ENERGY

Chapter 4

What is energy?

- Energy is the ability to do work (cause change).
  - When a force causes an object to be displaced, work was done upon the object.
- Examples: brushing your hair, walking down the hall, eating your lunch, yawning.

What are different forms of energy?

http://www.eia.gov/kids/energy.cfm?page=about_forms_of_energy-basics

Potential energy	Kinetic energy
Potential energy is stored energy and the energy of position — gravitational energy. There are several forms of potential energy.	Kinetic energy is motion — of waves, electrons, atoms, molecules, substances, and objects.
Chemical energy is energy stored in the bonds of atoms and molecules. Batteries, biomass, petroleum, natural gas, and coal are examples of stored chemical energy. Chemical energy is converted to thermal energy when we burn wood in a fireplace or burn gasoline in a car's engine. **Mechanical energy** is energy stored in objects by tension. Compressed springs and stretched rubber bands are examples of stored mechanical energy. **Nuclear energy** is energy stored in the nucleus of an atom — the energy that holds the nucleus together. Very large amounts of energy can be released when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called **fission**. The sun combines the nuclei of hydrogen atoms in a process called **fusion**. **Gravitational energy** is energy stored in an object's height. The higher and heavier the object, the more gravitational energy is stored. When you ride a bicycle down a steep hill and pick up speed, the gravitational energy is being converted to motion energy. Hydropower is another example of gravitational energy, where the dam "piles" up water from a river into a reservoir.	**Radiant energy** is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays and radio waves. Light is one type of radiant energy. Sunshine is radiant energy, which provides the fuel and warmth that make life on Earth possible. **Thermal energy**, or heat, is the vibration and movement of the atoms and molecules within substances. As an object is heated up, its atoms and molecules move and collide faster. Geothermal energy is the thermal energy in the Earth. **Motion energy** is energy stored in the movement of objects. The faster they move, the more energy is stored. It takes energy to get an object moving, and energy is released when an object slows down. Wind is an example of motion energy. A dramatic example of motion is a car crash, when the car comes to a total stop and releases all its motion energy at once in an uncontrolled instant. **Sound** is the movement of energy through substances in longitudinal (compression/rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate — the energy is transferred through the substance in a wave. Typically, the energy in sound is far less than other forms of energy. **Electrical energy** is delivered by tiny charged particles called electrons, typically moving through a wire. Lightning is an example of electrical energy in nature, so powerful that it is not confined to a wire.

Kinetic Energy

- Energy in the form of motion.
- Depends on mass and velocity (similar to momentum)
- Examples: spinning bicycle wheel, a car driving

Calculating Kinetic Energy

- Kinetic energy = ½ mass x velocity^2
- KE = ½ m x v^2
  - ↑ mass = ↑ kinetic energy
    ↑ velocity = ↑ kinetic energy
  - If you double the velocity, the energy quadruples.
  - Joule
    - Mass = kg; velocity = m/s

Let's Practice!

- A 15-kg bicycle carrying a 50-kg boy is traveling at a speed of 5 m/s. What is the kinetic energy of the bicycle (including the boy)?
  - 812.5 Joules (J)
- The kinetic energy of a boat is calculated at 52,000 J. If the boat has a mass of 39,000 kg, with what velocity is it moving?
  - 1.63 m/s

Potential Energy

- ***Potential energy*** = stored energy due to position
- Examples: an apple hanging in a tree; a book on a shelf

Elastic Potential Energy

- Energy stored by something that can stretch or compress
- Examples: a rubberband or a spring

Chemical Potential Energy

- Energy stored in chemical bonds between atoms
- Examples: Food, gasoline

Gravitational Potential Energy

- Energy stored in objects above Earth's surface.
- GPE = m x 9.8 m/s^2 x h
  - Mass – kg, height - meters
  - (↑ h = ↑ GPE)
  - measured in joules

More Practice!

- A 0.06-kg tennis ball starts to fall from a height of 2.9 m. How much gravitational potential energy does the ball have at that height?
  - 1.7 J
- An object of mass 10 kg is raised through a certain height. Its potential energy is increased by 1960 Joules. Find the height of the object initially.
  - 20 m

Let's Review KE and PE

- How are kinetic energy and potential energy different?
- What are the three types of potential energy?
- How are elastic potential energy and chemical potential energy different?

Conservation of Energy

- Energy is not lost or gained; it changes form.
- Transforming Energy
  - Often electrical energy is converted to light and thermal energy
    - Examples: light bulb, alarm clock, curling iron, computers
  - Chemical energy is usually converted to kinetic energy or thermal energy.
    - Examples: Your body, food, vehicles

Conversions

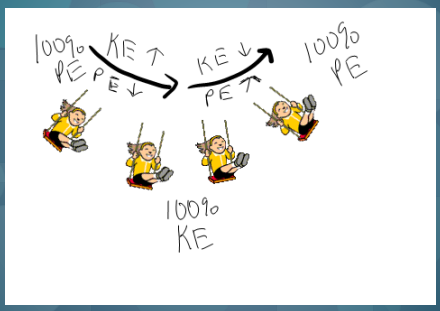
Potential ⇄ Kinetic ⇄ Potential

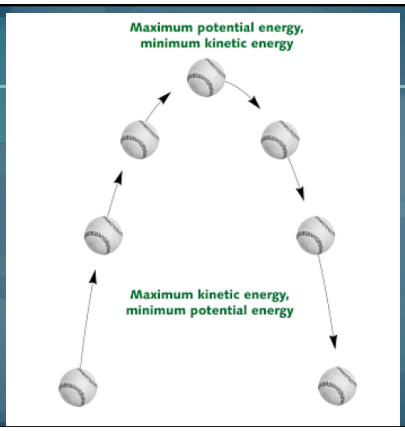
Mechanical energy (ME) = potential energy (PE) + kinetic energy (KE)

Falling Objects

- 100% PE
  0% KE
- Falling = change from PE to KE
- Ground: 0% PE
  100% KE

Swinging Energy





Conservation of Energy

- Energy cannot be created or destroyed, ONLY transferred from one to another.....

Finding Energy Transformations

- ***Friction***: seems like energy is disappearing, but it is actually converted into different energies, such as thermal energy.
- ***Mass into Energy***: Nuclear fusion is an example. Remember $e=mc^2$. A little mass = a lot of energy
  - Two hydrogen nuclei come together and combine to form one helium
- ***Nuclear Fission:*** Kinetic Energy to thermal energy
  - Mass into energy again!
  - Nuclei broken apart… ENORMOUS energy

Energy Conversions in Your Body

- Chemical energy to kinetic and thermal energy.
  - Stores energy as fat, example of potential energy
  - Also converts to heat and use this energy to move
- Maintaining Healthy Weight
  - Must have proper balance between energy contained in food eaten and energy body uses