c particles in a gas or particles in a solid at the same temperature?____________________

d particles in a gas at 20°C or particles in a gas at 40°C?____________________

e particles in a liquid at -20°C or particles in a liquid at 20°C?____________________

f particles in a solid at 20°C or particles in a solid at 40°C?____________________

Scientists know that substances are made up of particles – this is the particle model of matter. These particles move or vibrate. Therefore, every particle in a substance has a certain amount of kinetic energy. But when this amount of kinetic energy changes, heat energy becomes involved. If you heat a substance, its particles move or vibrate faster and so the substance expands. But if a substance cools (loses some heat), its particles move or vibrate more slowly and so the substance contracts. If you compress a gas, its particles can't move as much any more and so they have less kinetic energy; the 'lost' energy is given out as heat and as a result the surrounding area feels warmer.

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Particles and their energies

3 Explain what is happening to the particles in each of the following situations in terms of energy and heat.

a A party balloon is squashed smaller.

b A party balloon is stretched bigger.

c Gas is released into the air from a deodorant spray bottle. When the gas and deodorant hit your skin, they feel really cold.

d Air is forced through a small valve from a pushbike pump and the valve becomes quite hot.

e As water freezes, its temperature actually goes up a little.

f As ice melts, its temperature drops slightly.

g The refrigerant in the pipes inside the fridge is forced to boil and gets really cold.

h Gaps are left between adjoining railway tracks.

i In winter electricity cables seem to be tighter between poles than in summer.

j When the ocean water's temperature rises by just a few degrees, the level of the ocean goes up (and this is not only because of ice melting).

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How is it possible?

Read each statement about solids, liquids and gases, and then explain it.

1 *Paradox:* It looks like a contradiction, but it is possible. How?

- **a** Dishwashing foam is a gas and a liquid.
- **b** Jelly is a liquid and a solid.
- **c** Most solids sink in water, but ice doesn't.
- **d** Iron sinks in water, but an iron ship floats.

2 *Analogy:* Somehow they are similar. In which way?

- **a** A liquid is like a gas.
- **b** A solid is like a liquid.
- **c** A gas is like a solid.
- **d** A particle in water vapour is like a particle in liquid water.

3 *Discrepancy:* There is a difference. What is it?

- **a** A liquid is not like a gas.
- **b** A solid is not like a liquid.
- **c** A gas is not like a solid.
- **d** Develop a questionnaire which distinguishes between solids, liquids and gases.

4 *Provocation:* It seems impossible, but somehow it works. How?

- **a** A metal is used in thermometers. The metal moves up a scale when things get hotter.
- **b** A metal can containing some water is boiled for a minute, until steam is coming out of the hole at the top. Then the can is put in ice-cold water and the hole is blocked. After a few seconds the can crushes inwards.
- **c** A blown-up balloon is placed in a freezer. After a few minutes, it has shrunk.
- **d** A solid is moved along by a gas.

5 *Tolerance:* Just accept it and go along with it!

- **a** Imagine that water froze at 10°C. Write how your life would be different.
- **b** Imagine that the air contained 50% oxygen instead of the normal 20%. How would your life be different?
- **c** If the oceans were made of fresh water instead of 4% salt water, how could the world be different?
- **d** If air was made up of about 80% oxygen gas and 20% nitrogen gas, what would lungs in mammals, gills in fish and spiracles in insects look like?

6 *Evaluation:* What do you think?

- **a** Explore whether more heat is needed to change a solid to a liquid or a liquid to a gas.
- **b** Gases are better than solids.
- **c** Water freezes at 0°C (i.e. Celsius or Centigrade) and boils at 100°C. But when using my new scale, water freezes at 10°G (i.e. Greef) and boils at 70°G. Which is better?
- **d** Oxygen gas is the most important gas in the world.

7 *Visualisation:* This is what it could look like.

- **a** Draw three scientific beakers with lids. Then draw twenty tiny circles to represent the particles of a solid in the first beaker, a liquid in the second beaker and a gas in the third beaker. Add arrows to show their movement. Label the diagrams.
- **b** Imagine a solid in a beaker is 'poured' onto the table surface. Draw the solid in the beaker and then draw the solid a minute after it has been poured. Repeat with beakers of a liquid and a gas.
- **c** Draw ten dots representing the particles in liquid water at 100°C. Then let the liquid be heated for a little while. Now draw the ten dots again, but as the particles in gaseous water at 100°C. Give each diagram a heading. Since the particles did not become any hotter, what was the heat used for?
- **d** Draw three tiny circles close together, representing three particles in matter. Use arrows to indicate their movement: a short arrow for slow movement and a long one for fast movement. Now draw the particles in a cold solid and then a hot solid. Then do the same for a cold liquid and a hot liquid, and a cool gas and a hot gas.

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Wet and dry thermometers

The other day in science, we did this weird experiment – if that's what you call it. We had two thermometers. And around the bulb of one of them we put wet tissue paper. Then we hung them both off a clamp on a retort stand. Every minute we had to read the temperature on each thermometer.

Both of them started at 20°C. A minute later, the dry thermometer was still 20°C, but the wet one had dropped to 18°C. Next time the wet thermometer had dropped even more to 15°C, while the dry one was still the same as before. At three minutes the dry temperature was 20°C again and the wet one still lower at 11°C.

We missed the temperature of the dry thermometer at four minutes, but the wet one was 10°C. At five minutes the dry temperature was again 20°C and the wet one had gone up to 12°C. The teacher told us all to record the results in a table in our books and check the temperatures again five minutes later. At ten minutes both temperatures were 20°C and we noticed that the tissue was completely dry.

1 Draw and label a scientific diagram of the experiment using a pencil and a ruler.

2 Record the measurements of the experiment in the table below. Don't forget to give each column a title and a unit.

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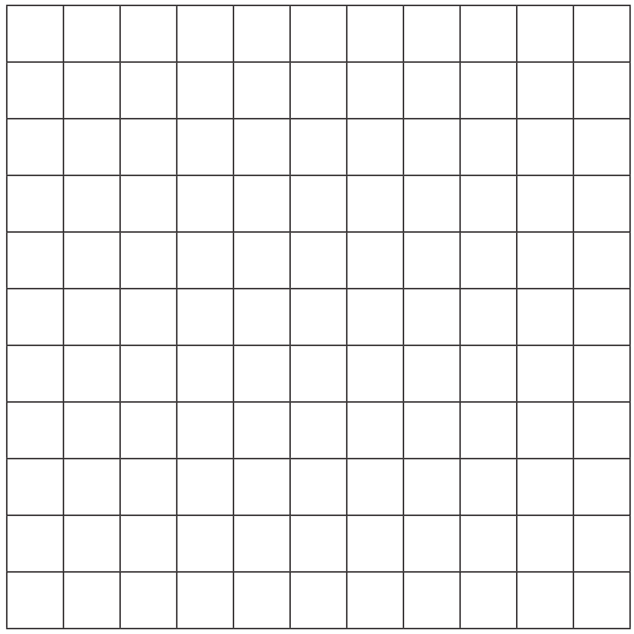
Wet and dry thermometers

3 Label the graph below with a heading and a title and units for each axis. Then plot the information from your table into the graph. Use a blue pen for the dry thermometer and a red pen for the wet thermometer and include a key. Finally, draw a smooth line connecting the blue marks in blue and the red marks in red.



4 Describe the shape of the graph for each thermometer.

5 The wet thermometer started with a wet tissue wrapped around its bulb but ended up with the tissue being dry.

a When was the tissue dry for the first time?

b What happened to the water of the wet tissue?

If we want to explain why the wet tissue became cooler as it dried, we need to look at the particles in the water. That is, we are using the particle model of matter to explain this.

6 **a** How fast are the particles in the liquid water moving?

b How fast are the particles in the gaseous water moving?

c Where did the particles get this extra kinetic energy from?

d If the surrounding, including the thermometer, loses heat energy, what happens to its temperature?

7 Explain how perspiring cools you on a hot day.

8 Suggest why perspiring works well in Alice Springs but not so well in Brisbane.

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Up, up and away – a hot air story

The story of the invention of the hot air balloon begins in the small town of Alchemy in southern France. Two brothers, Joseph and Jacques Montgolfier, were in the paper manufacturing business. They noticed that whenever they burnt paper, the ashes floated up into air. They discovered that the smoke and heat from the burning paper had a lifting quality.

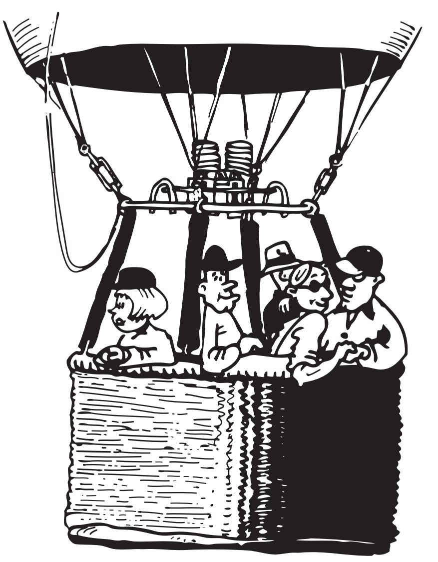
With this in mind, the brothers set out to design a craft that could capture the heat and smoke to allow the craft to lift off the ground. On 19th September 1783, the Montgolfier brothers were successful in creating and launching their invention: a hot air balloon.

Their hot air balloon was made from paper and cloth. They used a combination of chopped wool, straw and dried horse manure for burning in order to inflate the balloon. The straw provided the heat which heated the air inside the balloon. The wool and manure made lots of smoke and kept the flame low so the paper and cloth balloon did not catch fire.

The brothers were a little unsure how the balloon would fly or how safe it was, so they sent sheep, chicken and ducks up in their balloon. Their trials were a success – they managed to keep the animals floating for eight minutes and then land the balloon successfully.

On 21st November 1783, the Montgolfier brothers convinced the King of France to come and see their invention. This time, people would be on board instead of farm animals. Two of their best friends volunteered for the job. The balloon was successfully launched and rose about 150 m above the rooftops of Paris and successfully landed in a vineyard a few kilometres away.

Today, hot air balloons come in all shapes and sizes. The envelope that contains the heated air is made of nylon fabric. The mouth of the balloon which is closer to the flame is made of a fire-resistant material called Nomex. Attached to the envelope is a basket known as the gondola which carries the passengers. Connected above the basket is a burner which injects a flame into the envelope to heat the air. A liquefied gas called propane is stored in a pressure vessel and fuels the burner. At the top of the envelope is a small vent that can be opened briefly while in flight to start a rapid descent. For a slower descent, the air in the balloon is allowed to cool.



So why does the balloon float? Increasing the air temperature inside the envelope makes it lighter than the surrounding air. The balloon floats because of a buoyant force – it is a similar situation to an object floating in water. On a hot day, the balloon must not be loaded as much as it could be on a cool day, because more heat is needed to launch the balloon and too much extra heat could affect the nylon envelope.

Answer the comprehension questions, writing full sentences which contain the question as well as the answer.

On the lines

1 Where did the Montgolfier brothers live?

____

2 What kind of business did they run?

____

____

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Up, up and away – a hot air story

3 What inspired them to make a hot air balloon?

4 What did they send up in their hot air balloons while they were testing them?

Between the lines

5 Use the information in the text to compare and contrast the modern hot air balloons with the Montgolfier brothers' hot air balloon. Summarise your findings in the table below.

Features of the balloon	Montgolfier brothers' hot air balloon	Modern hot air balloons
Shape of the balloon		
Material the envelope is made from		
Fuel used to heat the air		
Other features		

Beyond the lines

6 Why does the air inside the balloon get lighter when it is heated?

7 Explain why the balloon must not be overloaded on a hot day.

8 Modern hot air balloons have a small vent at the top. For a rapid descent, the air vent is opened.
Use the particle theory of matter to explain why a rapid descent occurs.
Include a labelled diagram in your answer.

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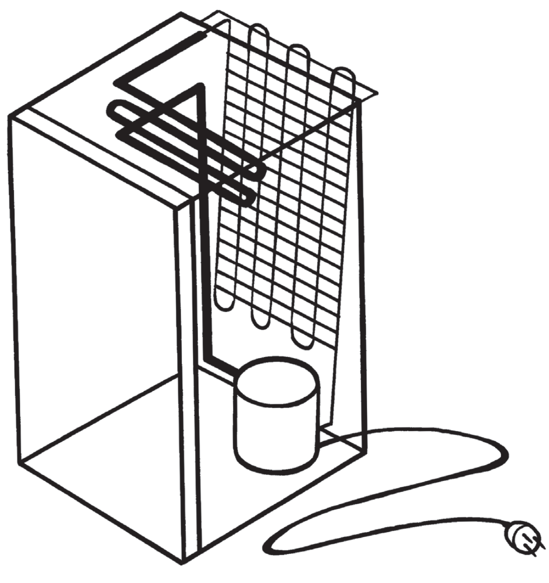
How does the fridge work?

Of course you know that the fridge is cold on the inside. But did you also know that a fridge is warm at the back on the outside? How does the fridge get so cold inside? And why is it warm behind the fridge?

In most fridges, there is a system of pipes on the inside and the outside. The inside pipes are usually fused onto a silver coloured metal plate. Outside at the back, the pipes are connected to many small black metal plates. Where the pipes enter the interior, there is an expansion valve. There is also an electric motor, which is usually under the fridge at the back. This motor runs a compressor.

Inside the pipes is a refrigerant. In old fridges this is Freon, which boils at -30°C. But Freon is one of the gases that destroy the ozone layer in the atmosphere and so it is no longer used. Old fridges should have their Freon taken out professionally. Freon destroys ozone molecules in the atmosphere and so they cannot absorb the dangerous and skin-cancer causing ultraviolet rays from the Sun. These days, different refrigerants are used; for example, ammonia which boils at -32°C and HFC which has a boiling point of -27°C.

1 Use the information above to label the diagram of a fridge.



2 The ordered list of statements below describes what happens in the pipes of a fridge.
Cross out the incorrect words in brackets.

a The compressor pumps the gaseous refrigerant into the *[black / silver]* outside pipes.
b Pressure in the black *[inside / outside]* pipes increases and space decreases.
c The *[gaseous / liquid]* refrigerant particles slow down.
d The kinetic energy of the particles in the black outside pipes becomes *[less / more]*.
e The 'lost' kinetic energy is changed to *[cold / heat]* energy.
f The gaseous refrigerant turns to a warm *[liquid / solid]* refrigerant.
g The black fins around the black outside pipes give off *[gas / heat]* and feel *[cool / warm]*.
h The pressurised liquid refrigerant is forced through the expansion *[pipe / valve]* to the silver inside pipes.
i The *[black / silver]* inside pipes are practically empty and have *[high / low]* pressure.
j The liquid *[air / refrigerant]* particles start to move really fast in the silver inside pipes.
k The liquid refrigerant becomes a *[gas / solid]* in the silver inside pipes.
l The needed *[kinetic / heat]* energy that is taken by the now faster moving particles comes from heat energy.
m The silver inside pipes become *[colder / warmer]* and colder.
n The *[air / heat]* of the air inside the fridge is taken by the very cold silver inside pipes.
o The fridge becomes *[colder / warmer]* inside.
p The silver *[inside / outside]* pipes become a little warmer.
q The gaseous refrigerant is pumped out of the silver inside pipes by the *[compressor / valve]*.

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How does the fridge work? 19b

3 The table below summarises what is happening inside the pipes of a fridge. Use the word bank to complete the table. Note that some words appear more than once.

Word bank

- cold
- gas
- high
- high
- high
- large
- low
- low
- low
- liquid
- small
- very fast
- very slow
- warm

<table>
<tr><th>Aspect of refrigerant</th><th>Immediately after compressor</th><th>In the black outside pipes</th><th>Immediately after expansion valve</th><th>In the silver inside pipes</th></tr>
<tr><td>State of matter</td><td rowspan="7">Gaseous refrigerant condenses into liquid refrigerant</td><td>a</td><td rowspan="7">Liquid refrigerant boils into gaseous refrigerant</td><td>h</td></tr>
<tr><td>Particles' speed</td><td>b</td><td>i</td></tr>
<tr><td>Pressure</td><td>c</td><td>j</td></tr>
<tr><td>Space</td><td>d</td><td>k</td></tr>
<tr><td>Kinetic energy</td><td>e</td><td>l</td></tr>
<tr><td>Heat energy</td><td>f</td><td>m</td></tr>
<tr><td>Temperature</td><td>g</td><td>n</td></tr>
</table>

4 As the refrigerant moves from the black outside pipes to the silver inside pipes and then back again to the black outside pipes, it undergoes changes. Write sentences describing these changes, in terms of each aspect listed below.

a State of matter: ____________________

b Speed of particles: ____________________

c Kinetic energy of particles: ____________________

d Heat energy of refrigerant: ____________________

e Pressure inside pipes: ____________________

f Temperature of pipes: ____________________

5 Complete the following sentences to explain the events in the silver inside pipes of a fridge.

a The silver inside pipes feel cold, because the refrigerant ____________________.

b The refrigerant boils in the silver inside pipes, because its particles ____________________.

c The particles gain kinetic energy, because they move ____________________.

d The particles lose heat energy, but they gain ____________________.

6 In your workbook, write similar sentences to those in question 5 for the events in the black outside pipes.

7 Finally, in your workbook write an explanation about how the inside of a fridge becomes cold.

- Write a brief **title**.
- In the short **introduction**, summarise how the fridge works.
- In a brief **description**, list the important parts of a fridge and where they are.
- In the **explanation sequence** write what is happening to the refrigerant and its particles; refer to kinetic energy and heat energy.
- Finally, in the **conclusion**, write how your life is better because of the fridge.

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Endo and exo

Endothermic and exothermic processes are involved when matter changes from one state of matter to another state.

Endo means 'in', and *exo* means 'out'; *thermic* refers to heat. So in some processes, heat is taken in by the state of matter. At other times, heat is given out by it.

For example, when you heat a test tube of water, the heat from the burner is taken in by the water and the water becomes hotter. This is an **endothermic** process for the water. When the sweat on your skin dries up during perspiration, you feel cooler. The drying water takes in heat which comes from you. As a result, you feel colder. This is also an endothermic process.

1 Below is a list of names and descriptions about changes of states of matter.

a Draw lines to join each process name to the correct process description.

b In the second last column, indicate with a tick if heat from a Bunsen burner is needed for this process. If heat is not needed, draw a cross in the cell.

c In the last column, write whether the process is **endothermic** (i.e. taking in heat) or **exothermic** (i.e. giving out heat).

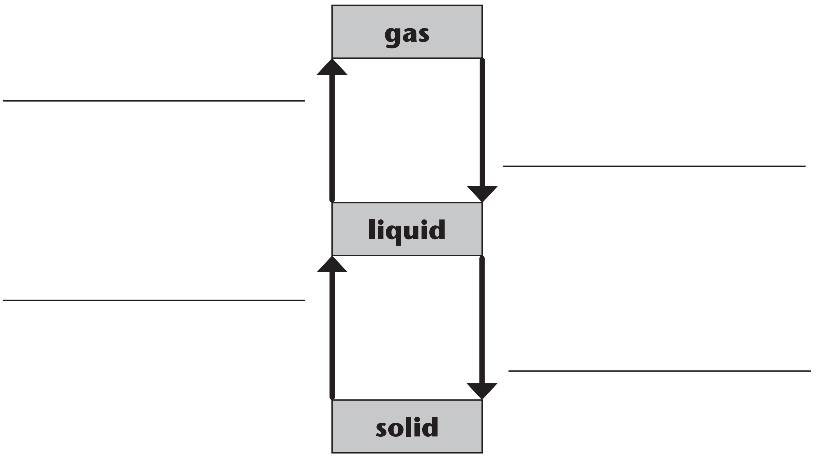
Process name
Boiling
Condensation
Evaporation
Freezing
Fusion
Melting
Sublimation
Sublimation
Warming of solid
Cooling of liquid

Process description	Heat from a burner needed?	Endothermic or exothermic?
Gas to liquid		
Gas to solid		
Liquid getting colder		
Liquid to gas		
Liquid to gas		
Liquid to solid		
Liquid to solid		
Solid getting warmer		
Solid to gas		
Solid to liquid		

2 Look at the diagram below.

a Next to each of the four arrows, write the best name for that process.

b On the three lines below the diagram, write these titles in their correct places: *Endothermic processes, Exothermic processes, States of matter.*



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Endo and exo

3 Use the diagram on the previous page to help you answer the following questions.

a Do the particles in a water vapour or in liquid water have more energy?________________

b Do the particles in liquid water or in ice have more energy?________________

c Do the particles in water vapour or in ice have more energy?________________

4 Think about the movement of particles. Which particles move the least? Which move the most? Write the states of matter in order according to how fast their particles move.

Least movement________________***Most movement***

5 Moving objects have kinetic energy. Write the states of matter in order according to how much kinetic energy their particles have.

Least kinetic energy________________***Most kinetic energy***

6 If particles move faster, their kinetic energy increases. Where do these faster particles get that extra energy from? They take it from around them in the form of heat and then convert it to kinetic energy. As a result, the surrounding area loses heat and becomes cooler.

a Is it an endothermic or exothermic process when particles move faster?________________

b Is it an endothermic or exothermic process when a solid becomes a liquid?________________

c Is it an endothermic or exothermic process when a gas becomes a liquid?________________

7 **a** Now state what happens to the kinetic energy of particles as they slow down.________________

b Do these slowing particles gain or lose energy?________________

c In which energy form would this energy be given out?________________

d Does the surrounding area then become warmer or colder?________________

e Is it an endothermic or exothermic process when particles in a substance slow down?________________

f Is it an endothermic or exothermic process when a liquid becomes a gas?________________

g Is it an endothermic or exothermic process when a liquid becomes a solid?________________

8 During perspiration, water on your skin dries up and you cool down. Explain how that works.

____

____

____

____

9 State whether each situation is endothermic or exothermic.

a Perspiring________________

b Compressing air in a car tyre during a bumpy ride________________

c Expanding propellant when you spray it out of a deodorant can________________

d Water vapour condensing into steam droplets in a cold bathroom during a shower________________

e Ice forming on a lake________________

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Matter – true or false game

Instructions

- Have students play in groups of two to four.
- Each group receives a game board.
- Students cut out the true or false cards.
- Each student cuts out a token and places it on square 1 of the gameboard.
- The teacher reads out each statement (see page 44) one at a time. Students decide whether each one is true or false, and use their true or false card to show their choice before the teacher gives the answer.
- Students with the correct answer move forward one space on the board and students with the incorrect answer remain where they are on the board.
- On the gameboard there are challenge questions which students can choose to answer. If they get the question correct, they move forward two spaces. If incorrect, students move back one space.

Variations

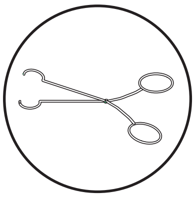
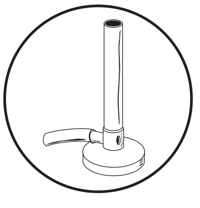
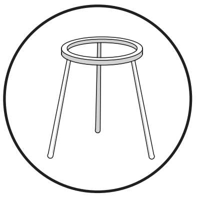
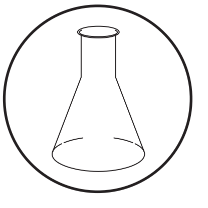
Variation 1 – The teacher could nominate one student in each group to read out the statements.

Variation 2 – The teacher could ask all students to stand. In one hand students hold the true card and in the other they hold the false card. The teacher reads out a statement and all students hold up a card to show their answers. Students with the incorrect response sit down. The game continues until one student remains standing. This is particularly useful for revision at the end of the topic.

True and false cards

TRUE	TRUE	TRUE	TRUE
FALSE	FALSE	FALSE	FALSE

Tokens

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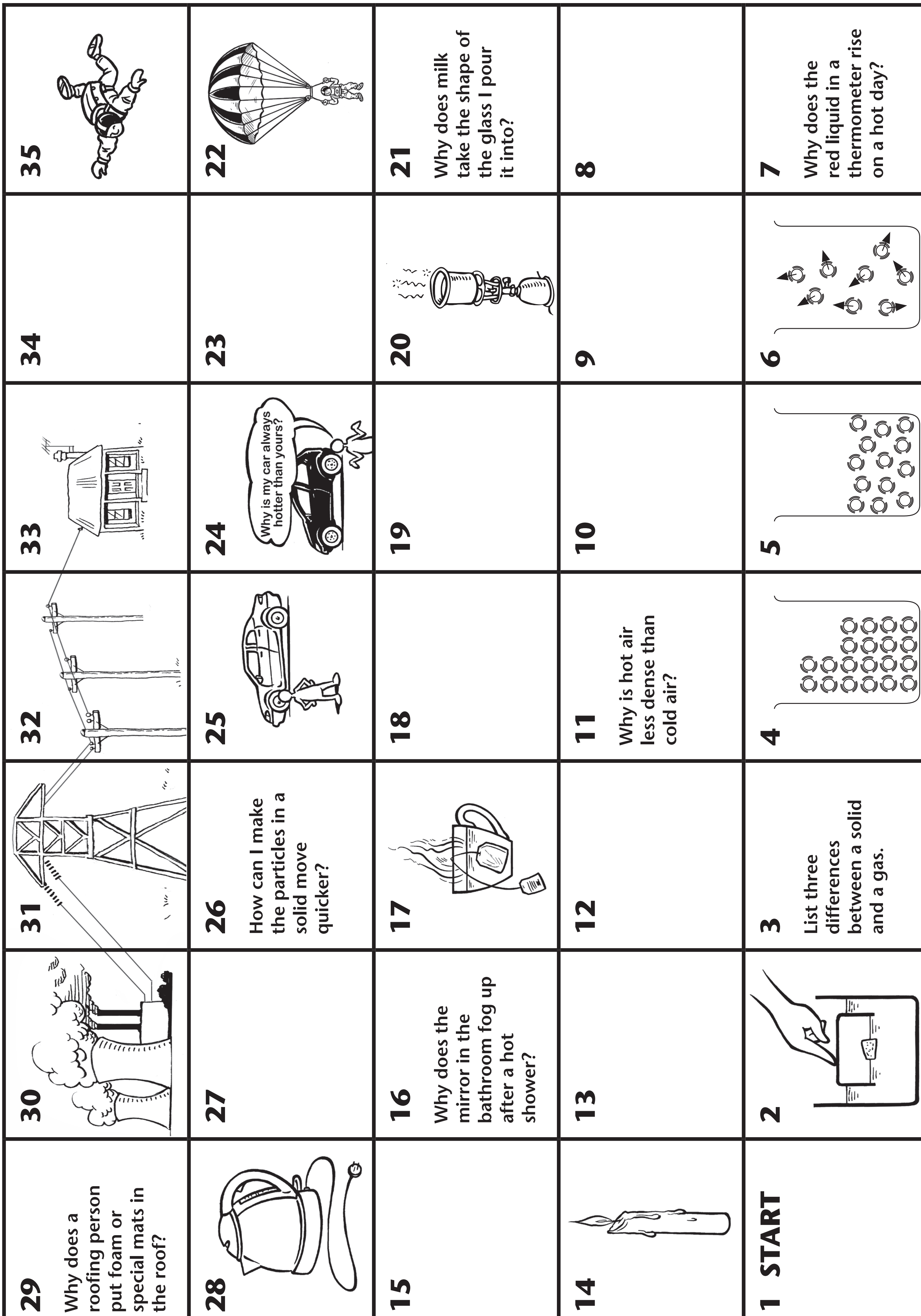
Matter – true or false gameboard



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Matter – true or false game questions 21c

1 Solids have a fixed shape. (T)

2 Liquids have a fixed volume. (T)

3 Oxygen is a solid. (F)

4 Gases can be compressed. (T)

5 Solids can be compressed. (F)

6 One example of a liquid is mercury. (T)

7 Liquids have a fixed shape. (F)

8 Liquids occupy space. (T)

9 Gases do not occupy space. (F)

10 Gases cannot be weighed because they are invisible. (F)

11 Solids and liquids can be weighed. (T)

12 Condensation is the opposite of evaporation. (T)

13 Milk is a solid at room temperature. (F)

14 Ice-cream condenses into a liquid when hot. (F)

15 Ice melts when cold. (F)

16 Solids melt when heated. (T)

17 Iodine solid sublimes into a gas when heated. (T)

18 When most gases cool they become liquids. (T)

19 Dry ice is solid carbon dioxide. (T)

20 The reason pop corn pops is because there is water in the corn. (T)

21 A gas will fill only part of a container. (F)

22 A solid takes the shape of the container it is in. (F)

23 All liquids are colourless. (F)

24 Liquids become gases when heated. (T)

25 Evaporation is the term used when liquid water is heated and turned into water vapour. (T)

26 Water is a solid at room temperature. (F)

27 Everything around us is made of matter. (T)

28 Particles (atoms) can be seen under a microscope. (F)

29 Hot air sinks while colder air rises. (F)

30 Metals are good conductors of heat. (T)

31 Copper makes a good insulator. (F)

32 Air is a good insulator. (T)

33 Vapour condenses on a cool mirror making it look foggy. (T)

34 Solids diffuse quickly. (F)

35 When matter is cooled, particles move faster. (F)

36 When particles move more slowly, they need less room. (T)

37 When particles move faster they need more room. (T)

38 Particles in a liquid are free to move. (F)

39 Easy compression occurs only in gases. (T)

40 There are no forces holding gas particles together. (T)

41 A wooden spoon is a good conductor of heat. (F)

42 We use wood or plastic on handles on saucepans to insulate from the heat. (T)

43 Insulators allow heat to travel through them. (F)

44 Liquids expand when heated. (T)

45 Expanded liquid floats to the top. (T)

46 Hot water is more dense than cold water. (F)

47 Convection currents are circular currents of the particles in the water. (T)

48 When water is heated at the bottom it contracts due to the heat. (F)

49 Dark surfaces absorb more heat energy than lighter surfaces. (T)

50 Radiation is heat energy travelling to Earth. (T)

51 Heat radiation also comes from hot objects on Earth. (T)

52 Shiny, light objects absorb heat energy easily. (F)

53 Bunsen burners are used to produce heat. (T)

54 Bunsen burners are used to freeze water. (F)

55 Dark coloured cars heat up more than lighter coloured cars. (T)

56 The rate of expansion in solids, liquids and gases is the same. (F)

57 Gases contract faster than solids. (T)

58 A black can absorbs less heat than a silver can. (F)

59 The cold lid of a saucepan which contains boiling water can cause the water vapour to condense. (T)

60 A bushfire is a good example of an exothermic reaction. (T)

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Selected answers

1: Energy what?

1 can have, need, need, keep, need, need, eat, change; is, is, makes, causes; are, is called, is called; are, is, could release, is, let go, becomes, is, have, race, is, have, are, becomes, travels, travels, can even travel, is, has, is kept, is changed, are released, is carried, comes.

2 Chemical, potential; elastic, potential; chemical/light, potential; elastic, potential; mechanical, moving; sound, moving; gravitational, potential; heat/light, moving.

3 Electric → heat, electric → sound, chemical → kinetic, electric → sound, electric → light, electric → kinetic, electric → heat, kinetic, chemical → heat, light.

2: Types of energy

1 **a** Energy stored inside molecules, P. **b** Energy stored in a stretched or compressed material, P. **c** Electrons travelling through a conductor, M. **d** Energy in objects being held up high, P. **e** Infra-red waves travelling away from hot objects, M. **f** Things that are moving, M. **g** Light waves travelling away from coloured objects, M **h** Energy stored inside the nucleus of atoms, P. **i** Sound waves travelling through matter, M

2 **Moving:** electric, heat, kinetic, light, sound
Potential: chemical, elastic, gravitational, nuclear

3 Energy form – elastic, elastic, gravitational, mechanical, light, nuclear, chemical, heat, sound.
Energy group – potential, potential, potential, moving, moving, potential, potential, moving, moving

4 Initial energy forms – electric, electric, electric, electric, chemical, electric, electric, chemical, chemical, electric, mechanical, chemical.
Final energy forms – light, heat; light, sound, heat; heat; mechanical, heat, sound; heat, light; heat, light; mechanical; mechanical, sound, heat; mechanical; mechanical, sound, heat; sound; sound, light, mechanical.

5 Other examples could include: gas stove, heat, light; light bulb, light, heat; television, sound/light, heat; petrol lawnmower, mechanical, sound/heat; electric drill, mechanical, sound/heat.

6 eyes, ears, nose, tongue, <u>skin</u>

7 **a** Eyes **b** Ears **c** Skin **d** Nose **e** Ears **f** Skin

3: What goes up must come down

1 **a** Chemical, mechanical and gravitational, gravitational, mechanical and gravitational, elastic and sound
b Chemical, kinetic and potential, potential, kinetic and potential, elastic and sound

2 **a** At the beginning and end **b** At the top
c At the top **d** At the beginning and end

3 **a** KE = $\frac{1}{2}mv^2 = \frac{1}{2} \times 50 \times 10 \times 10 = 2\,500$ J
b KE = $\frac{1}{2}mv^2 = \frac{1}{2} \times 1000 \times 20 \times 20 = 200\,000$ J = 200 kJ

4 **a** PE = $mgh = 50 \times 10 \times 100 = 50\,000$ J = 50 kJ
b PE = $mgh = 1\,000 \times 10 \times 10 = 100\,000$ J = 100 kJ

4: Heat conduction - recount

1 Corrections to spelling mistakes: thought, would, before, chopped, added, drawer, chose, metal, decided, soup; picked, stir, surprise, become, immediately, spoon, leave, see; transferred, conductors; wooden, insulators, heat, through; experiment, travel, different, wood, plastic; diagram, experiment.

2 Sample answer: Over a hot plate, Michael set up a large beaker of water. He connected 5 rods of the same length and diameter (1 copper, 2 iron, 3 glass, 4 wood, 5 plastic) shared between two retort stands. The rods were inserted into the beaker of water. On top of each rod he secured a match stick held with wax to all the rods. He timed how long it took for heat to travel up the rods and melt the wax therefore dropping the match stick.

3 Results showed that the glass, wood and plastic rods did not allow heat to travel through. Match sticks remained on top of these rods for over 20 minutes. On the other hand, the metal rods of iron and copper lost their match sticks in a matter of minutes. This experiment is consistent with the soup incident.

4 Michael used the some water bath. The rods were the same length and diameter.

5 Michael should repeat his experiment at least 2 more times.

6 Conductors: iron and copper
Insulators: glass, plastic and wood

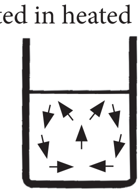
7 e.g. Wood around saucepan handles, insulating bats between roof and ceiling, plastic handles on irons

8 Different metals transfer heat at different rates. Results showed that copper allows heat to move through faster than iron. The match stick fell off the copper rod much quicker (8 minutes compared to 11.8 minutes for iron).

5: A convection mix-up

1 **Heading:** Convection currents
Aim: To observe convection currents in water
Equipment: 20 tea leaves, 250 mL beaker, Bunsen burner, tripod, wire gauze, heatproof mat.
Method:
1. Set up the experiment as shown in the diagram.
2. Add the tea leaves to the water.
3. Turn on the burner and observe the leaves.

Results: The tea leaves moved in a circular motion. The tea leaves floated to the top, then across the top and then to the bottom, only to rise to the top again.
Conclusion: Convection currents are created in heated water. As the water becomes hotter, tea leaves show how water moves in a circular motion.



2 Tea leaves move in a circular motion:

3 Hot water from the bottom of the beaker rises, the leaves move across the surface and cool, becoming more dense, then sink on the other side.

4 e.g. In a shower, boiling small pieces of vegetables

6: Heat radiation

1

Time (min)	0	1	2	3	4	5	6	7	8	9
Silver flask (°C)	85	85	84.5	84	83.5	83	82	82	81	80
Black flask (°C)	85	84	83.5	82	81.5	80	78	76.5	75	74

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Selected answers

10	11	12	13	14	15	16	17	18	19	20
79.5	79	78	77.5	77		76	75	74.5	73	71
73	71.5	70	69.5	69		66	65	63	61	59

3 Silver flask – 76.5°C. Black flask – 67°C.
5 **a** Experiment 1 **b** Experiment 2
6 **a** Black **b** Black
7 **a** Experiment 2 **b** Experiment 2 **c** Experiment 1
8 They would take longer to absorb the heat.
9 Experiment 1: same size conical flasks, placed in same position. Experiment 2: same size and type of cotton material, same distance from the globe.
10 Experiment 1: Independent variable – colour of flask. Dependent variable – temperature of flask. Experiment 2: Independent variable – colour of cotton material. Dependent variable – temperature of heat absorbed.
11 Because the globe emits heat.
12 Darker colours tend to absorb and emit more heat. Lighter colours tend to absorb and emit less heat.

8: The three laws of thermodynamics

1 Greek
2 Energy
3 Stays the same
4 Increases
5 Particles
6 About 150 years
7 About 100 years
8 Einstein includes matter.
9 To keep the same
10 More energy in the morning and more entropy in the evening
11 0 K
12 e.g. exothermic, endothermic, thermos, thermal
13 They are the languages of early scientists.
14 e.g. Heat, light, electricity, chemical, nuclear
15 Joule or J
16 E = mc2 where E = energy; m = mass; c = speed of light
17 Put in energy by placing things on shelves.
18 100°C and 373 K

9: Things here, there and everywhere

1 e.g. Air, water, soil, paper, pens, table, chair, window, taps, milk, orange juice, coke, chocolate, bread, fork, drinking glass
2 Students can group in a variety of ways, such as metals and non-metals or living and non-living.
5 **a** Yes **b** Yes
6 **a** No bubbles of gas, bubbles of gas **b** Sugar dissolves in water, sand doesn't dissolve. **c** Salt dissolves in water, pepper floats on water. **d** Tennis ball is lighter and softer; golf ball is smaller and heavier. **e** Cork floats in water, rubber stopper sinks in water. **f** Drawing pins has a larger head and is shorter in length, pin has a smaller head and is longer in length.
7 Meanings: diffuse – spread out; compressed – squeezed together; distinguish –to notice the difference between things; matter – a substance that takes up space and has mass; properties – features or characteristics; fixed – not moving; similar – the same.
8 **a** Substances with similar properties can be grouped together. **b** Matter is anything that has mass and takes up space. **c** Gases can be easily compressed. **d** Solids have a fixed shape and cannot be compressed **e** Air is an example of a gas and can be compressed. **f** Water is a liquid that takes the shape of its container.

11: Watch me expand

1 (Sample answer) **Experiment 1** – **Aim:** To find out if gases expand when heated. **Equipment:** balloon, conical flask, beaker, wire gauze, tripod, Bunsen burner. **Method:** 1. Set up Bunsen burner. 2. Half-fill a beaker of water and heat over Bunsen burner. 3. Stretch the opening of a balloon to cover the top of an empty conical flask. 4. Place the conical flask in the water bath. 5. Observe what happens to the balloon. **Results:** The balloon expanded as the water got hotter. **Conclusion:** Air is a gas. It expands when heated.
2 **a** To become smaller **b** Yes **c** **Experiment 1** – place the conical flask with the expanded balloon in a large beaker containing ice. **Experiment 2** – place the conical flask filled with water in a large beaker containing icy water. **Experiment 3** – place the hot ball in some cold water. The ball should then fit through the ring. **d** heating, faster, cooling, more slowly. **e** Experiment 1 – Gases expanded the most. The size of the balloon changed dramatically after the gas was heated.
3 For example: when opening a jam jar, the metal lid can be held under hot water to expand the lid; a metal shed door has large gaps in winter, and in summer the gaps are smaller; railway tracks have gaps to allow the rails to expand on hot days.
4 For example, power lines sag more on hot days; on hot days, rooms upstairs are warmer than rooms downstairs.

12: The particle theory of matter

1 **Gases:**
b Particles are far apart from each other. **d** Particles are not attracted to each other and move freely. **i** Particles move around each other and are attracted to each other. **j** Particles move much faster. **o** Particles move freely.
Liquids:
a Particles move faster but still touch each other often. **c** Particles have tiny spaces between them. **e** Particles are not attracted to each other and move freely. **h** Particles are not attracted to each other and move freely. **m** Particles touch each other. **p** Particles move freely but touch each other.
Solids:
f Particles have no spaces between them. **g** Particles don't move freely. **k** Particles vibrate more and take up more space. **l** Particles are strongly attracted to each other. **n** Particles touch each other.
3 **a** All states: solid, liquid and gas **b** All states **c** Gas, liquid **d** Liquid, solid **e** Solids, liquid **f** Liquid, solid **g** Liquid, gas **h** Liquid **i** All states **j** Solid, liquid **k** Solid, liquid **l** Solid **m** Solid, liquid

 ISBN 978 1 92209 083 6

Selected answers

13: Investigating the three states of matter

1

Property	Solids	Liquids	Gases
Can be weighed	✓	✓	✓
Have mass	✓	✓	✓
Occupy space	✓	✓	✓
Have a fixed shape	✓	✗	✗
Have a constant volume	✓	✓	✗
Can be compressed easily	✗	✗	✓
Expand when heated	✓	✓	✓
Expand a lot when heated	✗	✗	✓
Contract when cooled	✓	✓	✓
Fill the full space of the container	✗	✗	✓
Take the shape of the container	✗	✓	✓
Get hot when compressed quickly	✗	✗	✓

4

Aspect	Particles in a solid	Particles in a liquid	Particles in a gas
Attraction	Very strong	Strong	None
Movement	Vibrating	Sliding around	Flying fast
Vibration	Yes	No	No
Distance	Very close	Close together	Far apart

5 **a** No attraction, flying fast **b** Strong attraction, close together **c** Very strong attraction, very close together

14: Is air really there?

1 Can be compressed, takes the shape of its container, can be weighed and has mass

2 Group 1 filled a beaker of water and placed a cork in the beaker. They inverted a second, smaller beaker over the floating cork and pressed the small beaker until it touched the bottom of the large beaker.

3 Group 2 placed a filter funnel in a conical flask and completely covered the opening of the flask with plasticine. They then poured water into the funnel.

4 Because it contains air

5 Because the flask contained air

6 So no air could escape the flask as the water entered it

7 Yes

15: Particles and their energies

1

Particles in matter	Amount of kinetic energy	Amount of heat energy
Cool gas	Some	Less
Cool liquid	Little	Less
Cool solid	Very little	Less
Warm gas	Some	Medium
Warm liquid	Little	Medium
Warm solid	Little	Medium
Hot gas	Much	More
Hot liquid	Much	More
Hot solid	Some	More

2 **a** Gas **b** Liquid **c** Gas **d** Gas at 40°C **e** Liquid at 20°C **f** Neither – they are not moving

3 **a** Less kinetic energy of particles, more heat. So balloon gets warmer. **b** More kinetic energy needed, less heat. So balloon gets colder. **c** More kinetic energy, less heat. So deodorant gets cold on skin. **d** Less kinetic energy, more heat. So valve feels hot. **e** Less kinetic energy, more heat. Water becomes warmer. **f** More kinetic energy, less heat. So ice becomes colder. **g** Much more kinetic energy, much less heat. So fridge pipes feel really cold. **h** When it's hot, particles vibrate more and the tracks expand. Without gaps the track would buckle. **i** Cables lose heat, particles vibrate less and so the cables shorten. **j** When the ocean gets warmer, particles have more kinetic energy and take up more space and so the ocean expands.

16: How is it possible?

1 Answers will vary. **a** Foam is full of air, yet the bubbles are wet. **b** Jelly stands up like a solid but can be squashed into another shape like a liquid. **c** Most solids are denser than water and so sink, while ice is less dense than water and therefore floats on water. **d** The density of iron is higher than that of water, while the density of a ship, which is made up of iron and air, is less.

2 **a** Particles move in both. **b** Particles attract each other and are very close to each other. **c** Both are made of particles. **d** Water particles are the same no matter where they are; they are made of hydrogen and oxygen.

3 **a** Particles in liquids attract each other, particles in gases do not. **b** A solid keeps its shape, a liquid doesn't. **c** A gas fills the whole container, a solid keeps its size and shape. **d** Does it keep its shape? (Solid) Does it stay at the bottom of the container? (Liquid) Does it spread out in a container? (Gas)

4 **a** The metal is mercury, which is a liquid and can flow in the glass tube of the thermometer when it expands. **b** The steam condenses into liquid water when cooled. Liquid water takes up very little space (the inside of the can becomes like a vacuum) and the air around the can pushes it together. **c** Air contracts a lot when it is cooled. **d** When you blow through a blocked straw, your air pushes the solid blockage away.

6 **a** Particles in solids don't move, but particles in liquids move slowly and therefore require little amounts of energy; but if the particles of the substance change their slow speed in a liquid to the high speed in a gas, much more energy is needed. **c** Centigrade is better, because it starts with 0 and finishes with 100 and so is easier to use; the Greef scale starts and finishes with awkward numbers. **d** Every living thing needs oxygen to live. Oxygen is needed for burning and releasing energy.

17: Wet and dry thermometers

2

Time (min)	Temp. of dry thermometer (°C)	Temp. of wet thermometer (°C)
0	20	20
1	20	18
2	20	15

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3	20	11
4	?	10
5	20	12
10	20	20

3 Time on the horizontal axis (0 to 10 min); temperature on the vertical axis (10 to 20°C)

4 The line for the dry thermometer stayed the same throughout the experiment (at 20°C), while the wet thermometer dropped from 20°C to 10°C and then went up again to 20°C.

5 **a** At 4 min. **b** The water evaporated into the air.

6 **a** Slowly **b** Fast **c** From the tissue and surrounding area **d** It drops, i.e. it gets colder.

7 Your skin cells excrete water onto the skin. As the water evaporates, it cools the skin. When the particles in the liquid, which move slowly, take on extra kinetic energy in the gas, whose particles move fast, heat energy is taken in from the skin making it colder.

8 Alice Springs has dry air and it is easy for the water in sweat to evaporate thus cooling the skin. But Brisbane has much more humid air, so it is harder for water to evaporate and the skin stays wet making you feel hot.

18: Up, up and away – a hot air story

1 Town of Alchemy in southern France

2 Paper manufacturing business

3 Observing that smoke and heat from burning paper had lifting qualities

4 Sheep, chickens and ducks

5

Features of the balloon	Montgolfier brothers' hot air balloon	Modern hot air balloons
Shape of the balloon	Round	All shapes and sizes
Material the envelope is made from	Paper, cloth	Fire resistant material, Nomex and nylon
Fuel used to heat the air	Chopped wool, straw, dried horse manure	Propane gas
Other features	No vent	Small vent at the top

6 Its particles have more kinetic energy, become less dense than surrounding air.

7 More heat needed, extra heat could damage the nylon balloon.

8 Releasing the hot air causes the inside of the balloon to become denser because the hot air is replaced by cooler air. Cooler air is more dense, therefore a rapid descent occurs.

19: How does the fridge work?

2 **a** black **b** outside **c** gaseous **d** less **e** heat **f** liquid **g** heat, warm **h** valve **i** silver, low **j** refrigerant **k** gas **l** kinetic **m** colder **n** heat **o** colder **p** inside **q** compressor

3 **a** liquid **b** very slow **c** high **d** small **e** low **f** high **g** warm **h** gas **i** very fast **j** low **k** large **l** high **m** low **n** cold

4 **a** The liquid refrigerant outside becomes a gas inside. **b** Slow speed outside becomes high speed inside. **c** Low kinetic energy outside becomes high kinetic energy inside. **d** Warm heat outside becomes low heat inside. **e** High pressure outside becomes low pressure inside. **f** Warm outside pipes and cold inside pipes.

5 **a** boils/evaporates. **b** move freely. **c** faster. **d** kinetic energy.

7 Sample answer: The refrigerant inside the fridge pipes boils inside the fridge and so makes it cold.

The fridge has silver pipes inside the fridge and black pipes outside at the back. An electric pump moves the refrigerant into the black pipes and an expansion valve is at the beginning of the silver pipes. The electric pump pushes the gaseous refrigerant from the silver pipes into the black pipes.

As the refrigerant is compressed, its particles move more slowly and the gas condenses into a liquid. The lost kinetic energy of the particles is given out as heat and therefore the black pipes feel warm. When the liquid rushes through the expansion valve into the silver pipes, the refrigerant particles move really fast: the refrigerant is evaporating or boiling. Because the particles of the gas move much faster, they have extra kinetic energy. This extra energy is taken in as heat. As a result, the refrigerant becomes cold. The silver pipes and the inside of the fridge also lose heat and become cold. Eventually the pump pushes the refrigerant gas from the silver pipes back into the black outside pipes.

Fridges let us store food and keep it fresh. Therefore we don't have to shop everyday.

20: Endo and exo

1 Boiling – liquid to gas ✓ endo
Condensation – gas to liquid ✗ exo
Evaporation – liquid to gas ✓ endo
Freezing – liquid to solid ✗ exo
Fusion – liquid to solid ✗ exo
Melting – solid to liquid ✓ endo
Sublimation – solid to gas ✓ endo
Sublimation – gas to solid ✗ exo
Warming of solid – solid getting warmer ✓ endo
Cooling of liquid – liquid getting colder ✗ exo

2 **a** Solid → ***melting*** → liquid → ***evaporation or boiling*** → gas → ***condensation*** → liquid → ***freezing or fusion*** → solid
b [From left to right] Endothermic processes, States of matter, Exothermic processes

3 **a** Vapour **b** Liquid **c** Vapour

4 Solid, liquid, gas

5 Solid, liquid, gas

6 **a** Endothermic **b** Endothermic **c** Exothermic

7 **a** Less kinetic energy **b** Lose **c** Heat **d** Warmer **e** Exothermic **f** Endothermic **g** Exothermic

8 As the water on your skin evaporates, the water particles move much faster in the gaseous state of matter. This extra kinetic energy is taken in as heat from the skin. Therefore the skin loses heat and so becomes colder.

9 **a** Endothermic **b** Exothermic **c** Endothermic **d** Exothermic **e** Exothermic

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