

Background information

Year 3, unit 1: Transfer of heat

Definitions

Heat is a type of energy. When heat energy is given to something it usually gets hotter. If heat energy is taken away it will become colder. The faster the particles in an object are moving, the more heat energy an object has. The slower the particles are moving, the less heat energy an object has.

Temperature is a measure of how hot something is according to a defined scale. Objects that have a high temperature are hot and objects with a low temperature are cold.

Temperature is not the same as heat. For example, if you were to put exactly the same amount of heat energy into heating 100 mL and 200 mL of water the 100 mL of water would rise to a higher temperature even though the same amount of heat energy is being applied.

Even though temperature and heat energy are different, they are related. Temperature is a useful measure of the changes in heat energy of an object.

Transfer of heat

When two items are combined or touching each other, their particles will transfer energy called heat between the two items. They try to come to equilibrium, where they have the same temperature. Heat will flow from the hotter object to the cooler object. The particles in the hotter object will slow down and the particles in the cooler object will speed up. Eventually they will have the same temperature.

The modes of heat transfer are:

1. conduction or diffusion – the transfer of energy between objects that are in physical contact.
2. convection – the transfer of energy between an object and its environment due to fluid motion in liquids and gases.
3. radiation – the transfer of energy to or from a body by means of the emission or absorption of electromagnetic radiation. (This mode is not covered during this unit.)
4. advection – the transfer of energy from one location to another as a side effect of physically moving an object containing that energy. (This mode is not covered during this unit.)

Conduction

Conduction occurs when heat transfers from one object to another object when they are in contact. Some materials conduct heat better than others. Metal, for example, is a good conductor of heat. We use metal in pots and pans to cook because it will move the heat from the flame to our food quickly. Cloth, like a blanket, isn't a good

conductor of heat. A blanket, therefore, works well to keep us warm at night, as it won't conduct the heat from our bodies out to the cold air.

Measuring temperature

In most cases, when something gets hotter it will expand, or get bigger and when something gets colder it will shrink. This is because the particles will move further apart or closer together depending on the amount of energy they possess. This property is used to make thermometers. The line in the thermometer is actually liquid mercury or alcohol. As the liquid gets hotter it expands and rises in the thermometer to show a higher temperature. It is the expansion and contraction due to temperature that allows the thermometer to work.

Matter changing state

Heat has an impact on the state of matter. Matter can change state based on the amount of heat energy added or removed. For pure substances these changes of state occur at specific temperatures.

There are four states that matter can take depending on its temperature.

1. Solid – at below 0 °C the molecules of water do not move in relation to each other. The water will be a solid (ice).
2. Liquid – if water is warmed, the ice will melt and the water becomes a liquid.
3. Gas – if much heat is added to water, the particles will move very fast and it will become a gas (steam).
4. Plasma – occurs when a gas becomes so energetic that its atoms or molecules start losing their electrons. Lightning creates plasma for brief periods of time and the content of a lit fluorescent tube is a plasma.

Liquid water at 100 °C has a lot less heat energy than gaseous water (steam) at 100 °C which is why burns caused by steam are a lot more serious than those caused by boiling water.

Lesson 1: Heat energy – teacher demonstration

Materials

- a clear container of warm water
- a clear container of cold water
- food colouring

Procedure

1. Show students the containers of water describing the water temperature of each.
2. Place a drop of food colouring into the centre of each container of water.
3. Ask students to make suggestions about what they see.

4. Explain to students that things do not need to feel hot to have heat energy. The heat energy is present in both the warm and cold water because the food colouring is moving throughout the water.
5. Explain to students that the warm water had more heat energy so the food colouring moved faster in the warm water than the cold water.
6. Explain that heat energy is transferred in different ways.
7. Have students draw a diagram that illustrates what happened during the demonstration.

Lesson 2: Conduction and convection – teacher-led discussion

Sources of heat

1. Ask students to make suggestions about how heat is transferred from a hair straightener to hair. Inform students that heat is transferred through the plates of the hair straightener to our hair by direct contact.
2. Explain that conduction means that heat is transferred from one object to another when they are in contact.
3. Remind students of the activity they carried out in the Lesson 1 when they touched items around the classroom to determine if these were hot or cold.
4. Inform students that when they were touching the items, they were causing heat to transfer from the object they touched to their hand or vice versa by the process of conduction.
5. Ask students to nominate other ways that heat is conducted to us referring to the 'sources of heat' images to assist with illustrating some of these items.
6. Refer students to the images of the kettle and saucepan with water in them informing them that another way heat can be transferred is through convection.
7. Ask students to look at the images and make suggestions about what they think 'convection' means. Define the term 'convection' as the transfer of heat throughout liquids and fluids. Explain that convection:
 - is the movement of material, taking the heat from one area to another. The heat has been transferred.
 - is the transfer of heat by motion of liquids.
 - occurs when, for example, an area of hot water rises to the top of a pot and loses some heat energy, while cooler water sinks to the bottom of the pot and absorbs heat energy from the metal. Another example is warm air in the atmosphere rising and losing heat energy to the surrounding cooler air.
8. Conduction can also occur when different states are in contact; it doesn't have to be only solids. Heat is conducted from a metal saucepan into water, and heat energy is distributed through the water by both conduction and convection.