

Energy

Shooting Rubber Bands

Overview

For this introductory activity you will shoot rubber bands stretched to various distances.

- **Hypothesis:** ?
- **Materials:**
 - Rubber Band
 - Meter Stick
 - Data Table
- **Procedures:**
 - Write a hypothesis on the back of your data table.
 - Place a rubber band on the edge of the ruler, pull it back to 10 cm, and release the rubber band. Be sure the ruler is parallel to the floor.
 - Measure the distance traveled by the rubber band and record it in a data table.
 - Repeat these steps while increasing the distance the rubber band is pulled back by five centimeters for each release.
 - Average your results and create a line graph of your average data with distance traveled on the y-axis and the distance you pulled the rubber band back on the x-axis.

Data Table

Trial	10 cm	15 cm	20 cm	25 cm	30 cm
1					
2					
3					
Average					

Questions

1. What patterns or trends did you notice?
 2. Was energy used to launch the rubber band? If so, explain your reasoning.
 3. What factors could have impacted the accuracy of your data?
 4. Did your data support your hypothesis? Explain your reasoning.
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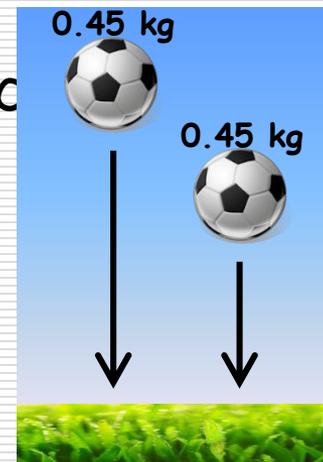
Energy

- the ability to do work or cause change
 - typically expressed in units of joules (J)
 - can be transferred from one object to another
 - two general types:
 - Potential
 - Kinetic
-

Potential Energy (PE)

- stored energy that an object has due to its position or chemical composition
- Types:
 - Gravitational - results from vertical position or height
 - Formula: $PE = mgh$
 - Elastic - results from stretching

CO Which soccer ball has more gravitational potential energy? Explain your reasoning.

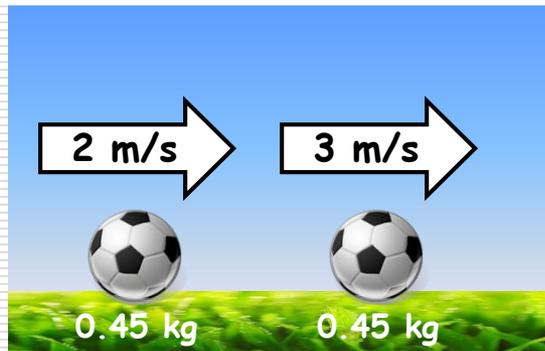


The types listed are not all-inclusive

Kinetic Energy (KE)

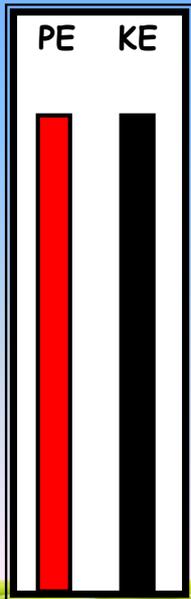
- energy of motion
- depends on mass and velocity
 - Formula: $KE = \frac{1}{2} mv^2$
- increases as mass or velocity increases and decreases as mass or velocity decreases

What is the difference between speed and velocity?



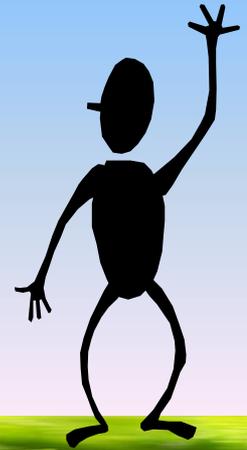
Which soccer ball has more kinetic energy? Explain your reasoning.

Relationship Between PE and KE



What is happening to the PE and KE as the soccer ball falls to the feet of the mid-fielder?

What about the PE/KE graph could be considered misleading?



Practice Problems

- A diver weighing 46 kg is preparing for a dive from the 10 meter diving platform. How much gravitational potential energy does the diver have?

$$PE = mgh$$

$$P.E. = (46 \text{ kg})(9.8 \text{ m/s}^2)(10 \text{ m}) = 4,508 \text{ J}$$

Note: In the original image, 'Earth's Gravity' is written in a dotted box around the 9.8 m/s² value, with arrows pointing from the '46 kg' and '10 m' in the problem text to it.

- A cheetah weighing approximately 50 kg was seen chasing a gazelle at a speed of 32.4 m/s. What is the kinetic energy of the cheetah?

$$KE = \frac{1mv^2}{2}$$

$$K.E. = \frac{(1)(50 \text{ kg})(32.4 \text{ m/s})^2}{2} = 26,244 \text{ J}$$

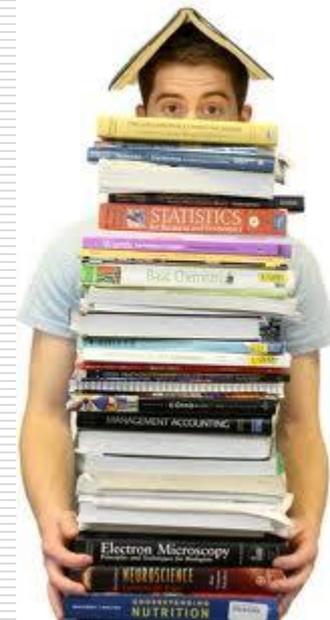
Note: In the original image, arrows point from the '50 kg' and '32.4 m/s' in the problem text to the corresponding values in the equation.

Forms of Energy

- Mechanical
 - Radiant (Electromagnetic)
 - Sound
 - Chemical
 - Heat (Thermal)
 - Electricity
 - Nuclear
-

Mechanical Energy

- energy that moves objects
- the total energy of motion and position of an object
- may be in the form of potential energy, kinetic energy, or both
- Example:
 - If a student were to lift and/or drop a stack of textbooks, mechanical energy would be involved



<http://www.columbiastate.edu/HSS-Textbook-Information>

What are some other examples of mechanical energy?



Radiant (Electromagnetic) Energy

- transmitted through space in the form of electromagnetic waves
- light, electricity, and magnetism are representative of electromagnetic energy
- can travel through empty space

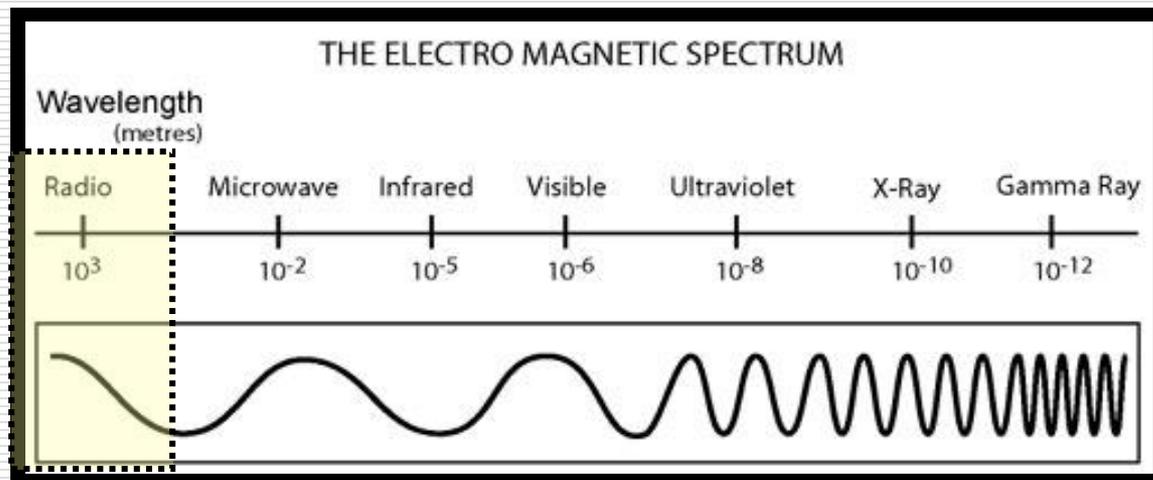


Image taken from: <http://zebu.uoregon.edu/~imamura/122/lecture-2/em.html>



Sound Energy

- an example of mechanical energy that results from the vibration of particles in a solid, liquid, or gas
- can be impacted by temperature and pressure
- must have a medium (usually air) to travel through - **cannot** travel through empty space
 - sound in a vacuum

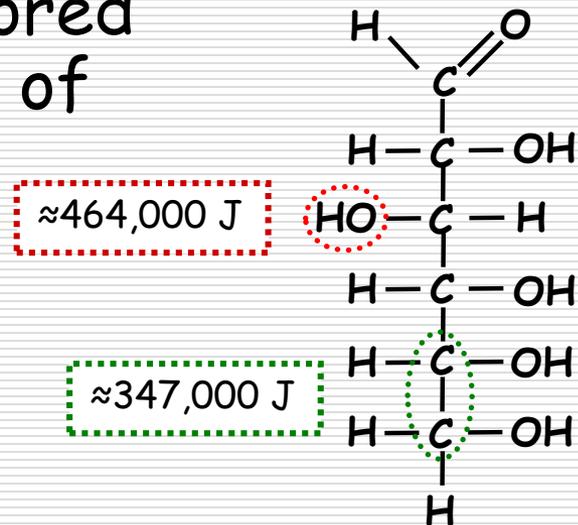


This person is listening to someone telling a secret. How are the sound waves being generated?



Chemical Energy

- type of potential energy stored in the chemical composition of matter
- depends on the types and arrangement of atoms in a substance
 - i.e.
 - A bond between a hydrogen atom and an oxygen (H-O) atom will release more energy than one between two carbon atoms (C-C)



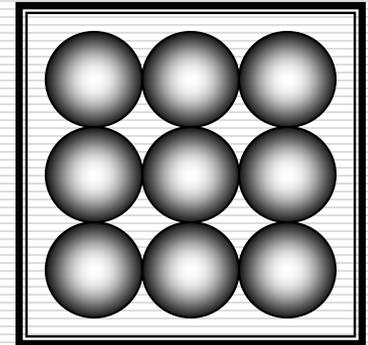
Glucose

What are some examples of chemical energy?

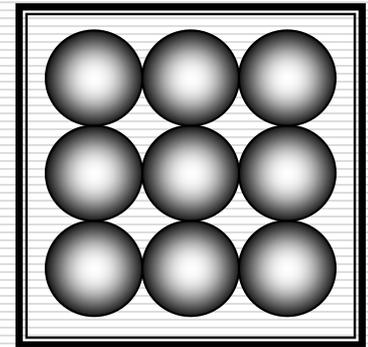


Heat (Thermal Energy)

- results from the movement (kinetic energy) of particles in matter
- when particles move faster they have more thermal energy than when they move slower
- particles of a substance that are farther apart have more thermal energy than if they were closer together
- depends on the number of particles in a substance



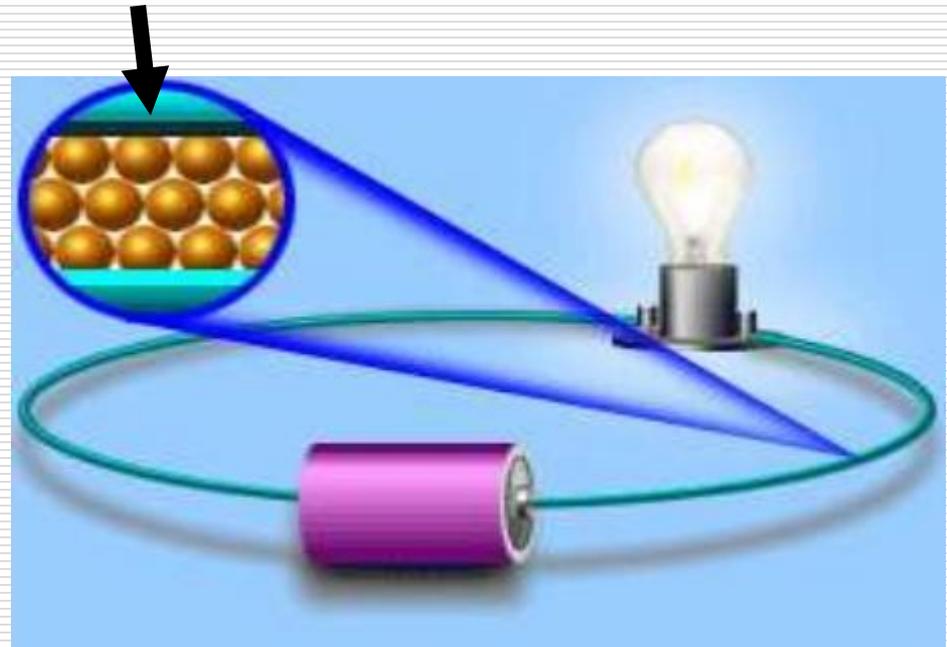
Which box of particles has more thermal energy? Why?



Electrical

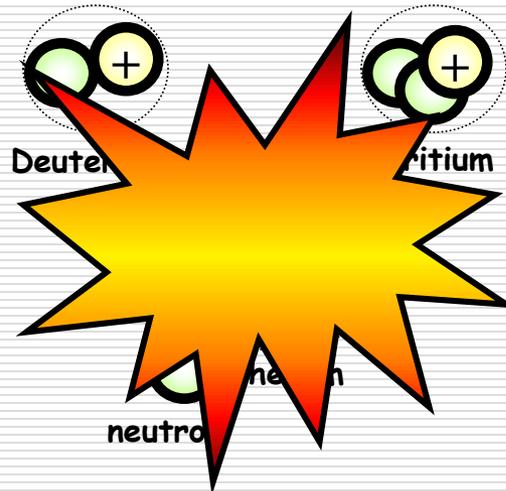
- ❑ Energy created by the movement of electrons.
- ❑ Electrical energy is potential energy stored in charged particles
- ❑ Charged particles create **electric fields** that exert force on other charged particles within the field
- ❑ Charged particles attract and repel to create force and cause work

Electrons



Nuclear Energy

- found in the nucleus of an atom
- is released when an atom's nucleus breaks apart (fission) or when the nuclei of two atoms come together (fusion)
- Example:
 - Nuclear fission takes place in a nuclear power plant while nuclear fusion takes place in the Sun.



Is nuclear fission or nuclear fusion taking place? Explain your reasoning.

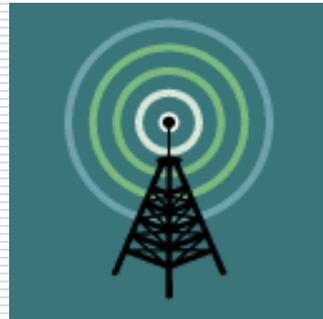


Identify the Form of Energy



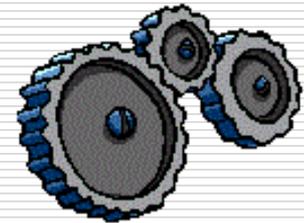
Thermal

(burner increases movement of H₂O molecules)



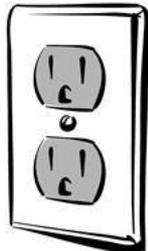
Electromagnetic

(radio waves)



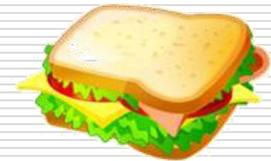
Mechanical

(moving gears)



Electrical

(electricity)



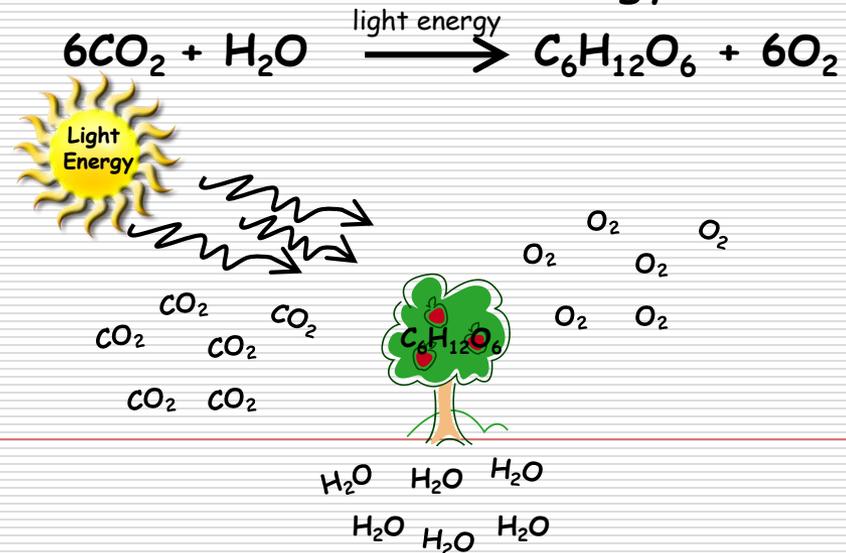
Chemical

(food)

Energy Conversions

- a change from one form of energy into another
- energy can be converted into any other form and is often converted into more than one form
- most of the wasted or unwanted energy in a conversion is attributed to heat (friction)
- Example
 - Electromagnetic energy (in the form of light) from the Sun is converted, by plants, into chemical energy in the form of glucose

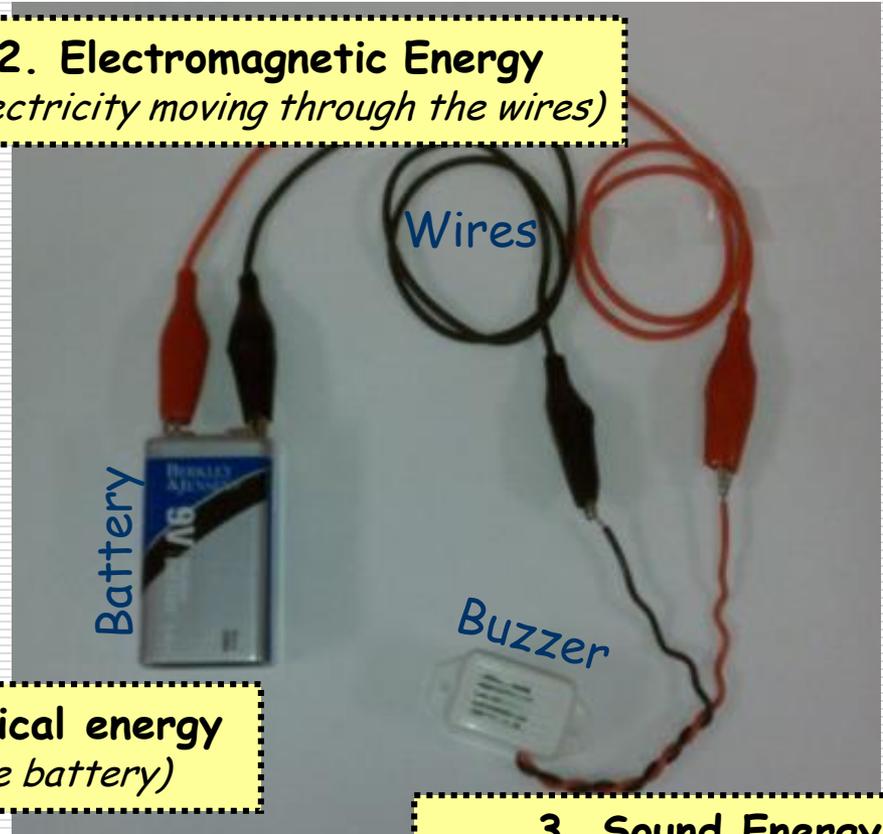
What is an example of an energy conversion you have experienced in your own life?



Identify the Energy Conversions

The apparatus to the right was placed into a bell jar. What energy conversions take place when it is operating?

2. Electromagnetic Energy
(electricity moving through the wires)



1. Chemical energy
(in the battery)

3. Sound Energy
(noise coming from the buzzer)

Energy Efficiency

- comparison of the amount of energy before a conversion with the amount of useful energy after a conversion
- the closer the energy (work) output is to the energy (work) input, the more efficient the conversion is
- more efficient conversions → less waste

■ **Formula:**

$$\text{Efficiency} = \frac{\text{energy output}}{\text{energy input}} \times 100$$

Sample Problem

A particular cell phone charger uses 4.83 joules per second when plugged into an outlet, but only 1.31 joules per second actually goes into the cell phone battery.

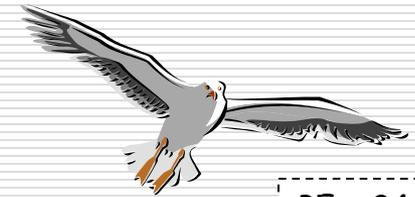
The remaining joules are lost as heat. That's why the battery feels warm after it has been charging for a while. How efficient is the charger?

$$\begin{aligned} &= \frac{1.31 \text{ J}}{4.83 \text{ J}} \times 100 \\ &= 27.1\% \end{aligned}$$

Law of Conservation of Energy

- states that energy can be neither created nor destroyed
- the total amount of energy in a closed system is the same
- energy can be changed from one form to another, but all of the different forms of energy add up to the same total amount of energy

A seagull steals a sandwich and drops it from a height of 7 m before eating it. What would be the sandwich's approximate PE and KE as it falls to the ground if air resistance is negligible?



PE = 24 J
KE = 0 J

PE = 12 J
KE = 12 J

PE = 0 J
KE = 24 J