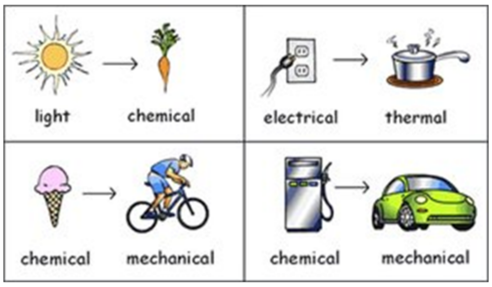
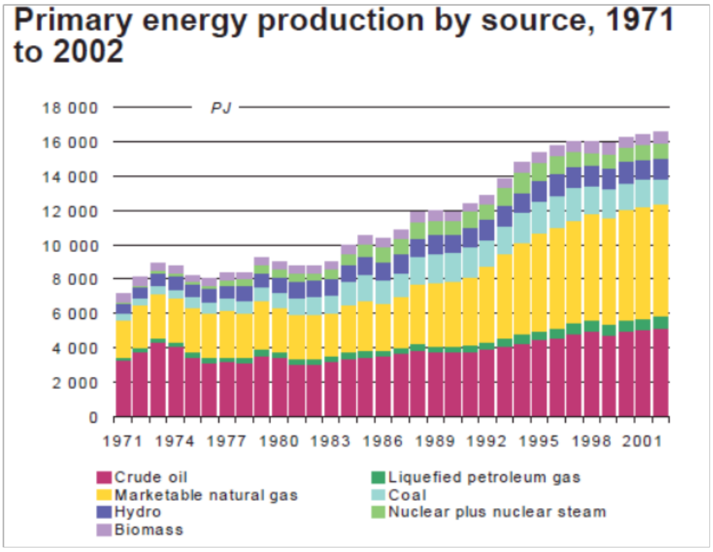
Outcome 2c:

Energy Transformations

- Energy transformation is the process of changing energy from one form to another

- Happening all the time, both in the world and within people...examples???





- The **Law of Conservation of Energy** says

  - energy cannot be created from nothing or destroyed BUT that it **can** change from **one form to another**

- Some examples of Energy conversions:
  - A falling object (gravitational potential → kinetic)
  - A burning log in the fireplace (chemical → thermal)
  - An internal combustion engine (chemical → kinetic)

Energy Conversions in Natural Systems

The original source for nearly all the energy we use on the Earth is from the conversion of hydrogen into helium in the Sun's core.

- This nuclear energy is converted into solar and thermal energy (heat).

- The solar energy travels through space and is absorbed by the Earth and its atmosphere.

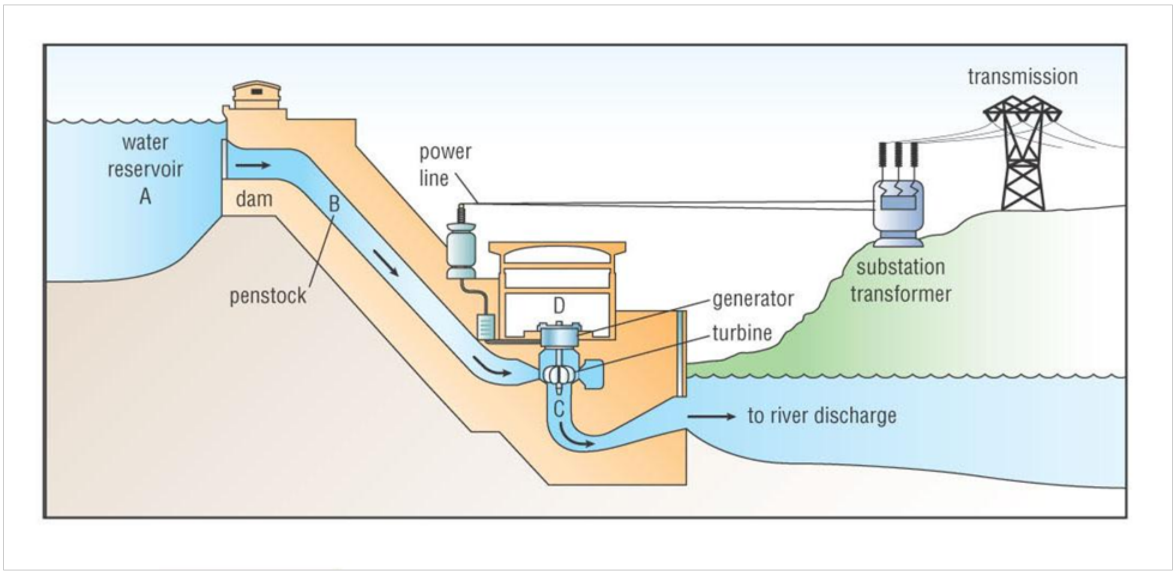
- The solar energy is then converted to heat, chemical energy (photosynthesis), and kinetic energy (weather and ocean currents)

Energy Conversions in Technological Systems

Our society depends on the conversion of other forms of energy into electrical energy.

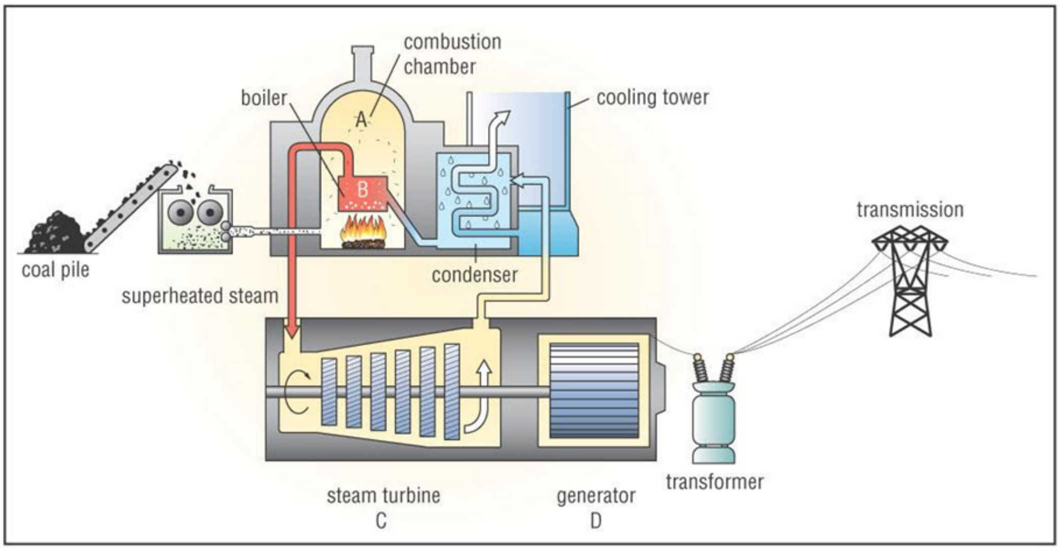
To produce electricity, a number of different means have been developed to convert less useful (at least to us) forms of energy to electricity.

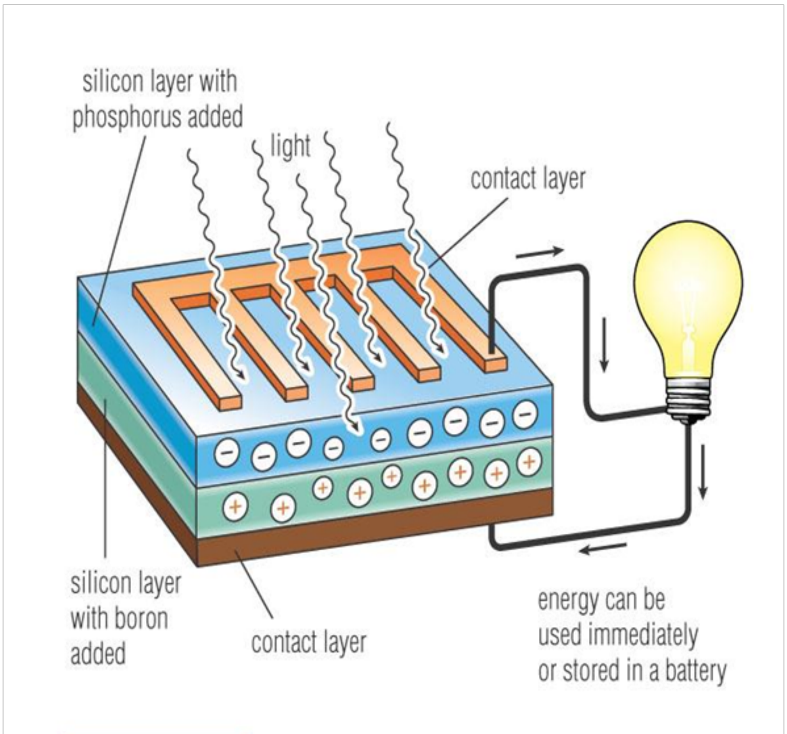
Try to figure out what form of energy is being transformed into electricity in the following example and how it occurs. List all the energy transformations that are occurring.



Practice Sheet 4

For the following two diagrams, list all the energy conversions/transformations that are occurring, starting with the original energy source.





Energy Effeciency

- The ability of a given machine or system to convert between forms of energy is called the "energy conversion efficiency."

- Term used to describe the amount of useful energy output that results from a given energy input in a device used to convert energy from one form to another

- All systems have different energy conversion efficiencies

- When we are talking about energy efficiency, it's in the sense that whenever energy is put into a system, some of it is turned into work while the rest is turned into heat.

Energy In = work + heat (from increase in T)

- The purpose of any machine is to convert the inial energy added to it into the form of energy you need to do the work you want done.

o The inial energy source is called the **energy input**.

o The desired energy needed to do the work is called **useful energy output**.

A classic example of energy efficiency is a simple light bulb:

o The inial energy source is **electricity**.
o The desired energy needed is **light energy**.
o The heat given off by a light bulb is the **wasted energy** lost to the surroundings.

$$\text{percent efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100\%$$

Example: A light bulb uses 2.5 x 10^3 J of electrical energy to produce 1.4 x 10^2 J of light energy. What is the efficiency of the light bulb?

$E_I = 2.5 \times 10^3 J$

$E_o = 1.4 \times 10^2 J$

$\% Eff = \frac{1.4 \times 10^2 J}{2.5 \times 10^3 J} \times 100 = 5.6\%$

Example: A microwave operates at 62% efficiency when heating up a cup of water. If the water gained 1.45 x 10^2 J of energy, how much electrical energy was used?

$\% Eff = 62\%$

$E_o = 1.45 \times 10^2 J = 145 J$

$E_I = ?$

$\% Eff = \frac{E_o}{E_I} \times 100$

$\frac{E_I \times 0.62}{0.62} = \frac{145 J}{0.62}$

$E_I = 233.87... J$

$= 2.3 \times 10^2 J$

Practice Sheet 5

1. Calculate the efficiency of a hair dryer which takes in 3000 J of energy and transfers 600 J as useful heat energy.

I (3000 J), O (600 J)

$$\% Eff = \frac{600 J}{3000 J} \times 100 = \boxed{20.0\%}$$

2. A light bulb takes in 30J of energy per second. It transfers 3 J as useful light energy and 27 J as heat energy. Calculate the efficiency.

I (30 J), O (3 J)

$$\% Eff = \frac{3 J}{30 J} \times 100 = 10\% = \boxed{1 \times 10^1 \%}$$

3. A small electric motor has an efficiency of 85%. In lifting a small load it produces 15J of energy output. What was the energy input into the motor?

$$\% Eff = \frac{O}{I} \times 100 \qquad 85\% = \frac{15 J}{E_I} \times 100$$

$$E_I = 17.647... J = \boxed{18 J}$$

4. A Bunsen burner supplies 4.00 x 10^3 J of heat to a small beaker of water. Only 125 J of energy is gained by the water. What is the % efficiency of the process?

I (4.00 x 10^3 J), O (125 J)

$$\% Eff = \frac{125 J}{4000 J} \times 100 = 3.125\% = \boxed{3.13\%}$$

5. In lifting a 3000 kg car, the total energy input of a hydraulic hoist is 5.61 x 10^4 J while the useful energy output of the crane (which equals the work done on the car) is 1.96 x 10^4 J.

I (5.61 x 10^4 J), O (1.96 x 10^4 J)

a. Calculate the percent efficiency of the hoist.

$$\% Eff = \frac{O}{I} \times 100 = \frac{(1.96 \times 10^4)}{(5.61 \times 10^4)} \times 100 = 34.93...\% = \boxed{34.9\%}$$

b. How high did the crane lift the car??

$W = E_p = mgh$

$E_p = 1.96 \times 10^4 J$

$m = 3000 kg$

$g = 9.81 m/s^2$

$h = ?$

$$E_p = mgh$$

$$(1.96 \times 10^4) = (3000 kg)(9.81 \frac{m}{s^2}) h$$

$$h = 0.6659.... m$$

$$= \boxed{0.666 m \;\; 66.6 cm}$$