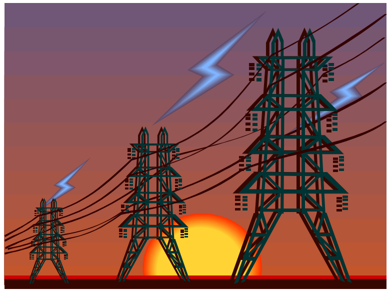
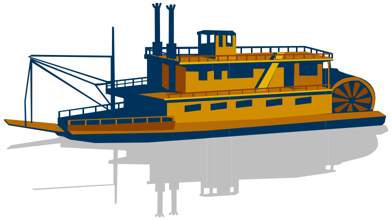
Energy: Forms and Changes



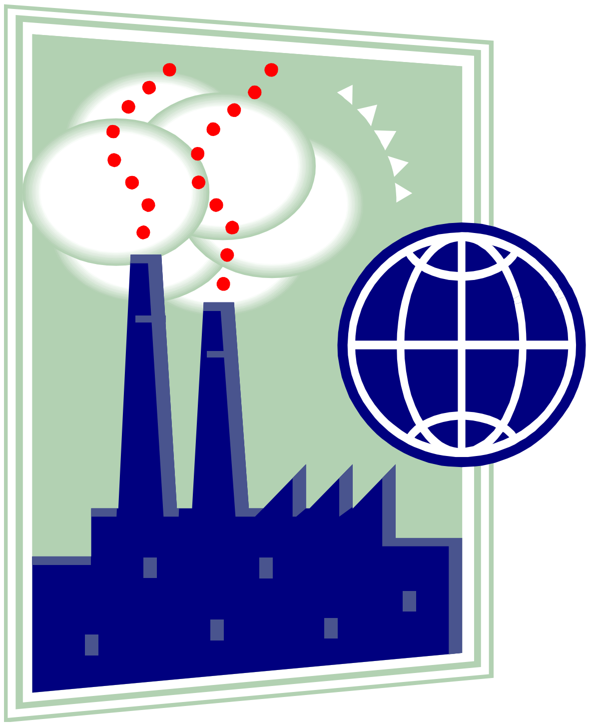
- “We do not inherit the earth from our parents, we borrow it from our children” –
  Chief Seattle

- Energy use has changed a great deal since people relied solely on th sun, their own strong bodies or beasts of burden a energy resources.

- Long ago, people learned how to use water power to turn paddle wheels and wind power for transportation and irrigation.



- People learned to use the chemical energy stored in materials like wood to cook and heat their homes.



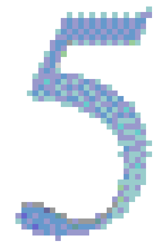
- But machines and technologies introduced during the Industrial Revolution of the late 18^{th} century required the use of other energy resources, especially fossil fuels.

- Fossil fuels like coal, oil and natural gas are considered to be nonrenewable energy resources.

- Our fossil fuel reserves formed over millions of years from decaying plants and animals.
- As we use them up, they will not be replenished in our lifetimes.

Forms of Energy

- The five main forms of energy are:
  - Heat
  - Chemical
  - Electromagnetic
  - Nuclear
  - Mechanical



Heat Energy

- The internal motion of the atoms is called heat energy, because moving particles produce heat.
- Heat energy can be produced by friction.
- Heat energy causes changes in temperature and phase of any form of matter.

Chemical Energy

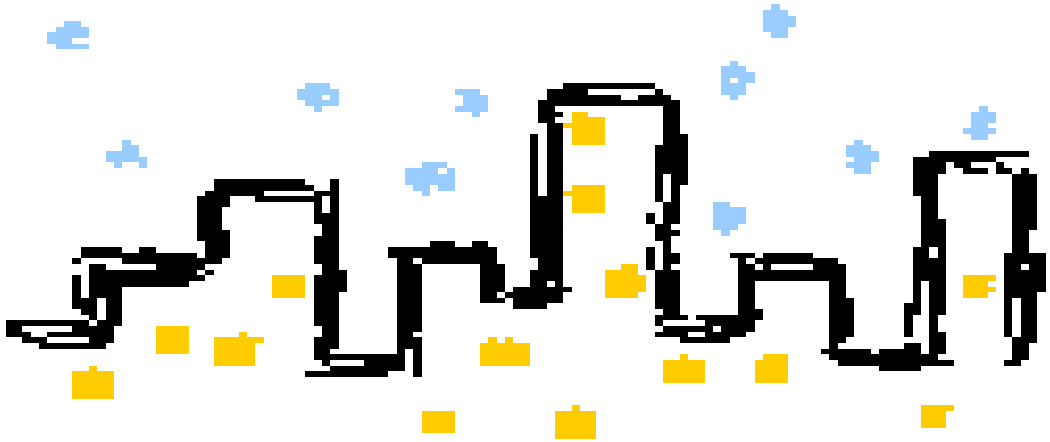
- Chemical Energy is required to bond atoms together.
- And when bonds are broken, energy is released.

Chemical Energy

- Fuel and food are forms of stored chemical energy.

Electromagnetic Energy

- Power lines carry electromagnetic energy into your home in the form of electricity.

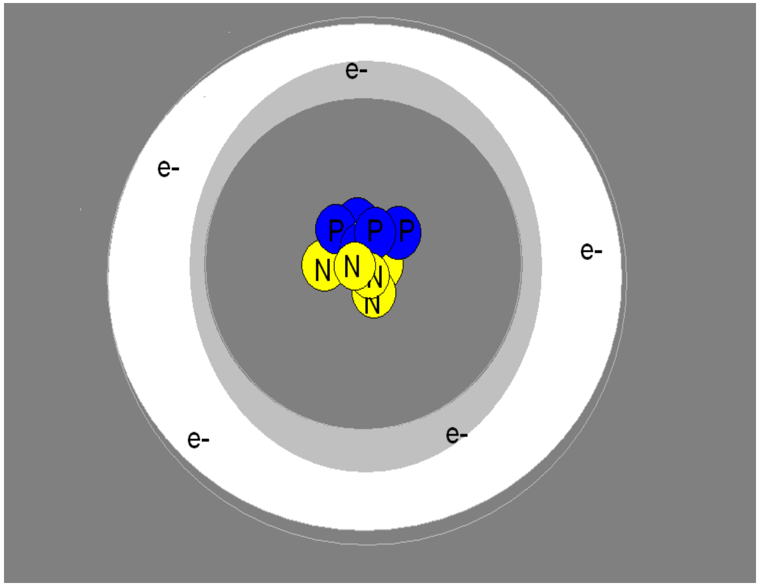


Electromagnetic Energy

- Light is a form of electromagnetic energy.
- Each color of light (Roy G Bv) represents a different amount of electromagnetic energy.
- Electromagnetic Energy is also carried by X-rays, radio waves, and laser light.

Nuclear Energy

- The nucleus of an atom is the source of nuclear energy.



Nuclear Energy

- When the nucleus splits (fission), nuclear energy is released in the form of heat energy and light energy.
- Nuclear energy is also released when nuclei collide at high speeds and join (fuse).

Nuclear Energy

The sun’s energy is produced from a nuclear fusion reaction in which hydrogen nuclei fuse to form helium nuclei.

Nuclear Energy

- Nuclear energy is the most concentrated form of energy.

Most of us live within 10 miles of the Surry Nuclear Power Plant which converts nuclear energy into electromagnetic energy.

Mechanical Energy

- When work is done to an object, it acquires energy. The energy it acquires is known as mechanical energy.

Mechanical Energy

- When you kick a football, you give mechancal energy to the football to make it move.

Mechanical Energy

When you throw a balling ball, you give it energy. When that bowling ball hits the pins, some of the energy is transferred to the pins (transfer of momentum).

Energy Conversion

- Energy can be changed from one form to another. Changes in the form of energy are called energy conversions.

Energy conversions

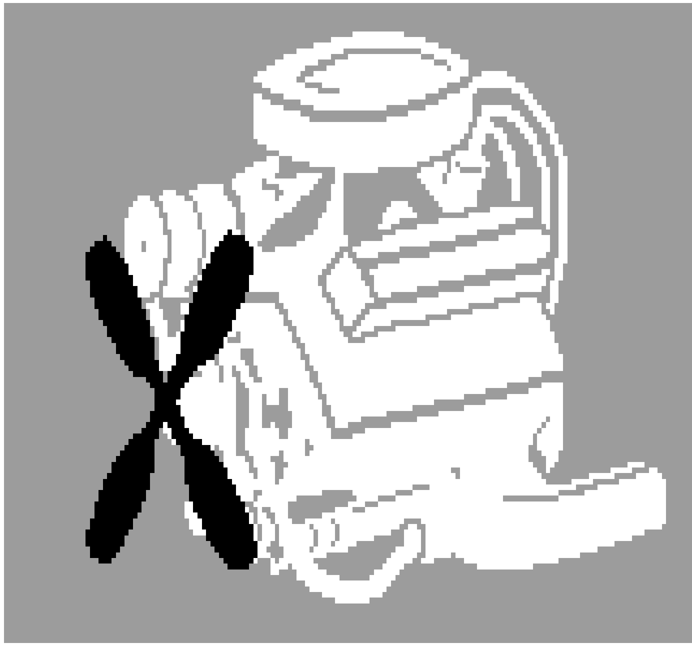
- All forms of energy can be converted into other forms.
  - The sun’s energy through solar cells can be converted directly into electricity.
  - Green plants convert the sun’s energy (electromagnetic) into starches and sugars (chemical energy).

Other energy conversions

- In an electric motor, electromagnetic energy is converted to mechanical energy.
- In a battery, chemical energy is converted into electromagnetic energy.
- The mechanical energy of a waterfall is converted to electrical energy in a generator.

Energy Conversions

- In an automobile engine, fuel is burned to convert chemical energy into heat energy. The heat energy is then changed into mechanical energy.



Chemical → Heat →Mechanical

States of Energy

- The most common energy conversion is the conversion between potential and kinetic energy.
- All forms of energy can be in either of two states:
  - Potential
  - Kinetic

States of Energy: Kinetic and Potential Energy

- Kinetic Energy is the energy of motion.
- Potential Energy is stored energy.

Kinetic Energy

- The energy of motion is called kinetic energy.
- The faster an object moves, the more kinetic energy it has.
- The greater the mass of a moving object, the more kinetic energy it has.
- Kinetic energy depends on both mass and velocity.

Kinetic Energy

$$K.E. = \frac{\text{mass x velocity}}{2}$$

What has a greater affect of kinetic energy, mass or velocity? Why?

Potential Energy

- Potential Energy is stored energy.
  - Stored chemically in fuel, the nucleus of atom, and in foods.
  - Or stored because of the work done on it:
    - Stretching a rubber band.
    - Winding a watch.
    - Pulling back on a bow's arrow.
    - Lifting a brick high in the air.

Gravitational Potential Energy

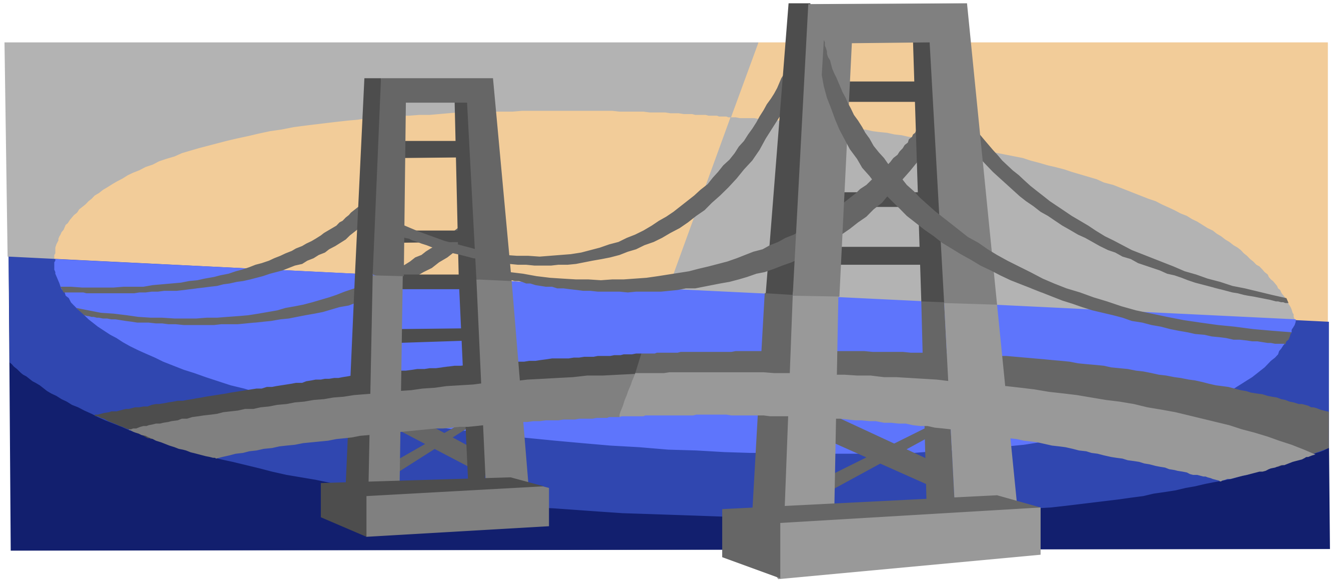
- Potential energy that is dependent on height is called gravitational potential energy.

Potential Energy

- Energy that is stored due to being stretched or compressed is called elastic potential energy.

Gravitational Potential Energy

- A waterfall, a suspension bridge, and a falling snowflake all have gravitational potential energy.



Gravitational Potential Energy

- If you stand on a 3-meter diving board, you have 3 times the G.P.E, than you had on a 1-meter diving board.

- “The bigger they are the harder they fall” is not just a saying. It’s true. Objects with more mass have greater G.P.E.
- The formula to find G.P.E. is G.P.E. = Weight X Height.

Gravitational Potential Energy

Kinetic-Potential Energy Conversion

Roller coasters work because of the energy that is built into the system. Initially, the cars are pulled mechanically up the tallest hill, giving them a great deal of potential energy. From that point, the conversion between potential and kinetic energy powers the cars throughout the entire ride.

Quantity	SI unit	Symbol
Basic		
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd
Derived		
Force	newton (kg m/s^2)	N
Energy	joule (N m)	J
Pressure	pascal (N/m^2)	Pa
Power	watt (J/s)	W
Volume	cubic meter	m^3
Density	kilogram/cubic meter	kg/m^3

Quantity	Name	Symbol	Expression in terms of SI base or other SI units
Frequency	hertz	Hz	1/s
Force; weight	newton	N	kg m/s^2
Pressure; stress	pascal	Pa	kg/m s^2 = N/m^2
Energy, work, quantity of heat	joule	J	kg m^2/s^2 = N m
Power; radiant flux	watt	W	kg m^2/s^3 = N m/s = J/s
Electric charge, quantity of electricity	coulomb	C	A s
Electrical potential, potential difference,	volt	V	kg m^2/A s^3 = W/A
Electric resistance	ohm	Ω	kg m^2/A^2 s^3 = V/A = 1/S
Electric conductance	siemens	S	A^2 s^3/kg m^2 = A/V = 1/Ω
Inductance	henry	H	kg m^2/A^2 s^2 = Wb/A
Capacitance	farad	F	A^2 s^4/kg m^2 = C/V
Magnetic flux	weber	Wb	kg m^2/A s^2 = V s
Magnetic flux density	tesla	T	kg/A s^2 = Wb/m^2
Luminous flux	lumen	lm	cd sr
Illuminance	lux	lx	cd sr/m^2

Heat capacity

total

(constant pressure) $C_P = q_P/\Delta T$

(constant volume) $C_V = q_V/\Delta T$

} extensive quantities

units: $J\ K^{-1}$

specific heat capacity $c_s = q_P/m\Delta T$ units: $J\ g^{-1}\ K^{-1}$

intensive quantity

molar heat capacity

(constant pressure) $c_P = q_P/n\Delta T$

(constant volume) $c_V = q_V/n\Delta T$

} intensive quantities

units: $J\ mol^{-1}\ K^{-1}$

Notes: (1) °C can substitute for K in ΔT

(2) other energy units may be used in place of J: kJ, cal, kcal

The Law of Conservation of Energy

- Energy can be neither created nor destroyed by ordinary means.
  - It can only be converted from one form to another.
  - If energy seems to disappear, then scientists look for it – leading to many important discoveries.

Law of Conservation of Energy

- In 1905, Albert Einstein said that mass and energy can be converted into each other.
- He showed that if matter is destroyed, energy is created, and if energy is destroyed mass is created.
  - $E = MC^2$

Vocabulary Words

energy
mechanical energy
heat energy
chemical energy
electromagnetic energy
nuclear energy
kinetic energy
potential energy
gravitational potential energy
energy conversion
Law of Conservation of Energy