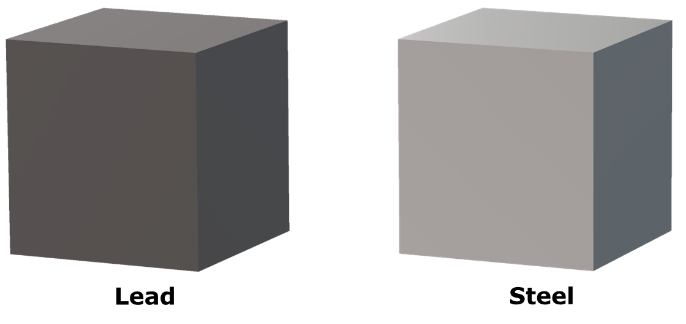
**Hot metal**



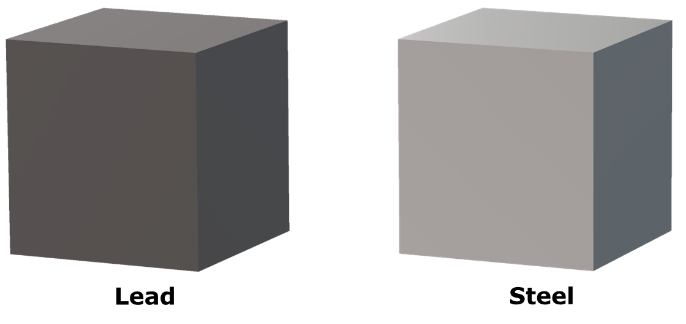
These cubes are made out of metal.

They are put into a beaker of very hot water to heat up.

Each one is put into a new beaker with 100cm3 of cold water.

**Predict**

Does the steel have more than twice the energy in its thermal store than the lead?

What will you observe if it does?

**Explain**

What are the reasons for your prediction?

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

**Observe**

Measure how much the temperature of the water goes up for each metal.

**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** |
| **Hot metal** |

**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: | Describe how the specific heat capacity of a material affects the amount of energy in its thermal store |
| Activity type: | Predict, explain, observe, explain - practical/demonstration |
| Key words: | Thermal store of energy, temperature, specific heat capacity |

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

* Diagnostic question: Specific heat capacity

**What does the research say?**

Apart from mass and temperature, the other factor that affects the amount of energy in the thermal store of a material is the specific heat capacity of the material. It is common for students to experience specific heat capacity, c, for the first time as the constant in the equation E=mcΔT (which they often learn in their later studies at age 14-16). Although they are often able to calculate values with this equation, students do not often understand what specific heat capacity tells us about a material. Using an investigative approach has been shown to help develop a clearer understanding of specific heat capacity. (Herrington, 2011)

**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:

* lead block and a steel block
* large plastic beaker
* access to hot water from a kettle
* x2 plastic beaker 250 cm3
* x2 thermometer (0-100oC)

**Technician notes**

The blocks need to be approximately the same size. The ones in a density block set have a volume of approximately 50cm3 and work well.

The amount of cold water used in should be as small as necessary to cover the blocks. The smaller the volume, the larger the temperature changes.

**Health and safety**

Plastic beakers will prevent breakages if a metal block slips and falls into a beaker.

The large beakers should be filled at students’ tables with a kettle. This reduces the risk of dropping beakers of hot water. Working close to a sink also reduces this risk when clearing away.

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**

Using blocks of approximately 50 cm3, in 100 cm3 of water: lead increases the temperature of the water by about 10oC and steel increases it by more than twice the amount that lead does.

This shows that steel, at the same temperature as lead, contains more energy in its thermal store. Both metals are heating the same volume of water and so the increase in temperature is proportional to the energy transferred to the water.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG), from an idea by Herrington (2011).

Images: Peter Fairhurst (UYSEG).

**References**

Herrington, D. G. (2011). The heat is on: an inquiry-based investigation for specific heat. *Journal of Chemical Education,* 88(11)**,** 1558-1561.