

# Things you already know about Heat Transfer

1. Does ice melt faster in water or in the air? Why?

(assume the air and water are both at room temperature)

Faster in water. Liquids have higher convective heat transfer coefficients than air.

2. Which cools faster when put in a freezer: hot water or cold water? Why? Which will form ice cubes first?

Hot water cools faster. It has a larger Temperature difference. Cold water will form ice first, it has less initial internal energy (U).

3. Why does a fan (or wind) cause you to feel cooler, even though the air temperature is the same?

Convective heat transfer is improved by molecular motion, so even though  $dT$  is the same,  $h$  is increased by the moving air.

4. The hottest time of day is typically 4:00 - 5:00 pm. Why isn't it hottest at noon, when the sun is directly overhead?

Solar radiation heats the earth. The earth also cools by re-radiation to outer space. During the day, the sun's rays are much greater than the re-radiation, so even though it's not directly overhead, heat continues to accumulate during the day until the cooling radiation becomes larger than solar radiation.

5. Clouds at night tend to keep things warmer. Daytime clouds tend to keep things cooler. Why?

See #4. Clouds block some solar radiation during the day. At night, clouds block the re-radiation to space.

6. Why does rubbing alcohol feel cooler on your skin than water, even if both are at room temp?

Evaporative cooling (with a phase change) is much larger than convective cooling.

7. Which will cool faster, coffee in a metal cup, plastic cup or ceramic cup? Why?

Metal fastest, then ceramic, then plastic. The thermal conductivity of the materials governs heat xfer rates.

8. Why does mint-flavored chewing gum have a "cool" sensation?

See #6. Menthol is a volatile chemical, and when exposed (chewed), it cools by evaporation.

9. On a hot summer day, which of these would be hottest: asphalt, a concrete sidewalk, or dirt? Why?

Hottest: asphalt, then concrete, then dirt. It has to do with the materials' absorptivity. Black asphalt absorbs more solar radiation than the other items.

10. Why do many people use pots with copper bottoms in cooking?

Copper has a very high thermal conductivity (better than most metals) and transfers the heat evenly between the stove and the bottom of the pan.

11. Why do home-builders install double-paned windows instead of single-paned windows?

The air gap between two panes of windows creates a thermal barrier or insulation because gases do not transmit heat efficiently.

12. Who would be more susceptible to cold weather: an infant or an adult? Why?

An infant. The surface area exposed to a temperature is important for convective heat transfer. While an adult has a higher total surface area, the surface area-to-volume ratio is higher in an infant.

13. If you want to heat up a bag of frozen vegetables, which will heat it faster: hot water at 100 °C

(with a little salt so the boiling point is higher than 100) or boiling water at 100 °C? Why?

Kind of a trick question: many people add salt to cook things faster. That's because salt causes boiling point elevation, so it cooks hotter. But in this problem, the salt water was not boiling. Both are at the same temperature, but convective heat transfer is much better when there is boiling. (so the boiling water is better)