

Heat

1st year



By the end of this chapter you will be able to:

- Describe heat energy, its' units and explain how it converts to other forms
- Explain how heat affects expansion and contraction of materials
- Explain conduction, convection and radiation
- Identify good and bad conductors of heat (insulators V conductors)
- Differentiate between heat energy and temperature



What is Heat?

- **Form of energy** because it can move things
 - E.g: Makes a hot air balloon rise.
 - Steam engines
- Measured in **JOULES (J)**



Heat can be converted to other forms of energy

- Sunlight (heat) is used by plants for Photosynthesis (to make food), it is converted to chemical energy.
- Oil and gas are burned in power stations to produce heat energy, this is used to turn turbines which produce electricity (electrical energy)



How is heat produced?

- The movement of particles/molecules produces heat
- Particles move about more and take up more room if heated – this is why things expand if heated
- It is also why substances change form when heated

solids → liquids → gases



Heat Transfer

- Heat always moves from a warmer place to a cooler place.
- Hot objects in a cooler room will cool to room temperature.e.g: tea, coffee
- Cold objects in a warmer room will heat up to room temperature.e.g: butter, ice



What do you think?



Forms of Heat Transfer

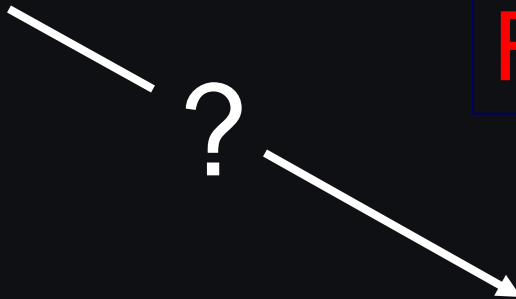
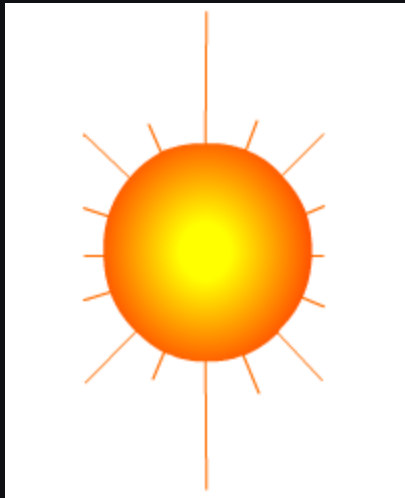
- 3 types;
- Conduction
- Convection
- Radiation



Radiation

How does heat energy get from the Sun to the Earth?

There are no particles between the Sun and the Earth so it MUST travel by radiation

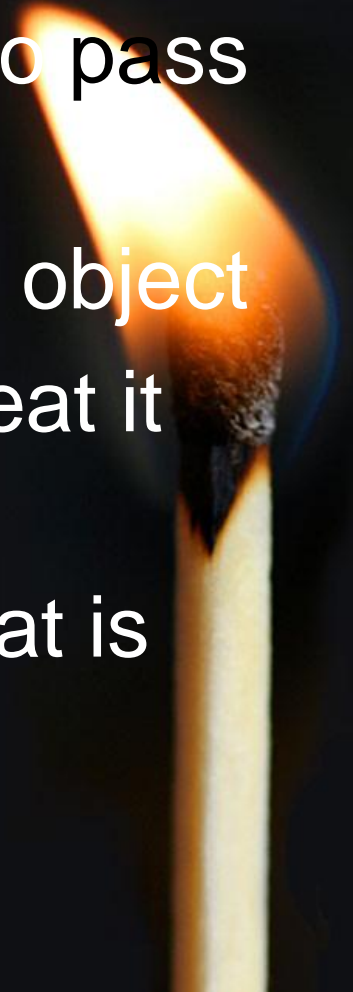


RADIATION



Radiation

- The transfer of heat in rays, from a hot object, without needing a medium to pass through
- It travels in all directions from a hot object
- The hotter an object is, the more heat it will radiate out
- Does the surface affect the way heat is radiated?



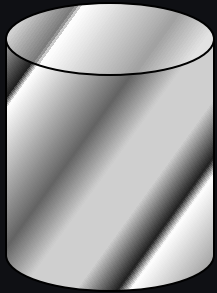
- What colour should we paint radiators?

Which colour is better to wear on a sunny day?
black or white?

- A dull black surface will radiate and absorb heat better than a bright shiny surface.

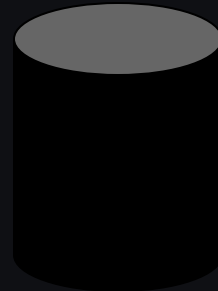
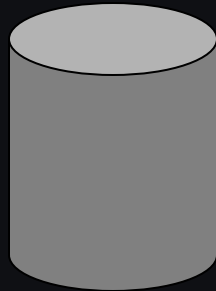


Four containers were filled with warm water. Which container would have the warmest water after ten minutes?



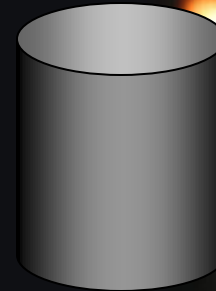
Shiny metal

Dull metal



Dull black

Shiny black



The shiny metal container would be the warmest after ten minutes because its shiny surface reflects heat radiation back into the container so less is lost. The dull black container would be the coolest because it is the best at emitting heat radiation.



Radiation – Think Pair-Share

Radiation travels in straight lines

True/~~False~~

Radiation can travel through a vacuum

True/~~False~~

Radiation requires particles to travel

~~True~~/False

Radiation travels at the speed of light

True/~~False~~



Radiation questions

Why are houses painted white in hot countries?

White reflects heat radiation and keeps the house cooler.

Why are shiny foil blankets wrapped around marathon runners at the end of a race?

The shiny metal reflects the heat radiation from the runner back in, this stops the runner getting cold.



Conduction

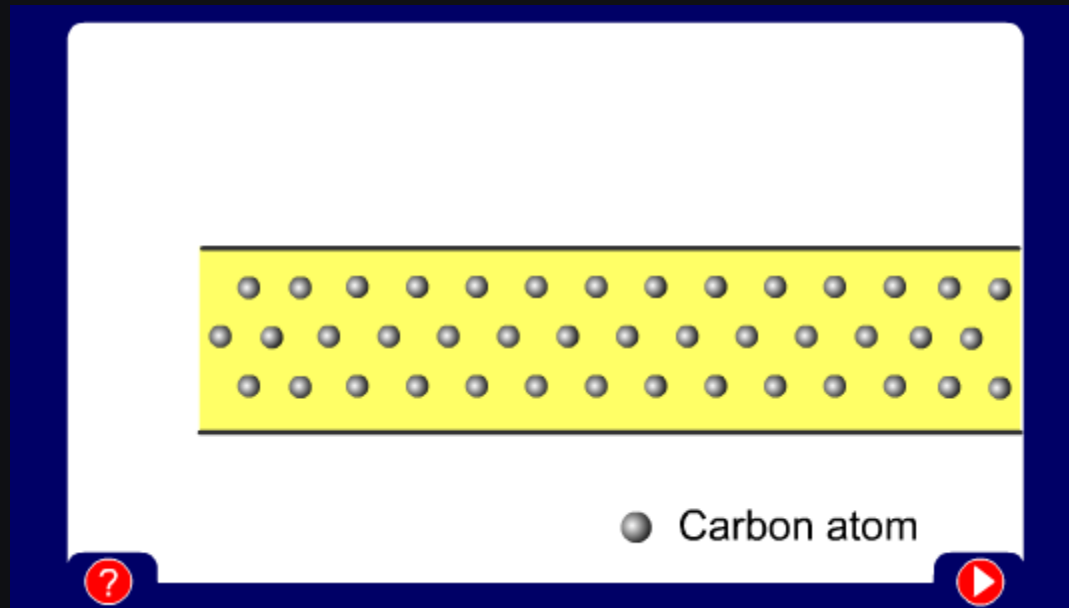
- Transfer of heat is through a SOLID by being passed from one particle to the next
- Particles at the warm end move faster and this then causes the next particles to move faster and so on. e.g: poker in fire
spoon in tea
- In this way heat in an object travels from:

the HOT end  the cold end



Conduction

- When you heat a metal strip at one end, the heat travels to the other end.



- As you heat the metal, the particles vibrate, these vibrations make the adjacent particles vibrate, and so on and so on, the vibrations are passed along the metal and so is the heat. We call this? Conduction

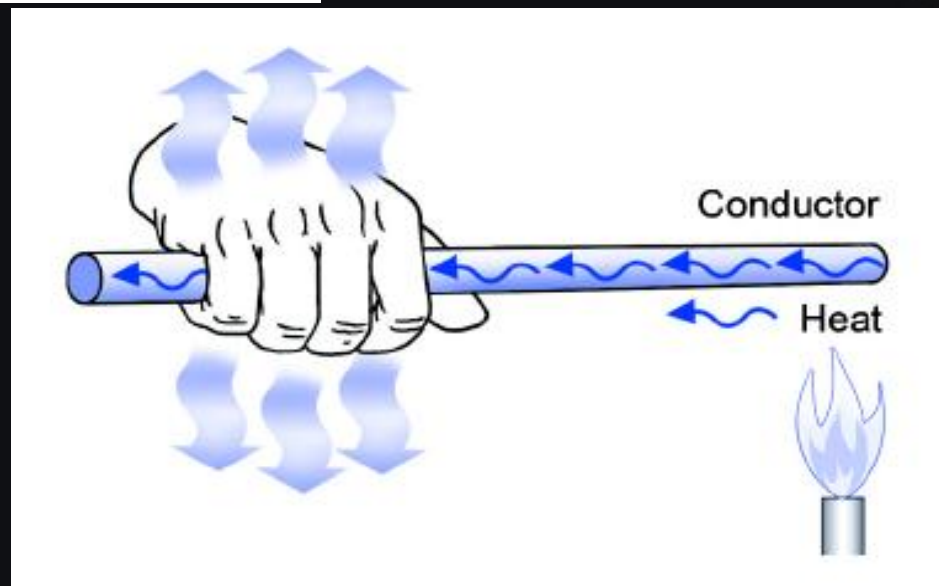
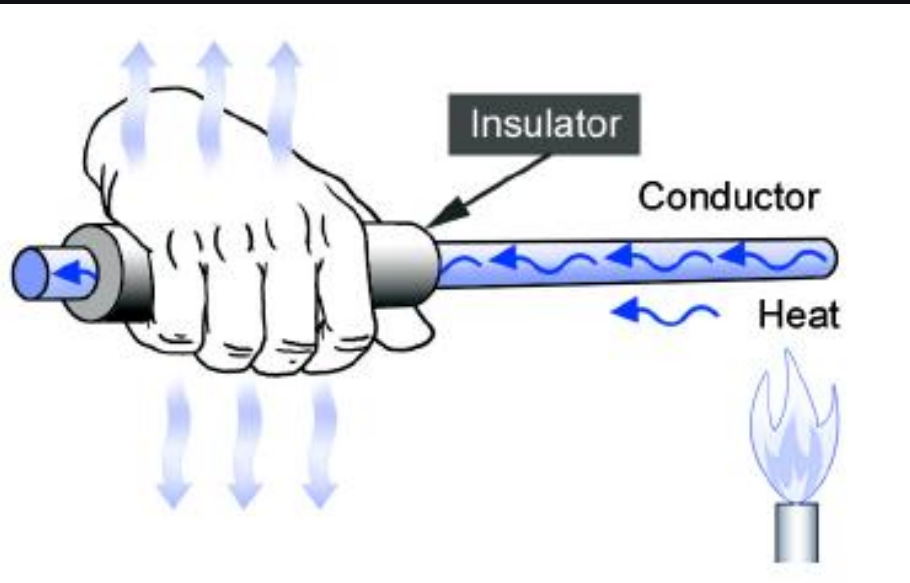


Conductors/Insulators

- If a substance easily allows heat to move through it, we can say it is a good conductor of heat. e.g: most metals
- If a substance does not allow heat to pass through it easily we can say it is an Insulator. E.g: wood, plastic, glass
- Why do many sauce pans have plastic handles?



Conduction V Insulation



Conductor or Insulator?

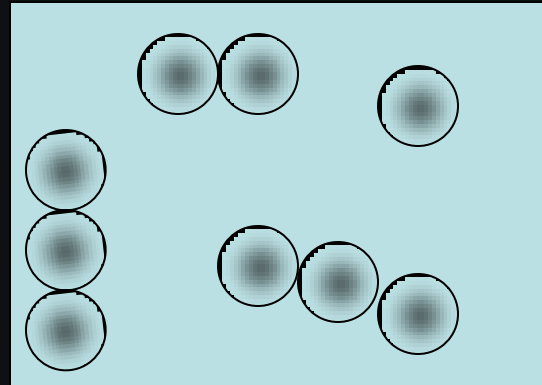
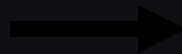
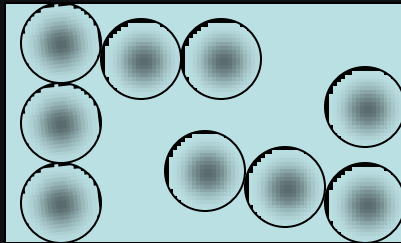
- Wood?
- Aluminium?
- Plastic?
- Glass?
- Iron?
- Polystyrene?
- Copper?
- Cardboard?



Convection

What happens to the particles in a liquid or a gas when you heat them?

The particles spread out and become less dense.



A liquid or gas.



Convection

- It is the way in which particles in a GAS or LIQUID move **upwards**, carrying heat with them



- Think about when you boil water, the bubbles move upwards
- Or think of a gas heater in the room, the heat rises around the room



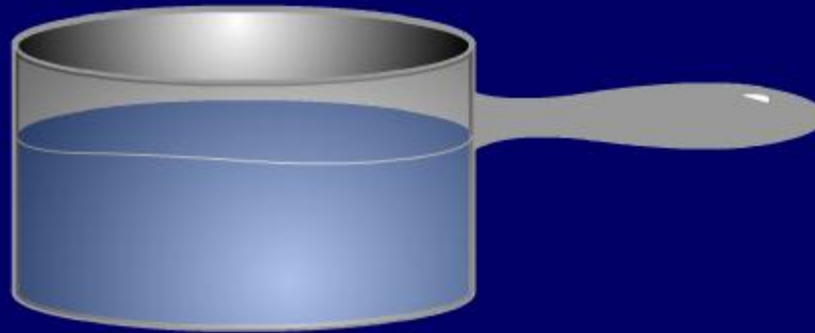
Convection

Cools at the
surface

Convection
current

Cooler
water sinks

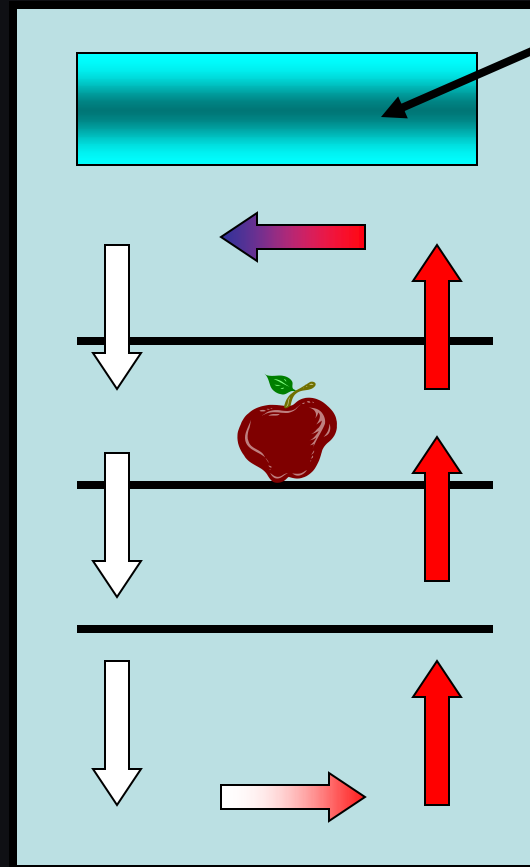
Hot water
rises



Convection

Where is the cooling compartment put in a fridge?

It is put at the top, because cool air sinks, so it cools the food on the way down.

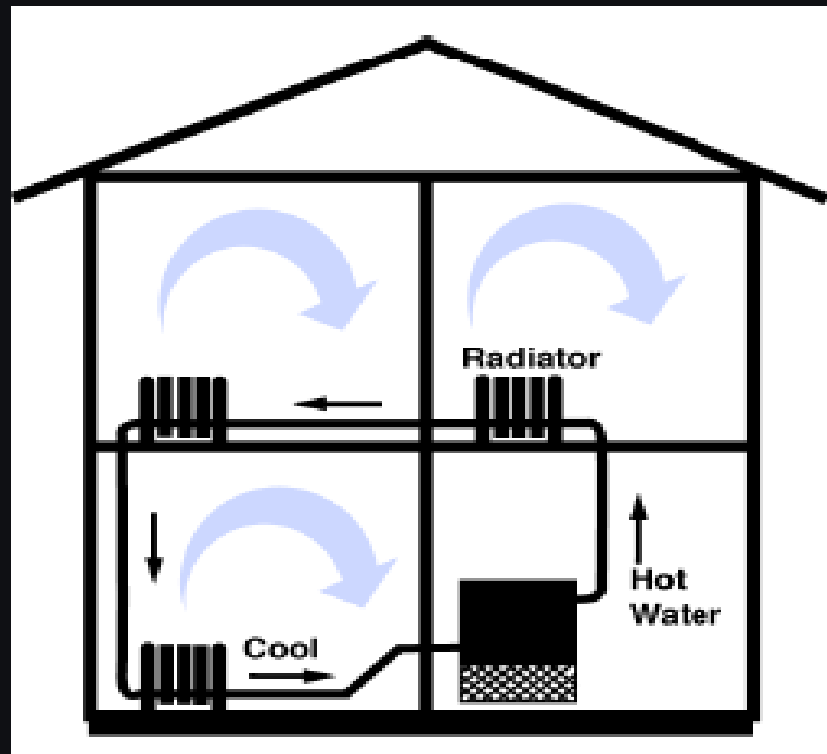


Cooling compartment

It is warmer the bottom, so this warmer air rises and a convection current is set up.



Should a radiator be called a radiator?



Convection questions

Why does hot air rise and cold air sink?

Cool air is more dense than warm air, so the cool air 'falls through' the warm air.

Why are boilers placed beneath hot water tanks in people's homes?

Hot water rises.

So when the boiler heats the water, and the hot water rises, the water tank is filled with hot water.



Heat Vs Temperature

- The temperature of an object tells us how **HOT** it is
- Measured in **degrees Celsius - °C**
- It is **NOT** the same as heat energy although the two quantities are related.
e.g. a beaker of water at 60 °C is hotter than a bath of water at 40 °C **BUT** the bath contains more joules of heat energy



Heating and Cooling

- If an object has become **hotter**, it means that it has **gained** heat energy.
- If an object **cools down**, it means it has **lost** energy



Heating and Cooling cont...

- Heat energy always moves from:

- **HOT** object  **COOLER** object

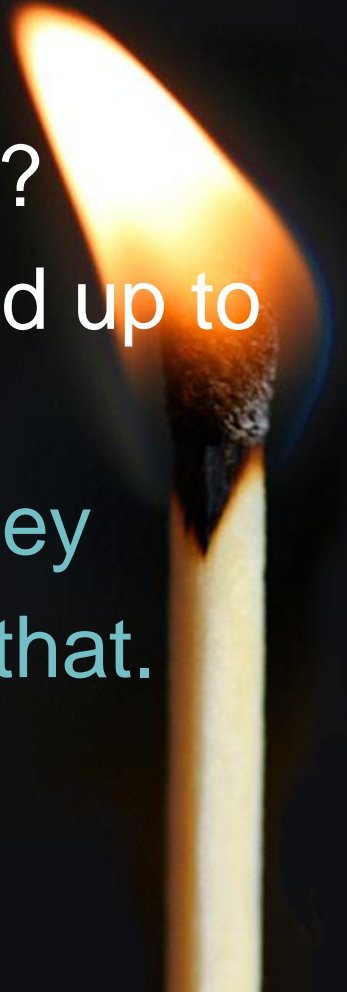
e.g. Cup of water at 20 °C in a room at 30°C - gains heat energy and heats up – its temperature rises

Cup of water at 20 °C in a room at 10°C loses heat energy and cools down – its temperature will fall.



Expansion/Contraction

- Why are gaps left in pavements, railway tracks, and floor boards?
- Why are electricity cables left slack?
- Why are bottles of minerals not filled up to the top?
- Because materials expand when they heat up we need to leave room for that.



Expansion V Contraction

- The reason materials expand when heated is because the heat gives the molecules energy and as a result they begin to move, leaving them further apart and hence the material expands
- Cooling has the opposite effect, the particles move closer together causing the molecules to contract
- One exception: water expands when cooled



Revision

1. Which of the following is not a method of heat transfer?

- A. Radiation
- B. Insulation
- C. Conduction
- D. Convection



Revision

1. Which of the following is not a method of heat transfer?

- A. Radiation
- B. Insulation
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2. In which of the following are the particles closest together?

- A. Solid
- B. Liquid
- C. Gas
- D. Fluid



2. In which of the following are the particles closest together?

A. Solid

B. Liquid

C. Gas

D. Fluid



3. How does heat energy reach the Earth from the Sun?

- A. Radiation
- B. Conduction
- C. Convection
- D. Insulation



3. How does heat energy reach the Earth from the Sun?

- A. Radiation
- B. Conduction
- C. Convection
- D. Insulation



4. Which is the best surface for reflecting heat radiation?

- A. Shiny white
- B. Dull white
- C. Shiny black
- D. Dull black



4. Which is the best surface for reflecting heat radiation?

A. Shiny white

B. Dull white

C. Shiny black

D. Dull black



5. Which is the best surface for absorbing heat radiation?

- A. Shiny white
- B. Dull white
- C. Shiny black
- D. Dull black



5. Which is the best surface for absorbing heat radiation?

- A. Shiny white
- B. Dull white
- C. Shiny black
- D. Dull black



Key Words

Temperature

Cold

Insulator

Radiation

Transfer

Heat

Convection

Conduction

Conductor

Absorb

Emit

