



Heating & Cooling

Set 11: Heat Transfer

11.1		This material is used to reduce heat transfer by radiation. The shiny surface causes the reflection of either heat energy back into the building in winter or reflection of external heat energy out again in summer.
11.2		The water near the surface is heated directly by the Sun's radiation. When the water is warmed it becomes less dense and therefore floats on the more dense unheated water below it. So there will be no convective mixing and if the water is still the only method of heat transfer to the deeper water it will be by conduction, which will be slow because water is a poor conductor.
11.3		The cold air in the freezer is denser than the surrounding air and so will not rise and cause convection currents. As long as the air is still in the area the heat gain is only due to radiation and conduction, which occur sufficiently slowly for the freezer compressor to remove it.
11.4		Your feet feel cold because heat flows from them. As the concrete floor is a better conductor than the carpet, more heat flows out from your feet in that case. (The carpet soon warms up to the same temperature as your feet and no more heat flows.)
11.5		Metals are better conductors than plastics so the metal fork will take heat away from your hand more quickly, effectively feeling colder.
11.6	(a)	The electrical energy supplied by the energy company causes the particles in the internal metal wire to vibrate more violently (the wire becomes hot). This hot wire emits red light and infrared radiation. The shiny backing around the element reflects the radiation, ensuring that most of the heat energy is sent in the desired direction. There is also some heating of the room in the air by convection, but as bar heaters are usually mounted high up, this hot air rises to the ceiling where it does little to increase the comfort of people in the room.
	(b)	Forced convection by the fan moves warm air horizontally for some distance instead of allowing it to rise straight up. This makes the user feel warmer without using significantly more power.
11.7		Dull, black, matt objects are the best absorbers of heat radiated by the sun whereas light coloured or white clothing tends to reflect this radiated heat away.
11.8		Clothes trap layers of air between your body and the surrounding environment and since air is an excellent insulator, it reduces heat loss through conduction. Also, since this air is fairly well trapped and cannot easily move around, it also reduces heat loss by convection. In the absence of clothing, air close to the skin is constantly being replaced (wind or draughts) by air that has not already been warmed by body heat. Wool is a better fabric than silk as it consists of relatively thick fibres which trap more air.
11.9		Glass is a poor conductor of heat. In addition the air between the fibres is an even poorer conductor. The air cannot transmit heat energy by convection because it is trapped and cannot move. (Some heat is transferred by radiation, which could be reduced by covering the pads with aluminium foil.)
11.10		The curtains are insulators. They also absorb radiation from the hot objects in the room and re-emit that as heat energy that is retained in the room. If the curtains have a pelmet a body of air is trapped that acts as an additional insulator. This is of course in addition to the fact that the curtains trap a layer of air between them and the window.
11.11		This is the result of localised heating of air over hot spots on the ground, predominantly darker areas, such as wheat fields, towns or sunlit hillsides. The extra hot air is less dense than the air above it and so it rises. As it rises it expands and cools. It stops rising when its

		density again matches the air around it.
11.12		The hotter the tea compared to the ambient temperature, the faster it will cool. So it would be better to add the milk immediately, in order to slow down the cooling process. However, if too much milk is added (e.g. an equal volume compared to that of the tea), then the method of mixtures suggests the tea will cool significantly on adding the milk. So it all depends on the amount of milk added.
11.13		Dull, black, matt objects are the best absorbers of heat radiated by hot coals or burning wood, whereas shiny materials will tend to reflect this radiated heat away.
11.14	(a)	Like water, glycol also has a high specific heat capacity however it is not as corrosive as water.
	(b)	It is made of a good conductor, it has a large surface area, it has narrow water tubes so the water cools quickly.
	(c)	The fan creates a forced convection component which increases the mass of cooler air flowing over the hot radiator.
	(d)	The engine operates more efficiently when it is hot. The thermostat acts like a switch would activate at a particular temperature. The coolant does not circulate when the engine is cold since it does not need to. The coolant circulates when the engine is hot, to avoid overheating.
	(e)	Relatively good conductor, low coefficient of expansion when hot, strong/tough enough that it does not break as the fuel burns and expansion moves the pistons.
11.15	(a)	Evaporation occurs from the surface of a material. When the tea is spread out on the saucer it has a greater surface area and more evaporation occurs. The escaping molecules of vapour take their latent heat of vaporisation from the remaining liquid, thereby cooling it.
	(b)	The blowing removes vaporised molecules more quickly from near the liquid surface. It is a form of forced convection which prevents the immediate area of air becoming saturated. This prevents them from recondensing and allows more molecules to escape from the surface. These escaping molecules of vapour take their latent heat of vaporisation from the remaining liquid cooling it.
11.16	(a)	Infrared radiation from the hot bricks and also some convected air currents produced immediately above the brick surface.
	(b)	The sun's nuclear reactions cause very high temperatures, which cause emission of infrared, visible and ultra-violet electromagnetic radiation. Much of the ultra-violet is absorbed by the earth's atmosphere, but the wall absorbs most of the remaining radiation.
11.17		The trapped layer of air acts as a good insulator and since the glass itself is a more conductor, very little heat will enter this gap and so fewer convection currents will be produced.
11.18		Aluminium is a better conductor of heat than either glass or plastic, so for the same temperature difference more heat would be conducted through the can thereby warming the drink faster than that in the bottle.
11.19		Unless your water comes from a partly frozen mountain stream, it would be better to wrap the bottle in a cloth and then wet this with the water from the bucket. In this situation, the water evaporates and cools the bottle and its contents below the temperature of the water in the bucket.