**Cool rod**

Sometimes in a practical, glass rods are used for stirring.

They can be used to stir hot liquids.

Some students are talking about the glass rod.

**Charlie:** You can hold a glass rod and melt the other end of it in a Bunsen flame.

**Brooke:** Glass is a conductor because it feels cold.

**David:** Plastic warms your hand because it is an insulator.

Glass doesn’t.

**Freya:** Thermometers are made from glass and they need to be conductors.

**Ella:** The glass rod sucks energy out of your hand.

**To answer**

1. Who is right about the glass rod? *Explain your answer.*
2. What mistakes do you think the other students made?

*What would you say to them to help them to understand?*

1. Do you think glass is a conductor or an insulator? *Explain your answer.*

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| Card Sort PMA1.2:  **Cool Rod** | **Brooke:** Glass is a conductor because it feels cold. |
| **Charlie:** You can hold a glass rod and melt the other end of it in a Bunsen flame. | **David:** Plastic warms your hand because it is an insulator.  Glass doesn’t. |
| **Ella:** The glass rod sucks energy out of your hand. | **Freya:** Thermometers are made from glass and they need to be conductors. |

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| **Ella:** The glass rod sucks energy out of your hand. | **Freya:** Thermometers are made from glass and they need to be conductors. |

*Physics > Big idea PMA: Matter > Topic PMA1: Heating and cooling > Key concept PMA1.3: Thermal conduction*

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| **Response activity** |
| **Cool rod** |

**Overview**

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| Learning focus: | Heating makes the particles in a material move more quickly. Heating raises the temperature quickly throughout a good thermal conductor, and very slowly through a good thermal insulator. |
| Observable learning outcome: | Explain why it is common for thermal insulators to feel warm and thermal conductors cold |
| Activity type: | Talking heads |
| Key words: | Conductor, insulator, thermometer |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Warm feeling

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| **B** | **BRIDGING**  This activity explores ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**What does the research say?**

Although it is a misunderstanding, it can make sense to think that because a plastic chair feels warmer than a metal one it contains more energy in its thermal store. This is a view that Chu et al. (2012) found was held by over 35% of 14- to 16-year-olds (n=344). They also found a similar proportion of 14- to 15-year-olds (n=178) thought that objects taken out of a fridge felt colder because they contained more ‘cold’. Students aged 12-to 15-years-old do not tend to examine temperature differences and explain phenomena in terms of the direction of energy flowing between thermal stores. Instead they often link properties of an object with what will happen: if it feels cold it will cool, and if it feels warm it will warm. (Erickson and Tiberghien, 1985)

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. The statements are also provided as cut-out cards for students to physically organise.

Students should work together to follow the instructions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

If there is disagreement when you take feedback, a good way to progress might be through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Expected answers**

1. Brooke, Charlie and Freya are correct. Brooke and Freya give two observations that show glass is a conductor. Charlie’s observation shows that although glass is a conductor, it is a poor one.
2. David is wrong that plastic warms your hand. It is an insulator which prevents energy flowing quickly out of your hand by heating. Ella is wrong because ‘sucking’ implies the glass rod is actively pulling energy out of your hand.
3. Glass is a poor thermal conductor. It conducts much better than insulators such as plastic, but a lot less than metals or other good conductors.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Chu, H.-E., et al. (2012). Evaluation of Students' Understanding of Thermal Concepts in Everyday Contexts. *International Journal of Science Education,* 34:10**,** 1509-1534.

Erickson, G. and Tiberghien, A. (1985). Heat and Temperature. In Driver, R., Guesne, E. & Tiberghien, A. (eds.) *Children's Ideas In Science.* Milton Keynes and Philadelphia: Open University Press.