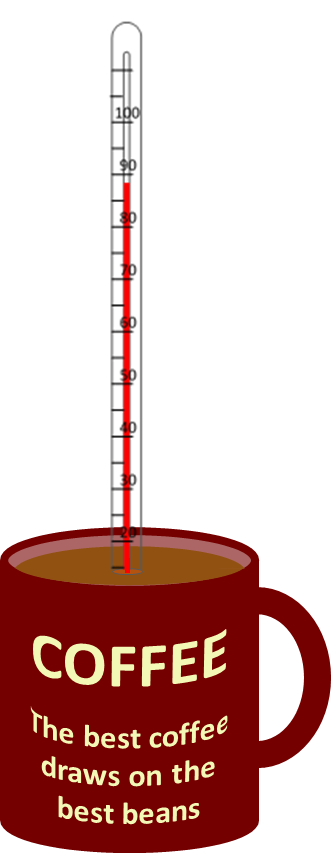
**Cooling curve**

Emma is a science teacher.

She has noticed her coffee cools down faster when she is on outside break duty.

She wonders what is happening.

**Predict**

How quickly do you think the temperature of hot coffee will fall?

What temperature do you think it will fall to?

**Explain**

Why do you think this will happen?

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

**Observe**

Draw a graph to show what happens.

Describe what happens to the temperature of water as it cools.

**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 PMA1.2: Heating and cooling*

|  |
| --- |
| **Response activity** |
| **Cooling curve** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | If two objects at different temperatures are in contact, energy will move spontaneously from the object at the higher temperature to the object at the lower temperature. |
| Observable learning outcome: | Describe how the temperature of hot water changes as it cools |
| Activity type: | Predict, explain, observe, explain – practical/demonstration |
| Key words: | Temperature, transfer, dissipation |

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

* Diagnostic question: Just cool?

**What does the research say?**

Students have a large store of everyday experiences of things heating or cooling, from which they will have developed ideas about these processes. Many however will not have formed a clear general (and scientific) understanding that they can apply to new situations. (Millar, 2011)

This activity gives students the opportunity to observe and describe how hot drinks cool more quickly when there is a greater difference in temperature between the drink and its surroundings and to consolidate the understanding that the drink will reach an equilibrium temperature with its surroundings.

**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 students plot a line graph of temperature against time. Some students may need extra support drawing their graphs, and in particular in choosing sensible scales. When describing what happens to the temperature as the water cools, students should be encouraged to describe how its rate of cooling changes as it approaches room temperature.

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:

* O-100 oC thermometer
* Stirring rod
* 250 cm3 beaker
* Clamp, boss and stand
* Access to a kettle

**Technician notes**

Sufficient kettles should be placed around the room in order to heat enough water for all groups and to minimise transport of hot kettles to students’ tables.

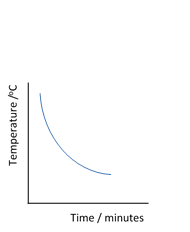
**Health and safety**

Risk of burning with hot water and hot beakers. This can be reduced if kettles are carried to students’ desks to fill beakers, rather than by carrying beakers of hot water. Using a clamp, boss and stand to hold the thermometer reduces the risk the beaker toppling over.

Putting beakers away before they have sufficiently cooled creates extra risks.

There is a risk of thermometers breaking if they are placed close to the edge of a table, or used to stir the water.

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 temperature falls quickly at first and then more slowly as the water approaches room temperature.

The water will eventually reach room temperature which is about 21 oC.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Millar, R. (2011). Energy. In Sang, D. (ed.) *Teaching Secondary Physics.* London: Hodder Education.