Hot moves

If you accidentally touch a hotplate you'll find out quickly — and painfully — that heat travels from warm objects to cooler objects.

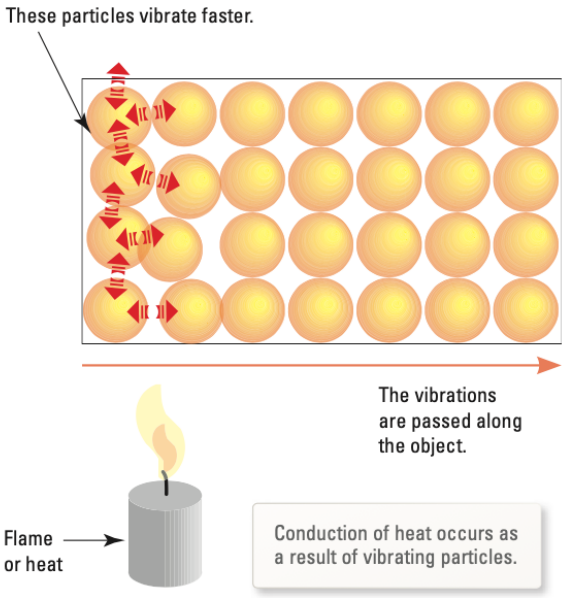
It is the rapid transfer of energy into your hand that causes the pain. Sports people sometimes use ice baths to assist with injury. The body heat is transferred quickly to the cold ice. If you touch something that has the same temperature as your hand, you won't feel any sensation of heat transfer into or away from your hand.

Heat is energy in transit from an object or substance to another object or substance with a lower temperature. Heat can move from one place to another in three different ways — by conduction, convection or radiation.

Conduction

If you've ever picked up a metal spoon that has been left in a hot saucepan of soup you will know that heat moves along the spoon and up to the handle. This is an example of **conduction** of heat. Metals are very good conductors of heat. Like all substances, metals are made up of tiny particles. The particles in all solid substances are vibrating. Of course, you can't see the vibrations because the particles are far too small to see — even with a microscope. When you heat a solid object, its temperature increases. The particles vibrate faster and bump into each other. The vibrations are passed from particle to particle along the object until the whole object is hot.

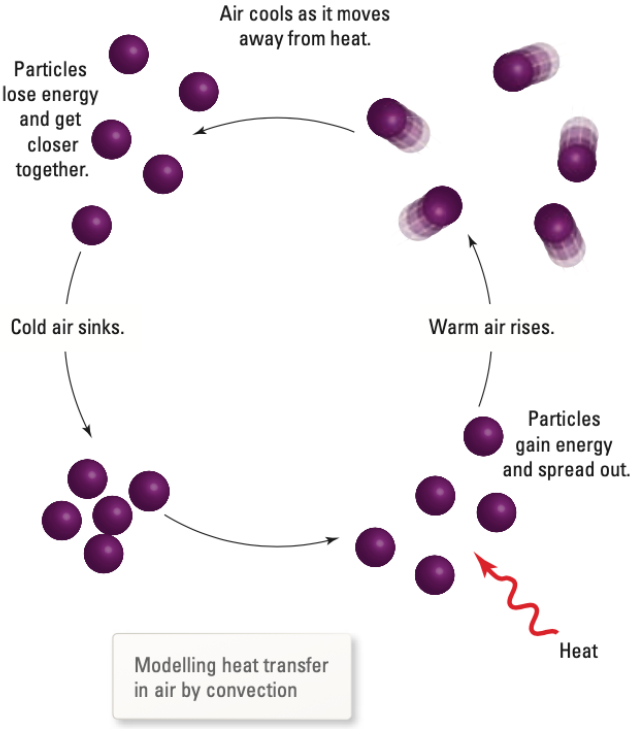
Not all solids conduct heat at the same rate. Metals, for example, are much better conductors than most other solids. Some solid substances are very poor conductors of heat. Glass, wood, rubber and plastic are all poor conductors of heat, and are called **insulators**. Many metal saucepans have a plastic or wooden handle. Suggest a reason for this.



Conduction of heat occurs as a result of vibrating particles.

Convection

The particles that make up solids are close to each other and held together tightly. They can vibrate faster only when heated. However, in liquids and gases the particles are further apart and can move around. So when they are heated, rather than the vibration passing between particles, the particles themselves can move. Heat can travel through liquids and gases by a process called **convection**.



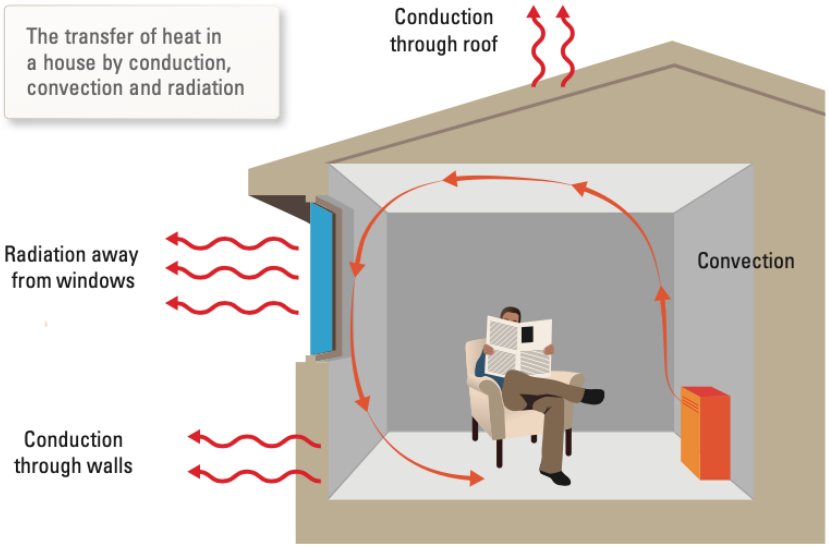
Modelling heat transfer in air by convection

The figure in the right column of the previous page shows how convection takes place. Heat causes the particles of air to gain energy, move faster and spread out. This warmer air is less dense than the air around it, so it rises. As it rises it begins to cool. The particles lose some of the energy gained, slow down and move closer together. This cooler air is denser than the air around it, so it falls. The whole process then starts again, creating a pattern of circulation called a convection current.

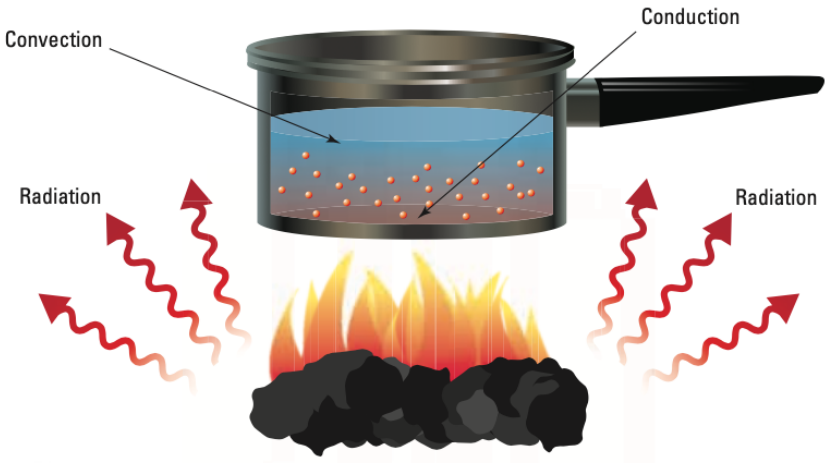
Gas wall heaters create convection currents with the aid of a fan that pushes warm air out near floor level so that it heats the entire room as the air rises.

Radiation

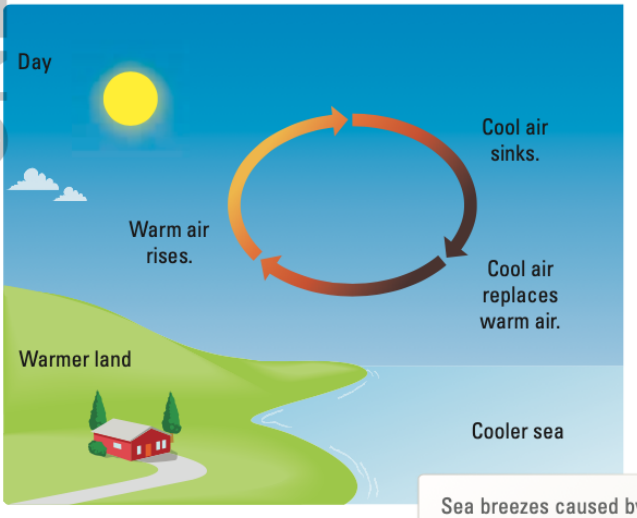
Heat from the sun cannot reach Earth by either conduction or convection because there are not enough particles in space to transfer heat by moving around or passing on vibrations. Heat from the sun reaches Earth by **radiation**. Heat transferred in this way is called **radiant heat**. Heat transfer by radiation is much faster than heat transfer by conduction or convection.

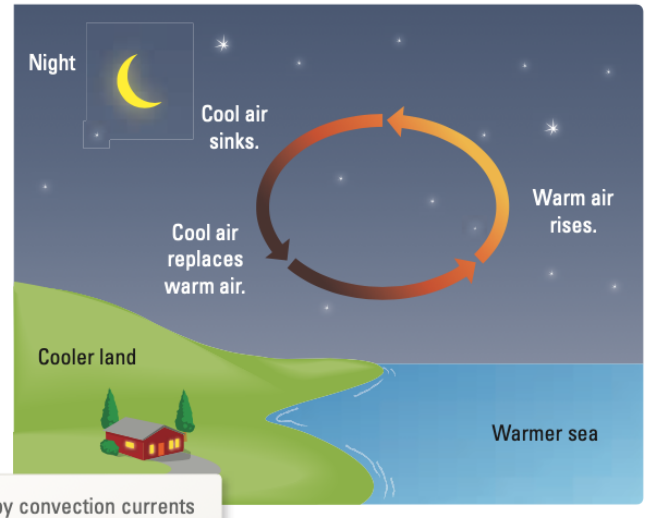


The transfer of heat in a house by conduction, convection and radiation



A camp cookout — heat is transferred by radiation, conduction and convection

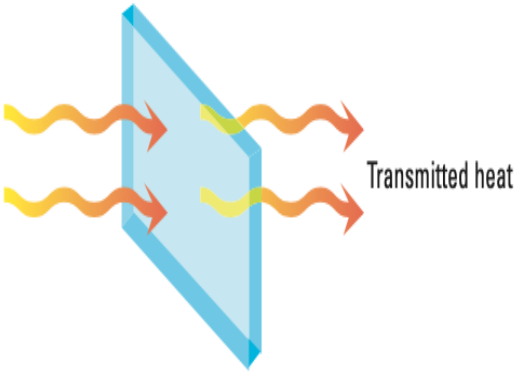




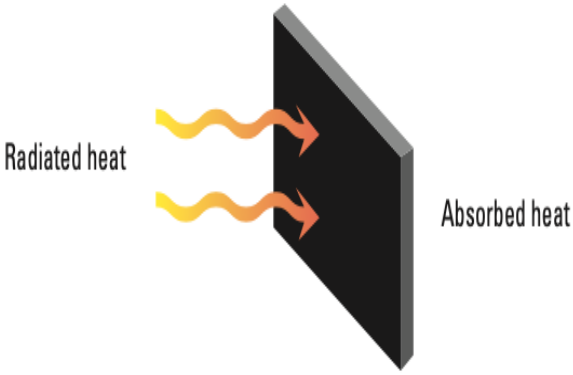
Sea breezes caused by convection currents

Transmission, absorption and reflection

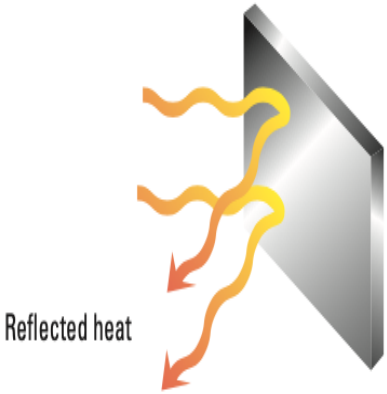
When radiant heat strikes a surface, it can be **reflected**, **transmitted** or **absorbed**. Most surfaces do all three; some surfaces are better reflectors, others are better absorbers and some transmit more heat. The diagrams on the right show how different surfaces are affected by radiant heat.



Transmitted radiant heat
Clear objects, like glass, allow light and radiant heat to pass through them. The temperature of these objects does not increase quickly when heat reaches them by radiation.



Absorbed radiant heat
Dark-coloured objects tend to absorb light and radiant heat. Their temperatures increase quickly when heat reaches them by radiation.



Reflected radiant heat
Shiny or light-coloured surfaces tend to reflect light and radiant heat away. The temperature of these objects does not change quickly when heat reaches them by radiation.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Copy and complete the table below.

Type of heat transfer	Describe briefly how heat moves	Substances in which heat moves in this way
Conduction		
Convection		
Radiation		

2 What is an insulator? Name three different materials that can act as insulators.

3 Heat can travel through empty space (for example, between the sun and Earth). How does the heat move?

4 What three things can happen to radiated heat when it arrives at any surface?

THINK

5 Conduction occurs in solid materials like metals but is not an effective way of transferring heat in liquids and gases. Explain why this is so.

6 Draw a diagram similar to the one on the page xxx (top right) to show how air-conditioners push cool air out near the ceiling to create convection currents that cool rooms in hot weather.

7 When you hold a mug of coffee or hot soup, your hands feel warm. How is the heat transferred to your hands? Use a storyboard, cartoon or flowchart to illustrate your response.

8 Would it be hotter to sit in a black or a white car during summer? Why?

INVESTIGATE

9 Compare the advantages and disadvantages of evaporative and refrigerated air-conditioners.

10 How quickly do things cool? The rate at which substances cool is determined by many factors. A cup of hot chocolate will cool more rapidly than the same cup filled with thick vegetable soup. The material in the cup is one variable that affects how quickly cooling takes place. The size of the container, the temperature around the outside of the container, and the type of container are other variables that affect the rate of cooling.

Choose one variable to investigate. All other variables must remain the same so that the test is fair. If, for example, you decide to investigate the effect of the shape of the cup, you must make sure that nothing but the shape changes. The two or three shapes of cup you choose to investigate would need to contain the same amount of liquid, start at the same temperature, be made from the same materials, and be in the same surroundings.

- Write down the aim of your investigation and state your hypothesis.
- List the set of steps that you will follow.
- Decide what equipment is needed and make a list of it.
- Decide how your results will be recorded and draw up any necessary tables.
- Check with your teacher before beginning.
- Use your results to write a conclusion. State whether your hypothesis was supported.