Thermal (heat) Energy Transfer:

Energy and temperature

When we know the **temperature** of something, we know how hot it is, not how much **thermal (heat) energy** is in it.

Temperature is measured in **degrees Celsius (°C)**.

$0^{o}C$ = 273 **Kelvin** (**K**)

Absolute zero is the lowest possible temperature where there is no movement of the particles (zero Kelvin or $-273^{o}C$)

Thermal (heat) energy is measured in **joules (J)**.

The amount of thermal energy stored in something depends on:

- how hot it is (its temperature)
- the material it is made from
- its mass.

When two objects are at different temperatures, energy will be transferred ***from the hotter one*** to ***the cooler one*** until they are at the same temperature.

Observations after raising the temperature of an object:

- Chemical reactions like ***combustion*** (burning).
- ***Radiates*** heat which we can feel on our skin without touching it.
- Raises the temperature of the surroundings.
- Causes fluids surrounding it to move and circulate.
- Causes other substances nearby to ***expand***.

Transferring energy by heating

Energy can be transferred by heating in 3 different ways.

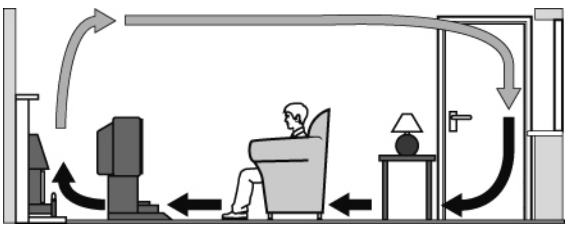
Conduction: solids (mostly). The particles in a solid are held together tightly. When they gain energy they vibrate faster and further, and the ***vibrations are passed on***. Metals are the best conductors. Most other solids are poor conductors (***insulators***).

Particles are not as close in a liquid, so conduction is not very good.

Particles are a long way apart in gases, so gases hardly conduct heat at all.

Something that does not conduct heat very well is a thermal insulator. Liquids, gases, and solids that contain a lot of ***trapped air*** are insulators.

Convection takes place in ***fluids*** (liquids and gases). When part of a fluid is heated, the particles spread further apart and the fluid becomes less dense. This makes it rise. As it rises it meets cooler fluid and passes the energy on. More cool fluid moves in to replace the rising fluid, setting up a **convection current**.

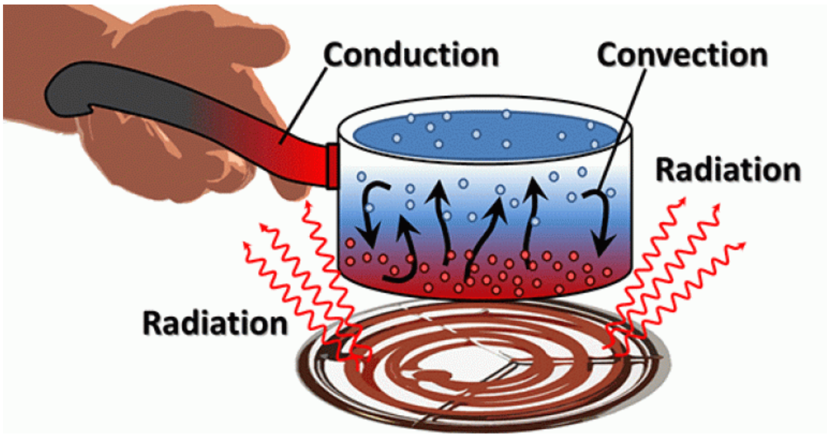


Infrared radiation: no need for particles so can transfer energy through empty space at the same speed as light. All objects emit radiation but hotter ones emit much more and a much wider range.

When something takes in energy from radiation, it is said to ***absorb*** it. ***Black bodies*** absorb **<u>all</u>** radiation and can emit a range of radiation too.

Different surfaces act differently with radiation…

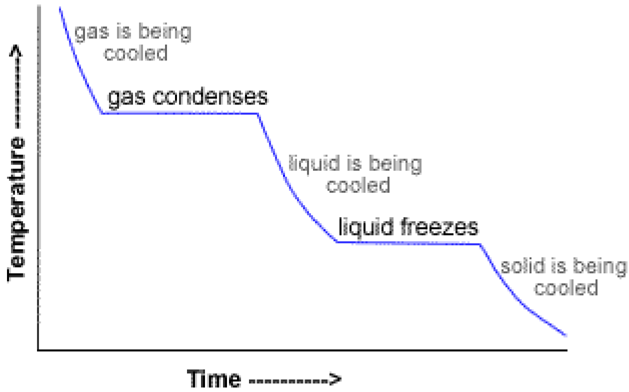
- ***Shiny/ white surfaces*** absorb less radiation (they ***reflect*** a lot of it)
- ***Black/ dull surfaces*** absorb more radiation
- ***Transparent surfaces*** transmit (allow it to go through) radiation



Extension section:

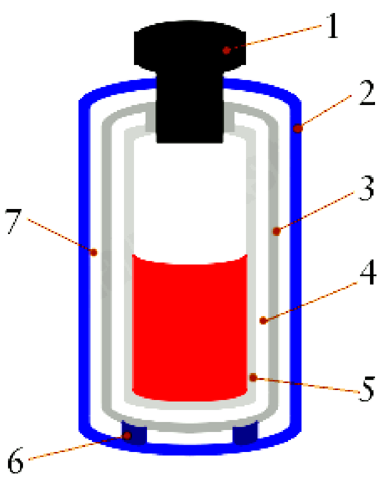
Shiny/ white surfaces are poor absorbers and emitters of radiation; black/ dull are good absorbers/ emitters.

Evaporation of liquids will absorb a lot of heat energy cooling the surrounding area- this is how sweating works to cool us down after exercise!



Latent heat: The 'hidden' heat involved in ***bond making*** (during cooling) or ***bond breaking*** (during heating) which gives flat areas of cooling curve graphs at the changes of state. These flat areas will tell us the ***melting point*** (MP) and ***boiling point*** (BP) of the substance e.g. for water MP= 0°C, BP=100°C.

Thermos flasks:



1. ***Insulating stopper*** prevents conduction and convection
2. Outer shell- to look nice and to protect; also contains air or insulation which a poor conductor (see 7).
3. Part of ***double wall*** containing a vacuum (see 4)
4. ***Vacuum***- prevents conduction and convection
5. Inner part of double wall- ***silvered*** to reduce heat loss by radiation.
6. Insulated supports- prevent heat loss by conduction.
7. Air/ insulation- poor conductor of heat.