B1 ACTIVITY 3: HOT VERSUS COLD

Background

This activity aims at clarifying students' understanding of the distinction between the terms 'hot', 'cold', 'heat energy' and 'temperature' using thermofilm – a liquid crystal film that changes colour as it heats up. Using the thermofilm introduces students to another thermometric property suitable for measuring temperature – colour change. The colours that appear as the film reacts to heat energy are referenced against the standard glass-in-liquid thermometer.

Before using the thermofilm the students need to calibrate the film and draw up a reference chart to use.

Suggested approaches:

- Let the students brainstorm about their ideas of hot versus cold, and temperature versus heat. They should record their ideas for future reference. They can then carry out the first activity, **B1 ACTIVITY 3 (I): IT'S ALL RELATIVE (TEACHER-LED)**, in groups of four. After completing this activity they can revisit their original ideas and see if they should change their minds.
- Alternatively the students can carry out the activity first, and then have a brief discussion on hot versus cold and temperature versus heat.
- Keeping any questions on hold, the students can then use the thermofilm. They can learn how to calibrate it and then use it to demonstrate energy flow.

B1 ACTIVITY 3 (I): IT'S ALL RELATIVE (TEACHER-LED)

Equipment required:

- Four beakers to be used as follows:
  - Beaker A containing hot water (from the tap)
  - Beaker B containing a mixture of cold water and ice cubes/crushed ice
  - Beakers C and D both containing body-temperature water (approx. 37°C)
- Thermometer

What to do:

1. Select two volunteers from the class: **Volunteer 1** and **Volunteer 2**.
2. Without disclosing the temperatures of the beakers, ask **Volunteer 1** to hold **Beaker A** in one hand and **Beaker B** in the other.
3. Ask **Volunteer 2** to measure the temperature of **Beaker A** and **Beaker B**.
4. Ask **Volunteer 1** to confirm which of the beakers is hot and which is cold.
5. Now ask **Volunteer 1** to put one hand into **Beaker C** and one hand into **Beaker D**, and ask them to tell you which contains hot water, and which contains cold water.
6. Ask **Volunteer 2** to measure the temperatures of **Beakers C** and **D** and announce them to the class.
   - Discuss the students' original ideas about hot and cold and see if this demonstration has changed those ideas. Do not press too much for answers at this stage.
7. After the students have completed the activities **B1 ACTIVITY 3 (II): CALIBRATING THERMOFILM** and **B1 ACTIVITY 3 (III) VISUALISING ENERGY FLOW**, revisit what they learned from this demonstration.

   At this point, explain that our skins have temperature sensors able to detect the direction of energy flow along the surface of our bodies. There are two different messages sent along the nerves: that heat energy is flowing into the skin (hot); and that heat energy is flowing out of the skin (cold).

B1 ACTIVITY 3 (II): CALIBRATING THERMOFILM

Before using the **thermofilm** the students need to calibrate the film and draw up a reference chart to use. The different colours that occur as a result of heat energy should be referenced against the standard glass-in-liquid thermometer as follows: black corresponds to approximately 25°C; brown to approximately 26°C; green to between 29°C and 30°C; and blue to above 30°C.

Equipment required:

- Hot plate or Bunsen burner with tripod and wire gauze
- Heatproof mat
- 250 cm3 beaker
- Thermometer
- Test tube
- Piece of thermofilm (3 cm x 1 cm)
- **B1.3 printout: Thermofilm calibration chart**

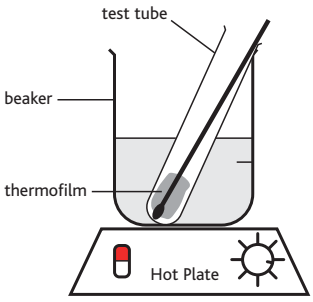

Figure 4

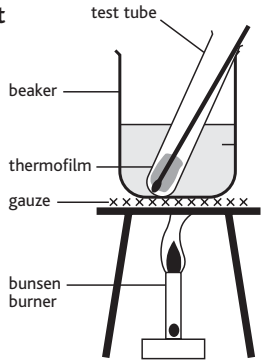

Figure 5

What to do:

1. Set up the hot plate or the Bunsen burner tripod and gauze as shown in Figure 4 and Figure 5.
2. Half fill the beaker with cold water and place it on the hot plate or the gauze.
3. Drop the thermofilm into the clean, dry test tube.
4. Place the thermometer into the test tube.
5. Place the test tube in the beaker of water.
   - ✔ Note the initial temperature of the water and the colour of the thermofilm.
6. Switch on the hot plate or light the Bunsen burner and slowly heat the water.
7. As the water heats up, the thermofilm changes colour.
   - ✔ Note the temperature readings for each of the colour changes.
   - ? ***What do you notice about the colour bands?***
   - ? ***What temperature range does each band cover?***
8. When the water temperature reaches 40°C switch off the heat.
   - ? ***Why do you think you should do this?***

B1.3 printout: Thermofilm calibration chart

TEMPERATURE RANGE	CORRESPONDING COLOUR

B1 ACTIVITY 3 (III) VISUALISING ENERGY FLOW

Equipment required:

- Two small empty aluminium cans (150 g tomato puree can is ideal)
- An aluminium sheet (3 x diameter of can)
  [Alternatively take two sheets of kitchen foil, put them together and laminate them as one. Gently peel the laminate cover apart giving two sheets which can then be cut to size. The laminated side can be stuck to the polystyrene.]
- Strip of thermofilm (5 cm x 2 cm)
- Thermometer
- Ice cubes
- Access to hot water
- Expanded polystyrene slab (approx. 25 cm x 10 cm)
- Calibration chart from previous experiment **B1 ACTIVITY 3 (II): CALIBRATING THERMOFILM**
- Insulating covers to fit cans (optional)
- Stopwatch

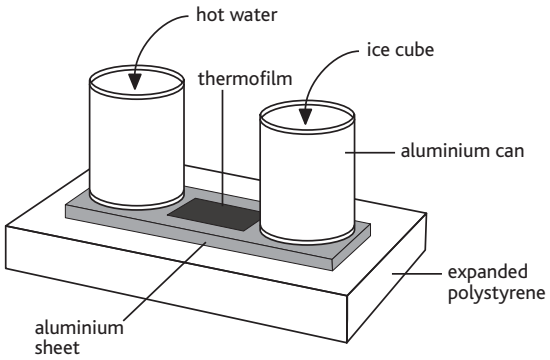

Figure 6

What to do:

1. Affix the thermofilm to the aluminium sheet as shown in Figure 6.
2. Place the aluminium sheet on the expanded polystyrene slab as shown in Figure 6.
3. Place the aluminium cans on either side as shown in Figure 6.
4. Put a cube or two of ice into one of the cans.
5. Fill the other can halfway with hot water.
6. Place the thermometer in the hot water and note the temperature.
   Observe what happens to the thermofilm, referencing the calibration chart from the previous experiment.
7. Repeat the experiment.
   This time, note the time it takes for the thermofilm to stop changing colour.
   ? ***What is this colour?***
   ? ***What has happened?***
8. Repeat again, this time placing lids on the cans.
   Compare time results.
   ? ***If using laminated kitchen foil, is it important which side is facing upwards?***
   ? ***Why?***

B1.3 Discussion points: Colour and Temperature

1. Students are familiar with mood rings, bracelets, etc. These come with a chart relating colours to emotions.
   - ? ***Is the colour-temperature range the same as that of the thermofilm used in* B1 ACTIVITY 3 (II): CALIBRATING THERMOFILM*?***
   - ? ***If the body temperature is 37°C when it is worn, why does the ring colour at lower temperatures?***
   - ? ***Is the colour-temperature range the same as the thermofilm?***
   - ? ***If the body temperature is 37°C, how can the ring change colour when it is worn?***

Figure 7: One of the many charts used with mood jewellery

- Stressed
- Fear
- Nervous
- Mixed Emotions
- Normal
- Relaxed
- Calm
- Cool
- Lovable
- Romance
- Passion
- Very Happy

RESOURCES:

- Search the National Stem Centre, UK for some great ideas on teaching heat and temperature.