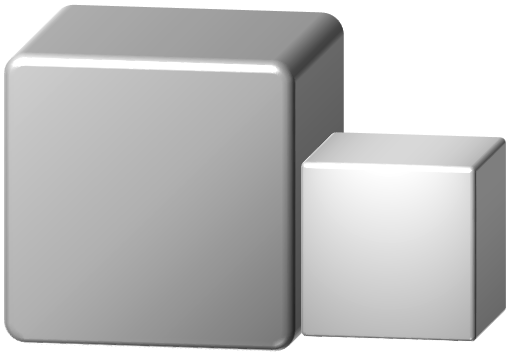
**Side-by-side**

Two metal blocks are placed next to each other so they are touching.

Each block has different properties.



Mass 0.5kg

Specific heat capacity 800 J/kg/oC

Temperature 25oC

Mass 2.5kg

Specific heat capacity 400 J/kg/oC

Temperature 30oC

**a.** In what direction do you think energy will be transferred?

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | From the large block to the small block. |  |
|  |  |  |
| **B** | From the small block to the large block. |  |

**b.** Which do you think is the best reason for your last answer?

*All the statements are correct.*

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | The large block has a higher temperature. |  |
|  |  |  |
| **B** | The large block has a larger mass. |  |
|  |  |  |
| **C** | The small block has got a higher specific heat capacity. |  |
|  |  |  |
| **D** | The large block has more energy in its thermal store. |  |

*Physics > Big idea PMA: Matter> Topic PMA3: Energy of moving particles > Key concept PMA3.2: Specific heat capacity*

|  |
| --- |
| **Diagnostic question** |
| **Side-by-side** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Specific heat capacity is the amount of energy added to the thermal store of a material in order to increase the temperature of 1kg of that material by 1oC. |
| Observable learning outcome: | Predict how one quantity in the equation ΔE = mcΔΘ is affected by changes to other quantities. |
| Question type: | Two-tier multiple choice |
| Key words: | Energy, temperature change, mass, specific heat capacity, thermal store |

**What does the research say?**

Herrington (2011) suggests the traditional method of teaching specific heat capacity, which involves learning the related definitions and equations and using equations to determine the specific heat capacity in a laboratory setting contributes to confusion about specific heat capacity. Although students are often able to calculate values with the equation, they often do not often understand what specific heat capacity tells us about a material. Instead it can be more effective to introduce students to the concept of heat capacity and to guide them to make connections to their own personal experiences before introducing definitions and equations.

This diagnostic question can be used to check whether students understand the physical effect of the variables involved in specific heat capacity calculations.

**Ways to use this question**

Students should complete the questions individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation. The follow on question will give you insights into how they are thinking and highlight specific misconceptions that some may hold.

If there is a range of answers, you may choose to respond 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*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

a. A, from the large block to the small block.

b. A, the large block has a higher temperature.

**How to respond - what next?**

The higher temperature of the larger block means that its particles are vibrating, on average, more vigorously than the particles in the smaller block. When they are in contact, the particles in the smaller block will be forced to vibrate more vigorously and the temperature of the smaller block will increase as energy is transferred to it.

*Part a*

Some students may choose wrongly option B if they think specific heat capacity is a concentration of energy. Combined with a misunderstanding that energy flows like a fluid, they might imagine energy squeezed into the smaller block at an increased pressure.

*Part b*

Each distractor (B, C and D) suggests the flow of a larger quantity held in one block into the other block. The misunderstanding that energy is some form of fluid that can flow is persistent amongst a significant minority of 14- to 16-year-olds. Responses B and D follow from a misunderstanding that energy is a substance that flows from where there is a more of it to a place there is less. Response C is consistent with the wrong response to part a.

If students have misunderstandings about physical expression of quantities in the equation ΔE = mcΔΘ, it can help to review ideas about temperature and energy. Careful questioning should elicit understanding of the connection between the vigour of vibrating particles in a solid and its temperature as well as understanding that energy is transferred to them when they are made to vibrate more quickly. A student model, in which students are vibrating particles, can quickly demonstrate how the vigour of vibrations is transferred between blocks at different temperatures, no matter what their size. Students in the smaller block could additionally link arms more securely so they require more energy in order to vibrate than the particles in the larger block. This partially explains why the smaller block has a higher specific heat capacity.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG), from an idea by Jasien and Oberem (California State University San Marcos).

Images: Peter Fairhurst (UYSEG).

**References**

Herrington, D. G. (2011). The heat is on: an inquiry-based investigation for specific heat. *Journal of Chemical Education,* 88(11)**,** 1558-1561.

Jasien, P. G. and Oberem, G. E. (2002). Understanding of elementary concepts in heat and temperature among college students and K-12 Teachers. *Journal of Chemical Education,* 79 (7)**,** 889-895.