**A cup of tea**

The temperature of a cup of tea is measured with a thermometer.

There is a red liquid inside this thermometer.

**1.** What happens to the **liquid** in the thermometer when it is put in the hot tea?

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

|  |  |  |
| --- | --- | --- |
| **A** | Its temperature goes up and it expands (gets bigger) |  |
|  |  |  |
| **B** | Its temperature goes up |  |
|  |  |  |
| **C** | Its temperature goes up and it contracts (gets smaller) |  |

**2.** What is the **best answer** that explains why this happens?

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

|  |  |  |
| --- | --- | --- |
| **A** | The particles move more quickly |  |
|  |  |  |
| **B** | The particles expand (get bigger) |  |
|  |  |  |
| **C** | The particles break up |  |
|  |  |  |
| **D** | The temperature of each particle goes up |  |

*Physics > Big idea PMA: Matter > Topic PMA1: Heating and cooling > Key concept PMA1.1: Temperature*

|  |
| --- |
| **Diagnostic question** |
| **A cup of tea** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Temperature is a measure of the average speed at which the particles in a substance or material are moving |
| Observable learning outcome: | Explain the changes in volume of solids and liquids when their temperature is changed |
| Question type: | Two-tier multiple choice |
| Key words: | Particle, vibrate, temperature, expand, contract |

**What does the research say?**

An understanding of what happens to particles when they are heated is necessary in order to explain the mechanisms of heating, and to understand the difference between temperature and a thermal store of energy. Earlier ideas about the arrangement and movement of particles in solids, liquids and gases (BEST key concept: *CPS1.1: Particle model for the solid, liquid and gas states*) can be used to construct models in order to help develop students’ understanding of these things.

Johnson (1998) found research evidence showed that very few students have an appreciation of the intrinsic motion of particles. Many have difficulties with the idea that there is ‘nothing’ between particles. Others think of particles with the same properties as tiny pieces of the bulk material. This may lead to students thinking that particles expand when they are heated, in the same way that a substance does.

This question investigates students’ understanding about the effect heating has on particles in a substance or material.

**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**

1. A, it expands

2. A, the particles move more quickly

**How to respond - what next?**

Question 1 describes what happens to the liquid in the thermometer and the fact that it expands can be demonstrated.

In question 2, a significant number of students are likely to choose option B: the particles expand. These students probably think individual particles behave in the same way as the bulk liquid.

A few students may choose answer C because they notice that burning can destroy things.

Answer D again ascribes properties of the bulk liquid to individual particles.

If students have misunderstandings about why heating a liquid causes it to expand, it can help to discuss with the class how the scientific model (kinetic particle model) explains expansion. Challenging students to explain why alternative models do not work and applying the kinetic particle model to a new situation can help consolidate understanding.

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

* Response activity: Expansion model

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Johnson, P. (1998). Progression in children's understanding of a 'basic' particle theory: a longitudinal study. *International Journal of Science Education,* 20(4)**,** 393-412.