As materials are heated they are in fact gaining energy, with the molecules making up the structure of a solid material vibrating. In gases and liquids, molecules can move more easily relative to one another and are not limited to vibrating as with solids.

The more an object is heated, the ore the molecules move. Solid materials that are heated will undergo thermal expansion, which is typically positive, but can in some cases be a negative expansion (contraction). In order to heat on object, the energy must be transferred from a warmer object, and can take place through three modes; conduction, convection and radiation.

CONDUCTION

Conduction takes place when objects are physically touching, with the molecules in a warmer object increasing the energy of materials in a cooler object. For example, if a heated metal bar (kept at a constant temperature) is placed against one end of a cold metal bar, the cooler bar will begin to heat up, initially in the region of contact with the warmer bar. Over time, the bar will begin to heat through as the molecules in the warmer regions of the second bar transmit energy sequentially into the colder areas. This is illustrated below.

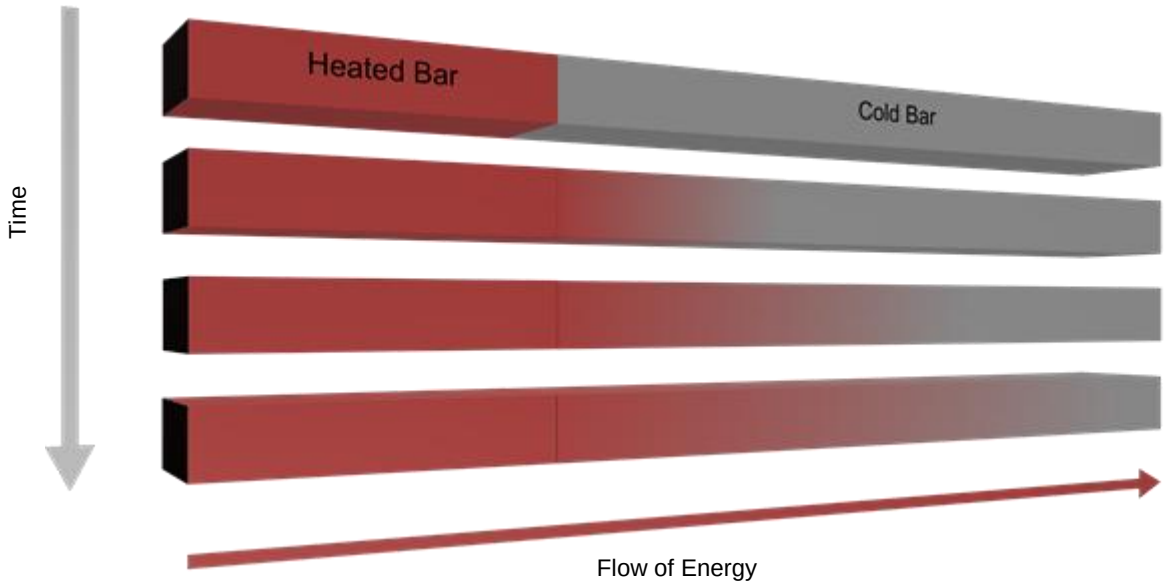

Figure 1 - Illustration of Thermal Conduction

Different materials conduct heat at different rates, depending upon their molecular structure. Metals for example, conduct heat far more effectively than glass or plastic.

CONVECTION

Convection happens in liquids and gases, and unlike solids where molecules can only vibrate, the process involves heat energy moving through a material as the molecules themselves move through the material. As a liquid or gas gains more energy, the molecules move further apart and so the liquid or gas becomes less dense.

Convection currents occur as the less dense portions of the liquid or gas move rise above the colder regions. For example, when a radiator heats air in a room, that air, being less dense, will rise. As it does so, it will transfer energy to the cooler regions of air, become denser, and then fall below the more recently heated regions of air. If we consider the flow in discrete regions, it can be illustrated as below:

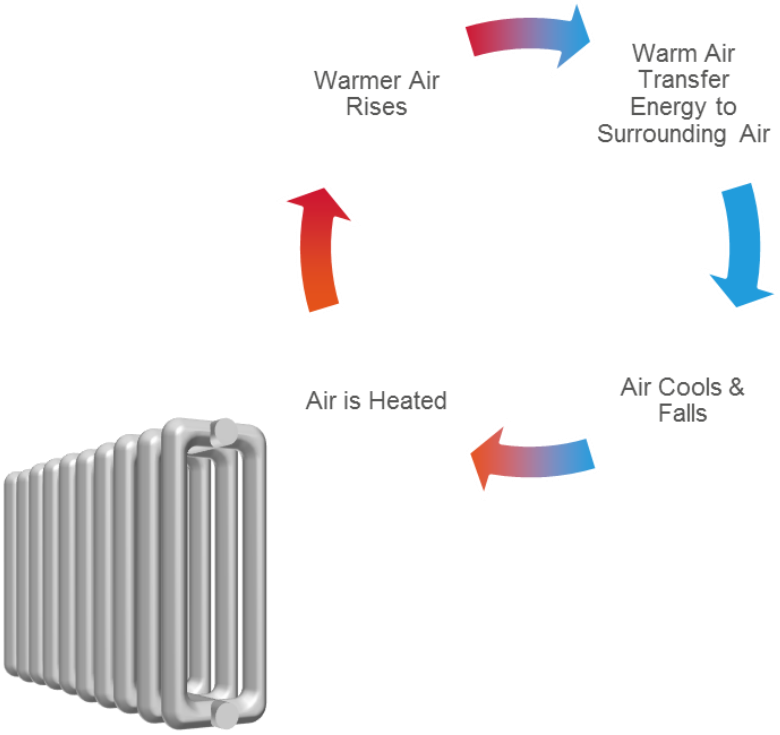

Figure 2 - Illustration of Thermal Convection

RADIATION

Radiation involves the transfer of energy by electromagnetic waves in the region of 780 nm (near infrared) to 1 mm (far infrared). All objects emit infrared radiation to some degree, dependent on temperature, with warmer objects emitting more energy than cooler objects.

Heating does not require direct contact, the sun, for example, heats the earth through infrared heating, with the waves able to travel through the vacuum of space.

As with light, infrared radiation can be transmitted, reflected and absorbed. The absorptance of a material, as above is dependent on colour and is effectively the remainder of energy after transmission and reflection has occurred.

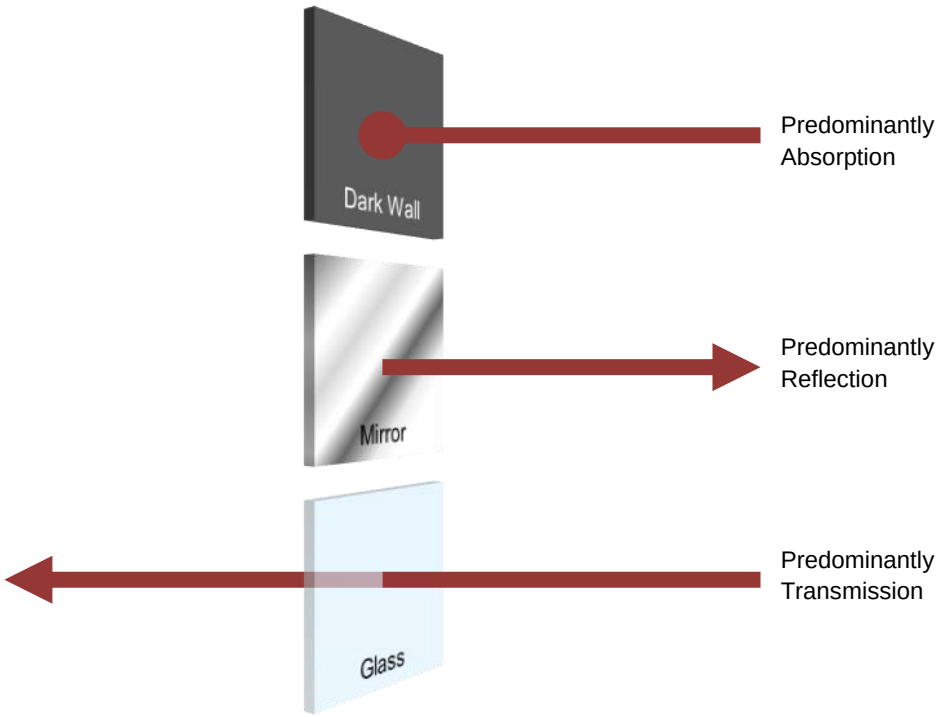

Figure 3 - Illustration of Thermal Radiation

As illustrated above, darker objects will predominantly absorb more energy, reflective surfaces, such as mirrors will reflect, and transparent materials, such as clear float glass will transmit energy.