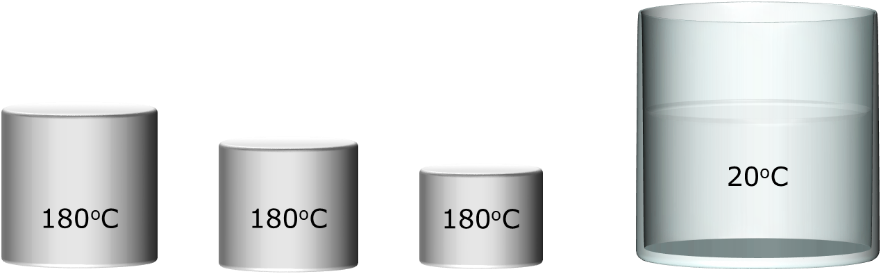
**Hot water**

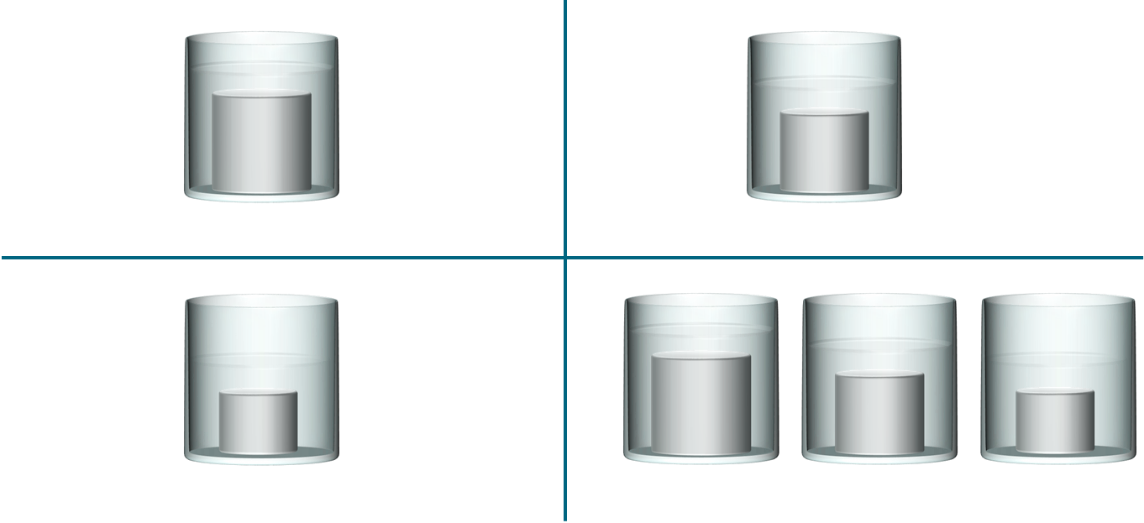
Three metal blocks are heated in an oven.

The temperature of each block is 180oC.

Each block is put into a beaker of cold water.

**a.** Which beaker of water will reach the highest temperature?

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



**A** Water with the large block.

**D** All the same temperature

**C** Water with the small block.

**B** Water with the medium block.

**b.** What do you think is the best reason for your answer to the last question?

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

|  |  |  |
| --- | --- | --- |
| **A** | The temperature of each block was the same. |  |
|  |  |  |
| **B** | This block contained the most temperature. |  |
|  |  |  |
| **C** | The energy of each block was the same. |  |
|  |  |  |
| **D** | This block contained the most energy. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Hot water** |

**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: | Distinguish between energy in the thermal store of an object and the object’s temperature. |
| Question type: | Two-tier multiple choice |
| Key words: | Energy, temperature, thermal store |

|  |  |
| --- | --- |
| **P** | **PRIOR UNDERSTANDING**  This diagnostic question probes understanding of ideas that are usually taught at age 11-14, to aid transition from earlier stages of learning. |

**What does the research say?**

Some misunderstandings about thermal ideas are both common and persistent (Erickson and Tiberghien, 1985; Driver et al., 1994), so it makes sense to check students understanding at each stage of their learning to make sure you are building on a good understanding of the key concepts before progressing with new ones. For example, a significant minority of students continue to confuse the concepts of temperature and energy throughout their secondary science education (Driver et al., 1994; Chu et al., 2012; Adadan and Yavuzkaya, 2018).

Most students correctly understand that raising the temperature of a particular object also increases the energy in its thermal store. However, fewer than half (n=342) of 11- to 15-year-olds in a study by Gonen and Kocakaya (2010) understood that, when they are at the same temperature, a larger mass of a material contains more energy in its thermal store than a smaller mass of the same material. It is common for students to think that an object at a higher temperature has more energy in its thermal store than an object at a lower temperature, even when the hotter object has a much smaller mass.

**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

b. D

**How to respond - what next?**

Temperature is a measure of the average energy each particle in a material has because of its movement. The more particles at a particular temperature, the more energy in total.

It is common for students of all ages to muddle the terms temperature and energy. Students who do this may select the correct answer to *part a*, but not to *part b*.

Other students who think of temperature as a ‘substance’ that heats something up, are likely to choose answer D for *part a* followed by answer A or C for *part b*.

If students have misunderstandings about the distinction between energy in the thermal store of an object and the object’s temperature, it can challenge students thinking by approaching the same problem in a different way. Start by asking what happens to the temperature of the water when a small hot block is added. Next ask what will happen to the temperature of the water if a second small hot block is added, and then a third. Students can compare this with the situation of adding three small hot blocks at the same time, or a single large hot block.

Asking students to explain in their own words, why the largest block at a particular temperature increases the temperature of the water by the greatest amount, gives them opportunity to consolidate their understanding.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

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