D1 ACTIVITY 4: HEATING THE HOME

Background

This activity demonstrates a number of important principles for students. It can be used to encourage an understanding of how heat is transferred around the house and how a home heating system works, and should help students to understand the concept of a closed heating system and the problems caused by airlocks in 'radiators' (tubing acting as a radiator), as well as the role of insulation in reducing heat energy loss.

In the activity the boiling tubes and plastic tubing represent a 'closed' system and the hot water represents the source of heat (i.e. the Sun, or a boiler). The students can see that there is no physical contact between the heat source (i.e. the water in the large beaker) and the water in the boiling tubes yet heat energy is transferred. The migration of the food colouring will demonstrate the heat transfer.

Suggested approaches:

- Start with a short brainstorming session to see what the students understand by convection heating.
- Ask them to clarify for you their understanding of the direction of heat flow.

  ? ***Does heat flow from hot regions to cold regions?***

  ? ***Does it flow from cold regions to hot regions?***

  ? ***Do hot and cold flow towards each other?***

  As you carry out the activity, ask the students to describe what they see.
- If it is appropriate, challenge the students to carry out the role-plays demonstrated in Figure 4 and Figure 5. You will need between five and ten red balls to carry them out.

Conduction role-play:

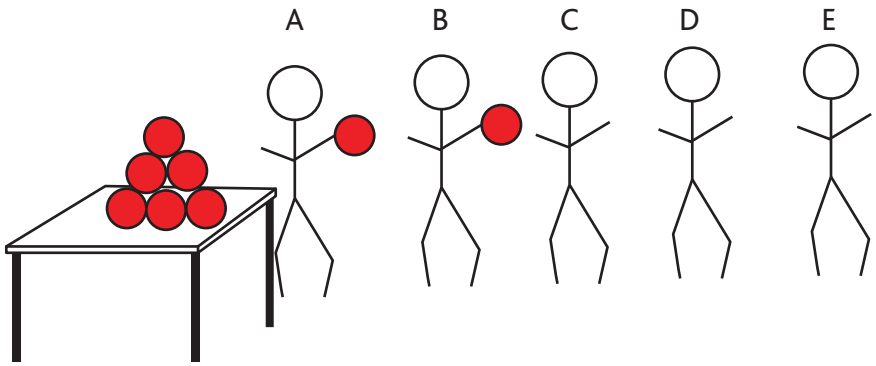

Figure 4

Role-play to demonstrate heating by conduction. Heat energy travels through the molecules but the molecules themselves do not move.

1. Place the red balls in a pile on the table or floor. The red balls represent the heat source.
2. Choose five volunteers. Name them A, B, C, D and E. They represent molecules of metal.
3. Stand them in a row in their letter sequence, with student A nearest to the heat source (red balls).
4. Explain to the students that they are going to demonstrate the heating process.
5. Ask student A to begin the heating process by picking up a red ball. This is to show the molecule acquiring heat energy.
6. Ask student A to pass the ball to student B who should pass it on to student C, who must pass it on. Explain that the molecules are conducting heat.
7. As soon as student A has passed on one ball, he or she must pick up another and pass it on until all the metal molecules have a ball. They are now the same temperature.
8. Explain that this movement of heat energy through the metal is referred to as **energy transfer by conduction.**

Convection role-play:

1. Now collect the balls into a pile again.
2. Select five new students and label them A, B, C, D and E. These students represent the molecules of a liquid or a gas.
3. Organise the molecules in a row.
4. Student A is nearest to the heat source (red balls) and so once the heating process starts will acquire a quantity of heat energy.
5. Explain that these are not metal molecules, so they will not behave like the previous group.
6. Ask student A to take a ball and move to the end of the line with the energy quantity.
7. Ask student B to move into the space, attain a quantity of heat energy, and move to the end of the line, while C moves nearer the pile of balls.
8. Explain that this movement of heated molecules is referred to as **energy transfer by convection.**

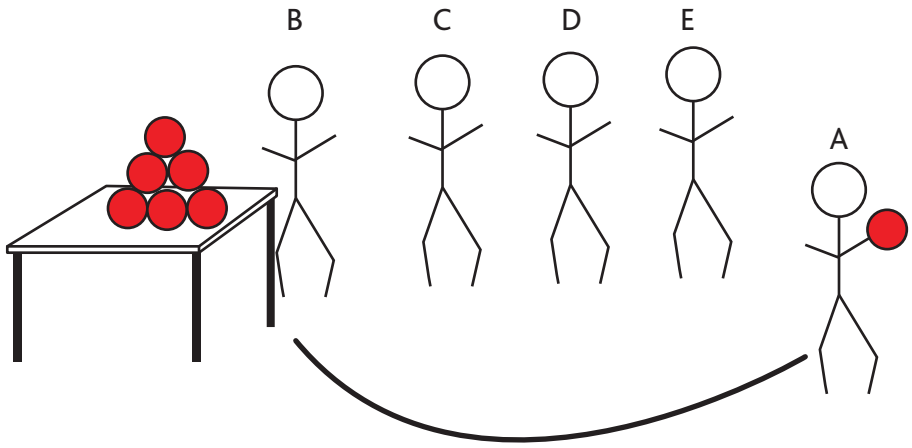

Figure 5
Role-play to demonstrate heating by convection. The molecule is heated and then moves, allowing the next molecule to be heated.

Equipment required:

- Two boiling tubes
- Two-holed bungs to fit tubes
- A boiling tube rack
- Plastic tubing to fit into the bungs
- Food dye
- Thermofilm strip
- 100/250 cm^3 beaker
- Hot water and cold water

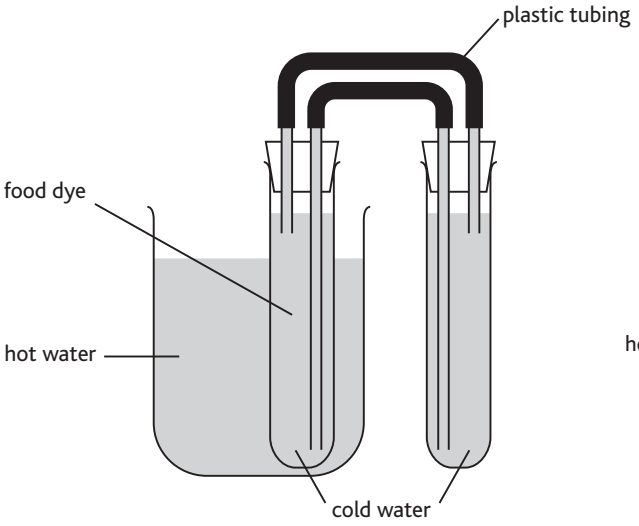

Figure 6

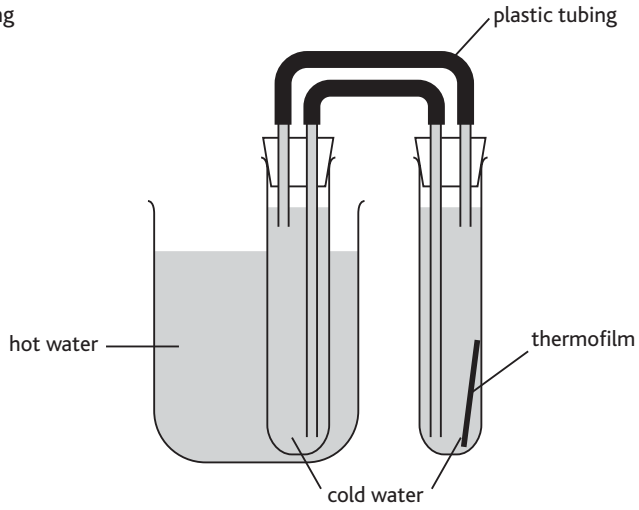

Figure 7

What to do:

1. Thread the plastic tubing through the two bungs as shown in Figure 6 and Figure 7.
2. Place the food colouring in one of the tubes, as shown in Figure 6.
3. Place the thermofilm in the other tube, as shown in Figure 7.
4. Almost fill both boiling tubes with cold water and push the bungs onto the boiling tubes, making sure that all tubing is below the water line.
5. Hold one of the boiling tubes upside down to eliminate any air pockets in the system.
6. Make sure that all the plastic tubing in both boiling tubes is under water.
7. Stand the boiling tube containing thermofilm in the boiling tube rack and the other boiling tube, containing food colouring, in a beaker of very hot water as shown in Figure 6 and Figure 7.
8. Record what you observe taking place

   ? ***What is happening in the boiling tube that is in the hot water?***

   ? ***What is happening in the boiling tube in the boiling tube rack?***

   ? ***What is happening in the plastic tubing connecting both boiling tubes?***

   ? ***What happens to the food dye?***

   ? ***What happens to the thermofilm?***

   ? ***What conclusions can you draw from your observations?***

D1.4 DISCUSSION POINTS: HEAT TRANSFER

1. In this activity, it is recommended that the boiling tubes are almost filled. What might happen if they are both filled to the top?
2. Why was it important to eliminate any air pockets?
3. What would happen if the hot water in the beaker was replaced with cold water?

   ? ***Why?***