HEAT AND TEMPERATURE

8.1 Thermal Energy

Thermal energy is the internal energy arising from the motion of particles and is associated with temperature and is a form of kinetic energy.

The higher the temperature, the greater the average kinetic energy of the particle.

Temperature is the measure of the average kinetic energy of particles in a substance.

Thermal Expansion

The particles in solids and liquids are in constant vibration. When they are heated, they vibrate faster leading to an increase in kinetic energy. They force each other a little further apart resulting in the thermal expansion where the substance expands.

Bimetallic Strips

Bimetallic strips consist of two different metals bonded together. Since different metals have different coefficients of thermal expansion, the strip bends when exposed to temperature changes.

For example:

- Fire alarms: Heat from the fire makes the bimetallic strips bend and complete the electrical circuit, so ringing the alarm bell.

Note: Thermal energy is transferred from a body with a high temperature to the one at a lower temperature.

8.2 Heat Transfer

Heat transfer is the movement of heat from one place to another.

There are three modes of heat transfer:

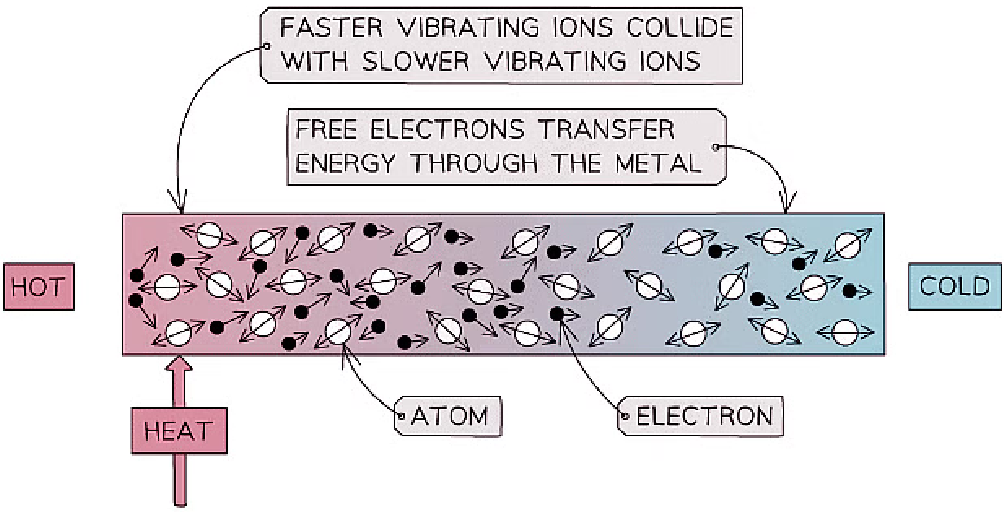
- Conduction.
- Convection.
- Radiation.

Conduction

Conduction is the movement of heat through matter from a region at a higher temperature to a region with a lower temperature without the movement of the matter as a whole.

Mechanism of heat transfer by conduction:

- In metals, there are delocalized electrons, whereby the electrons of a region at a higher temperature vibrate and transfer their heat to the electrons in the colder region. This process makes the particles vibrate vigorously making them transfer heat from the higher temperature region to a cooler temperature region and the delocalized electrons gain heat therefore making metals a good conductor of heat.

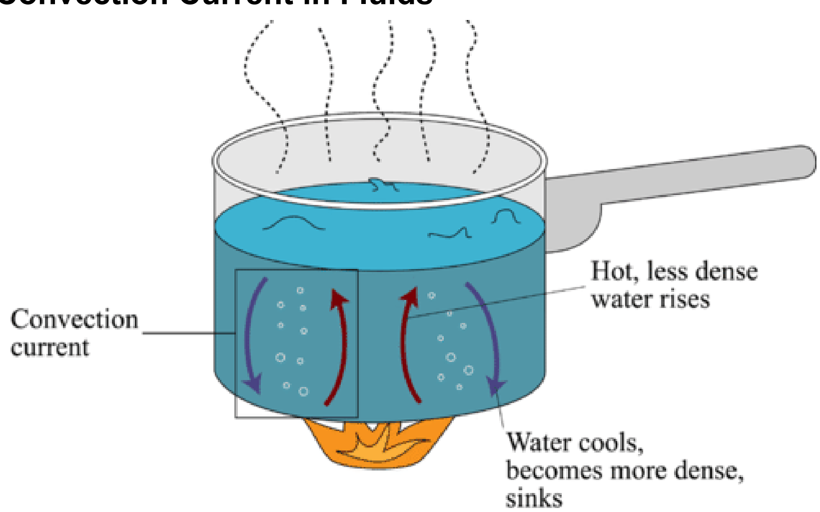


Credit: EduRev.in

Convection

Convection is the heat transfer through fluid i.e. liquids and gases from a region at high temperatures to a region at low temperatures by movement of the fluid itself.

Convection Current in Fluids



Credit: CK12-Foundation

The water molecules at the bottom heat up and gain more heat energy. They become less dense and rise up. The dense molecules come at the bottom getting heated up and they get less dense and the process continues until the whole liquid boils.

Natural Convection Currents

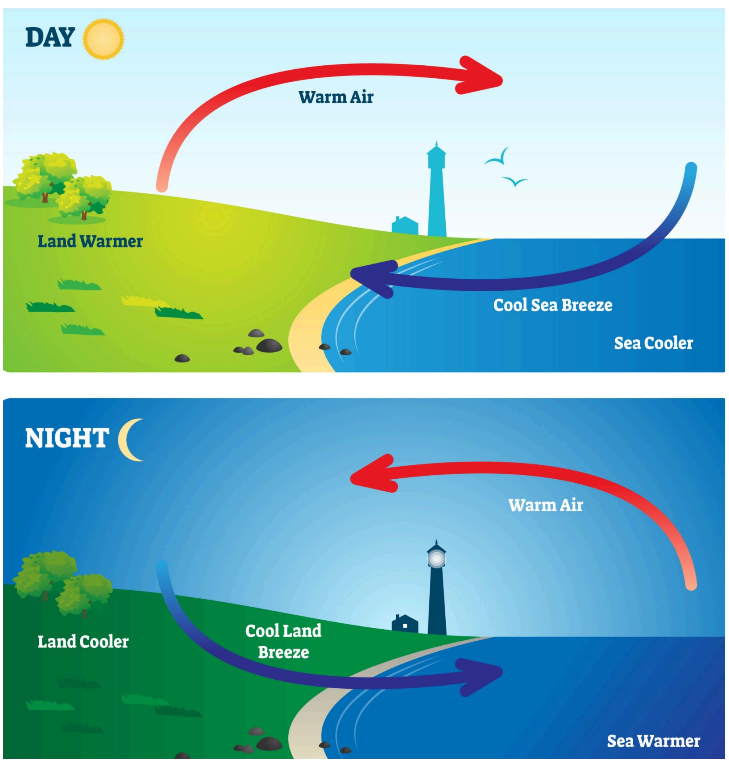
- Land Breeze
- Sea Breeze

Sea breeze

During the day, both the land and the sea are heated at the same time, they are heated by the sun, the land being a better absorber of heat than the sea. The warm less dense air above the land rises up. The more dense cool air above the sea flows to the land to occupy the position below the less dense air. The less dense air also gets heated and the process continues.

Land Breeze

Land breeze takes place at night. The land is a better emitter of heat than the sea. At night, land becomes very colder than the sea, the warm air on top of the sea rises up and cold air from the land close to the sea occupies the space blowing the less dense air above the sea. The process continues the same way.

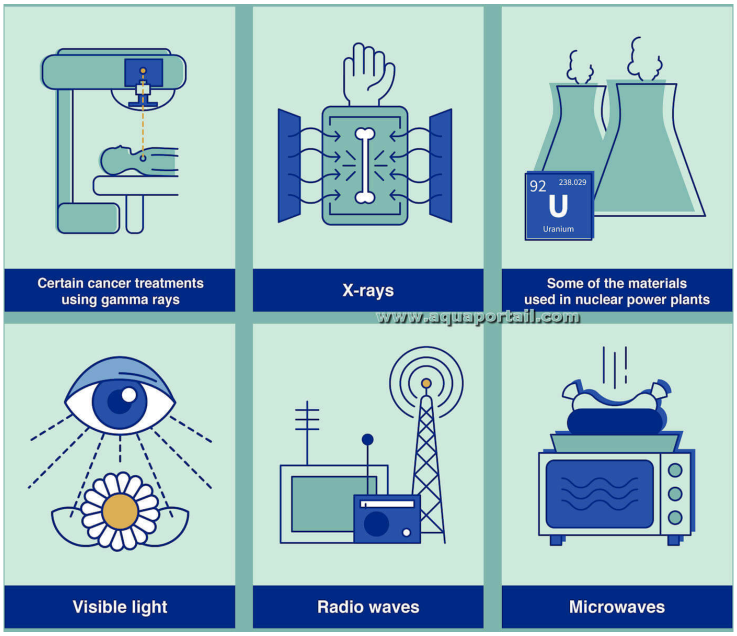


Credit:Science-sparks.com

Radiation

Radiation is the movement of heat from a region at a higher temperature to a region at a lower temperature through a vacuum.

E.g. How heat from the sun reaches us on the Earth. Buildings in hot countries are always painted white to reflect back the radiation (heat) hence keeping the building cool.



8.3 Heat Thermal capacity and latent heat

Thermal capacity

The **thermal capacity** of an object is the energy that must be supplied to the object to raise its temperature by 1^{o}C.
It is measured in joules per degree Celsius (J/^{o}C).

If the energy supplied (E) and the temperature changes from $\ominus_1$ to $\ominus_2$ then:

→Thermal capacity = $\frac{Energy\ supplied}{Temperature\ change}$

→ Thermal capacity = $\frac{E}{\Delta\ominus}$

For a temperature raise of 1^{o}C, the heat equation becomes:
Heat received = mass x 1 x specific heat capacity
Thermal capacity = mass x specific heat capacity

Specific Heat Capacity

Specific heat capacity is the heat required to raise a 1kg mass of a substance by 1^{o}C.
The symbol for specific heat capacity is "c".

If the mass (m) of a substance requires energy E for the temperature to rise from $\ominus_1$ to $\ominus_2$ then:

Energy supplied= mass x specific heat capacity x change in temperature
$Q = m \times c \times \Delta\ominus$

When a substance is heated, its temperature rise depends on the following:

1. Amount of energy supplied.
2. The mass of the substance: the greater the mass, the smaller the temperature rise.
3. The nature of the substance.

LATENT HEAT

Latent heat is the amount of heat required to change the state of the substance without temperature change.

Specific latent heat of fusion

This is the heat required to change 1kg of substance from solid to liquid without changing the temperature.

Specific latent heat of fusion:

$$L_f = \frac{Energy\ supplied}{Mass}$$

$$L_f = \frac{E}{M}$$

Its units are Joules per kilogram (J/kg).

Specific latent heat of vapourization

This is the energy needed to change 1kg of a substance from liquid to gas/vapor without temperature change.

Energy supplied= mass x specific latent heat of vapourization
$E = m \times L_V$

$$L_V = \frac{E}{m}$$

Its units are Joules per kilogram (J/kg).