

Energy

- can be defined as the ability to do work.

Work?

- the ability to move matter

Kinds of energy

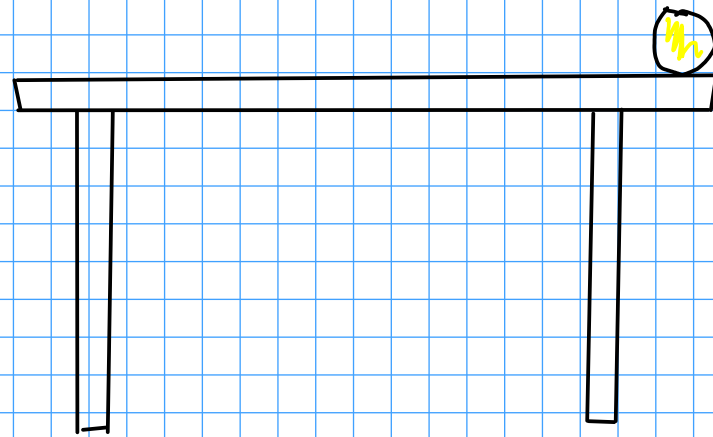
KINETIC ENERGY is the energy of matter in motion



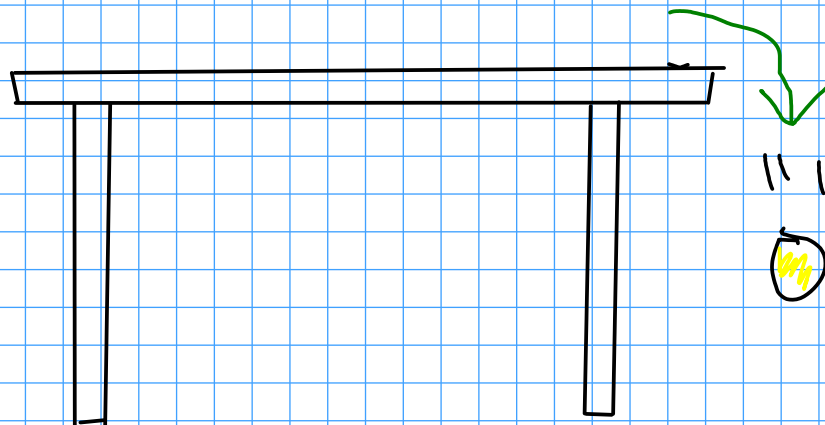
Throwing a ball gives it kinetic energy!

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.



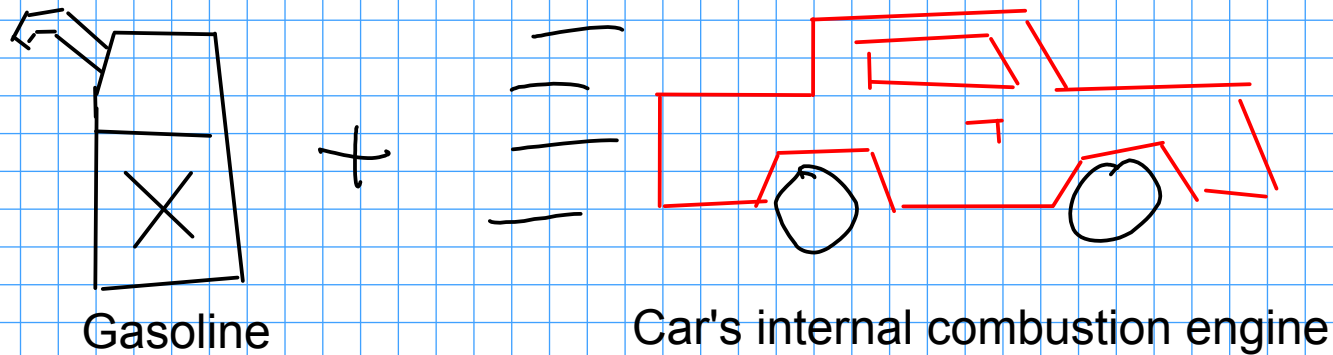
A ball on a table has
POTENTIAL ENERGY
because it is being acted
on by **GRAVITY**



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

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



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 chemical 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"

sometimes called

"First Law of Thermodynamics"

study of energy
transfer

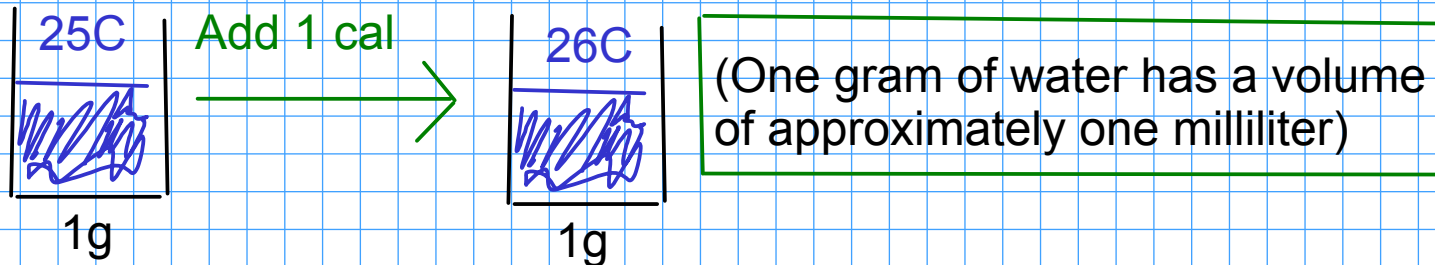


Energy units

- 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.

$$4.184 \text{ J} = 1 \text{ cal}$$

The joule is a DERIVED UNIT:

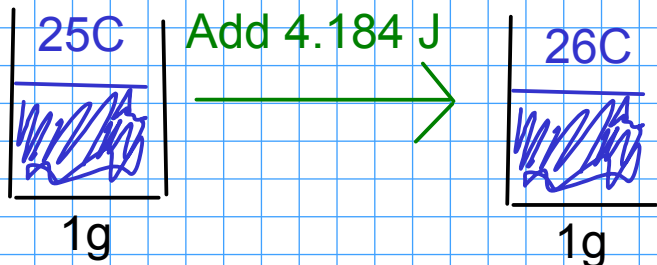
$$1 \text{ J} = 1 \frac{\text{Kg m}^2}{\text{s}^2}, \text{ from}$$

$$E_k = \frac{1}{2} m v^2$$

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

$$1 \text{ cal} = 4.184 \text{ J}$$

$$1 \text{ kJ} = 10^3 \text{ J}$$

Conversion factors

$$15.7 \text{ kJ} \times \frac{10^3 \text{ J}}{1 \text{ kJ}} \times \frac{1 \text{ cal}}{4.184 \text{ J}} = 3752.39 \text{ cal}$$

$$3750 \text{ cal}$$

Round answer to three sig figs (15.7 kJ has three sig figs)

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
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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: $\frac{\text{J}}{\text{g}^{\circ}\text{C}}$ OR $\frac{\text{cal}}{\text{g}^{\circ}\text{C}}$

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

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

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

$$\text{ENERGY} = (15.4 \text{ g}) \times (0.384 \text{ J/g}^\circ\text{C}) \times (100.0^\circ\text{C} - 25.2^\circ\text{C})$$

74.8°C

$$= 442.33728 \text{ J}$$

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

See p 74-76 for more examples!