

Heat Transfer Study Guide

Conduction- transfer of heat through direct contact.

A Few Examples:

- Burning your hand after touching a hot plate (heat is transferred from the hot plate to your hand)
- Frying bacon in a frying pan (heat is transferred from the frying pan to the bacon)
- Frying an egg in a frying pan (heat is transferred from the frying pan to the egg)
- An egg cooking by being placed on hot concrete (heat is transferred from the concrete to the egg)
- Stepping on the hot pavement with bare feet (heat is transferred from the concrete to your feet)
- Sliding down a metal slide in the summer (heat is transferred from the metal to the back of your leg or bottom)

Convection- the transfer of heat through fluids (air, liquid, gas)

A Few Examples:

- Boiling water (the heat is transferred throughout the water by the hot water rising and cool water sinking)
- Hot air balloon (the air inside the balloon is heated, causing the balloon to inflate (expand) and rise)
- Sea breeze- (wind blowing from the sea toward the land because of the air temperature differences)
- Land breeze- - (wind blowing from the land toward the sea because of the air temperature differences)
- Campfire, firepit, fireplace, house fire- (heat is transferred to the air, attaches to air molecules, warm air rises and heats cooler air and the cycle continues as air moves)
- Uneven heating of the Earth's atmosphere (think about wind and pressure systems of cool or warm air moving around the Earth)

Radiation- the transfer of energy through electromagnetic waves

Examples:

- Being warmed while lying in the sun (the heat from the sun radiates and warms you up)
- Cooking in the microwave (electromagnetic waves cook the food)
- Heat from a fire (the heat radiates towards you)
- Heat from a light bulb (the heat from the bulb radiates towards you)
- An animal being warmed under a heating light (the heat from the bulb radiates heat to the animal)
- Solar panels (energy from the sun heats the panels and the energy is used in your home)
- Being warmed sitting in front of a fireplace (heat radiates outward toward you)

Expanding & Contracting

Expanding- When heat energy is added to materials, these materials expand (think: they grow!)

Examples:

- Railroad tracks- as they are heated by the sun's radiation, they expand in length. This is why expansion joints are used when making tracks.
- Sidewalks- as they are heated by the sun's radiation, they expand in length. This is why gaps are left in between sidewalk blocks; to give them room to expand in the hot months.
- Bridges- as they are heated by the sun's radiation, they expand in length. This is why expansion joints are used when building bridges.

Contracting- When heat energy is subtracted from materials, these materials contract (think: get closer together, molecules slow down)

Examples:

- Railroad tracks & bridges- when these materials get cold, they contract and move closer together. The expansion joints allow for easy expanding and contracting without damaging the materials used to make railroad tracks and bridges.
- Sidewalks- when the weather turns cold, this material also contracts. The gaps allow for easy expanding and contracting without damaging the concrete.

An exception to the expanding and contracting rule: WATER

Water is a special substance that actually expands when it freezes! Think about putting a water bottle in the freezer. Once frozen, it appears that more “water” is in the bottle.

Because water freezes and expands when frozen, this can create a problem for roads in the winter. Water can get into cracks in the road. When the water freezes, it expands and makes the cracks larger or cause potholes.

Insulators & Conductors

Conductors accept, or take in, heat more easily than other materials. They heat up, and cool off, very quickly.

Examples:

- Metal
- Copper
- Stainless steel
- Aluminum
- Iron

Insulators are materials that do not allow heat to pass through them easily. They are good for keeping you warm (coats, blankets) and helping drinks maintain a temperature. You even have insulation in your home to allow the air to stay inside during the summer and the heat in the winter!

Examples:

- Plastic
- Styrofoam
- Wood
- Paper

Think about cooking. Many pots and pans use stainless steel or similar materials because they are great conductors of heat. However, the handles of pots and pans are often made of plastic or wood. Since those items are insulators, this allows you to hold onto the handle without getting burned while cooking!