PHYSICS
FORM 5
TRANSFER OF THERMAL ENERGY

Heat energy is transferred from one place to the next by three mechanisms:

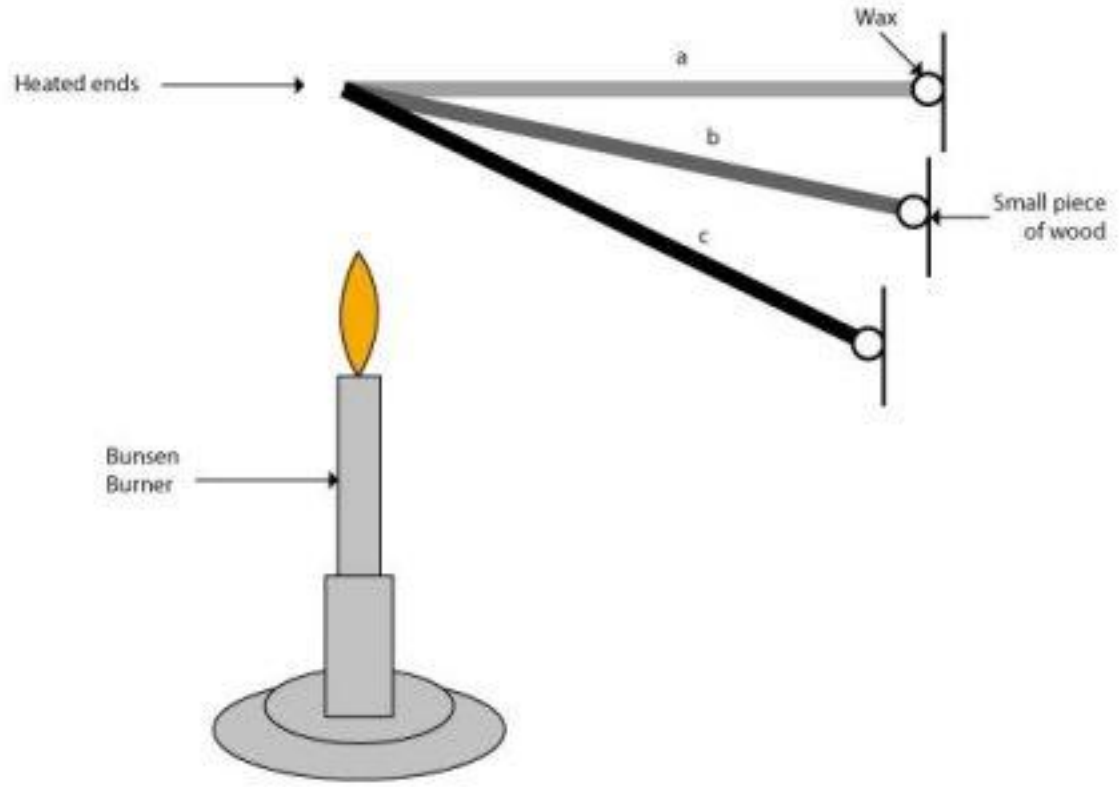
1. Conduction
2. Convection
3. Radiation

Conduction

This is the process of heat transfer from one place to another using the movement/vibration of particles.

The particles that contain heat energy vibrate. A vibrating particle results in neighbouring particles to vibrate the same way. Vibration is passed on from one particle to the next. The heat energy is also passed on since conduction rely on the vibration of particles. Conduction can only occur using a medium (substance).

Experiment to Demonstrate the Difference in Conduction of Metals



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The experiment is set up as shown in the diagram using identical size metal rods and wax droplets. The time taken for the wax droplet to fall will give an indication as to the conduction of the metals.

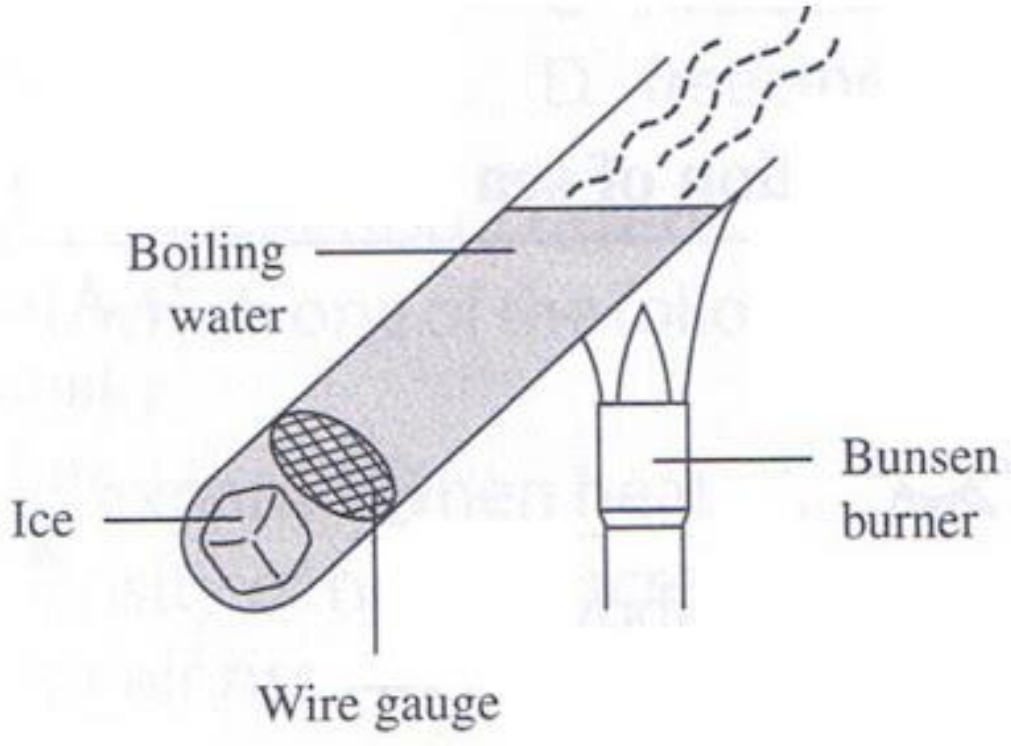
Note: The metal rods are made from different types of metals.

Why do Metals feel Cold?

On touching a metal, the heat from one's hand is conducting away thus giving a cold sensation. **Metals are good conductors of heat!**

Plastic, wood, air and water are poor conductors of heat!

Experiment to Demonstrate that Water is Poor Conductor of Heat.



The boiling tube is set up as shown above. On heating the top layer of the water, without the ice melting completely. The metal gauze is used to prevent the ice from floating.

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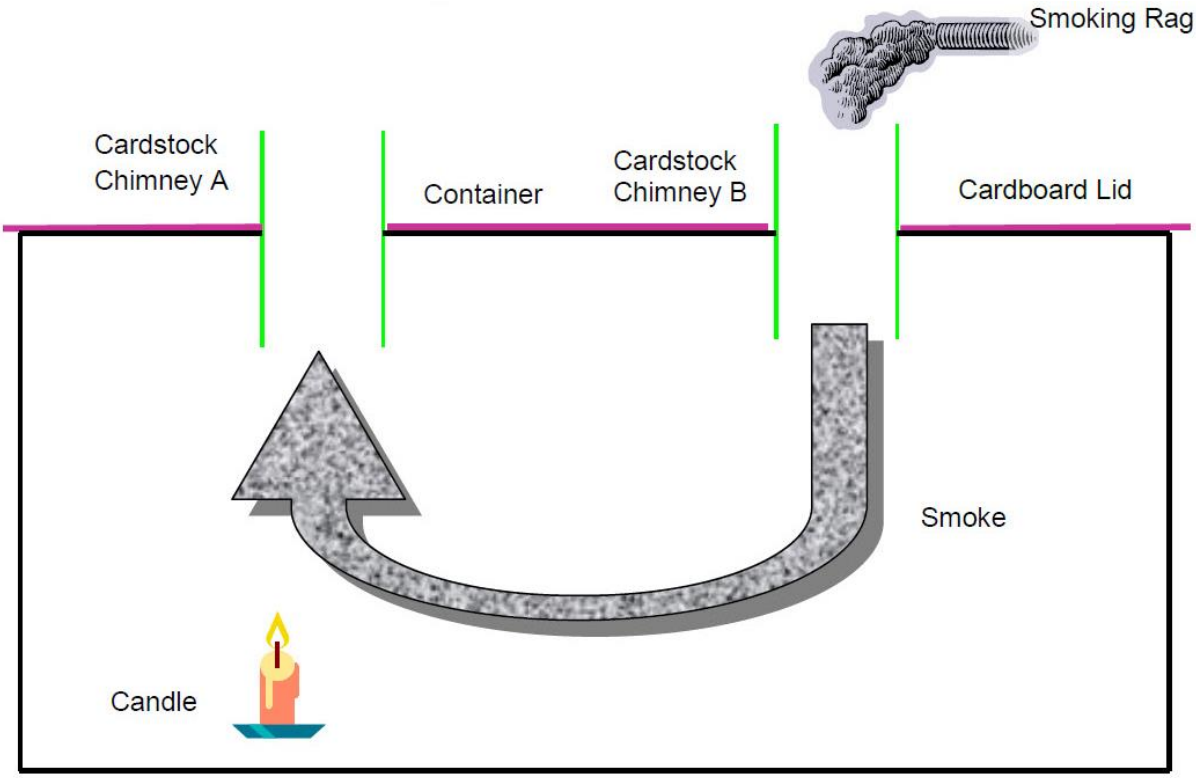
Convection

This is the transfer of heat energy via the movement of a medium from one are to another. This movement is brought about by changes in density of the medium.



In the above experiment, when the candle is lit, the air immediately around the candle becomes heated, the air particles therefore gain kinetic energy causing them to move faster and for longer distances. The heated air therefore expands. Since the air remains the same then the density therefore decreases. By Archimedes' Principle, the hot air expands and therefore rises. This creates an area of low pressure above the candle causing the air to be sucked in. The direction of the air can be seen from the smoke produced by the smouldering ash. This current of air is called a convectional current.

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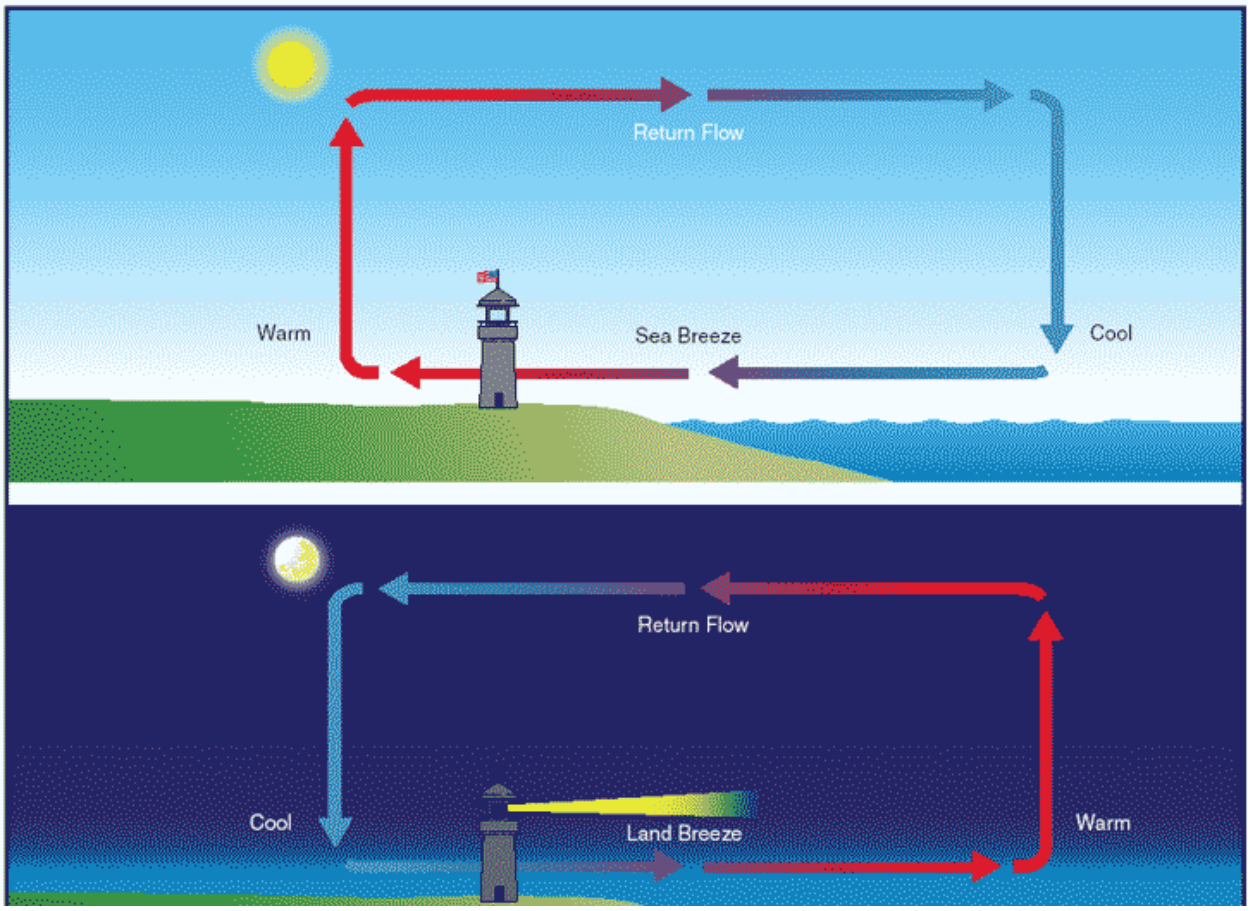
Land and Sea Breeze



LAND BREEZE	SEA BREEZE
NIGHT	DAY
COOL AIR SINK ON LAND (HIGH PRESSURE)	WARM AIR EXPAND AND RISE ON LAND (LOW PRESSURE)
WARM AIR EXPAND AND RISE ON SEA (LOW PRESSURE)	COOL AIR SINK ALONG SEA (HIGH PRESSURE)
WIND BLOWS AN AREA OF LOW PRESSURE TO HIGH PRESSURE	WIND BLOWS AN AREA OF HIGH PRESSURE TO LOW PRESSURE
WIND BLOWS FROM THE LAND TOWARDS THE SEA	WIND BLOWS FROM THE SEA TOWARDS THE LAND

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Radiation

This is the transfer of heat energy by the use of electromagnetic waves (infrared rays). All hot objects emit infrared rays. The heating component of sunlight is infrared rays. When an object emits infrared rays, it loses heat energy. When an object absorbs infrared rays, it gains heat energy.

Infrared rays are part of the electromagnetic spectrum and has the following properties:

1. Possesses the same speed in a vacuum.
2. Can travel in a vacuum
3. Can undergo reflection, refraction, diffraction
4. Transfers energy from one place to another
5. Can be emitted or absorbed by matter
6. Are transverse waves and therefore polarised
7. Carries no charge
8. If superimposed, can undergo interference

Factors Affecting Absorption and Emission of Infrared Rays

1. Shiny surfaces are poor absorbers and poor emitters
2. Black surfaces absorb heat energy readily and also emit heat energy
3. Larger the surface area, the greater the degree of heat absorption and emission

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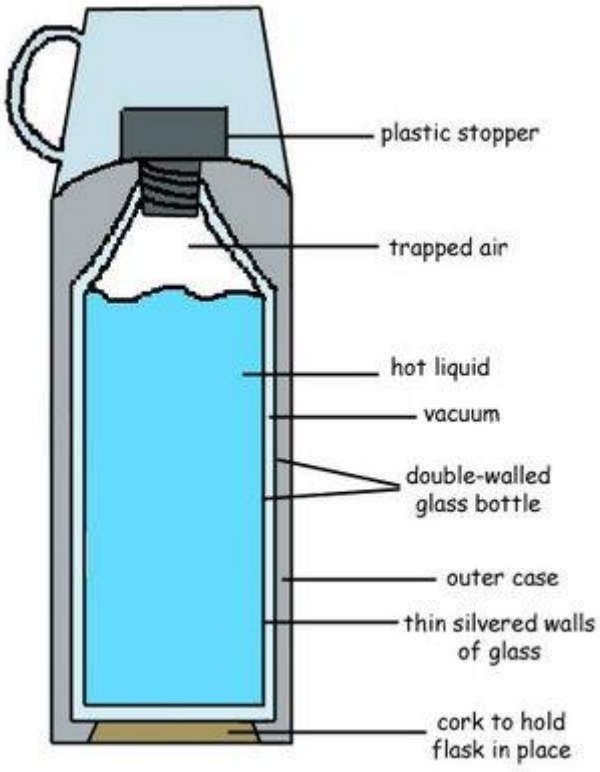
The Vacuum Flask



Conduction:

- The pockets of air around the middle of the flask which contains the liquid (the container) are poor conductors, because air is a poor conductor.
- The vacuum prevents conduction from occurring because there is no air (and therefore no atoms for these heat transfers to take place).
- The thinness of the walls stops heat entering or leaving the flask by conduction.

Convection:

- Air is trapped in areas around the liquid container. Convection is prevented by stopping the air from circulating.
- The vacuum between the container and the flask prevents heat moving by convection.
- The lid prevents convection from taking place.
- The cap stops convection.

Radiation:

- The inside of the liquid container is shiny and not black, preventing heat transfer by radiation. Shiny mirrored surfaces on the inside and outside of the liquid container reflect heat and prevents heat from being lost (good for hot liquids) and reflects heat radiation (good for cold liquids).

Evaporation:

- The lid reduces evaporation because the hot liquid isn't exposed to the air.
- Vacuum prevents evaporation.

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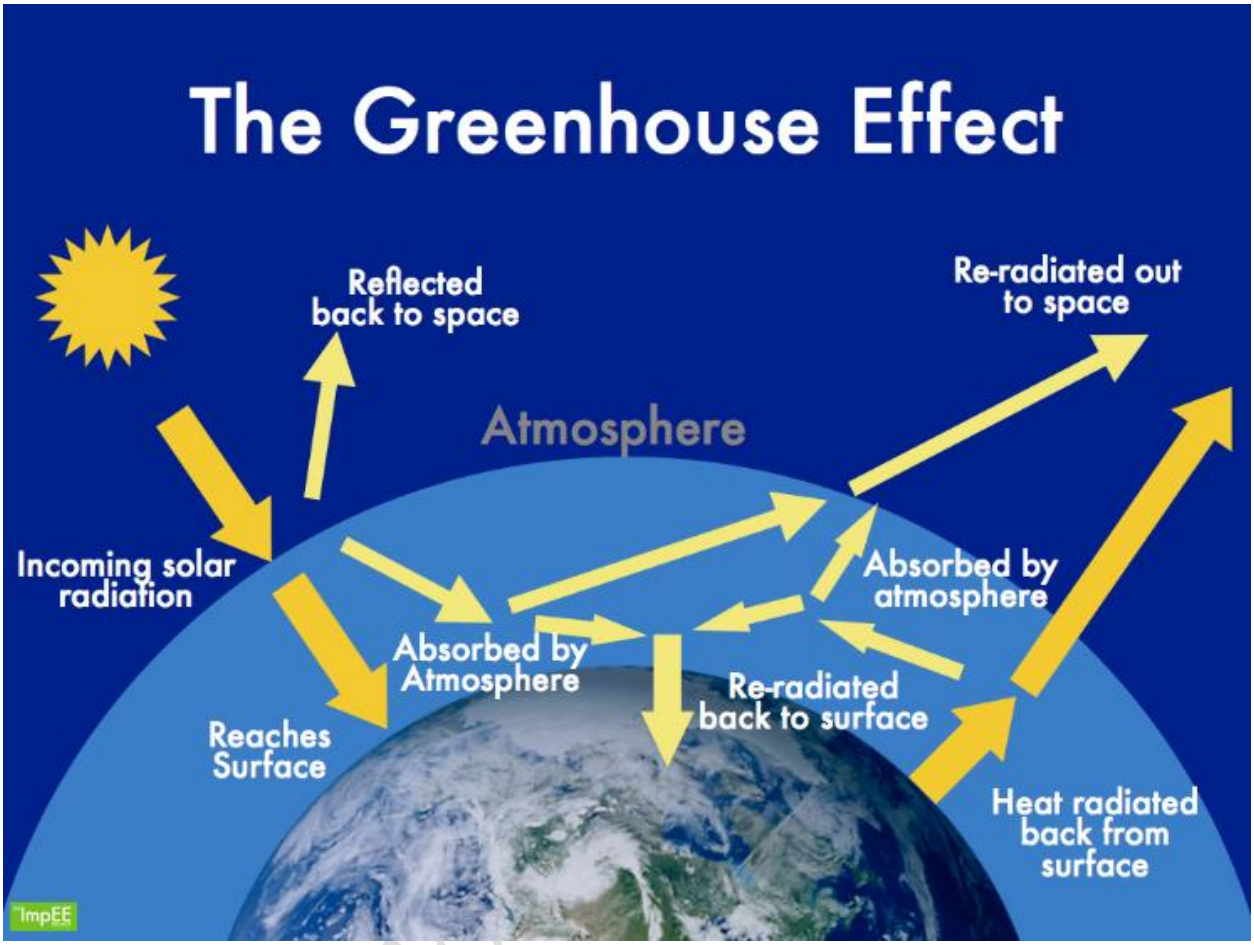
Greenhouse Effect & Global Warming



Heat energy is able to enter the glass house because the energy from the sun have very short wavelength. This allows them to penetrate the atmosphere. When the incoming radiation reaches the surface, it is absorbed and emitted back into the atmosphere. The radiation emitted back has a longer wavelength and will not penetrate the atmosphere and therefore remains trapped in the atmosphere. This causes a significant rise in temperature.

The principle of global warming is the same as that of the greenhouse effects. The earth functions as a glass house while the carbon dioxide layer in the atmosphere functions as a glass. Heat energy from the sun reaches the atmosphere and penetrates it due to its short wavelength. The heat that is emitted by the earth has a much larger wavelength and is therefore unable to penetrate the carbon dioxide layer. The heat energy remains trapped within the atmosphere resulting in global warming.