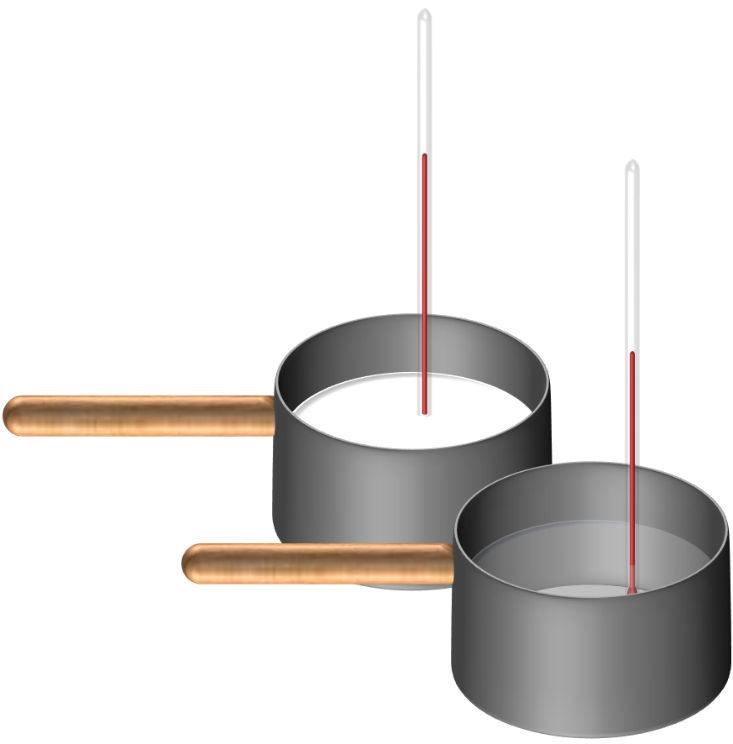
**Hot drinks**



Equal masses of water and milk are both heated in the same way.

They are heated for five minutes.

The temperature of the milk increases more than the temperature of the water.

1. Has more energy been transferred to the thermal store of the milk or to the thermal store of the water?

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

|  |  |  |
| --- | --- | --- |
| **A** | The thermal store of the milk. |  |
|  |  |  |
| **B** | The thermal store of the water. |  |
|  |  |  |
| **C** | The same amount to both. |  |

2. Which has the highest specific heat capacity?

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

|  |  |  |
| --- | --- | --- |
| **A** | Milk |  |
|  |  |  |
| **B** | Water |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Hot drinks** |

**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: | Explain why a material’s specific heat capacity affects the rate at which its temperature will change as its thermal store gains or loses energy. |
| Question type: | Simple multiple choice |
| Key words: | Energy, temperature, 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.

One way to think about specific heat capacity is as a measure of how hard it is to change the temperature of a material. For two objects of the same mass, the one with the bigger specific heat capacity will be harder to warm up as it requires more energy to increase its temperature by each 1oC.

**Ways to use this question**

Students should complete the question 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 answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

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**

1. C, the same amount to both.

2. B, water.

**How to respond - what next?**

*Question 1*

The same amount of energy is transferred into the thermal store of both the milk and the water as they are heated in the same way. Students who think that temperature is a measure of the amount of energy in a thermal store are likely to choose answer A.

*Question 2*

Milk heats up more rapidly than the same mass of water, which is heated in the same way, because it has a smaller specific heat capacity. This means that the milk requires less energy than water does to be transferred into its thermal store in order to increase its temperature by a particular amount.

Some students are likely to think specific heat capacity is a measure of how easily an object heats up. In fact the opposite is true, but in addition to specific heat capacity the mass and temperature change of the object also need to be taken into account. At this stage comparing temperature changes for equal masses of substances gaining the same amounts of energy in their thermal stores can help develop a deeper understanding of what it means for an object to have a bigger, or smaller, specific heat capacity.

If students have misunderstandings about why a material’s specific heat capacity affects the rate at which its temperature will change as its thermal store gains or loses energy, it can help challenge thinking by giving students the opportunity to measure the increase in temperature of a particular mass of cooking oil and of the same mass of water. The water has a much higher specific heat capacity than cooking oil, so when they are each heated with the same heat source the temperature of the oil increases much more quickly.

Giving students values for the specific heat capacity of the cooking oil and of water and asking them to use these values to predict what will happen and why they think it will happen, before they carry out the investigation, can encourage social construction of new ideas through dialogue.

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Hot water bottle

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

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.