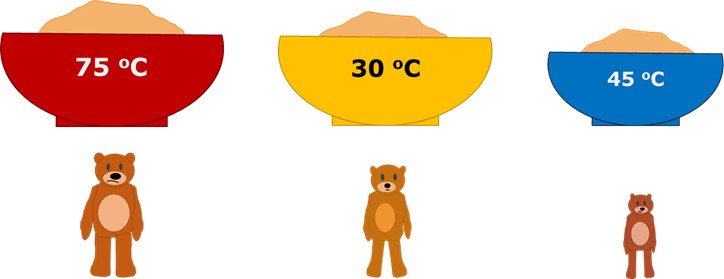
**Three bears**

The three bears were arguing.

They can’t decide whose porridge has most energy in its thermal store.



Read each statement about the bears’ porridge?

What do you think about each one?

For each statement, tick (✓) **one** column to show what you think*.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Statement | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | Daddy Bear has the most energy in his porridge |  |  |  |  |
| **B** | Mummy Bear has more spoonfuls of porridge than Baby Bear |  |  |  |  |
| **C** | One spoonful of Mummy Bear’s porridge has more energy than one spoonful of Daddy Bear’s porridge |  |  |  |  |
| **D** | Mummy Bear has more energy in her porridge than Baby Bear |  |  |  |  |

*Physics > Big idea PMA: Matter > Topic PMA1: Heating and cooling > Key concept PMA1.4: Thermal store of energy*

|  |
| --- |
| **Diagnostic question** |
| **Three bears** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Each different material will have more energy in its thermal store if either its temperature or mass is increased |
| Observable learning outcome: | Explain the difference between energy (in a thermal store) and temperature |
| Question type: | Confidence grid |
| Key words: | Thermal store of energy, temperature |

**What does the research say?**

Most students correctly understand that raising the temperature of a particular object also increases the energy in its thermal store. However, fewer than half of 11- to 14-year-olds understand 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. (Gonen and Kocakaya, 2010)

It has been found that about a quarter of students aged 10-16 do not distinguish between temperature and energy in a thermal store. They often have the misunderstanding that temperature is a means of measuring energy in a thermal store. (Driver et al., 1994; Tiberghien, 1983)

This question investigates students’ understanding of how both temperature and mass need to be taken into account in order to estimate the amount of energy in a thermal store.

**Ways to use this question**

Students should complete the confidence grid 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.

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**

Answers A and B are correct.

C is wrong.

D is correct, but ‘you can’t tell’ is equally acceptable.

**How to respond - what next?**

Daddy Bear has both the greatest amount of porridge and porridge at the highest temperature.

Mummy Bear has the porridge at the coldest temperature. Hers will have the least energy in the thermal store when equal amounts are compared.

Baby Bear has porridge at a higher temperature than Mummy Bear, but less of it. Spoonful by spoonful his has more energy, but Mummy Bear has more spoonfuls to add to work out the total amount of energy in the thermal store of her porridge. Who has the most energy is uncertain, although it is likely that Mummy Bear has the most because she has a lot more porridge, and its temperature is just a little bit lower. (For the good mathematician who understands the Kelvin temperature scale: Mummy Bear has roughly twice the mass of porridge and its temperature is about 5% lower than Baby Bear’s)

If students have misunderstandings about how the amount of energy in a thermal store depends on both the temperature and the mass of substance, it can help to use a model to demonstrate how this works. The following BEST ‘response activity’ could be used to do this, in follow-up to this diagnostic question:

* Response activity: Energy v temperature

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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