Thermal Energy

A. Temperature & Heat

1. Temperature is related to the average kinetic energy of the particles in a substance.

The atoms in an object are in constant motion.

A When the horseshoe is hot, the particles in it move very quickly.

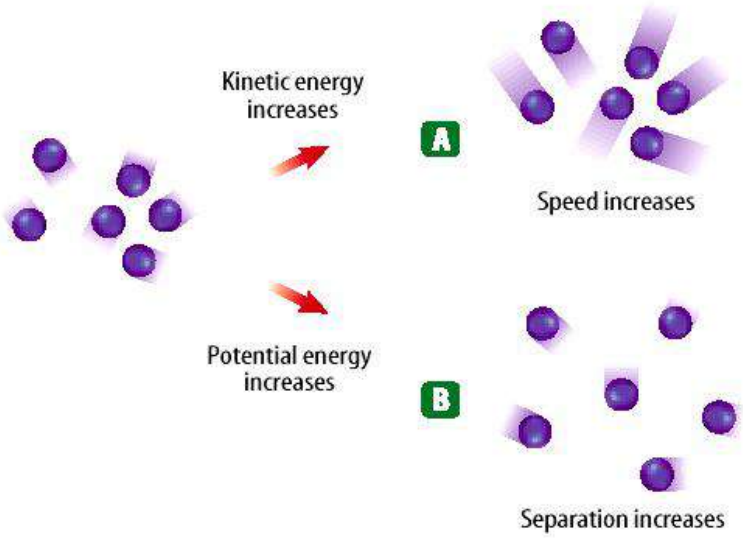
B When the horseshoe has cooled, its particles are moving more slowly.

2. SI unit for temp. is the Kelvin

   a. K = C + 273 (10C = 283K)

   b. C = K – 273 (10K = -263C)

3. Thermal Energy – the total of all the kinetic and potential energy of all the particles in a substance.



4. Thermal energy relationships

a. As temperature increases, so does thermal energy (because the kinetic energy of the particles increased).

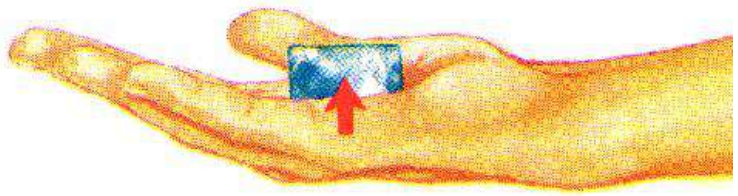
b. Even if the temperature doesn't change, the thermal energy in a more massive substance is higher (because it is a total measure of energy).

5. Heat

a. The ***flow*** of thermal energy from one object to another.

b. Heat ***always*** flows from warmer to cooler objects.

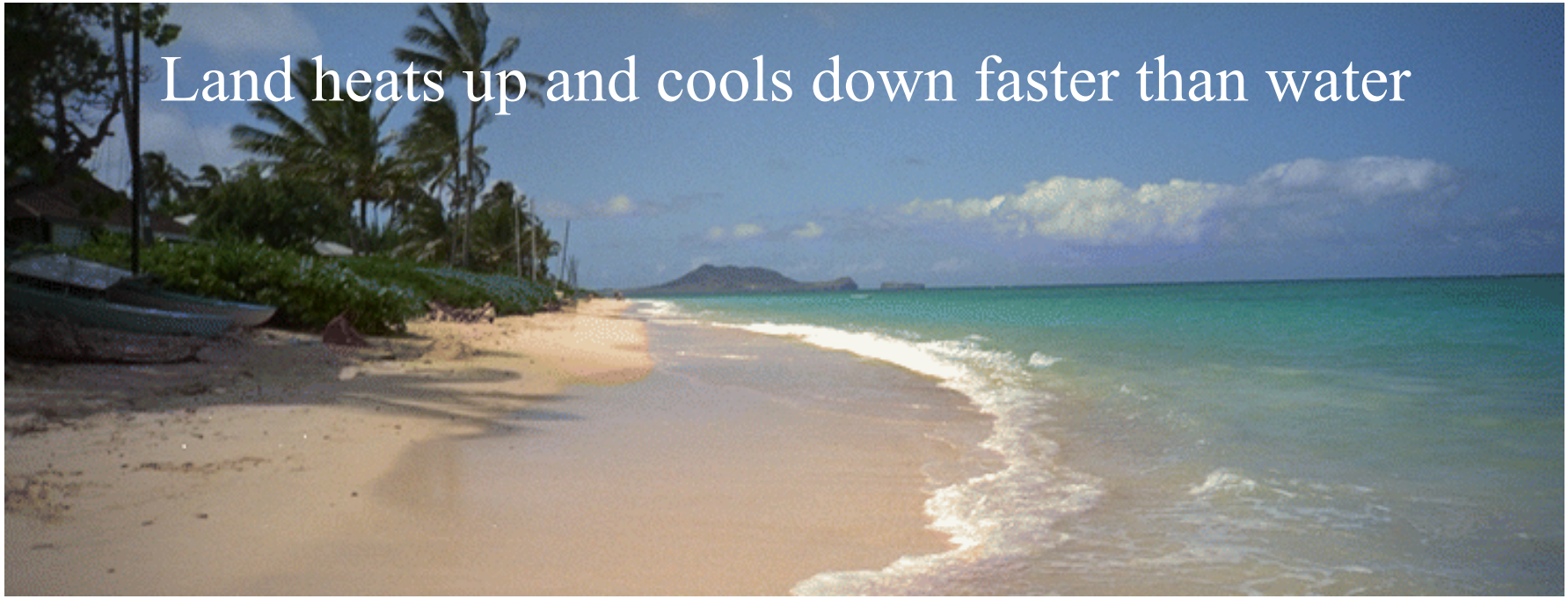
Cup gets cooler while hand gets warmer



Ice gets warmer while hand gets cooler

6. Specific Heat

a. Some things heat up or cool down faster than others.



b. Specific heat is the amount of heat required to raise the temperature of 1 kg of a material by one degree (C or K).

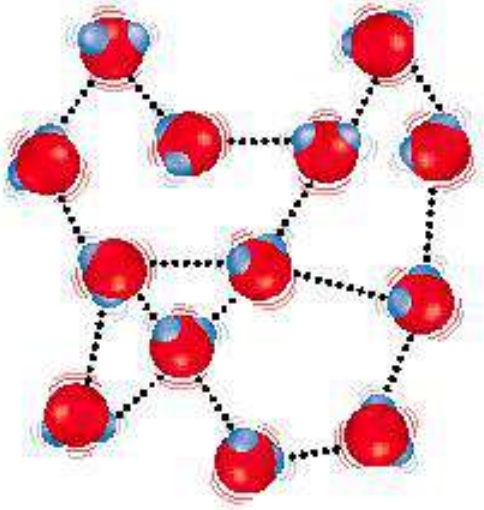
1) $C_{water} = 4184$ J / kg C

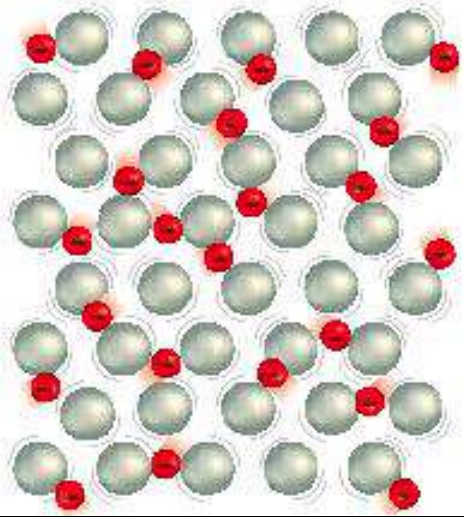
2) $C_{sand} = 664$ J / kg C

This is why land heats up quickly during the day and cools quickly at night and why water takes longer.

Why does water have such a high specific heat?

water





metal

Water molecules form strong bonds with each other; therefore it takes more heat energy to break them. Metals have weak bonds and do not need as much energy to break them.

How to calculate changes in thermal energy

$$Q = m \times \triangle T \times C_p$$

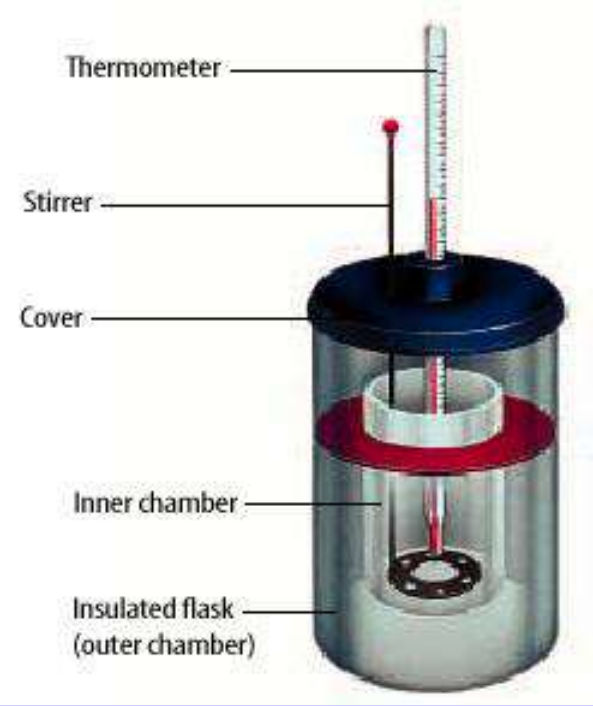
Q = change in thermal energy

m = mass of substance

$\triangle T$ = change in temperature ($T_f - T_i$)

C_p = specific heat of substance

c. A calorimeter is used to help measure the specific heat of a substance.



Knowing its Q value, its mass, and its $\triangle T$, its C_p can be calculated