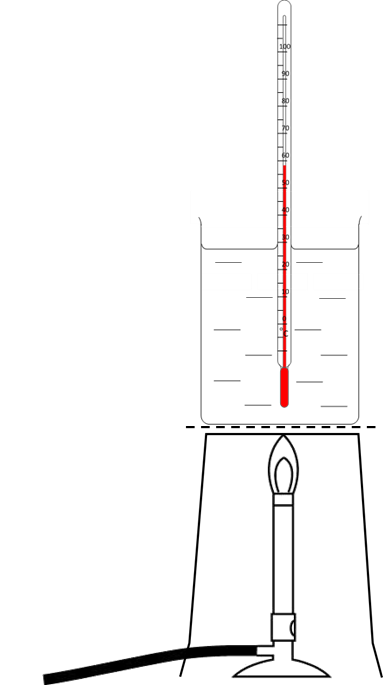
**The same Bunsen**

Holly is heating water with a Bunsen burner.

She is wondering why her water is taking so long to boil.

**Predict**

100 cm3 of water is heated for two minutes.

200 cm3 of water is heated for two minutes with the **same** Bunsen burner.

What do you think will happen?

**Explain**

Why do you think this will happen?

|  |
| --- |
| **Now carry out the investigation** |

**Observe**

Record how much the temperature goes up for each volume of water.

**Explain**

Were your prediction and explanation correct?

If not, can you explain what you observed?

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

|  |
| --- |
| **Response activity** |
| **The same Bunsen** |

**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: | Identify which of two objects or substances has the most energy in its thermal store when the only difference between them is their mass |
| Activity type: | Predict, explain, observe, explain - practical/demonstration |
| Key words: | Thermal store of energy, temperature |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Thermal store of energy

**What does the research say?**

The difference between temperature and a thermal store of energy is a crucial idea in the understanding of thermal concepts. When an object is warmed up its temperature rises, the amount of energy in its thermal store increases and the particles in the object move or vibrate more. All of these changes are interconnected and happen at the same time. Heating an object makes its particles move around more; temperature is a measure of the average kinetic energy of the particles; and the extra kinetic energy of all the particles adds to the energy in the thermal store (Institute of Physics).

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. (Gonen and Kocakaya, 2010)

This activity challenges students to explain what happens when equal amounts of energy are added to different masses of water.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* Bunsen burner
* x2 glass beaker (250 cm3)
* tripod, gauze and heat resistant mat
* thermometer (0-100oC)
* clamp, boss and stand
* timer

**Technician notes**

If this investigation is carried out as a demonstration, then data-loggers may allow the temperature readings to be projected onto a screen.

**Health and safety**

Holding the thermometer in a clamp, boss and stand reduces the risk of the beaker toppling.

Hot beakers will need to be taken off the tripod. Heating for shorter times will reduce the temperature and the risk, and the observations will still be clear.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

The increase in temperature of 100 cm3 of water is twice the increase of the 200 cm3.

The energy added to the water is the same in both cases, but if it is heating twice as much water there is half as much energy to heat each equal sized ‘bit’ of water.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Gonen, S. and Kocakaya, S. (2010). A cross age study on the understanding of heat and temperature. *Eurasian Journal of Physics and Chemistry Education,* 2(1)**,** 1-15.

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