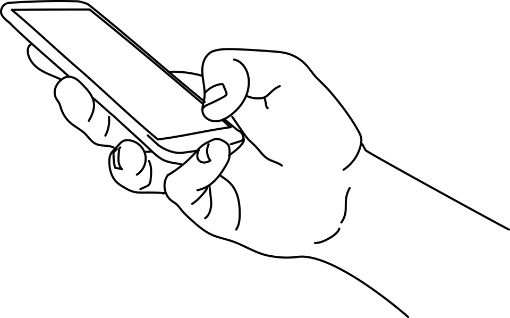
**Feel the heat**

Luca has a protective plastic case on his phone.

He has noticed that the plastic case sometimes feels very warm.



Luca is discussing with his friends why the plastic case of his phone sometimes feels very warm.

**Luca:** Heat flows through the plastic when the phone gets hot.

**Peter:** All the particles in the plastic are connected because plastic is a solid.

**Ollie:** Heat isn’t something that can flow. We feel hotness when particles in the plastic vibrate a lot.

**Nadia:** The phone is heating the plastic and making its particles vibrate more vigorously.

**Matilda:** Luca is feeling the warmth of his own hand. Plastic is an insulator.

**To answer**

1. Who is right about why the plastic case sometimes feels very warm?

*Explain your answer*

1. Who is wrong about why the plastic case sometimes feels very warm?

*What would you say to help them understand?*

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| --- | --- |
| Cards for  **Feel the heat** | **Luca:** Heat flows through the plastic when the phone gets hot. |
| **Matilda:** Luca is feeling the warmth of his own hand. Plastic is an insulator. | **Nadia:** The phone is heating the plastic and making its particles vibrate more vigorously. |
| **Ollie:** Heat isn’t something that can flow. We feel hotness when particles in the plastic vibrate a lot. | **Peter:** All the particles in the plastic are connected because plastic is a solid. |

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| Cards for  **Feel the heat** | **Luca:** Heat flows through the plastic when the phone gets hot. |
| **Matilda:** Luca is feeling the warmth of his own hand. Plastic is an insulator. | **Nadia:** The phone is heating the plastic and making its particles vibrate more vigorously. |
| **Ollie:** Heat isn’t something that can flow. We feel hotness when particles in the plastic vibrate a lot. | **Peter:** All the particles in the plastic are connected because plastic is a solid. |

*Physics > Big idea PMA: Matter > Topic PMA3: Energy of moving particles > Key concept PMA3.1: Transfer of energy by conduction*

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| **Response activity** |
| **Feel the heat** |

**Overview**

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| Learning focus: | Energy is transferred through a solid away from regions of higher temperature as its particles are caused to vibrate more vigorously. |
| Observable learning outcome: | Describe how the sensation of hotness is caused by vibrating particles.  Describe the mechanism of thermal conduction that can occur in all solids. |
| Activity type: | Talking heads |
| Key words: | Heat, energy, particle, vibrate |

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

* Diagnostic question: Hot blocks
* Diagnostic question: Hot iron
* Diagnostic question: Heating spoons

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| **P** | **PRIOR UNDERSTANDING**  This activity explores ideas that are usually taught at age 5-11, to aid transition from earlier stages of learning. |

**What does the research say?**

The notion that heat and cold are material substances that can flow from one place to another seem to be both common and persistent (Engel Clough and Driver, 1985; Hatzikraniotis et al., 2010; Thomaz et al., 1995). Engel Clough and Driver (1985) found that almost all 12- to 16-year-olds understood that ‘heat’ travelled through metals, but often described heat flowing rather than the actual mechanism. Hatzikraniotis et al. (2010) reported that the majority of 13- to 14-year-olds (n=24) described thermal conduction as the flow of hot particles. In their study in Portugal, Thomaz et al. (1995) similarly found that before teaching, 42% of 14- to 15-year-olds (n=79) wrongly thought of ‘heat’ (or ‘cold’) as a substance.

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*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 the 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.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

Nadia, Ollie and Peter are right about why the plastic case sometimes feels very warm.

Nadia describes the source of heating and its effect on the particles in the plastic case. Peter describes a mechanism that enables the transmission of vibrations through the plastic to Luca’s hand. As Ollie explains, it is just the more vigorous vibration of the particles in the plastic that Luca feels as extra warmth.

Luca and Matilda are wrong about why the plastic case sometimes feels very warm.

Luca is using ‘heat’ in a way that is not scientific and in a way that implies that heat is a fluid flowing through the plastic case. Matilda is partially right, in that the case would feel warm because it does not quickly transfer energy away from Luca’s hand and he would sense the warmth of his hand when he touches the case. It could not however, feel any hotter than Luca’s hand, so it would not feel *very* warm because of this.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Augusto Ordonez from Pixabay

**References**

Engel Clough, E. and Driver, R. (1985). Secondary students' conceptions of the conduction of heat: bringing together scientific and personal views. *Physics Education,* 20**,** 176-182.

Hatzikraniotis, E., et al. (2010). Students' design of experiments: an inquiry module on the conduction of heat. *Physics Education,* 45 (4)**,** 335-344.

Thomaz, M. F., et al. (1995). An attempt to overcome alternative conceptions related to heat and temperature. *Physics Education,* 30 (1)**,** 19-26.