Lesson 9.1 Heat Energy and Movement

Part A What is Heat and Temperature
As you learnt in Year 8, Heat is a form of energy. So it's measured in Joules like all forms of energy. An average teenager consumes 13 000 Joules of energy per day!

Most of our heat originates from the sun but it's also made constantly since it is a byproduct of most energy conversions. In fact instead of creating this heat with all our many energy gadgets soaking up this heat would help with Global warming!

Q. How dependant on heat are we?

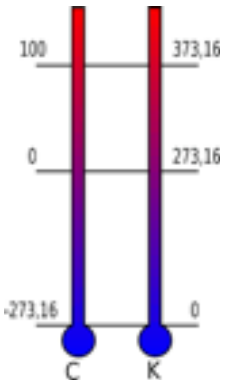
As warm blooded animals we have a constant body temperature we have to maintain. This can be severely tested in extreme weather. Clothes or lack of them are our best source of maintaining temperature but most animals don't have that luxury. Food obviously is also needed to maintain temperature.
We have a blood system, fat deposits, almost transparent skin, sweat glands and many other functions in our body to keep us warm.
We, humans are often trying to change the temperature artificially to make us more comfortable and this depends on our own individual preferences. So there can be real issues when arguments start in the family over the aircon or blankets on the bed etc.

Q. Do you prefer it hot, warm, cool or cold?

So what physics is there in maintaining our body temperature. We want to keep warm but not over heat.
Here are some questions to research:
Q1. Why do people appear red when hot?
Q2. What does sweating do?
Q3. What makes you burn in the sun?
Q4. Why do some people feel colder than others?
Q5. Why do you feel colder in water at 24ºC, than air?
Q6. Why do metals feel cold?
Q7. How do dogs keep cool/ warm?

Temperature is simply a scale to compare the amount of heat energy coming from an object.

You can look up different scales like Celsius, Fahrenheit and the most scientific scale Kelvin.



Temperature is actually related to the amount of kinetic energy of the particles.
Q Have you heard of the Kinetic model or theory of matter? This is still called a theory because its open to be challenged.

This model has a number of proposals:
1. particles are constantly moving in all directions
2. The space between particles is much greater than the particles themselves.
3. force between particles is less the further they are apart.
4. heating an object increases the kinetic energy of the particles.

** Do Activity 9.2 Investigation Measuring Temperature*

Part B Heat Movement
Q. So heating an object makes it hotter right?
Not always! Can you give an example?

Amazing Water
Water is the most amazing substance for many reasons but one of its most amazing properties is that adding heat to it, doesn't increase it's temperature that much. It's called a "heat sink" because you can sink a lot of heat into it without it getting too hot. So hot objects will cool quickly with water on them without the water boiling over. Of course that depends how much water you have!

Q. Where is water used as a heat sink?

Heating Effects
What other changes can occur when you heat an object?

Research - Report on one of these changes to the class:
1. Expansion - Look up why power lines sag and concrete slabs must have gaps between them.
2. Change of state - All substances will melt and boil at the right temperature. What are these temperatures and how can they change?
3. Burning, exploding or some other chemical reaction- heating many objects in the presence of air or oxygen to be more precise is dangerous. How does ignition temperature of substances change?
4. Change of colour - metals can glow red hot or even white hot. Why do metals change colour when they are heated?
5. Change of hardness and malleability - metals can be forged (hardened) in a furnace. Many metals become brittle if cooled too quickly. It needs to be annealed. Why does metal and its alloys get annealed?
6. Change of appearance - crystals lose their water of crystallisation and this changes their appeal. Give some examples.

7. Evaporation - Liquids will change to gas and leave behind dissolved solids. How is evaporation different to boiling?

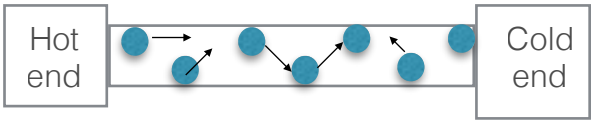
Heat Conduction
The main thing that occurs when you heat something is that it gets hot!
Q. So if heat travels from hot to cold, can cold travel from cold to hot.

Well not really!
That's like saying darkness in a room gets sucked up into a light bulb rather than light being emitted from the bulb to change the darkness to light.
We talk about heat moving not cold because cold is just less internal heat energy than hot.

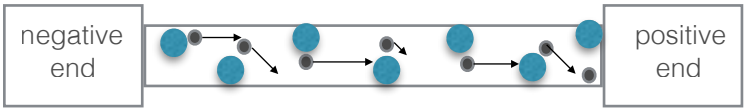
Q. When you touch metal your hand feels cold but not plastic or wood. Why is this?

Metals feel cold sometimes because they are good conductors of heat. That sounds contradictory but it’s not! It means metals remove heat very quickly from whatever it touches including your hand and when the heat receptors in your hand have heat removed they feel cold.

Metals don't always feel cold, in fact they can feel very hot if the other end is stuck in something hot like a pot of stew. So metals are good conductors of heat and electricity. They let heat and electricity flow either way.



Collisions pushes atoms along from hot to cold.



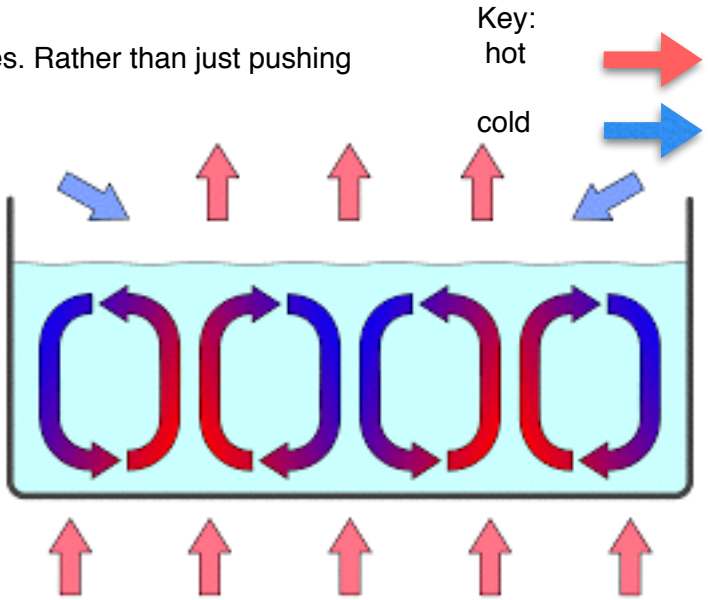
Negative electrons move towards positive

The opposite of a conductor is an insulator. The great thing about insulators is that because they reduce the flow of heat they keep your temperature just right in both summer and winter! Q. How?

Do Activity 9.3 Investigating Heat Movement in Matter: A Testing Heat conduction

Heat Convection

Heat can move another way in liquids and gases. Rather than just pushing particles along from one to another like dominoes, particles can move together and create spaces.
For example: heating the air causes currents.
Because heat from the bottom makes particles move faster and spread out, the extra space means the matter is lighter. Gravity takes over and the heavier cold air sinks while the lighter warm air rises.
Hot air rising and cold air sinking is an important Physics concept because it means we heat things from the bottom and let heat out at the top.



Wind is caused by the heating of air near the ground by the earth causing hot air to spiral upwards
and cold air spiralling down. What we feel on the ground is the edges of these large spiralling air masses as wind. If the differences between hot and cold air temperatures are great, you get very fast winds as in a cyclone or tornado.
These currents also work in water and ocean currents work the same way.

To reduce convection and losing heat you can reduce space with walls or baffles. Plugging gaps or caulking also helps reduce air flow. Of course the opposite is true if you want to keep cool, So natural and forced ventilation will increase cooling.

Questions to research.
1. What ways can you reduce convection currents in a home or on a hot day increase it?
2. Why is it always cooler near the beach?
3. Why cant you burn a candle on the Space Station?
4. Why is it important to keep a window open when using a fireplace?
5. In a fridge where is the best place to put the cooling system?
6. Investigate heat exchangers. How could these be used to produce energy?

Do 9.3 Investigating Heat Movement in Matter: B Testing Heat Convection.