Heat

From last class...

In terms of temperature, what happens when a room temperature can of soda is placed into an ice bath?

reach equilibrium

heat will flow from soda (warm) to water (cold)

In order for the temperature of the can and water to change, there must also be a change in energy .

(Remember that temperature is directly proportional to kinetic energy)

- **Heat** – the energy transferred between objects because of the difference in their temperatures

Measured in joules (J) or calories (cal)

4.186 J = 1 cal

Energy transferred as heat moves from an object of **higher temperature to one of lower temperature**. Think of the flow of energy similar to the movement due to gravitational potential energy.

$$P_g = mgh$$

A pencil on the desk will fall to the floor if dropped. However, the pencil will not spontaneously jump from the floor onto the desk. This same principle applies to energy flow from high to low.

Effects of Heating

Imagine that an object of mass, m, is being heated from an initial temperature of T_i to a final temperature of T_f. The amount of energy needed for this change is represented as Q.

$$Q = m\,c\,\Delta T$$

Q = amount of energy
m = mass
c = specific heat
ΔT = change in temperature

(c)

- **Specific heat** – the amount of energy required to raise the temperature of 1 kg of material by 1 °C.

phase dependent

Some Specific Heat Capacities

Water	4186 J/kg°C	Steam	2010 J/kg°C
Aluminum	899 J/kg°C	Iron	448 J/kg°C
Ice	2090 J/kg°C	Copper	387 J/kg°C

Even though water, ice, and steam are all made of H_2O, why do they have different specific heats?

- Imagine that I have equal amounts of air and water. I add an equal amount of energy to each. If the final temperature of air is higher than that of water, which substance has the higher specific heat capacity?

The water because it absorbs more energy for each degree change in temperature

Example 1:

Find the energy required to raise the temperature of 150 g of water at 10°C to 85°C. (Specific heat of water = 4186 J/kg°C)

$$Q = mc\Delta T$$
$$= (.15)(4186)(85-10)$$
$$= 47{,}092.5\text{ J}$$

Example 2:

A 250 g block of copper at 15°C is supplied with 10,000 J of heat. Find the final temperature of the block. (Specific heat of copper = 387 J/kg°C)

$$Q = mc(T_f - T_i)$$
$$10{,}000 = (.25)(387)(T_f - 15)$$
$$T_f = 118.4\,°C$$

Example 3:

A slice of bread contains about 4.19×10^5 J of energy. If the specific heat capacity of a person is 4.19×10^3 J/kg°C, by how many degrees Celsius would the temperature of a 70 kg person increase if all the energy in the bread were converted to heat?

$$Q = mc\Delta T$$

$$4.19 \times 10^5 \text{ J} = (70)(4.19 \times 10^3)\Delta T$$

$$\Delta T = 1.43°C$$