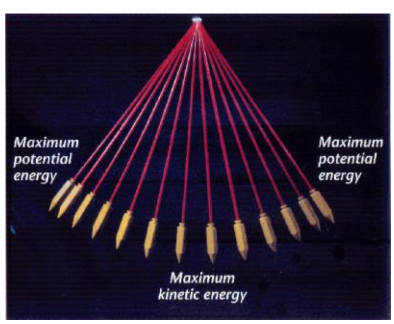
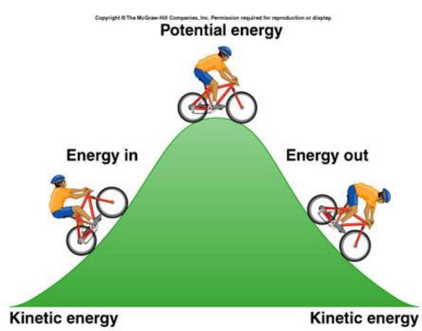
Physical Science Chapter 5

Energy & Power

5.1 The Nature of Energy

- **Energy – the ability to do work or cause a change.**
  - work is the transfer of energy
  - SI unit for energy is the same as the SI unit for work – Joule
- Two main types of energy: **Kinetic and Potential**
  - **Kinetic Energy: the energy of motion**
  - **Potential Energy: Energy stored for use at a later time**





Calculating Kinetic Energy

- **Kinetic Energy: the energy of motion**
- The amount of kinetic energy depends on the objects **mass and velocity**
- Energy is transferred during work
  - The more work one does on an object…
  - The more energy one imparts on the object
- **Kinetic energy = Mass x Velocity² / 2** $K = \frac{1}{2}mv^2$

When mass is doubled; Kinetic Energy is doubled

When velocity is doubled; Kinetic Energy is quadrupled!!

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

$$E_k = \text{kinetic energy of object}$$
$$m = \text{mass of object}$$
$$v = \text{speed of object}$$

What's the Kinetic Energy?

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

- **What is the Kinetic Energy (in Joules) of an object with a mass of 10 kg and a velocity of 10 m/s?**
- **When mass is doubled; Kinetic Energy is doubled**

$$K.E = \frac{10\text{ kg} \times (10\text{m/s})^2}{2} \qquad K.E. = \frac{10 \times 100}{2} = \frac{1000}{2} = 500$$

- **When velocity is doubled; Kinetic Energy is quadrupled!!**

$$K.E = \frac{20\text{ kg} \times (10\text{m/s})^2}{2} \qquad K.E. = \frac{20 \times 100}{2} = \frac{2000}{2} = 1000$$

$$K.E = \frac{10\text{ kg} \times (20\text{m/s})^2}{2} \qquad K.E. = \frac{10 \times 400}{2} = \frac{4000}{2} = 2000$$

Potential Energy:

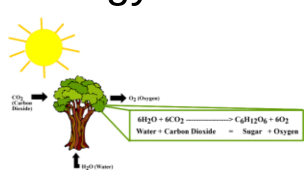
- Energy stored for use at a later time
- 2 Types:
  - Elastic Potential Energy:
    - Energy stored in springs, bow and arrow, stretched elastic or rubber bands.
    - Associated w/ objects that can be stretched or compressed.
  - Gravitational Potential Energy:
    - **Height and weight dependant (notice its weight, NOT mass!)**
    - **GPE = work done to lift and object to a height**
    - **GPE = Weight x Height** (remember that weight = mass x 9.8 m/s2)
    - **GPE = mass x 9.8 m/s2 x Height**

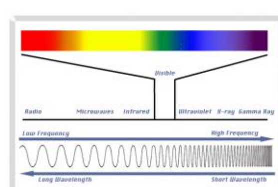
1. What is the potential energy of a rock that weighs 100 newtons that is sitting on top of a hill 300 meters high?

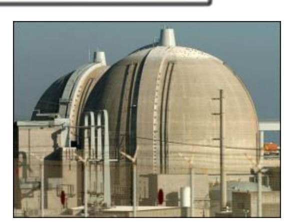
GPE = 100 N x 300 m = 30,000 Nm = 30,000 Joules Answer: ___________

Different Forms of Energy

- **6 different types**:
  - **Mechanical**
  - **Thermal Energy**
  - **Chemical Energy**
  - **Electrical Energy**
  - **Electromagnetic Energy**
  - **Nuclear Energy**





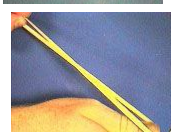


Mechanical Energy

- associated w/ the motion (kinetic) or position of an object (potential)
- Kinetic Energy **exists whenever an object which has mass is in motion with some velocity. Everything you see moving about has kinetic energy.**
- Potential Energy **exists whenever an object which has mass has a position within a force field. The most everyday example of this is the position of objects in the earth's gravitational field.**

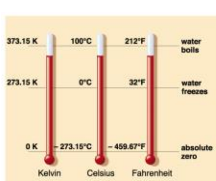
$$K = \frac{1}{2}mv^2$$

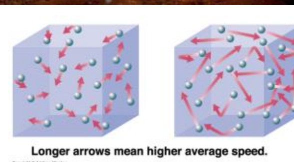
GPE = Weight x Height


Thermal Energy

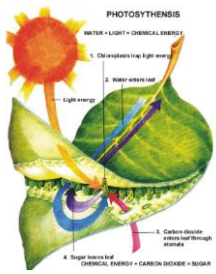
- associated w/ the total energy of the particles (atoms and molecules) in an object. As thermal energy increases, the particles increase in speed and the thermal energy (temperature) of the object increases.

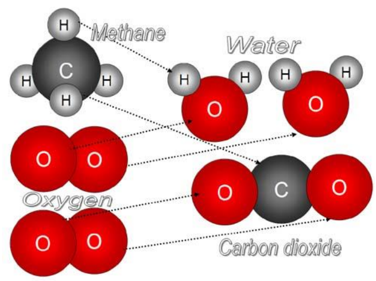


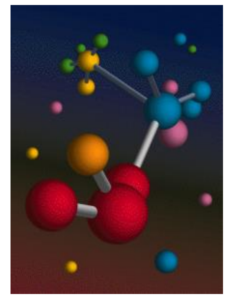
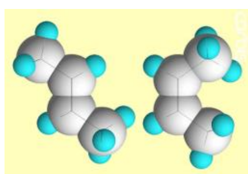
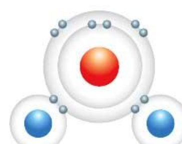
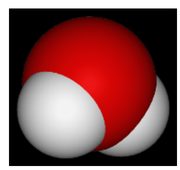


Chemical Energy

- the energy stored in chemical bonds. The potential energy stored in compounds.

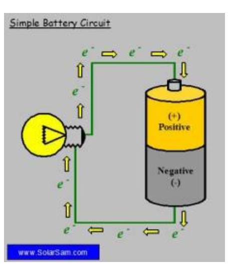


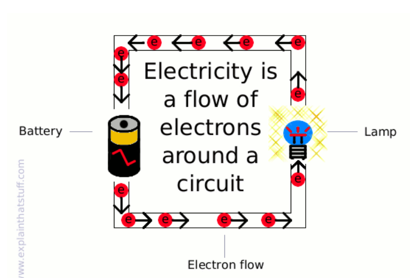


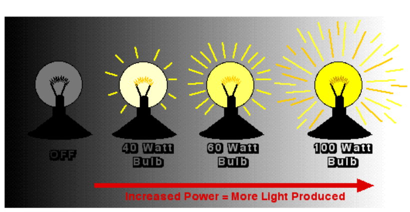





Electrical Energy

- Moving electrical charges. Electricity!!

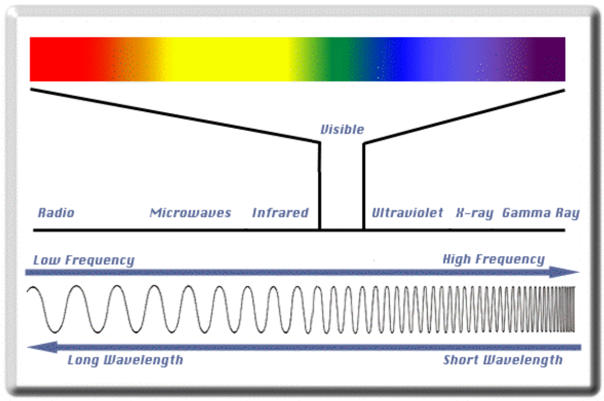




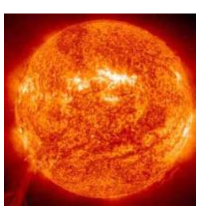
Electromagnetic energy

- Travels in waves, associated w/ light, infrared, ultraviolet, microwaves, x-rays, etc
- Longer wavelength yields low frequency & low energy
- Shorter wavelength yield high frequency & high energy

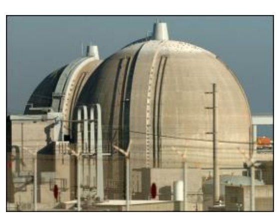


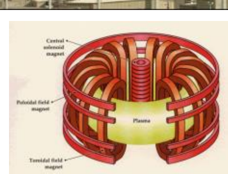
Nuclear Energy

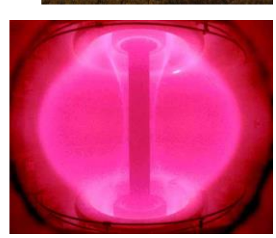
- Associated w/ the fusion or fission of nuclear atoms.

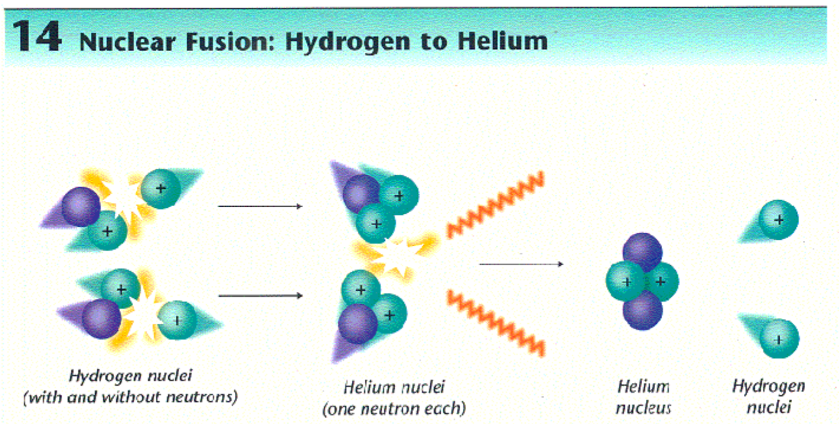


The fusion of hydrogen into helium fuels the power of the sun



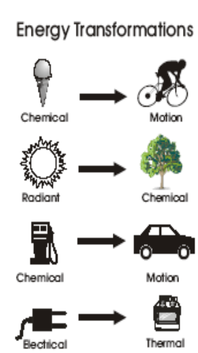


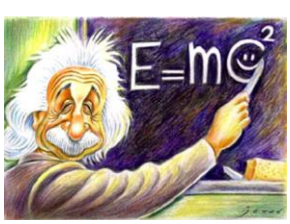




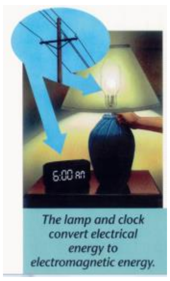
5.2 Energy Conversion and Conservation

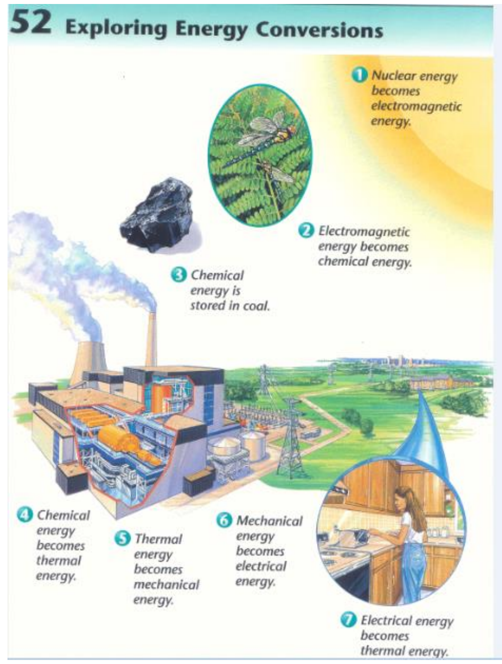
- Most forms of **energy can be converted from one type to another.**
- **Law of the Conservation of Energy -** states that energy cannot be created or destroyed. It simply changes from one form into another
- Einstein's theory of Relativity **- E = mc^2**
    - a small amount of mass can be changed directly into a tremendous amount of energy
    - E = **the energy produced**
    - m = **the mass being converted**
    - c = **the speed of light (186,000 miles/second)**





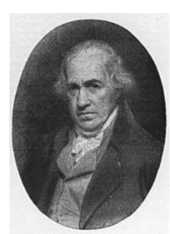
Energy Conversion

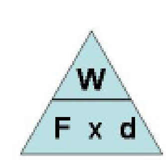




Section 5.4 Power

- Power: the rate at which work is done
- Power = **work / time** and since:
  - Work = force x distance….
- Power = Force x Distance / Time
- SI Unit for Power is the Watt
- 1 Watt = 1Joule / 1 Second
- Horsepower : An American unit of power
  - The amount of work a horse does when it lifts 33,000 pounds of coal to a height of 1 foot in 1 minute.
  - **1 horsepower = 746 watts**


James Watt

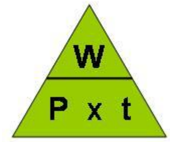


Same amount of work was done; however there was more power in lifter B since his took less time

Power Problems

Power = $\frac{\text{work}}{\text{time}}$

work = joules
time = seconds



How much power is used if a force of 35 newtons is used to push a box a distance of 10 meters in 5 seconds?

W = F x D

P = F x D / T   P = 35 N x 10 m / 5 sec   P = 350 J / 5 sec = 70 J/sec

P = 70 Watts

Answer: ________

How much work is done using a 60-watt light bulb for 1 hour?

W = P x T

convert 1 hour into seconds: 1 hour $\frac{60\text{ min}}{1\text{ hr}} \times \frac{60\text{ sec}}{1\text{ min}}$

Work = 60 watts x 3600 sec = 216,000 Joules

= 216 Kilojoules

Answer: ________

No mas !!
No mas!!

I give up…..