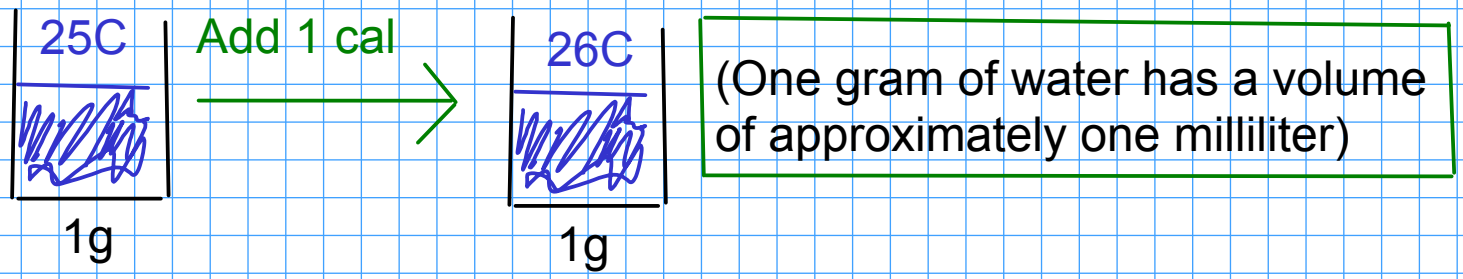
Energy units

- two common units. Both are based on the metric system

CALORIE

- the amount of energy required to change the temperature of one gram of water by 1 degree Celsius.

- abbreviation: cal



- the Calorie reported on the side of most food labels is actually a KILOCALORIE (kcal). 1 kcal = 1000 cal

JOULE

- the standard metric unit of energy is the JOULE.

- abbreviation: J

- the Joule is defined based on KINETIC ENERGY, but is smaller than the calorie.

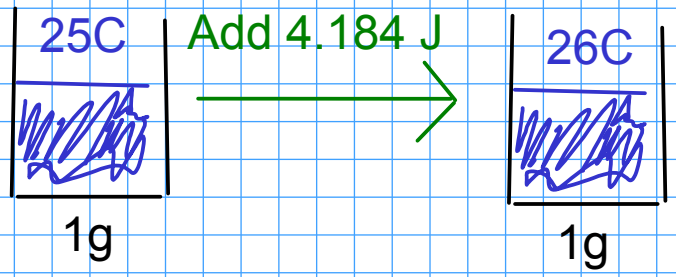
4.184 J = 1 cal

The joule is a DERIVED UNIT:

$1\ J = 1\ \frac{Kg\ m^2}{s^2}$, from

$E_K = \frac{1}{2} m V^2$

kinetic energy — mass — velocity



(One gram of water has a volume of approximately one milliliter)

Energy conversions

- It's simple to convert back and forth between calorie-based units and Joule-based units. Just use dimensional analysis! Remember that these energy units are both based on the metric system, and use the metric prefixes.

Example:

Convert 15.7 kJ to cal

$4.184\ J = 1\ cal$

$kJ = 10^3\ J$

Conversion factors

$$15.7\ kJ \times \frac{10^3\ J}{1\ kJ} \times \frac{1\ cal}{4.184\ J} = 3752.390057\ cal$$

$3750\ cal$

$3.75 \times 10^3\ cal$

Round this answer to three significant figures, since the original measured number (15.7 kJ) has three significant figures!

HEAT

- is the flow of energy from a region of high temperature to a region of low temperature

- can be measured by monitoring temperature changes

SPECIFIC HEAT

- the same amount of energy will change the temperature of different substances by different amounts.

- the SPECIFIC HEAT is the amount of energy required to change the temperature of one gram of a substance by 1 degree Celsius

Units: $\frac{J}{g\ ^{o}C}$ OR $\frac{cal}{g\ ^{o}C}$

See the table of specific heats on page 73 of your textbook for values!

Water's specific heat is: $4.184\ \frac{J}{g\ ^{o}C}$ OR $1\ \frac{cal}{g\ ^{o}C}$

The higher the specific heat, the more energy is required to change the temperature!

Using specific heat

- specific heat is used to relate energy to temperature changes.

$$\text{ENERGY} = \text{MASS} \times \text{SPECIFIC HEAT} \times \text{TEMPERATURE CHANGE}$$

Example:

How much energy does it take to raise the temperature of a 15.4 gram piece of copper from 25.2 °C to 100.0 °C?

The specific heat of copper is 0.384 J / g °C

$$\text{Energy} = (15.4\ \text{g}) \times \left(0.384\ \frac{\text{J}}{\text{g}\,^\circ\text{C}}\right) \times (100.0\,^\circ\text{C} - 25.2\,^\circ\text{C})$$

$$= (15.4\ \text{g}) \times \left(0.384\ \frac{\text{J}}{\text{g}\,^\circ\text{C}}\right) \times (74.8\,^\circ\text{C})$$

$$= 442.33728\ \text{J}$$

$$= \boxed{442\ \text{J}}$$

3 significant figures

See p 74-76 for more examples!