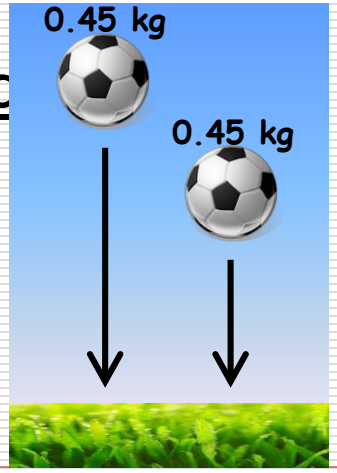
Energy

- 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 stretc
    co

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

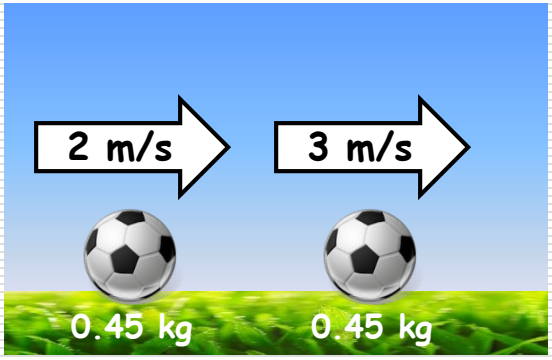


The types listed are not all-inclusive

Kinetic Energy (KE)

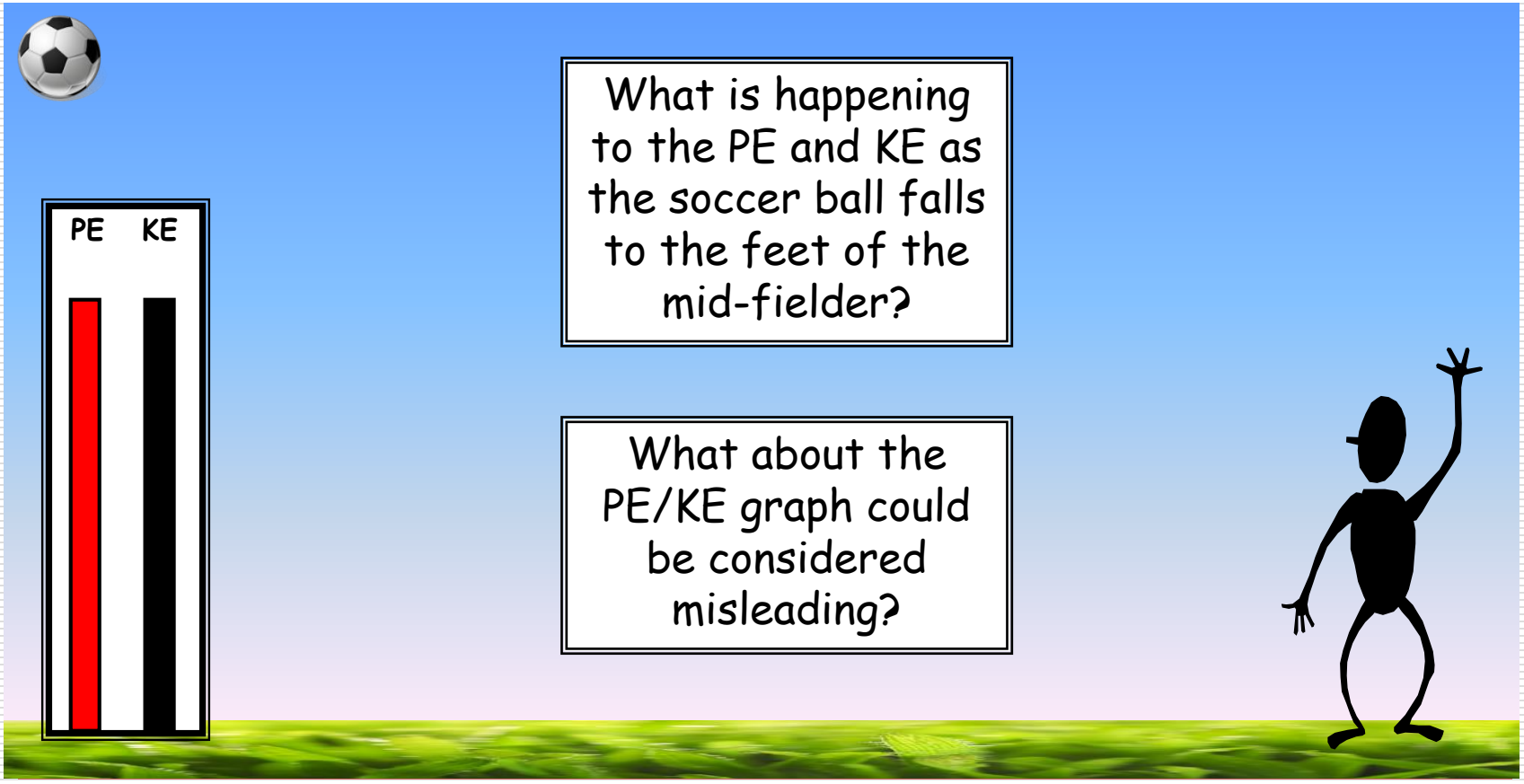
- energy of motion
- depends on mass and velocity
  - **Formula**: $KE = \frac{1}{2} mv^2$
- increases as mass or velocity increases and decreases as mass or velocity decreases

What is the difference between speed and velocity?



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

Relationship Between PE and KE



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 kg)(9.8 m/s^2)(10 m) = 4,508 J

(9.8 m/s^2: Earth's Gravity)

- 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?

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

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

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?

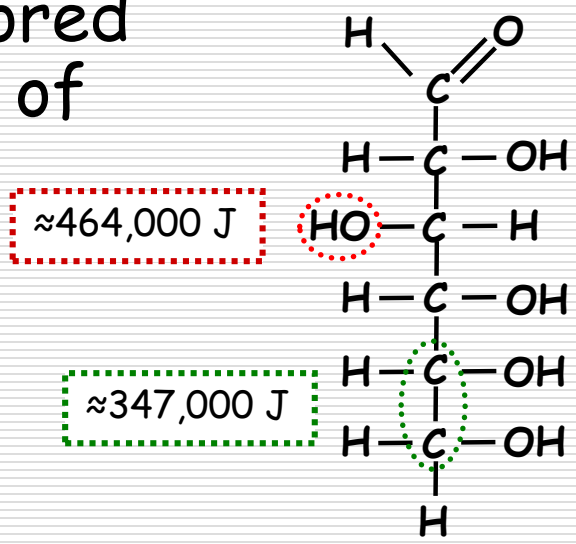
Sound Energy

- 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)

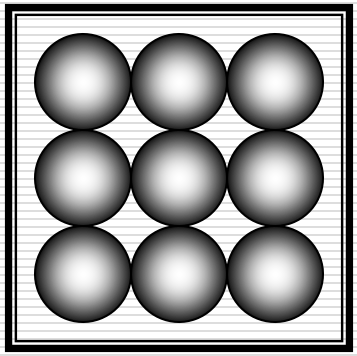


Glucose

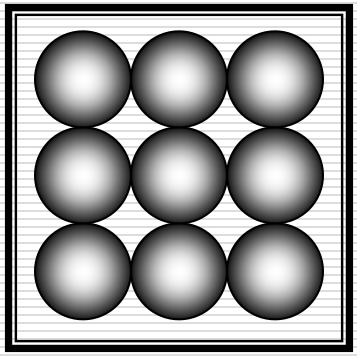
What are some examples of chemical energy?

Thermal Energy (Heat)

- 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?



Electromagnetic Energy (Radiant)

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

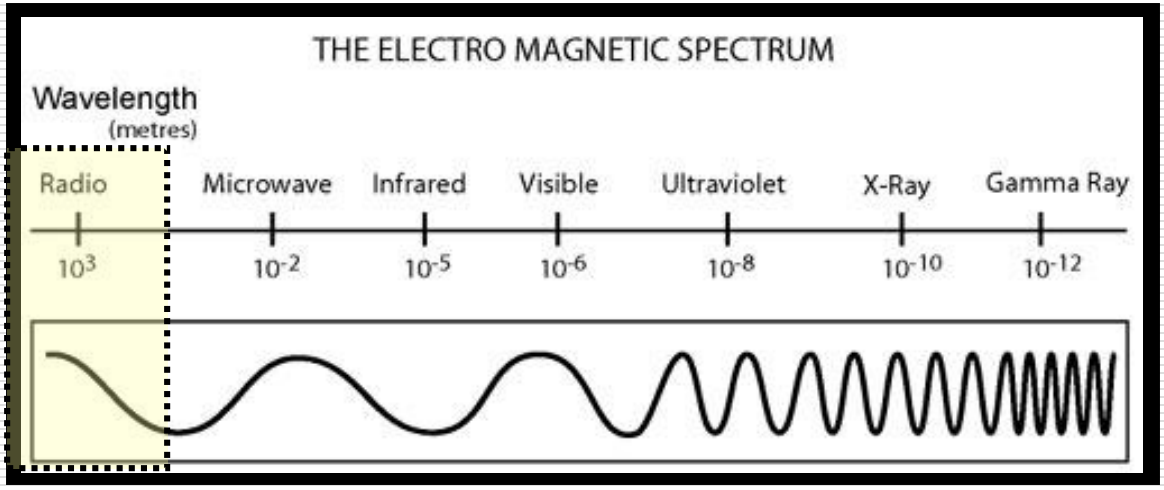
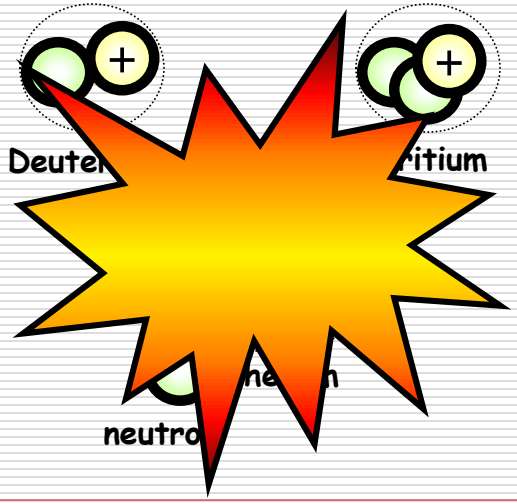


Image taken from: http://zebu.uoregon.edu/~imamura/122/lecture-2/em.html

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.

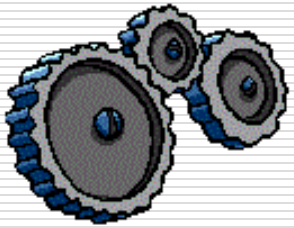


Is nuclear fission or nuclear fusion taking place? Explain your reasoning.

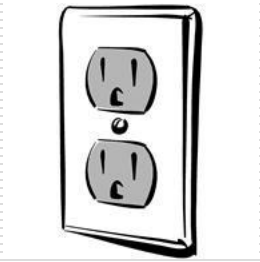
Identify the Form of Energy

Thermal
(burner increases movement of H_2O molecules)

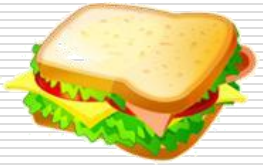
Electromagnetic
(radio waves)



Mechanical
(moving gears)



Electromagnetic
(electricity)

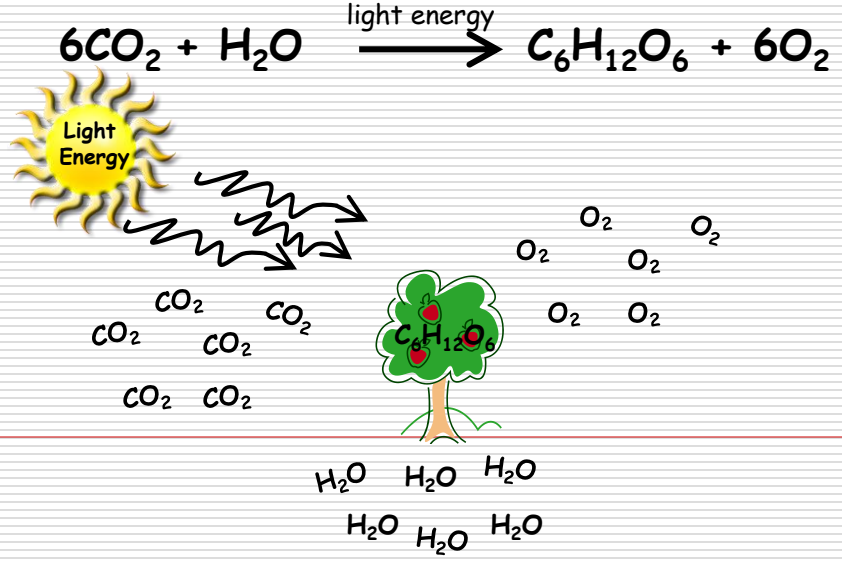


Chemical
(food)

Energy Conversions

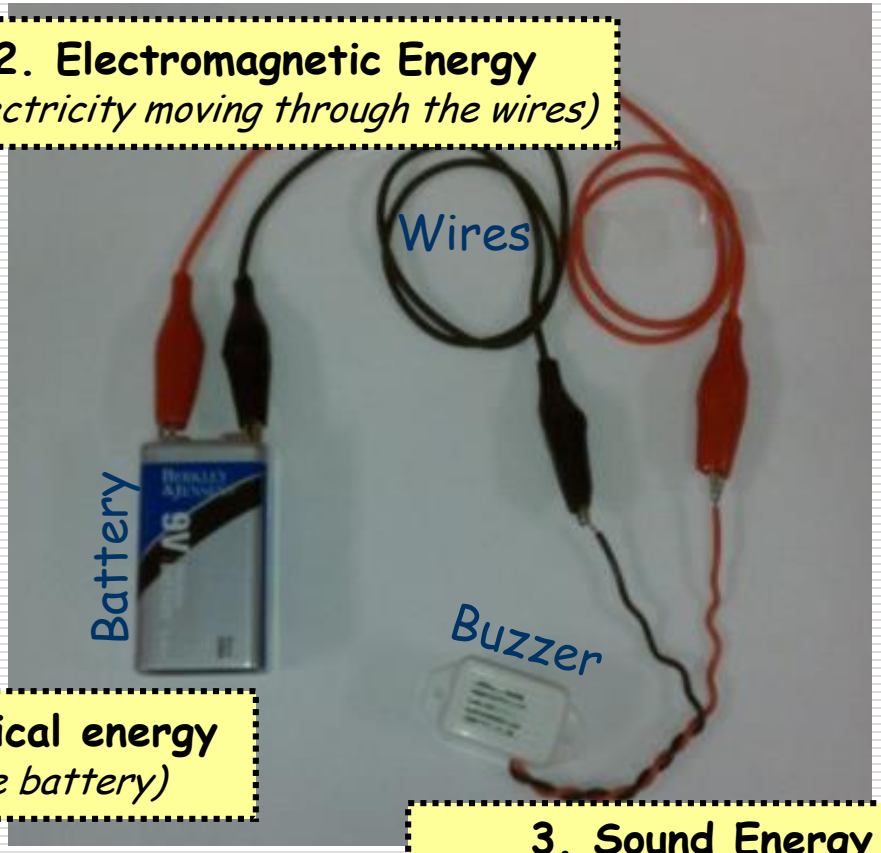
- a change from one form of energy into another
- energy can be converted into any other form and is often converted into more than one form
- most of the wasted or unwanted energy in a conversion is attributed to heat (friction)
- Example
  - Electromagnetic energy (in the form of light) from the Sun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

$$= \frac{1.31\ \text{J}}{4.83\ \text{J}} \times 100$$

$$= 27.1\%$$

Sample Problem taken from: http://www.cposcience.com/home/Portals/2/Media/post_sale_content/PHY2/Ancillaries/SkillSheets/Unit_4/11.1_Efficiency.pdf

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

PE = 24 J
KE = 0 J

PE = 12 J
KE = 12 J

PE = 0 J
KE = 24 J

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?

Work

- Occurs when a force causes an object to move in the direction of the force
- Typically Expressed in units of joules (J)
- **Formula**: W = F x d

What are some examples that align with this definition of work?

$$W = (F)(d)$$

$$= (10{,}000\text{N})(0\text{ m})$$

$$= 0\text{ N}\cdot\text{m or } 0\text{ J}$$

Sample Problem

Mr. Jones' class of students applied 10,000 N of force to a wall in an attempt to move it. Needless to say, the students were too weak and the wall did not budge (0 m). How much work did the students perform in their failing effort?