



Reminder

- Vocabulary Quiz due date is Saturday, January 31 at midnight. (Go to blackboard, click on vocabulary quiz)
- Test will be available by Thursday

Newton's Cradle

- There are five balls, each with mass m .
- Write down an expression for the momentum of 1, 2, 3, or 4 balls if they are all traveling with velocity v .
- Can conservation of momentum explain this behavior alone?

Sometimes it is hard to describe all of the motion in a system, and we want something simpler

Sometimes it is hard to describe all of the motion in a system, and we want something simpler

- A more complicated example: Power plant

Energy

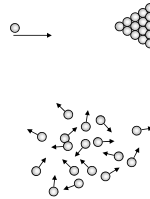
- A more complicated example: Power plant

Energy

- Energy is
 - the capacity "to do something"
 - Ability to exert a force on an object while moving it through a distance
- Energy can either be associated with an objects position (potential) or its motion (kinetic)
- Total energy is conserved: Energy can be neither created nor destroyed. The total amount of energy in the universe never changes. However, energy can change from one form to another, or be transferred from one object to another.

Kinetic Energy

- Kinetic energy is the energy of motion.
- Kinetic Energy = $\frac{1}{2} mv^2$



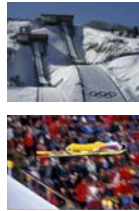
$$\frac{1}{2} mv^2 = \frac{1}{2} mv^2$$

$$mv = mv$$

What about a ball rolling up a hill?

Gravitational Potential Energy

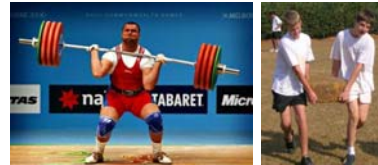
- energy associated with the height of an object
- gravitational potential energy = (weight) x (height)
- Examples
 - Balls rolling on tracks (energy transfers from potential to kinetic)
 - Pendulum
 - Ski Jump
 - Bouncing ball



In physics, the word "work" has precise meaning that is somewhat different than you may be used to.

$$\text{Work} = (\text{force}) \times (\text{distance parallel to force})$$

- For work to be done in the physics sense, a force must be applied and the object must have some motion parallel to the force
- Work is a method of **transferring** energy, it is not a form of energy itself.



Internal Energy

- Internal energy is energy "hidden" inside materials. It is associated with the temperature of the materials (thermal energy) and the chemical potential energy of materials

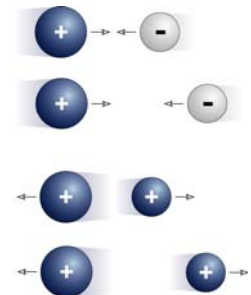
Examples

- Mass on a spring
- Garage Door



Electrical Potential Energy

- energy associated with the electrical force
- Unlike charges attract and behave like gravitational potential (farther apart=more potential)
- Like charges repel and have more potential when close together
- Gives rise to chemical potential energy



Thermal Energy

Internal energy associated with kinetic energy of individual particles.

- Related to temperature (average KE of atoms and molecules)
- A warm object has more internal energy than when it is cold
- Two objects at the same temperature may have different amounts of thermal energy
 - water 1 cal/g°C
 - gold .03 cal/g°C

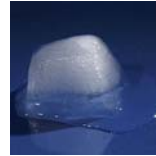


Chemical Potential Energy

Internal electrical potential energy of atoms in a material

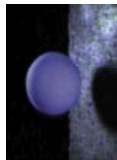
Examples

- change of state (rearrangement of atoms)
- chemical bonds
 - burning gasoline, natural gas, or wood
 - exploding firecracker



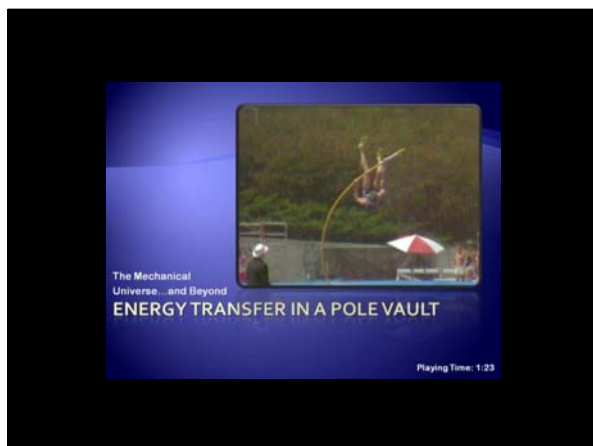
Elastic Potential Energy

- Energy stored in a material by deforming it in such a way that its molecules are displaced from their equilibrium positions.
- A form of internal electrical potential energy
- Examples:
 - deformation (springs, balls)
 - Rubber band
 - Trampoline



Forms of energy

- Kinetic Energy
- Gravitational Potential Energy
- Electrical Potential Energy
- Internal Energy
- Radiant Energy

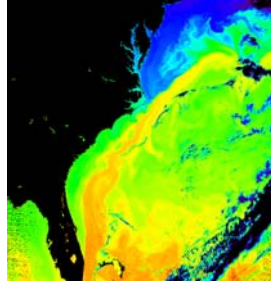


Energy Transfer and Transformation

- Conduction (Heat Flow): a process in which internal energy is transferred because of a difference in temperature. (electric stove, soldering iron)
- Radiation: energy is transmitted by visible light, infrared radiation, ultraviolet radiation, X-rays, or radio waves. (sun, space heater)
- Convection: internal energy is transferred because matter moves from one place to another. (hot air furnace)
- Work: energy is transferred or transformed by forces acting on an object. (friction, muscles, electric motor)
- Combustion: chemical potential energy is transformed into another form (gasoline engine, dynamite, light stick)

The gulf stream carries warm water into the north Atlantic making Europe somewhat warmer than it otherwise would be.

- This is an example of
 - A. Convection
 - B. Conduction
 - C. Radiation
 - D. Combustion



The method of heat transfer used to cook microwave popcorn is

- a) radiation
- b) conduction
- c) convection

Popcorn

- Three methods for popping popcorn
 - Microwave -- Radiation
 - Hot air -- Convection
 - Stove top -- Conduction
- Identify the method of heat transfer for each.



Conservation of Linear Momentum at Very High Speeds

- As an object is accelerated to very high speeds, its resistance to acceleration begins to increase. We classify this increased resistance to acceleration as an increase of mass
- What about conservation of mass?



Consequences of relativity: Short, Fat, Slow (like getting old)

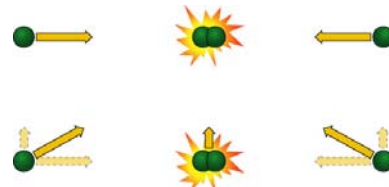
Kinetic energy at very high speeds

- The engine is running, doing work on the car.
- Energy is going in, but speed can't increase past the speed of light.
- Energy depends on Mass and Speed -- Mass must increase.



Conservation of Mass-Energy

- $E=mc^2$
- Mass and energy are two manifestations of the same quantity
- The total amount of mass-energy in an isolated system is constant
- Mass and energy can be converted from one form to the other



Nuclear Potential Energy

- By studying the masses of nuclear decay products, we find that the products are significantly less-massive than the original nucleus.

