**Fresh bread**

Two loaves of bread are baked in the same oven at 200oC.

They are taken out of the oven at the same time.



These statements are about the bread at the instant it is taken out of the oven.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | The big loaf has more energy than the small loaf. |  |  |  |  |
| **B** | The small loaf has a higher temperature. |  |  |  |  |
| **C** | Temperature of the bread depends on the size of the loaf. |  |  |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Fresh bread** |

**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: | Confidence grid |
| 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 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**

Statement A is right; and statements B and C are wrong.

**How to respond - what next?**

Temperature is a measure of the average energy each particle in a material has because of its movement. The oven causes all the particles in each loaf of bread to vibrate, on average, with the same energy as each other. The larger loaf has more particles and therefore more energy, but is at the same temperature as the smaller loaf.

Some students may be thinking wrongly that temperature is a measure of the amount of energy in the bread. These students are likely to think that statements A and C are correct.

By contrast, students with the same misunderstanding may think that the temperature of the oven indicates how much energy has been transferred to each loaf as it was heated. In this case they are likely to think statement B is correct because it makes sense for the temperature of the small loaf to be higher if it is sharing the same amount of energy, which the large loaf has, amongst fewer particles.

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. Perhaps start by asking whether students whether there would be a difference in the temperature between two *identica*l loaves of bread taken out of the oven at the same time, or differences in the amount of energy each one had. Careful questioning should elicit the understanding that placing the loaves next to each other and in contact (as if they were one larger loaf) does not affect their temperatures, but together they have twice the energy as one loaf has on its own.

Asking students to explain in their own words, why a small loaf of bread taken out of an oven at the same time as a large loaf has less energy but the same temperature, gives them opportunity to consolidate their understanding.

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Images by Alexander Lesnitsky, from Pixabay.

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