Energy

- can be defined as the ability to do work.

This material is covered in Sections 10.1-10.5 in your textbook ... Pages 288-301

Work?

- the ability to move matter

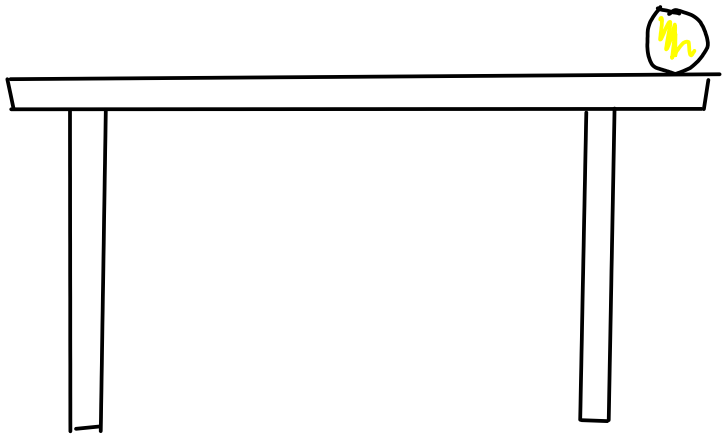
Kinds of energy

1. KINETIC ENERGY is the energy of matter in motion

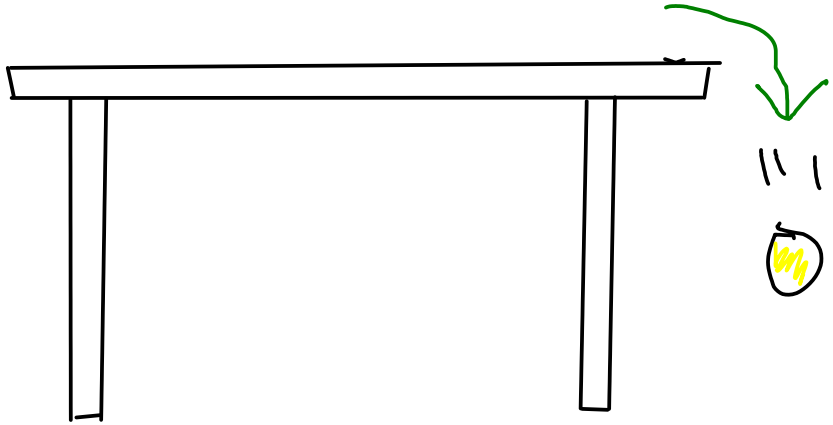
Throwing a ball gives it kinetic energy!

2 POTENTIAL ENERGY is energy of matter that is being acted on by a FIELD OF FORCE

- Fields of force may be things like gravity, magnetism, electricity, etc.



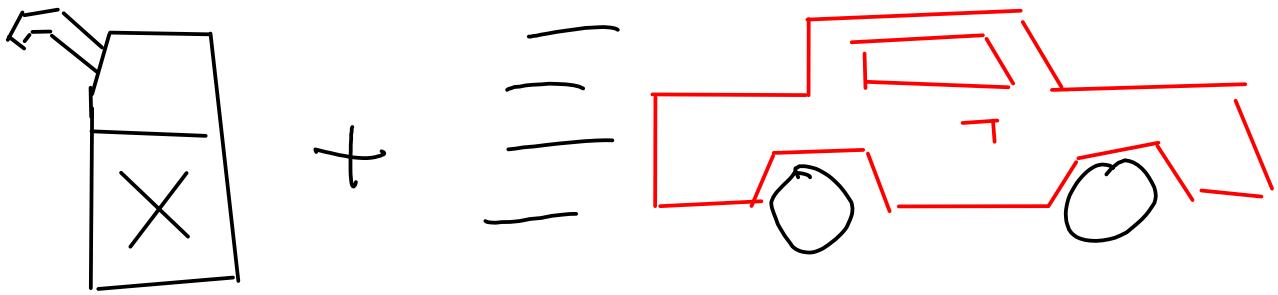
A ball on a table has POTENTIAL ENERGY because it is being acted on by GRAVITY



When the ball falls, the POTENTIAL ENERGY is converted to KINETIC ENERGY

3 CHEMICAL ENERGY is energy stored in matter. Think of chemical energy as the sum of the kinetic and potential energy of the atoms in a chemical

CHEMICAL ENERGY may be converted to other forms of energy during chemical reactions



Gasoline

Car's internal combustion engine

The chemical energy of the gasoline is CONVERTED to thermal and kinetic energy when the gas is burned in the engine of the car.

Conservation of energy

- Like mass, energy is conserved in physical and chemical changes.

- During a chemcal or physical process, the overall amount of energy remains constant, even if there is a change in the type of energy.

"Law of conservation of energy"

is usually called the

"First Law of Thermodynamics"

study of energy transfer

More simply put ... "all the energy has to go SOMEWHERE..."

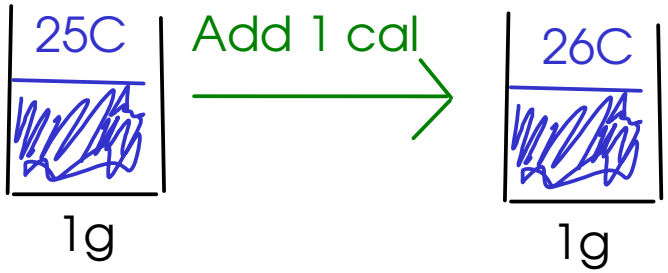
Energy units

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

1 CALORIE

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

- abbreviation: cal



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

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

2 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.

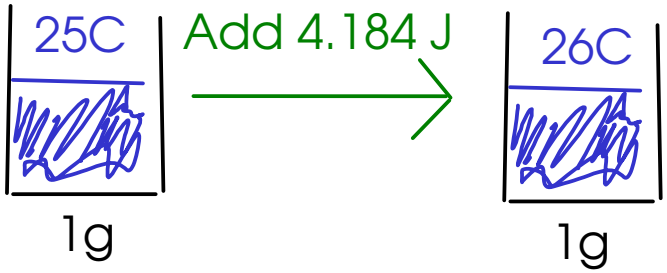
4.184 J = 1 cal

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

$1\ cal = 4.184\ J$

$1\ kJ = 10^3\ J$

$$15.7\ kJ \times \frac{10^3\ J}{1\ kJ} \times \frac{1\ cal}{4.184\ J} = 3750\ cal$$

Round to THREE significant figures since the initial measurement of 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. Usually represented by the letter "Q"

- can be measured by monitoring temperature changes

Since heat is a FLOW of energy, it has a direction. The direction is indicated by a SIGN ... positive for energy flowing in, and negative for energy flowing out..

When we talk about heat, we need to be specific ... from where does energy flow, and where does it go?

SYSTEM: the object or material under study

SURROUNDINGS: everything else

And when we talk about processes involving heat, we need an easy way to describe them...

Type of process	Energy is ...	Sign of Q	Temp of SURROUNDINGS ...
ENDOTHERMIC	transferred from SURROUNDINGS to SYSTEM	+	decreases
EXOTHERMIC	transferred from SYSTEM to SURROUNDINGS	−	increases

(Why is the temperature of the surroundings important? Because the thermometer is usually part of the surroundings!)

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 297 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!