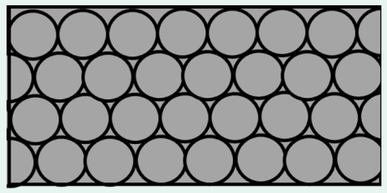
Unit 1.3/3.3 Heat transfer

Heat always transfers **from hot to cold**, but how it transfers depends on the material or state of the matter (solid, liquid, gas or vacuum).

The greater the **difference** in temperature, the greater the **rate** of heat transfer.
A mug of tea at 90˚C will cool quicker outside where the temperature is 5˚C than in the house where the temperature is 20˚C.

Conduction

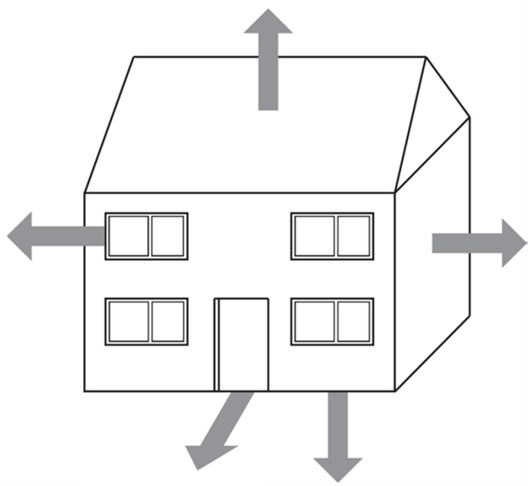
Conduction happens in **solids**. Heat energy causes the **particles** to vibrate more and is transferred from one particle to the next as they **collide**. **Metals** are the best conductors as they have free **electrons** that can move the energy quickly from the hot side to the cold.



Air is a poor conductor as it is a gas. It has large gaps between particles and reduces the rate of collisions. This makes it very useful as an **insulator**.

Loft insulation reduces heat loss due to **conduction**. Fibreglass wool between the ceiling and the loft space has pockets of trapped air which acts as an insulator.

Double glazed windows reduce heat losses due to **conduction**. Trapping air between two layers of glass acts as an insulator.



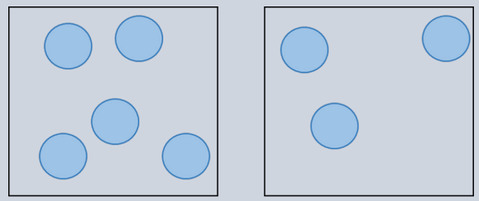
Cavity walls reduce heat losses due to **conduction**. Trapping air between two layers of bricks acts as an insulator. Filling the cavity (gap) with fibreglass wool or foam stops the air in the gap moving and reduces **convection**.

Stopping draughts reduces **convection** currents in the house through stopping cold air being sucked into the house as the hot air inside rises.

Floor insulation reduces heat losses due to **conduction**. Fibreglass wool below the floor has pockets of trapped air that acts as an insulator.

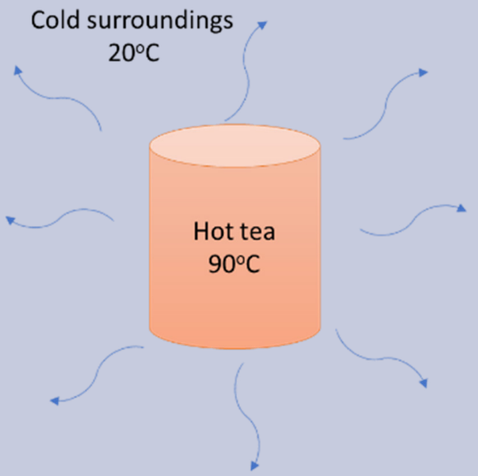
Convection

Convection happens in **liquids** and **gases**. Heat energy causes the **particles** to move quicker and make them move **further apart**. This means there will be fewer particles in a specific volume and therefore will be **less dense**. This less dense liquid or gas will **rise above** the denser cold liquid, this forms a **convection current**.



Radiation

All warm things **emit** heat **radiation** in the form of infrared waves. Hotter bodies emit more radiation than cold bodies. These **waves** can travel through **solids**, **liquids**, **gases** and through a **vacuum** like space. They travel in **all directions** from the hot body into a colder body.



Black surfaces **absorb** radiation best and **emit** radiation best. Tea in a black mug will cool down quicker than tea in a white mug.

Shiny surfaces **reflect** radiation well but are poor emitters and absorbers.

Payback time

Comparing different methods of insulating the home is difficult as the **initial cost** and the **saving each year** for the methods can be very different. To compare methods, it is important to be able to calculate the payback time, which is the time it takes to save the same amount as the initial cost of insulation.

For example, loft insulation that costs £400 but saves £50 each year will take 8 years to pay back, whereas loft insulation that costs £500 but saves £100 each year has a pay back time of 5 years.

The equation is not to be given on the equation page.

$$\text{Payback time} = \frac{\text{installation cost}}{\text{annual savings}}$$