The metals used to make pots and pans are very good conductors of heat. This helps to ensure that the heat from the flame or hotplate is evenly spread. To understand how heat is transferred through an object by conduction you need to 'look inside' the object.

**Looking inside an object**

The particles in a solid are packed very closely together. They can vibrate on the spot, but they cannot move from one place to another. If some of the particles are heated, they cannot move along the object to transfer heat to the whole object.

Conduction

Heat travels by conduction when fast-moving particles collide with other particles, making them move faster. Heat can travel by conduction through objects, or from one object to another.

Heat travels by conduction at different speeds, depending on the type of substance. Heat travels more quickly in solids than in liquids or gases. Conduction occurs more quickly when the particles in an object are closer together.

Solids are usually very good conductors of heat because the particles in them are packed closely together. Gases are the poorest conductors because the particles in them are far apart.
**Observing conduction in solids**

You will need:
- heatproof mat
- Bunsen burner and matches
- tripod
- copper rod
- iron rod
- glass rod
- wax
- ruler
- stopwatch.

- Set up the equipment as shown at right.
- Light the Bunsen burner and start the stopwatch.
- Time how long it takes for the last of the three pieces of wax to melt completely on the copper rod. Record your results.
- Repeat for the other two rods. Make sure that the last piece of wax is the same distance from the heated end of each rod.

1. **REMEMBER**
   1. In which type of object (solids, liquids or gases) does heat travel fastest by conduction?
   2. What effect does heating an object have on the speed of the particles inside it?

2. **THINK**
   3. Draw two diagrams of the particles inside a metal. In the first diagram, show how the particles would move before they are heated with a Bunsen burner. In the second diagram, show how the particles would move while they are being heated with a Bunsen burner.
   4. Can heat travel by conduction through a vacuum, where there are no particles? Explain your answer.
   5. Why does heat travel faster by conduction in some objects?

3. **SKILLBUILDER**
   6. The following is a table of results collected during an experiment similar to the one on this page.

<table>
<thead>
<tr>
<th>Material</th>
<th>Time taken for last piece of wax to melt (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock</td>
<td>8.0</td>
</tr>
<tr>
<td>Copper</td>
<td>6.5</td>
</tr>
<tr>
<td>Brick</td>
<td>11.0</td>
</tr>
<tr>
<td>Silver</td>
<td>5.0</td>
</tr>
<tr>
<td>Aluminium</td>
<td>7.7</td>
</tr>
</tbody>
</table>

List the items in the table from the best conductor of heat to the poorest conductor of heat.

7. **INVESTIGATE**
   7. What is a poor conductor of heat called?
   8. Name two substances that are poor conductors of heat. Find out what they are used for.

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**I CAN:**
- describe how heat is transferred by conduction.
- explain why solids transfer heat by conduction more quickly than liquids and gases.
Heat transfer: convection

Unless you have run out of hot water in the middle of a shower, you may not have given much thought to how the water was heated in the first place. Hot water comes out of the shower head, but it wasn’t always hot. Heat has to be transferred to the water from somewhere else.

Heat does not travel through liquids by conduction very well. Another heat transfer method, convection, is responsible for heating the water that comes out of your shower.

Hot water systems

Ready to use
A pipe connects the water at the top of the water tank with the shower and every other hot-water tap. If this water is not used, it cools and sinks to the bottom, where it is heated again.

Rising
Hot water rises because its particles are further apart than those in cold water; it is less dense than cold water. As the hot water rises, cold water continues to move to the bottom of the water tank.

Heating
The flame heats the cold water at the bottom of the tank. The particles begin to move more quickly and spread out.

Gas flame
If you have a gas hot-water system, there is a flame at the bottom of the water tank. The flame heats the water near the bottom of the tank. An electric hot-water system has elements, similar to those in a kettle, inside the water tank.

Sinking
The particles in the cold water move more slowly than the particles in the warmer water. The cold water sinks because its particles are close together. Cold water is more dense than hot water.

Cold water in
Cold water enters the hot-water system through a pipe that takes it to the bottom of the tank.
Convection currents

Like solids, the particles in liquids and gases take up more space when they are heated because they move faster. But, unlike solids, the particles in liquids and gases can move freely. The movement of particles in liquids and gases is called convection. The rising and sinking of water in the hot-water system is an example of a convection current.

Convection currents can form in air as well as water because warm air is less dense than cold air. So, the warm air rises and the cold air sinks (where it is heated again).

Activities

REMEMBER
1. List two sources of energy that are used to heat the water in hot-water systems.
2. Which is more dense — hot or cold water?
3. When water is heated by a flame at the bottom of a container, why does water near the flame rise?

THINK
4. Why can’t heat travel through a solid by convection?
5. Is this an effective way to heat water in a saucepan? Explain your answer in terms of convection currents.
6. Why is the water that leads to hot-water taps taken from the top of a hot-water tank?
7. Gas wall furnaces usually push warm air out near the floor. Why not higher up?
8. Why doesn’t the smoke from a factory keep rising forever?

INVESTIGATE
9. Convection currents can occur in fluids. What does the word ‘fluid’ mean?
10. Find out what a convection oven is and how it works.
11. The newest technology in hot-water systems is the ‘continuous-flow’ system. This system heats water only when hot water is required. Find out how ‘continuous-flow’ hot-water systems work. What advantages do ‘continuous-flow’ hot-water systems have over the type described on the opposite page.

Coloured convection currents

You will need:
250 mL beaker
heatproof mat, Bunsen burner and matches
tripod and gauze mat
food colouring with dropper
drinking straw.

• Fill the beaker with water. Place it over the Bunsen burner as shown below.

1. (a) Draw a diagram to show what happens to the food colouring as the water is heated.
   (b) Why does this happen?
2. What is the purpose of the food colouring in this experiment?