Calories and Joules

Traditionally, Heat was measured in calories (cal):

- **1 calorie** is an amount of heat needed to increase the temperature of 1g of water by 1°C.
- For nutritional/dietary purposes people use "big Calories" (Cal, with capital "C"). **1 Cal=1000cal** (or simply kilocalorie). By definition, this is an amount of heat needed to increase the temperature of 1 kg (1 liter) of water by 1°C.
- Since Heat is a form or energy, calories can be converted to Joules:

1 cal = 4.184 J

1 Cal = 1000cal = 4184 J (used for dietary purposes)

Specific Heat

In order to know how much energy is needed to heat up an object by certain temperature, you need to know the specific heat capacity (aka specific heat) of the material, C:

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

Here m is mass of the object, ΔT is change of its temperature, C is specific heat of its material. For instance, specific heat of liquid water is:

$$C_{water} = 1000\,\frac{cal}{kg\cdot\,^0C} = 4184\,\frac{J}{kg\cdot\,^0C}$$

Power

- Power is an amount of work done in unit time:

$$P = \frac{\Delta W}{\Delta t}$$

Unit of power is called Watt, 1W=1J/s

•Power is also used to characterize the rate with which heat is produced:

$$P = \frac{\Delta Q}{\Delta t}$$

Homework 23

Problem 1

A cyclist is moving at speed v=5m/s. He applies brakes and comes to a complete stop. Assuming that all the heat generated during the braking is concentrated in rubber blocks that "squeeze" the wheel, find the change in temperature of the rubber after the braking, ΔT. Mass of the cyclist with the bicycle is M=100kg, total mass of all rubber blocks is m=50g. Specific heat of rubber is $c = 2000 \frac{\mathrm{J}}{\mathrm{kg} \cdot ^\circ \mathrm{C}}$

Problem 2

What should be a power of an electric heater that can bring 10 liter (10 kg) of water to the boiling, starting at 20°C, in 3 minutes. Specific heat of water is $4200 \frac{\mathrm{J}}{\mathrm{kg} \cdot ^\circ \mathrm{C}}$