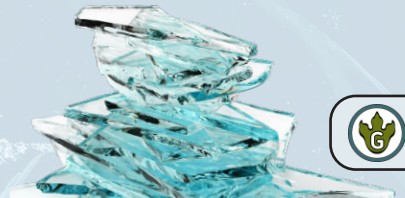
Properties and changes of materials

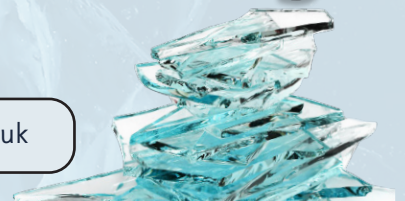
How do materials change?

Lesson 2

Which material will keep a hot drink warm the longest?









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Scientific enquiry types and skills



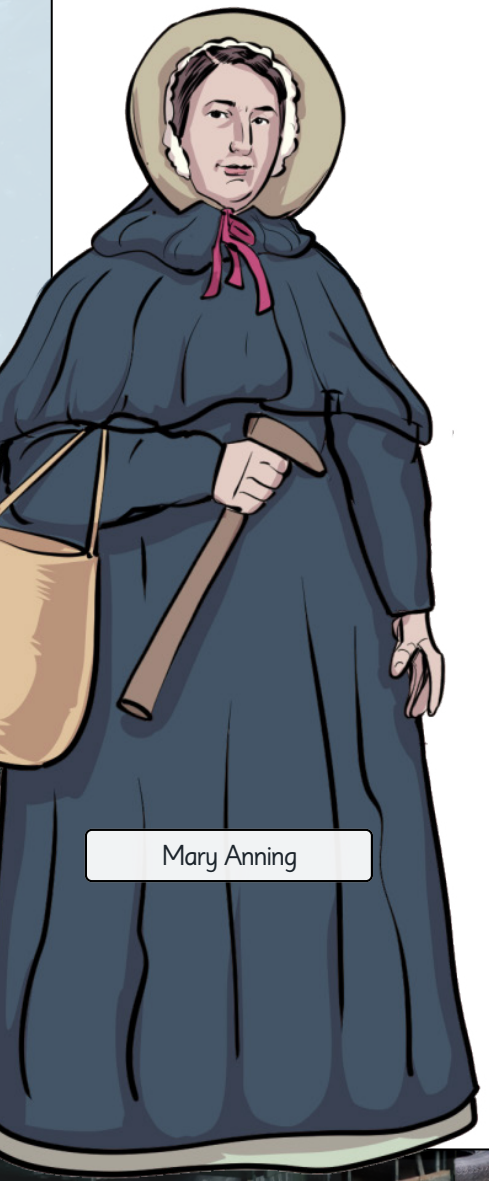
Scientific enquiry types

- Testing ✓
- Researching
- Observing
- Pattern seeking
- Identifying & classifying
- Problem solving

Working scientifically skills

- Asking questions
- Making predictions
- Setting up tests ✓
- Observing & measuring ✓
- Recording data
- Interpreting & communicating results
- Evaluating

How do materials change?



Lesson 1: How can we sort these materials?

Lesson 2: Which materials will keep a drink warm the longest?

Lesson 3: Why does sugar disappear in water but sand doesn't?

Lesson 4: How can we make something dissolve *faster*?

Lesson 5: How can we clean muddy water?

Lesson 6: How can we get the salt back out of salty water?

Lesson 7: Why can't we "un-cook" an egg?



Key vocabulary for this lesson



compare – to see how things are the same and how they are different



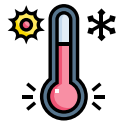
conclusion – a statement that uses our results to explain what we found out



measure – to find out the size, amount, or degree of something using a tool



prediction – a statement saying what we think will happen

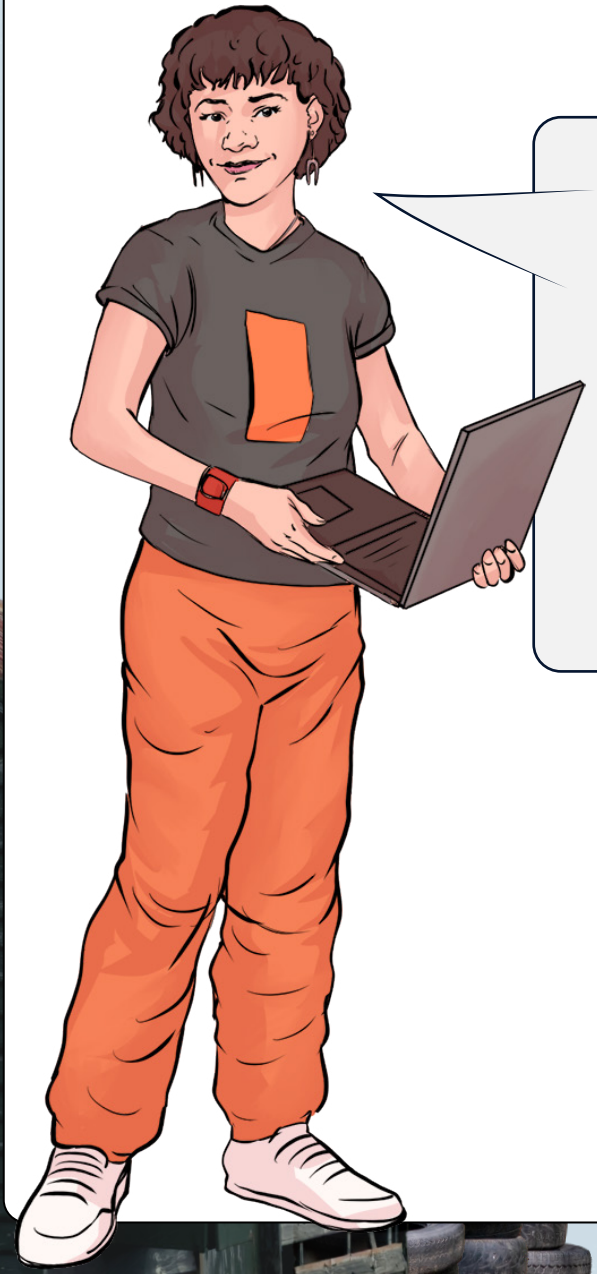


temperature – how hot or cold something is



variable – something that can be changed

Testing



Hello, I'm Hannah. I design products that need to work reliably and make everyday life easier, from water bottles to travel mugs. I've been asked to create a new sleeve for a hot-drink cup, and before I can choose the right material, I need to **compare** how well different materials perform. To do that, I carry out tests where I keep everything the same except the material I'm investigating. Careful testing helps me judge how effective each material is.



Let's recap

We can describe a material's **properties** by describing what it is like or how it behaves. In the last lesson, we tested properties such as rigid, flexible, waterproof and absorbent. These properties help us understand why certain materials are chosen for particular jobs.

With your learning partner, look at the photos below. Name the object, the material and then think of a property that the material has that makes it useful.







Be ready to **share your feedback** with the class.

Let's recap

answers

Sponges can be made from many different materials. They are useful because they are lightweight, flexible and absorbent.



sponge



bottle

The bottle is made of plastic. It is lightweight, waterproof, flexible and transparent.

The windowpane is made of glass, which is waterproof and transparent, allowing light to pass through.



windowpane

Properties of materials

These three spoons below are made from different materials: metal, plastic and wood. Each material has its own properties, which affect how the spoon behaves when used. Designers choose materials carefully so the object can do its job safely and effectively.

Look closely at the three spoons.

Why might each one be chosen for a particular job in the kitchen?

Discuss this question with your learning partner.



Be ready to **share your feedback** with the class.

Let's investigate

To compare these materials, we can observe how each spoon behaves when placed in the same cup of hot water. This helps us notice differences in how materials respond to heat. Keep everything the same except the spoon's material.



Follow these instructions to test out how the different materials respond to heat.

1. Place the **metal**, **plastic** and **wooden** spoons into the same cup of hot water (one at a time or three identical cups).
2. Leave each spoon in the water for the same amount of time.
3. Carefully touch the handle of each spoon. What do you notice?

Remember

To be safe, the water should be no hotter than **50°C**.

Let's investigate

answers

When you place each spoon in hot water, they do not behave in the same way. The metal spoon's handle warms quickly. The wooden spoon stays cool. The plastic spoon warms slowly, and in some cases, if the water is hot enough, it can begin to soften and bend out of shape.







Thermal conductors

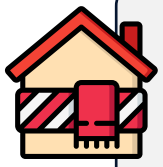
Different materials allow heat to move through them at different speeds. Some let heat travel through quickly, while others slow it down.

Heat always moves from the hotter object to the cooler object!

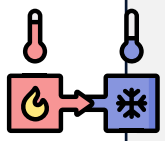
The metal tin is a thermal conductor. It heats up quickly because heat travels through metal fast.



The oven gloves are thermal insulators. They slow down the heat and protect the hands.



New word alert!
thermal insulator – a material that slows heat passing through it



New word alert!
thermal conductor – a material that lets heat pass through it quickly

What do we need to find out?

Testing



I need to design a product for a busy cafe. Customers keep complaining that their takeaway drinks cool down before they've even walked back to work. The cafe has asked me to design a sleeve that helps a hot drink stay warm for longer. Before I can design anything, I need to find out which material would work best.

Read the questions below with your learning partner and decide which of these questions I need to investigate.

- **Which sleeve would customers like the most?**
- **Which material will keep a hot drink warm for the longest?**
- **Which sleeve looks the nicest?**

Be ready to **share your feedback** with the class.

What do we need to find out?

answers

Testing



The question I need to investigate is:

- **Which sleeve would customers like the most?**
- **Which material will keep a hot drink warm for the longest?**
- **Which sleeve looks the nicest?**

Variables

Testing

Setting up tests

To find out which material keeps a hot drink warm for the longest, I need to use a comparative test. A comparative test is when we **compare** two or more things under the same conditions. In this investigation, I will compare different materials to determine which keeps a hot drink warm the longest. To make the comparison fair, I must change only one thing, **measure** only one thing, and keep everything else the same.

Independent variable

Dependent variable

Control variables

Independent variable

Testing

Setting up tests

Which material will keep a hot drink warm for the longest?

Look closely at the question above. Can you spot the part that tells us what we will change? And can you spot the part that tells us what we will measure? Discuss these questions with your learning partner. Be ready to **share your feedback** with the class.



Independent variable



Dependent variable



Control variables

Independent variable

answers

Which **material** will keep a hot drink warm for the longest?

The question says '**which material**'.
That tells us the independent variable.
This is the one thing we will **change** each time.

Independent variable

We will **change** the material.

Dependent variable

Control variables

Dependant variable

Which **material** will keep a hot drink warm for the longest?

The question says to '**keep a hot drink warm for the longest**'. That tells us the dependent variable.

We will **measure** the drink's temperature after a set time.



Independent variable

We will **change** the material.



Dependent variable

We will **measure** the **temperature** of the drink after a set **time**.



Control variables

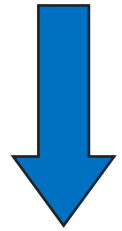
Control variables

To make this a fair comparative test, everything else must stay the same.

What things do you think must stay the same so we can compare the materials fairly?

Discuss this question with your **learning partner**.

Be ready to share your feedback with the class.





Independent variable

We will **change** the material.



Dependent variable

We will **measure** the **temperature** of the drink after a set **time**.



Control variables

Control variables

answers

These variables help ensure the test is fair and that our results are reliable.

If any of these change, the test won't be fair, and we won't know if the material made the difference.





Independent variable

We will **change** the material.



Dependent variable

We will **measure** the **temperature** of the drink after a set **time**.



Control variables

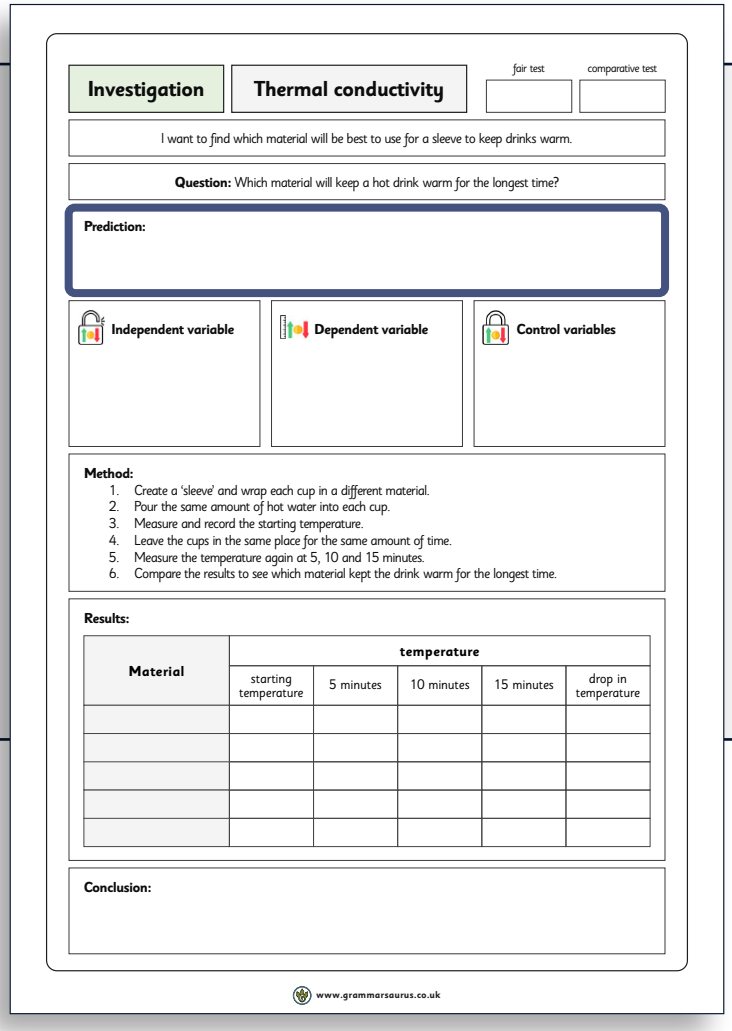
- starting temperature
- amount of liquid
- size and type of cup
- time intervals for measuring
- where the cups are placed
- type of thermometer used
- how the material is wrapped around the cup

Investigation



Before you start the investigation, write your prediction on your investigation worksheet.
Which material do you think will keep the drink warm the longest, and why?
Use the words thermal conductor or thermal insulator to explain your thinking.
Don't worry about filling in the other sections of the worksheet yet. We will go through them together.

Use the following sentence starter to help you.
"I think the…will keep the drink warmest because…"



Investigation | **Thermal conductivity** | fair test | comparative test

I want to find which material will be best to use for a sleeve to keep drinks warm.

Question: Which material will keep a hot drink warm for the longest time?

Prediction:

Independent variable | **Dependent variable** | **Control variables**

Method:
1. Create a 'sleeve' and wrap each cup in a different material.
2. Pour the same amount of hot water into each cup.
3. Measure and record the starting temperature.
4. Leave the cups in the same place for the same amount of time.
5. Measure the temperature again at 5, 10 and 15 minutes.
6. Compare the results to see which material kept the drink warm for the longest time.

Results:

Material	temperature				
	starting temperature	5 minutes	10 minutes	15 minutes	drop in temperature

Conclusion:

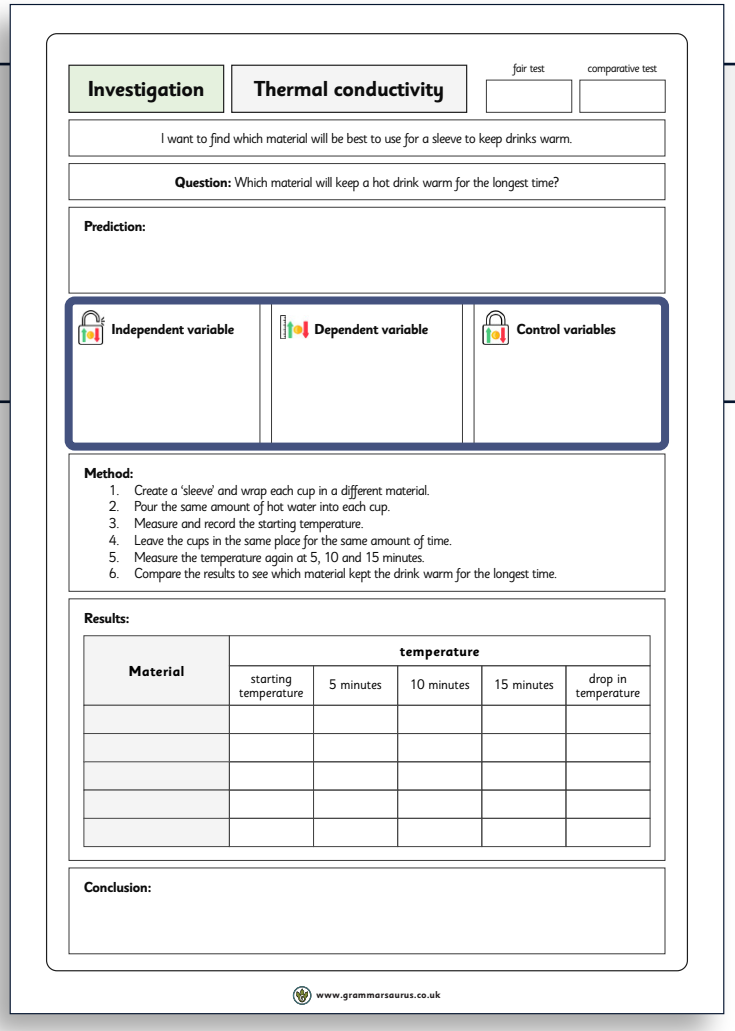
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Investigation



Complete the variables section on your investigation worksheet. Write down the independent variable, the dependent variable and all the control variables you identified.

Don't worry about filling in the other sections of the worksheet yet. We will go through them together.



Investigation | **Thermal conductivity**

fair test ☐ comparative test ☐

I want to find which material will be best to use for a sleeve to keep drinks warm.

Question: Which material will keep a hot drink warm for the longest time?

Prediction:

Independent variable	Dependent variable	Control variables

Method:

1. Create a 'sleeve' and wrap each cup in a different material.
2. Pour the same amount of hot water into each cup.
3. Measure and record the starting temperature.
4. Leave the cups in the same place for the same amount of time.
5. Measure the temperature again at 5, 10 and 15 minutes.
6. Compare the results to see which material kept the drink warm for the longest time.

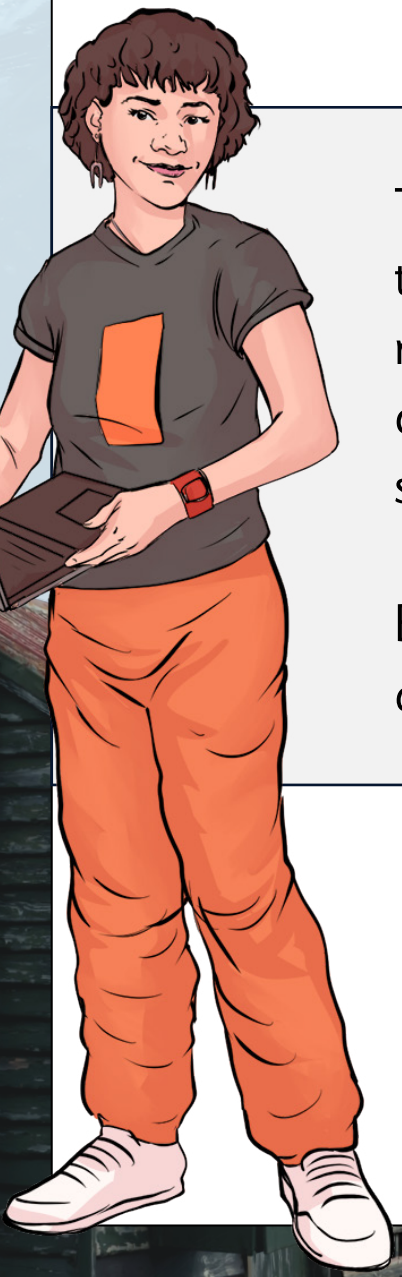
Results:

Material	temperature				
	starting temperature	5 minutes	10 minutes	15 minutes	drop in temperature

Conclusion:

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Investigation



To carry out this test, we need a range of everyday materials that could be used to make a cup sleeve. We must choose materials that are safe to handle and easy to wrap around a cup, like cardboard or bubble wrap. As you work through the steps, you must keep all the control variables the same.

Before you begin your investigation, read through the method and make sure you understand what you need to do.



Investigation | **Thermal conductivity**

fair test ☐ comparative test ☐

I want to find which material will be best to use for a sleeve to keep drinks warm.

Question: Which material will keep a hot drink warm for the longest time?

Prediction:

Independent variable	Dependent variable	Control variables

Method:

1. Create a 'sleeve' and wrap each cup in a different material.
2. Pour the same amount of hot water into each cup.
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Results:

Material	temperature				
	starting temperature	5 minutes	10 minutes	15 minutes	drop in temperature

Conclusion:

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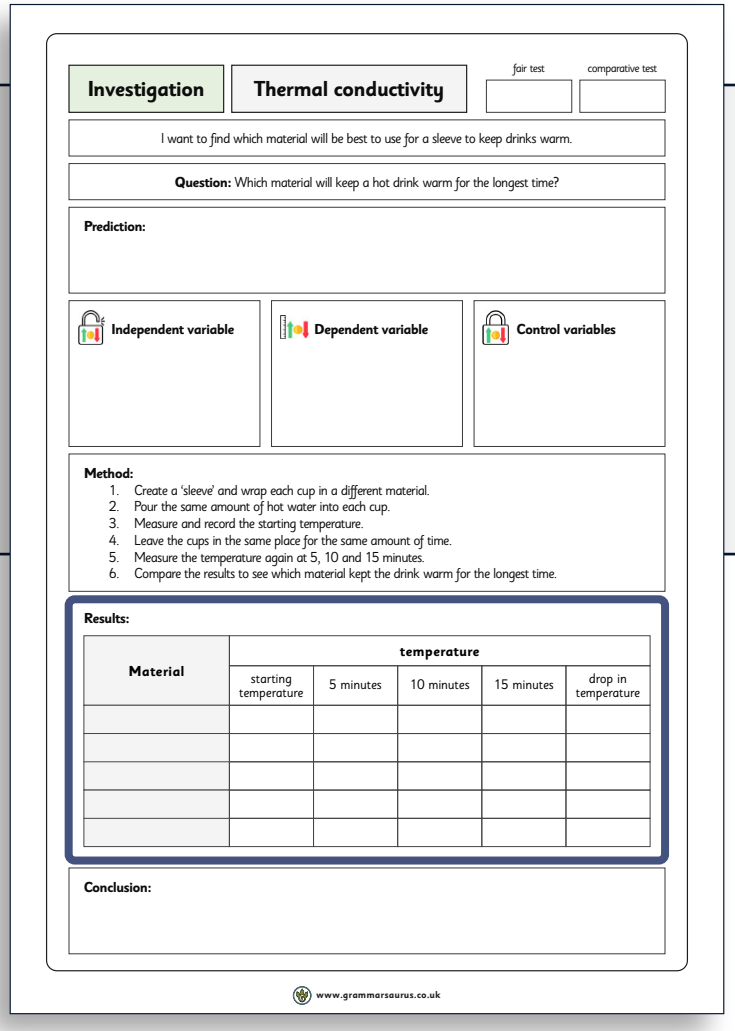
Investigation

Testing

Recording data



Use the results table on your investigation worksheet to record the starting temperature and the temperatures at 5, 10 and 15 minutes. Make sure you write the results in the correct row for each material. Accurate measurements will help us decide which material kept the drink warm for the longest.



Investigation | **Thermal conductivity**

fair test | comparative test

I want to find which material will be best to use for a sleeve to keep drinks warm.

Question: Which material will keep a hot drink warm for the longest time?

Prediction:

Independent variable

Dependent variable

Control variables

Method:

1. Create a 'sleeve' and wrap each cup in a different material.
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Results:

Material	temperature				
	starting temperature	5 minutes	10 minutes	15 minutes	drop in temperature

Conclusion:

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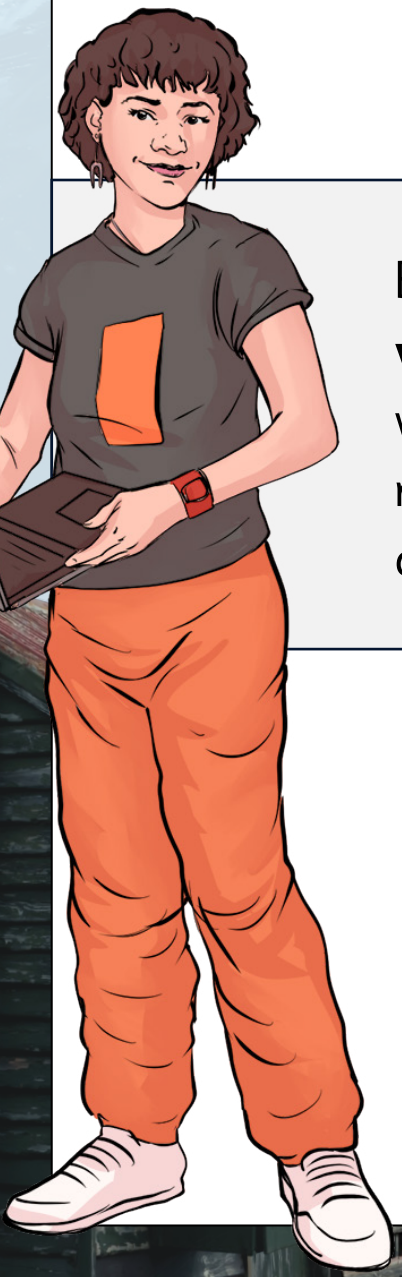
Interpreting results

Now that you've looked closely at your results, you should see a clear pattern. The material that kept the drink warmest after 15 minutes was the one that stayed warmest and showed the smallest drop in **temperature** . This means it was the best **thermal insulator**  in our comparative test.

Material	**temperature**				
	starting temperature	5 minutes	10 minutes	15 minutes	drop in temperature
foil	50	44	40	37	13
paper	50	46	43	40	10
fabric	50	47	46	43	7
bubble wrap	50	48	46	44	6

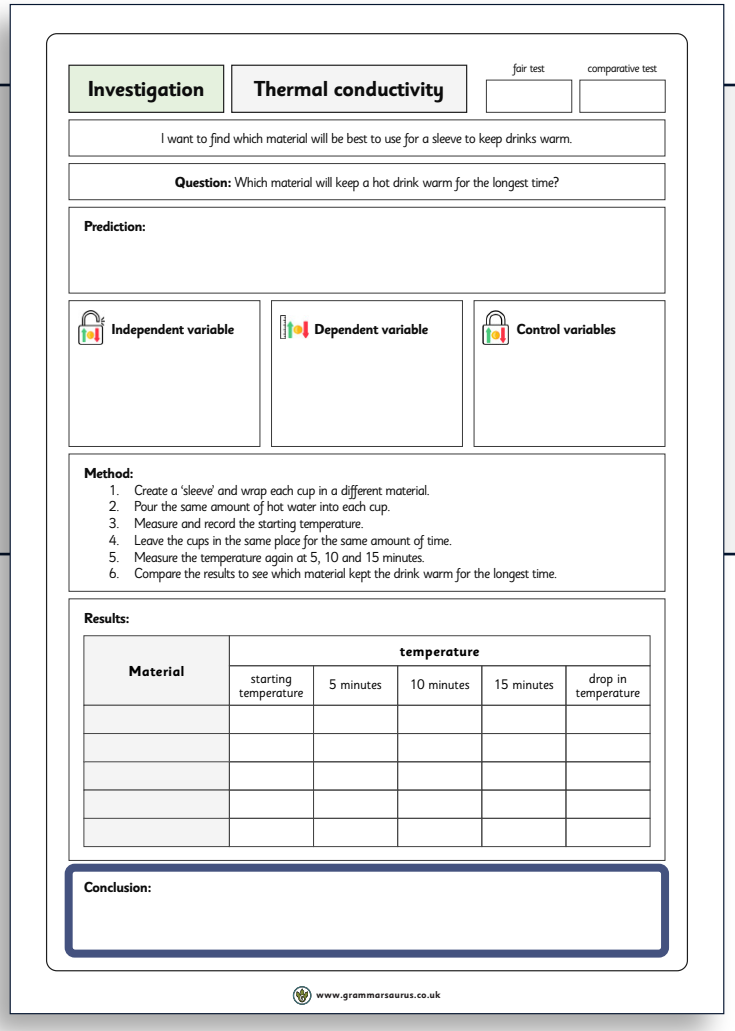
The evidence from my test shows that bubble wrap was the most effective material at keeping the drink warm.

Investigation



Based on my comparative test results, I would choose **bubble wrap** as the material for my cup sleeve design. It kept the drink warm for the longest time, which solves the cafe's problem. I can now begin designing a sleeve that uses bubble wrap to help customers keep their drinks hotter for longer.

Use your results to complete the conclusion section of your investigation worksheet.



Investigation | **Thermal conductivity**

fair test | comparative test

I want to find which material will be best to use for a sleeve to keep drinks warm.

Question: Which material will keep a hot drink warm for the longest time?

Prediction:

Independent variable | **Dependent variable** | **Control variables**

Method:

1. Create a 'sleeve' and wrap each cup in a different material.
2. Pour the same amount of hot water into each cup.
3. Measure and record the starting temperature.
4. Leave the cups in the same place for the same amount of time.
5. Measure the temperature again at 5, 10 and 15 minutes.
6. Compare the results to see which material kept the drink warm for the longest time.

Results:

Material	temperature				
	starting temperature	5 minutes	10 minutes	15 minutes	drop in temperature

Conclusion:

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What have we learnt?

Different materials behave differently when heat tries to move through them. Some let heat travel quickly, while others slow it down. Designers carefully choose materials based on whether they want to keep heat in or let it out. Insulators don't just keep hot things hot. They also help keep cold things cold by slowing the heat from getting in. That's why the same ideas can help us solve new problems.

Thermal conductors

These materials let heat pass through them quickly. They do not keep things warm.

Examples include:

- **metal** – used for saucepans and baking trays because it heats up fast
- **glass** – lets heat through in ovens and kettles

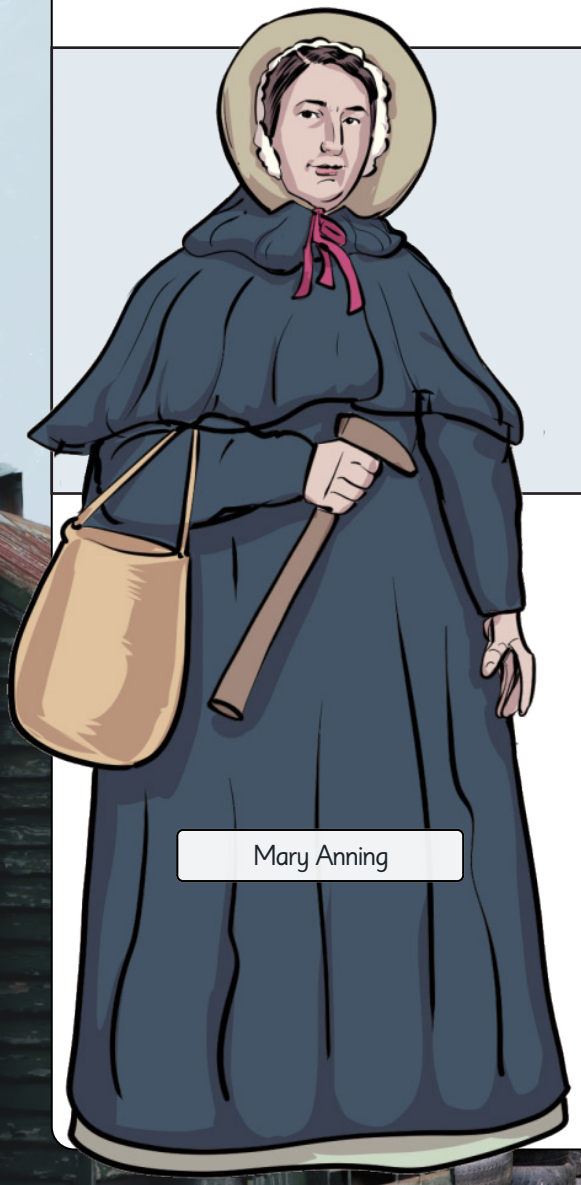
Thermal insulators

These materials slow down the heat. They help keep things warm or cold.

Examples include:

- **fabric** – used in oven gloves to protect hands
- **bubble wrap** – traps air and slows heat transfer
- **cardboard** – used in takeaway cup sleeves
- **wool** – keeps clothes warm in winter
- **foam** – used in cool bags and lunchboxes

Challenge



A cafe also sells ice cream, and customers say it melts too quickly.

What material might keep ice cream cold for the longest, and why?

Discuss this question with your **learning partner**.
Be ready to **share your feedback** with the class.

Use the following sentence starters to help you.

"I think the best material would be… because…"

"A material that would work well would be… because it is a good…"



Challenge

answers



The best material would be bubble wrap because it would slow the heat from getting to the ice cream.

A material that would work well is fabric because it is a good thermal insulator .

