

Energy

4. Heating and Cooling

CONCEPT 2

LESSON GUIDE

HEATING

PRECISE LEARNING POINTS

KNOW

I know how to describe heating by conduction, convection and radiation.

APPLY

I can apply my knowledge of heating to explain how conduction, convection and radiation happens.

EXTEND

I can extend my knowledge of heating to explain the differences between conduction and radiation.

NOTES

Energy sometimes travels, whether we want it to or not. We might want to keep hot food hot and cold food cold. However, sometimes we want energy to be transferred. We want it to spread around our home on a cold day and to travel out of our body on a hot day. It's got more than one way of being transferred.

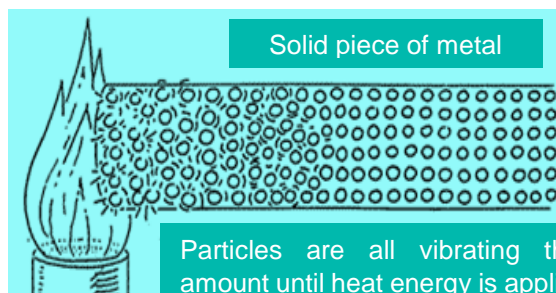
We know that particles in a solid vibrate because they have energy – the greater the energy an object has in its thermal stores, the greater the vibration of the particles. We know that the particles in a liquid or a gas move because they have energy – the greater the energy an liquid or a gas has in its thermal stores, the greater the movement of the particles.

Conduction

This is where a particle with high energy (speed or vibration) collides with a particle with low energy (speed of vibration) and passes energy onto it. We tend to describe conduction as happening within solids or between solids but we can observe conduction happening within liquids and gases and between any combinations of these states.

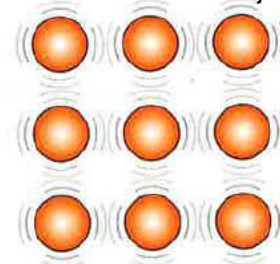
Let's look at solids as they are easier to visualise. If the thermal energy store of a solid increases, energy is transferred to its particles. They vibrate faster and transfer energy as they continually collide with their neighbours. Some

materials are not as good as others at transferring the energy from particle to particle. Ones that are good are good conductors.

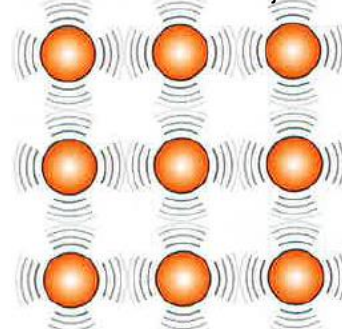


Particles are all vibrating the same amount until heat energy is applied at one end. The particles next to the flame vibrate more and then this energy is passed onto neighbouring particles.

Particles in a cold object

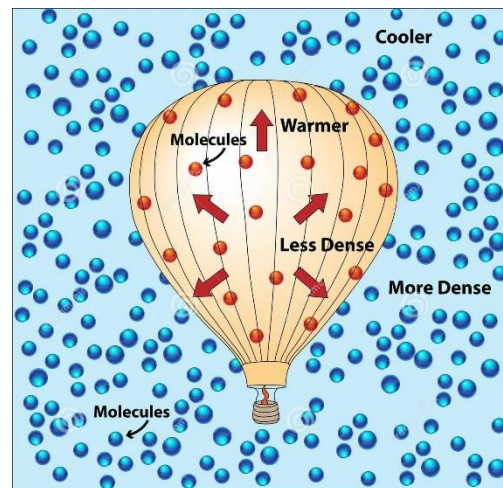
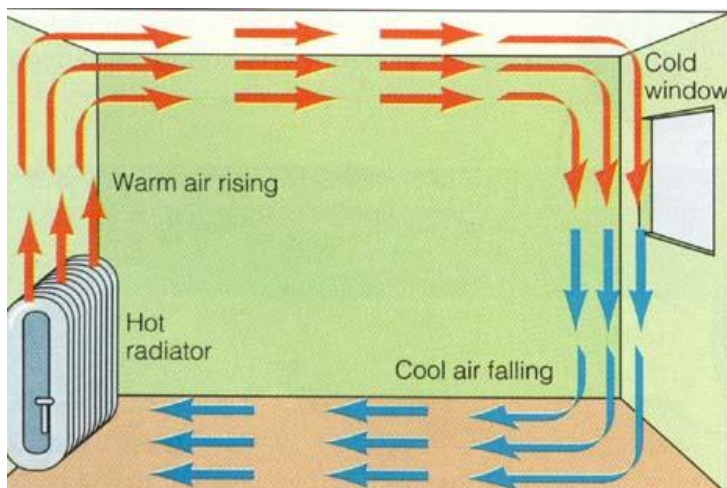
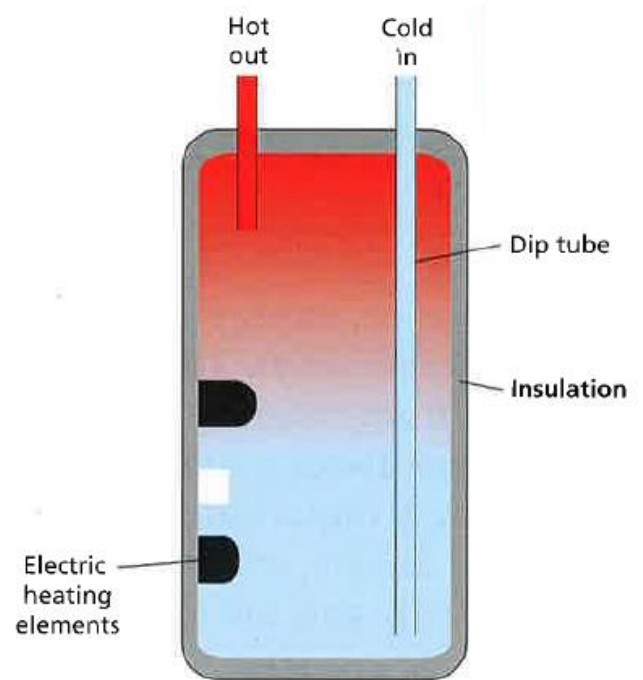


Particles in a hot object



Convection

Even though conduction occurs within liquids and gases, the main way energy is transferred through them is by convection. If energy is transferred to a liquid or gas, the substance will expand as the particles move around more. This area/region becomes less dense and will rise. For example the hot water tank in a house has the heating element at the bottom. Energy is transferred to the water, which rises to the top. Cold water falls to take its place and energy is transferred into this too. This means that the water circulates. We call this movement convection currents. The same thing happens with air – hot air rises. This is what makes a hot air balloon rise up. It happens with a bonfire too – you can often see bits of ash being carried upwards. Convection only works with liquids and gases as the material has to be able to flow, and it only works if the fluid lower down is hotter than higher up. As soon as all the tank gets hot, the circulation stops.



Radiation

Energy is also transferred by radiation. Any hot object will radiate energy. We can feel this from an open fire or from a radiant heater, but the object doesn't need to be glowing – it just needs to be hot.

In fact, any object, animal, plant will have a temperature. They all emit energy by radiation. The hotter an object, the more energy it will emit. The energy travels in the form of an infrared light wave. We can't see these but when our body absorbs them we feel this as heat. The Sun heats up the Earth because it radiates infrared energy towards us. The Sun's surface is around 5500°C , an open fire is around 600°C . The sun radiates more energy than an open fire. Even an ice cube at 0°C radiates some infrared energy.

Unlike conduction and convection, radiation does not need particles to carry it. Infrared waves can travel through the vacuum of space and through air. They do not travel easily through solids and liquids.

A thermal imaging camera can detect the infrared waves that radiate from an object instead of detecting the visible light from an object.

