2.B.1 Definition and Units of Heat

Heat

Energy in transit.

Adding heat to something increases its energy content.

Heat is denoted by a capital "Q"

Q of Star Trek

Heat Unit Conversions

SI unit is Joule (J).

Other units:

Kilocalorie (kcal) = heats 1 kg water 1 ºC.

calorie = heats 1 gram of water by 1 ºC.

British thermal unit (Btu) = amount of heat needed to raise the temperature of 1 pound of water 1 ºF.

1 Btu = 252 cal = 0.252 kcal

Other Conversions: 1 Cal = 1 kcal = 4186 J = 4.186 kJ

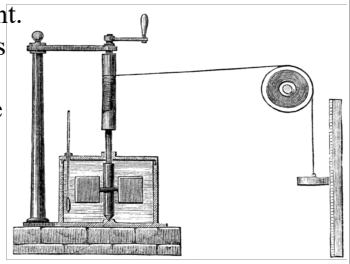
1 cal = 4.186 J

Calorie Rabbit Hole!!

Mechanical Equivalent of Heat

James Prescott Joule made a device in 1849 demonstrating that mechanical work done on a fluid increased its heat content.

It tied in to observations of frictional heating, providing a quantifiable correlation between work and energy.



James Joule's contraption.

One year, a student built one of these out of lego!

Energy Example

A candy bar has an energy value of 220 Cal/bar.
(1 Cal (Food Calorie) = 1 kcal)

1. What's this energy in J/bar?

$$\frac{220\,Cal}{bar} \bullet \frac{4186\,J}{Cal} = 9.20\,E5\;J/bar$$

Energy Example

2. If you had a 2.0 kW engine that ran on candy bars, how many would you need to burn each hour for this power output?
Each candy bar has 9.2 E 5 J.
Remember: a Watt = 1 J/s, so 2.0 kW = 2000 J/s

$$\frac{2000\,J}{s} \bullet \frac{3600\,s}{h} = 7.2\,E6\,J/h$$

$$\frac{7.2\,E6\,J}{h} \bullet \frac{1\,bar}{9.2\,E5\,J} = 7.8\,bars/h$$

I'm envisioning very fouled fuel injectors.

Homework

Preview 2.B.2

2.B.1 Booklet Problems.
Due next class.

Food Calorie Note

A food calorie (Cal) = kilocalorie in US. Other countries measure food energy in Joules(candy wrappers).

A Calorie (capital C) is actually 1000 calories. To make the units on labels more user-friendly (smaller numbers), manufacturers use units of Calories.
1 Calorie = 1000 calories.