Melting ice – Student sheet

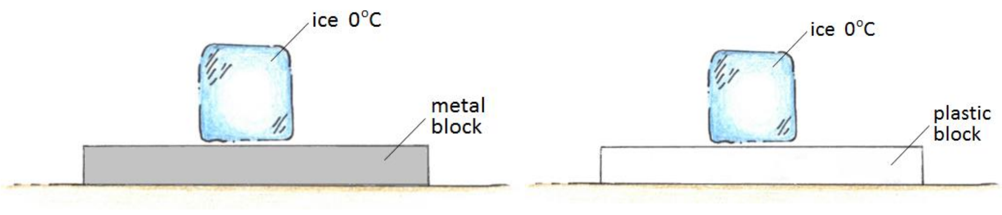
Predict – Which ice cube will melt first?

Why? (Give a scientific explanation)

Questions to think about: Why does ice melt?

Why might one ice cube melt more quickly than the other?

Observe – Describe what you saw happen.



Explain – Write a scientific explanation of what you saw happen.

Use as many key words as you can!

<u>Key word bank</u>: melting, conduction, energy transfer, temperature, energy

Draw a diagram to help your explanation.

Why does ice melt faster on metal than it does on plastic?

Read this answer and compare it to your own.

> Ice is at a temperature of 0 °C; the surroundings are at about 20 °C. For ice to melt, it must gain energy from the surroundings.
>
> Energy can be transferred (move) from the surroundings to the ice by conduction through the metal or plastic. Metal is a better conductor than plastic, so energy is transferred more quickly through the metal. This is why we saw the ice on the metal block melt more quickly.
>
> (Note that a small amount of energy may enter the ice from the air, but this is a small effect compared to conduction through the metal/plastic because air has very little mass.)

1 What did you do well in your answer?

....

....

....

2 What could you improve?

....

....

....

Now go back and improve your answer.

True or false?

Decide whether each of the following statements is true or false.

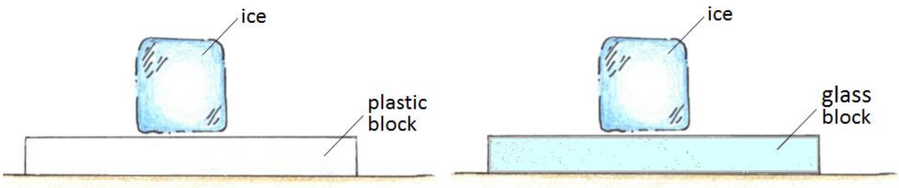
For those which are false, cross out the incorrect words and write a correction in the space underneath it.

	true / false
1 A block of ice will melt when energy escapes from it.	
Correction:	
2 Plastics are good conductors of heat energy.	
Correction:	
3 Ice cream will melt more quickly if it falls on a metal bench than on a wooden one.	
Correction:	
4 Frozen food will thaw quickly if placed on a ceramic (china) plate.	
Correction:	
5 Energy is conducted from a place where the temperature is higher to a place where the temperature is lower.	
Correction:	

Plastic vs glass

To study

Jo has a flat piece of plastic and a similar piece of glass. She wants to know which is a better thermal conductor (conductor of heat), the plastic or the glass.



She places an ice cube on top of each of the two pieces.
She sees that the ice on the glass melts more quickly than the ice on the plastic.

To answer

a Explain why the ice cubes melt.

b Which is a better conductor, glass or plastic? Explain how you know.

c Suggest two ways in which Jo could ensure that her experiment is a fair test.

d Jo challenges her friend Jay. She says, 'The ice melted more quickly on the glass than on the plastic. If you touch the two materials, which will feel warmer?'

Jay says that he thinks the glass will feel warmer and that is why the ice melted more quickly on the glass.

Explain why he is wrong.

Learning structure of the lesson

The big picture

This lesson is designed to exemplify an argumentation approach to practical work, using a ‘predict-observe-explain’ framework.

Students often think that some materials are intrinsically warm (wood, plastic, wool) while others are intrinsically cold (metals, glass, water). This lesson challenges these ideas by presenting observations which many will find counter-intuitive. Through argumentation, students predict the outcome of an experiment, observe the result, and discuss how scientific ideas about energy transfer can explain what they see.

Age range: 12–14
(Could be adapted for 14–16)

Timing: 50 minutes

Learning episode 1 (teacher-led) 5 mins

Introduce lesson objectives. Explain what makes a good argument. Pass the metal and plastic blocks around. In small groups students discuss how the blocks feel to touch.

Learning episode 2 (student-led) 15 mins

Introduce the practical. Students discuss and write down their prediction. Groups must justify their prediction with an explanation using scientific ideas.

A few groups report back to the class. The rest of the class say whether they agree or disagree and whether they can improve the predictions and justifications.

Learning episode 3 (teacher-led) 5 mins

Students carry out the practical activity and make observations. Alternatively the practical can be carried out as a teacher demonstration.

Learning episode 4 (student-led) 30 mins

Groups discuss their observations and decide whether their prediction was correct. They agree an explanation for what they have seen, and develop an argument for why they think their explanation is correct.

A few groups report back to the class. The rest of the class say whether they agree or disagree, and whether they have something to add.

Groups self assess their explanation against the model answer. Allow groups to improve their explanations.

Ask students what makes a good argument and how they went about developing their own arguments.

Learning outcomes

Students will be able to:

- generate and evaluate scientific arguments
- present a scientific argument using words and diagrams
- describe how energy is transferred through a solid conductor from higher to lower temperature
- apply ideas about energy transfer by thermal conduction in unfamiliar situations.

Equipment and materials

Teacher guidance

Practical guidance

Slide presentation

Student sheet

Per group
Metal and plastic blocks (one of each)
Supply of ice cubes

Optional
Camera linked to data projector

Refer to the health and safety advice and practical guidance

Key words

Melting, conduction, energy transfer, temperature, argument, claim, evidence / data
(For a discussion of the terms *heat* and *temperature* see www.nuffieldfoundation.org/practical-physics/heat-and-temperature).

Prior knowledge

This lesson makes use of ideas about energy transfer, in particular, conduction of heat. It could be used to consolidate these ideas, or (with some adaptation) as an introduction to conduction.

It is assumed that students know the following.

- Ice melts at 0 °C.

Other relevant background knowledge that supports this lesson includes:

- Energy must be supplied to make ice melt.
- Energy is transferred from higher to lower temperature.
- Energy is transferred through solids by conduction.
- Some materials are better conductors than others.

Students may also be familiar with the mechanisms of conduction.

Background information

To melt ice, energy must be supplied. Energy is transferred from hotter to colder places by conduction, convection and radiation, i.e. temperature difference results in energy transfer. Metals are better conductors than plastics.

Terminology

The terms which students need to understand and use in this lesson are:

melting – the change from solid to liquid; energy must be supplied to cause a solid to melt

conduction – the transfer of energy through a solid or liquid without the material itself moving

energy transfer – the movement of energy from one place to another

temperature – a measure of the hotness or coldness of an object

argument – the process that students use to articulate, support and justify claims or conclusions

claim – a conclusion, idea, proposition or assertion

evidence / data – the observations and accepted scientific theories used to support the claim

Note that in this resource we have used the term energy throughout. Energy which is transferred due to a temperature difference is sometimes known as heat or heat energy (or even thermal energy, although this is not a standard term). Conduction is sometimes described as a thermal energy transfer. You will have to decide if any of these terms are appropriate to your own scheme of work.

Differentiation

- For less confident students, the lesson can be used after they have learned about thermal conduction. They can then be challenged to use what they have learned – that metals are better conductors than plastics, and so on.
- Additional scaffolding could be provided as a description and explanation of the experiment as a series of statements on separate cards for students to sequence.
- Add greater challenge to the lesson by using it to introduce ideas about thermal conduction. The lesson can challenge students to address the conflict between their everyday ideas (plastic is warm, etc.) and the observation that ice melts more quickly on metal.

Optional extension activities

- Pass round samples of other materials (e.g. wood, glass, acrylic, expanded polystyrene, copper) similar to the plastic and metal blocks and ask 'On which of these would ice melt quickly; on which would ice melt more slowly?' If time allows, try it out.
- Use the 'further questions' on slide 10.

  Answers to further questions

  1. The results would be the same, because the metal box would conduct energy from the surroundings to the inside of the box more quickly than the plastic box.

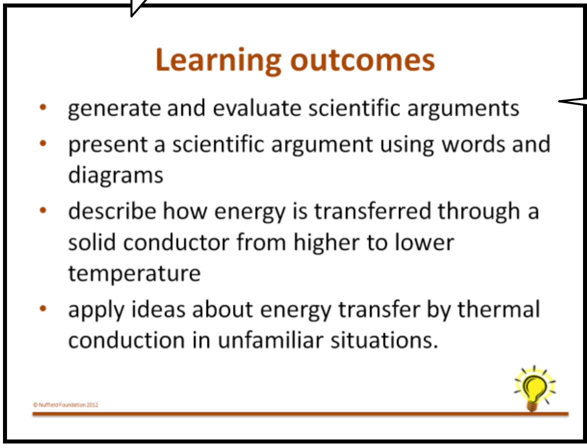
  2. Place an ice cube on a sample of each material, making sure that the samples are all in the same environment. Time the ice cubes melting. The best conductor will result in the fastest melting ice cube.

  3. When you touch a material that is a good conductor, energy escapes from your finger. This cools the skin and receptors in the skin detect a decrease in temperature. Diamond shows this effect and so must be a good conductor – its thermal conductivity is higher than any metal.

- You could repeat the practical as a demonstration with temperature probes attached to the blocks. Can students predict how the readings will change? There is a video of this here: www.nationalstemcentre.org.uk/elibrary/resource/2087/thermal-conductivity

Lesson details

Slide 2



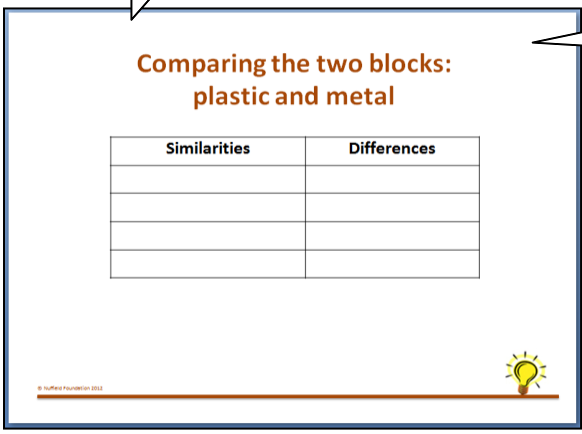
Task: Pass the **metal and plastic blocks** around so that students can feel them.

Explain: Introduce objectives for lesson, and explain what makes a good scientific argument.

The lesson is about energy transfers and working together to develop scientific arguments. **A good scientific argument uses evidence and scientific ideas to justify a claim**. At the end, students will be able to give better explanations of phenomena that involve conduction.

Task: Check students understand key terminology – heat, temperature, energy, energy transfer etc.

Slide 3

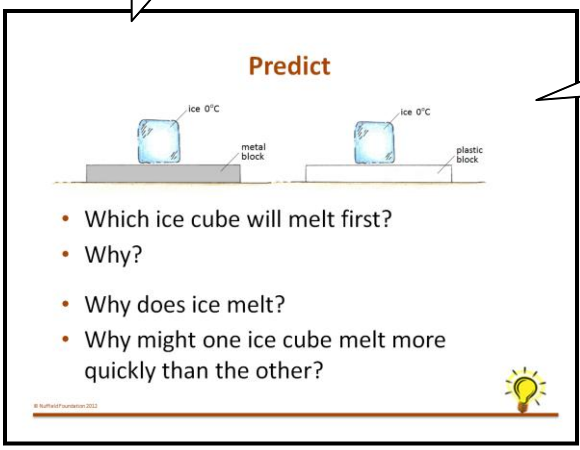


Task: In groups of three, students discuss (and could also write down) words to describe how the two blocks felt to the touch.

Discussion should concentrate on ‘similarities’ and ‘differences’. Encourage students to think about the materials the blocks are made of rather than the shape of the blocks.

Putting students in groups of three rather than pairs is more likely to result in debate in the next part of the lesson.

Slide 4

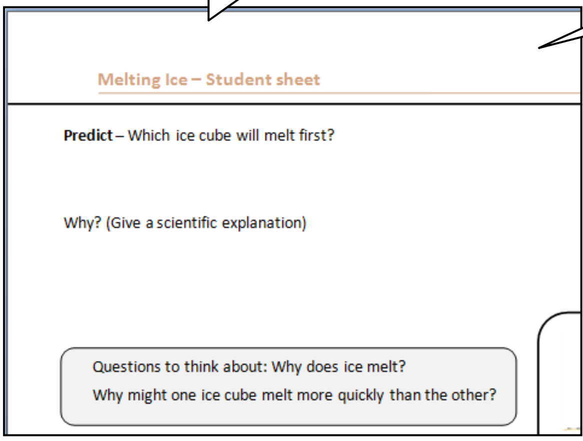


Explain: Explain that you are going to place an ice cube on each block. Ask the first two questions on **slide 4.** Give students 1 minute to discuss in their groups.

Where one person in a group disagrees with the other two, they should be given priority to explain their ideas.

Task: While students are discussing, give out the ‘Predict, Observe, Explain’ A3 placemats.

A3 placemat



Task: Direct students towards the ‘**Predict**’ section of the A3 placemats.

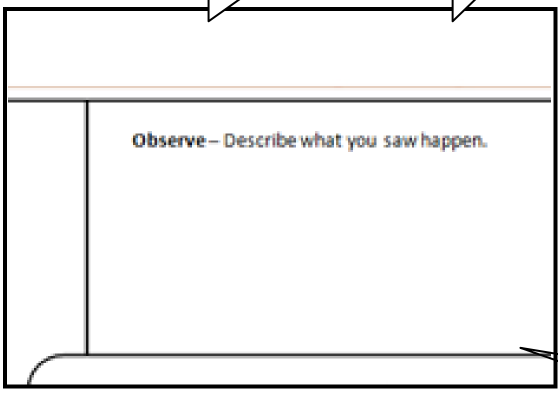
Use the prompt questions (also on **slide 4**) to **ensure groups justify their prediction with an explanation using scientific ideas**. Initial explanations may include the idea that ‘metals are cold’. Asking why ice melts should prompt thoughts about energy transfer.

Task: Give groups a further 2–3 minutes to finish their discussion and complete the ‘Predict’ section.

Task: Two groups give a 30–60 second report to the class explaining their thinking. If possible, choose one proposing plastic, the other metal. After this allow each group to say why they consider the other argument to be incorrect.

Ask the rest of the class to suggest whether they agree or disagree with the presented arguments and whether they can improve them.

A3 placemat **Practical**



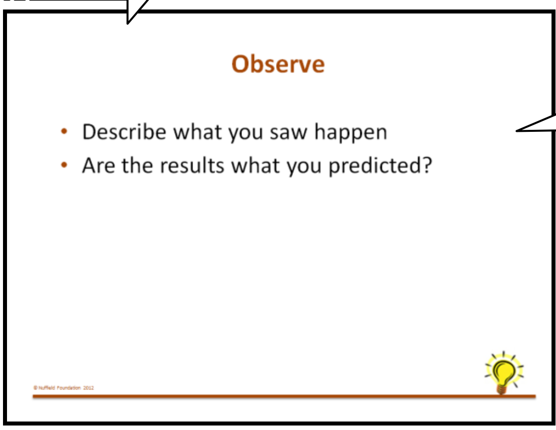
Task: Students carry out the practical activity (see Practical guidance). Alternatively demonstrate the phenomenon.

Each group will need a pair of blocks and two ice cubes. They place the ice cubes simultaneously on the blocks, then leave them to observe what happens.

The ice on metal melts first. Ask, ‘Who is surprised?’

Task: Students write their **observations** on the A3 placemat.

Slide 5

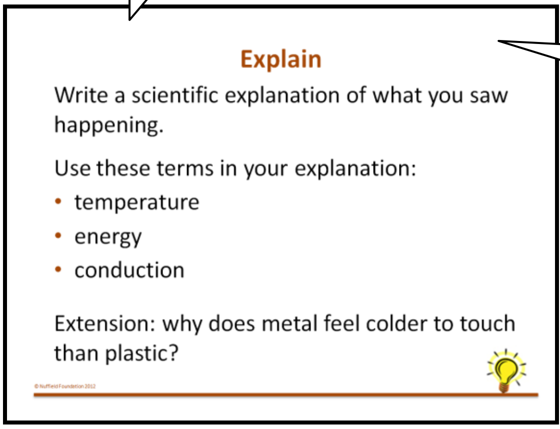


Task: Give groups 2 minutes to discuss in their groups what they have seen and to decide whether their prediction was correct.

If their prediction was incorrect, ask them to try and explain what they saw.

Differentiation: Students may already be thinking in terms of energy. You may need to remind some students that metals are conductors and plastics are insulators, and how energy is transferred through solids.

Slide 6

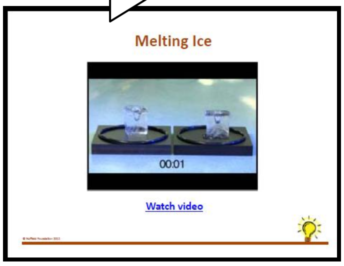


Task: After 2 minutes, each group should agree an explanation for what they have seen, and develop an argument for why they think their explanation is correct.

To develop an argument, students will need to **support their explanation with evidence (i.e. what they saw happening and their existing knowledge of melting ice).** Use the prompt questions (on **slide 6**) to direct their thinking.

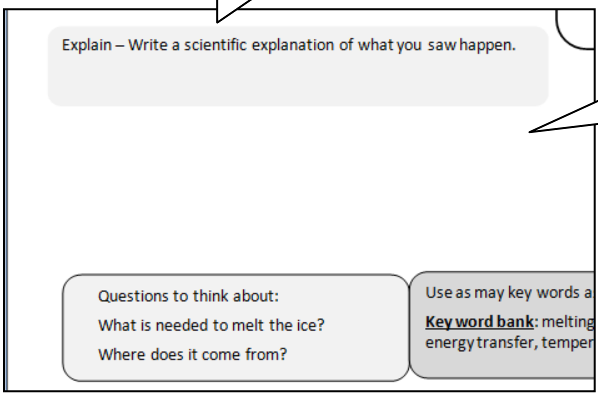
Challenge students to justify their explanations by offering up counter-claims for them to address, e.g. Ask questions such as, 'Why don't you think it was the temperature of the metal which made the ice melt faster?'

Option: Slide 7



Optional: A video of the practical activity may be used to remind students of what they have seen (**slide 7**).

A3 placemat



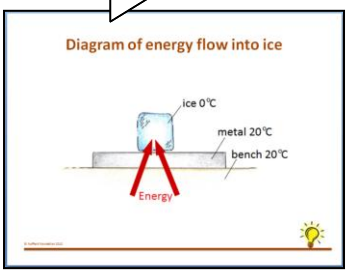
Task: Students write their explanations, using key words, and draw a diagram, on the placemat. An example of the type of diagram that could be used is on **slide 8.**

Differentiation: You could provide a description and explanation of the experiment as a series of statements on separate cards for students to sequence.

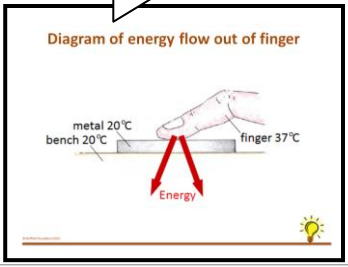
Task: Get one or two groups to share their explanations with the class. Ask others where they disagree, or where they have something to add.

You could give students coloured cards to hold up to indicate if they disagree (red card) or if they have something to add (orange card).

Option: Slide 8

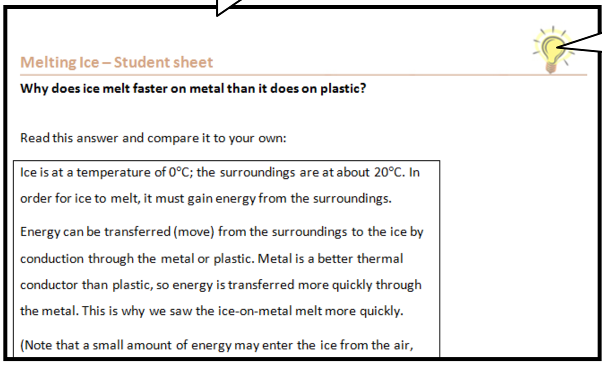


Option: Slide 9



Differentiation: Add greater challenge by asking students to explain why the 'plastic is warmer' idea is not supported by their observations, and why metal feels colder to touch than plastic (see **slide 9**).

Worksheet 1


Melting Ice – Student sheet

Why does ice melt faster on metal than it does on plastic?

Read this answer and compare it to your own:

Ice is at a temperature of 0°C; the surroundings are at about 20°C. In order for ice to melt, it must gain energy from the surroundings.

Energy can be transferred (move) from the surroundings to the ice by conduction through the metal or plastic. Metal is a better thermal conductor than plastic, so energy is transferred more quickly through the metal. This is why we saw the ice-on-metal melt more quickly.

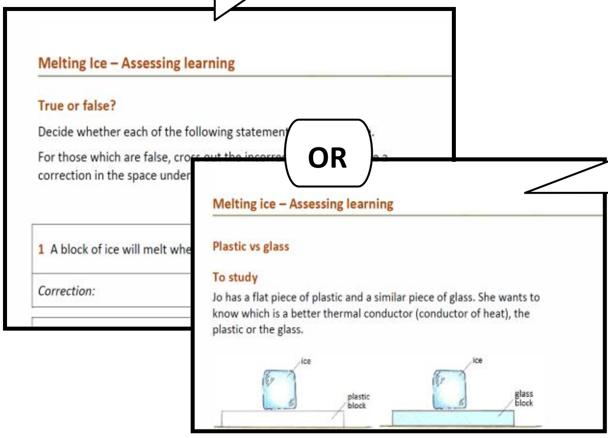
(Note that a small amount of energy may enter the ice from the air,

Task: Give groups the model answer and ask them to compare it with their own. Each group identifies what they have done well and how they could improve. Allow groups to improve their answers.

Differentiation: More scaffolding could involve reading through the model answer and discussing how students' explanations compare with it.

Task: Ask students what makes a good argument and how they went about developing their own arguments. They should explain the importance of using evidence to support a claim.

Worksheet 2


Melting Ice – Assessing learning

True or false?

Decide whether each of the following statement

For those which are false, cro

correction in the space under

1 A block of ice will melt whe

Correction:

OR

Melting ice – Assessing learning

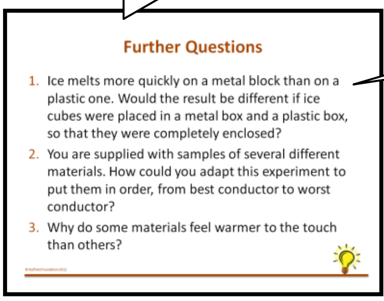
Plastic vs glass

To study

Jo has a flat piece of plastic and a similar piece of glass. She wants to know which is a better thermal conductor (conductor of heat), the plastic or the glass.

Task: Students complete either the true/false questions (less challenge) or the plastic vs. glass questions (greater challenge). These provide an opportunity to apply what they have learnt about conduction.

Option: Slide 10



Optional: The 'further questions' on **slide 10** can be used as an extension exercise or for homework.

Assessing learning: Answers to questions on the student sheets

True or false

	true / false
1 A block of ice will melt when energy ~~escapes from~~ it.	false
Correction: ***is transferred into***	
2 Plastics are ~~good~~ conductors of heat energy.	false
Correction: ***poor/bad (or change conductors to insulators)***	
3 Ice cream will melt more quickly if it falls on a metal bench than on a wooden one.	true
Correction:	
4 Frozen food will thaw quickly if placed on a ~~ceramic (china)~~ plate.	false
Correction: ***metal*** *(or change 'quickly' to 'slowly')*	
5 Energy is conducted from a place where the temperature is higher to a place where the temperature is lower.	true
Correction:	

Plastic vs. glass

a The ice is colder than its surroundings. Energy from the warmer surroundings is conducted through the glass or plastic to the colder ice, melting it.

b Glass is a better conductor. Energy moves more quickly through the glass than the plastic, causing the ice to melt more quickly.

c The pieces of plastic and glass should be the same thickness (and area); the ice cubes should be the same mass (and at the same temperature).

Note: This experiment would only be a fair test if the two materials also had similar values of specific heat capacity, but we can ignore this.

d The plastic will feel warmer. This is because, when you touch the glass, energy from your finger is conducted into the glass, lowering the temperature of your finger. The glass feels cold. Energy is conducted only very slowly into the plastic because it is a better thermal insulator, so your finger does not cool, and it does not detect a lower temperature.

A video of the practical, without a commentary, can be found here:
www.nationalstemcentre.org.uk/elibrary/resource/2087/thermal-conductivity
Click on the link to the video: 'Thermal conductivity demonstration only'. There is also a link to this in the slide presentation.

Equipment and materials

Per group
Metal and plastic blocks (one of each) – see notes
Supply of ice cubes

Per class
Optional: Flexicam linked to data projector

Health and safety and technical notes

Before carrying out this practical, users are reminded that it is their responsibility to carry out a risk assessment in accordance with their employer's requirements, making use of up-to-date information.

Read our standard health & safety guidance.

1 The blocks should be about the same size and shape (perhaps 5 cm square and 1 cm thick) and preferably have the same colour. Caution: metal blocks could be heavy. Suitable blocks are commercially available; these have a rim to prevent the melting ice from slipping off. For example,
www.timstar.co.uk/Item/NA/HE92305/ice_melting_kit.html

2 To prevent the ice sliding off blocks without a rim, a thin roll of Blu-tack could be used around the edge.

3 If a plastic block is not available, a wooden block could be used.

4 The blocks should be at the same temperature (room temperature) before the demonstration.

5 If there are not enough blocks available for this to be carried out as a student practical, it could be run as a demonstration. A camera linked to a projector would help to make the demonstration more visible.

Procedure

a Simultaneously place one ice cube on the metal block and one ice cube on the plastic block.

b Observe the rate at which the two ice cubes melt.