TRANSFER OF HEAT

Heat usually flows from a body at a higher temperature to another body at a lower temperature. This transfer of heat can happen in three ways: conduction, convection, and radiation.

Conduction

Conduction of heat is the process by which heat energy is transferred through a material and the average position of the particles of the material remain the same.

When one end of a material is heated, the molecules there gain energy and vibrate with increasing speed. They vibrate faster and faster and farther out. They therefore bump against neighbouring molecules more than before and so transfer greater energy to them. This goes on all the way along the solid. All the molecules of the solid eventually vibrate more rapidly about their fixed

position. Therefore, in this way, thermal energy is transferred along the solid although the "average" positions of the molecules remain unchanged.

Most metals (e.g. copper, aluminium, silver, mercury, iron) allow heat energy to pass through them very easily. Such materials are known as conductors of heat. Most non-metals (e.g. water, air, wood, plastic, cloth, cotton wool, cork) are poor conductors of heat or insulators. Such materials do not allow heat to pass easily through them, thus such materials are used to insulate the handle of cookware.

Although most metals are good conductors, their thermal conductivities differ from one another. Thermal conductivity simply means the ability of a material (e.g. metal) to conduct heat.

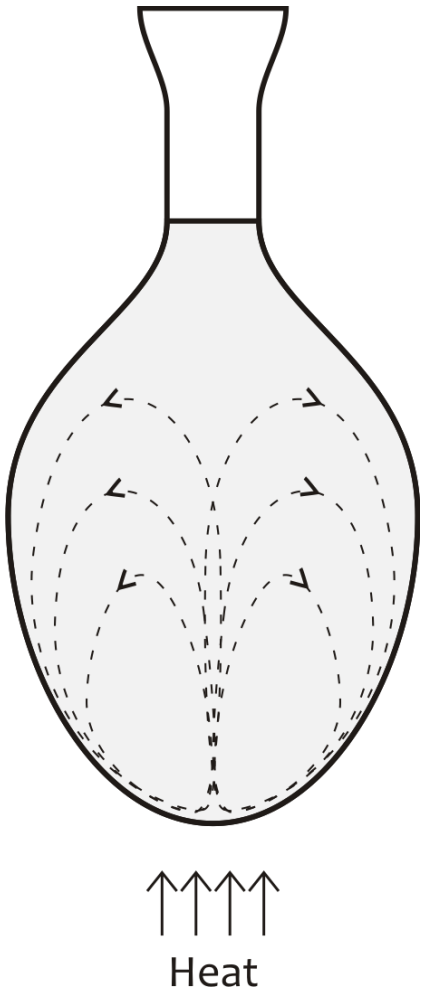
Convection

Convection is the process by which heat is transferred in a liquid or gas by the actual

movement of the heated fluid from the hotter to the colder parts.

The difference between conduction and convection is that in conduction the average position of the molecules remain the same but in convection, heat is carried to the other parts of the liquid by the actual movement of the warm liquid itself.

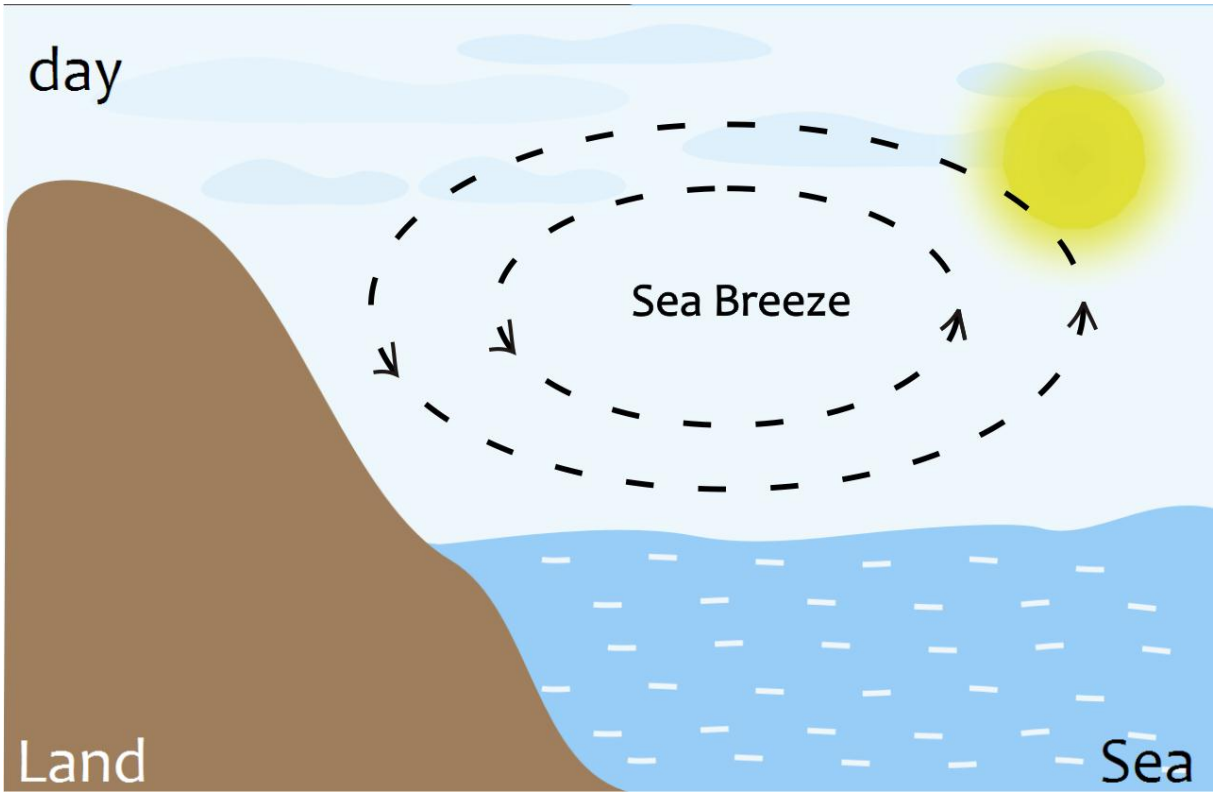
When the liquid at the bottom of the flask is heated, its volume expands (as $V \propto T$, Charles' Law) and since the mass remains constant, the density () of the liquid decreases. As liquid molecules become lighter than the cold surrounding liquid molecules, they rise upwards and are replaced by the colder denser liquid from the top. This in turn gets heated and moves upwards. Thus, a cyclic motion of liquid, a convection current, is set up.



Gases expand much more readily than liquids. Therefore, convection currents are easily set up in gases when their temperature rises.

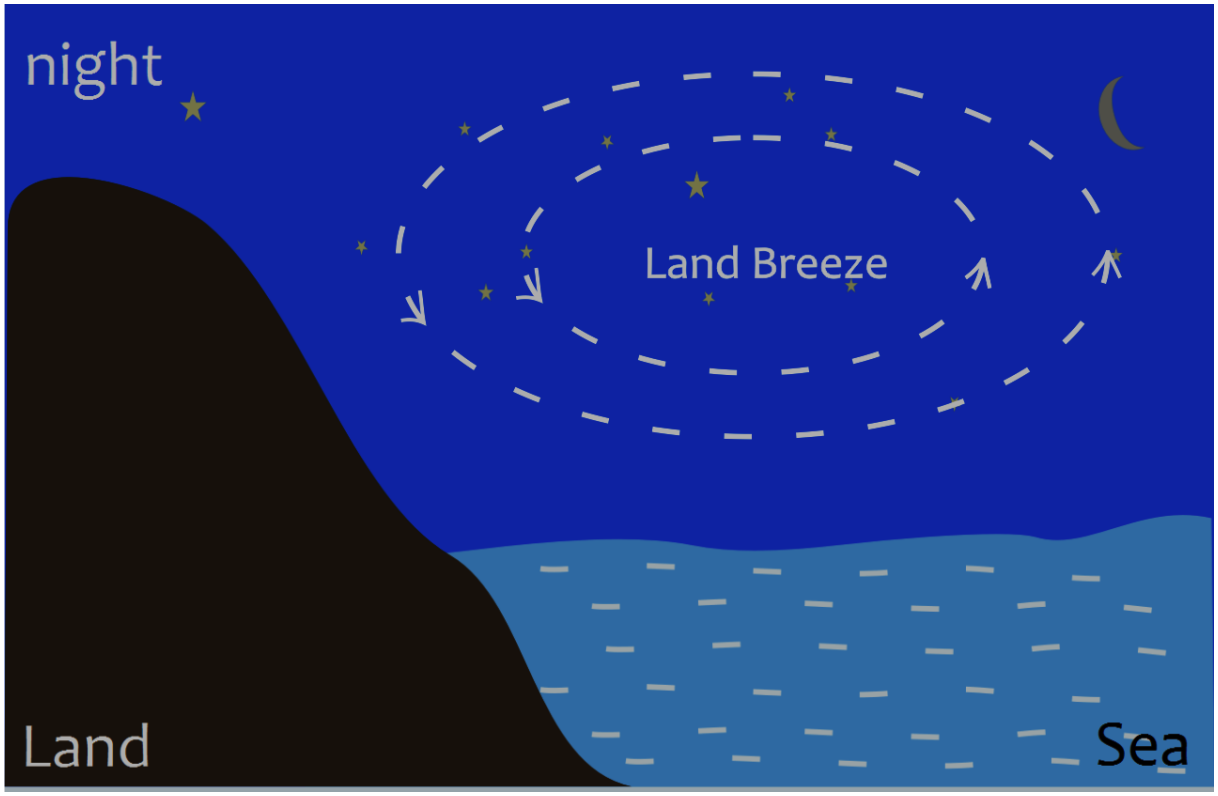
Land and sea breezes are the result of convection current in nature. In a hot day the sun warms the land more quickly than the sea, because the land is a better absorber (or conductor) of heat and also has a lower specific heat capacity. As a

result, the air near the land warms up and rises. Cooler air from the sea moves in to replace the risen air. The convection current is completed by the air in the upper atmosphere moving down in the opposite direction. The cool breeze that blows inland from the sea is known as sea breeze.



At night, the reverse process takes place. The sea retains much of its heat in the night, while the land temperature drops considerably. As a result, the sea is warmer than the land. Convection current is set up

in the opposite direction to the daytime. The breeze moving from the land to the sea is known as land breeze.



Radiation

Radiation is the process by which heat is transferred from a hotter place to a cooler place without heating the intervening medium.

No material medium is required in radiation, unlike in conduction and convection. Heat from the

sun reaches the earth and other planetary bodies through radiation.

The heat given out by radiation is known as radiant energy or radiant heat. Such a radiation is an electromagnetic radiation of the type called *Infra-Red*. It travels with the velocity of light ($3 \times 10^8 \text{ ms}^{-1}$).

Radiation can be detected by a radiometer and a thermopile. A thermopile can both detect and measure radiant energy. It does so by the deflection of a galvanometer, a sensitive current measuring instrument. The radiation is detected by the conversion of radiant energy into electrical energy. This electricity causes the deflection; thus, the greater the radiation, the greater the deflection of the galvanometer of the thermopile.

Different types of surfaces at the same temperature emit or radiate heat at different rates which is dependent on the nature of the surface. It is found that, for a given temperature, a dull-black surface absorbs and radiates most while a highly

polished surface absorbs and radiates least. This can be demonstrated by using a Leslie cube and a thermopile.