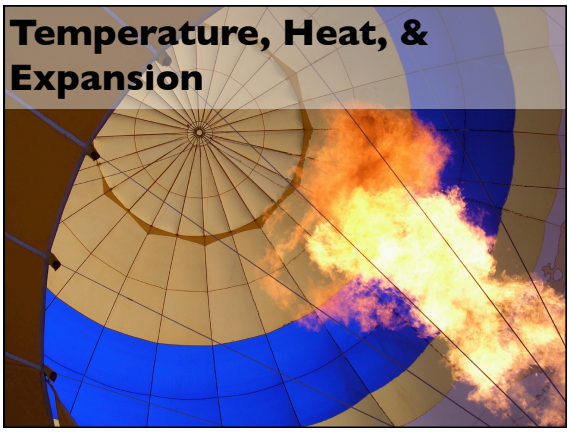
Temperature, Heat, & Expansion



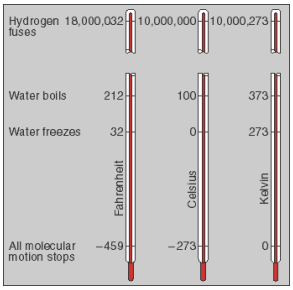
Temperature

- Atoms and molecules are constantly in motion, and *temperature* is related to the average kinetic energy of these molecules.
- The more the molecules move, the greater their KE, and the greater the temperature of the object.
- Temperature IS NOT the energy of the object. It's *related to* the energy of the object.

Thermometers

- ...measure temperature.
- There are three common temperature scales.
  - *Fahrenheit*
  - *Celsius (formerly "Centigrade")*
  - *Kelvin*

Temperature Scales



$$°C = \frac{5}{9}(°F - 32)$$

$$K = °C + 273.15$$

Heat

Heat is simply the transfer of energy from one body to another. We can call the type of energy being transferred *thermal energy*, but it's more appropriate to call it a *change in internal energy* (because it is related to the changing internal kinetic energy of the moving molecules in a substance).

When two substances of different temperatures are brought into contact with each other, energy (in the form of "heat") spontaneously flows from the warmer body to the cooler body.

Thermal Equilibrium

As you might expect, this can't go on forever. Eventually, the two bodies reach the same temperature, at which point they are in *thermal equilibrium*.

How is heat (energy flow) measured?

$$Q = mC\Delta T$$

Q = heat (in Joules or calories, depending)
m = mass of material being heated or cooled (in g, usually)
C = *specific heat capacity*
ΔT = change in temperature (°C)

C for water = 1 calorie/g°C
C for water = 4.184 J/g°C
1 calorie = 4.184 J

What is "specific heat capacity"?

$$Q = mC\Delta T$$

How much energy will it take to heat 100g of water up by 10°C?

How much energy will it take to heat 100g of iron up by 10°C? (C_{iron}=0.107 cal / g°C)

We say that iron has a lower heat capacity than water, because it takes less energy to change its temperature.

Example-1

How much heat is necessary to raise the temperature of 50 g of a metal from 20.0° C (room temperature) to 50.0°C if the specific heat capacity for the metal is 0.4 cal / g °C?

Example-2

What is the final temperature of 300 ml of water, if it starts out at boiling (100°C), and has 3.77e4 Joules of energy taken away?

Example-3

500 ml of water at 20.0°C is mixed with hot water at 70.0°C to produce water with a final temperature of 50.0°C How much hot water was there?

Example-4

What is the final (equilibrium) temperature of 20g of iron at 300°C dropped in a 2-liter bottle of water at 70°F?