Energy Part 4: Energy Conversion

Last week we asked:

> Remember the Plant-in-a-Jar system that we started last year?
> What do you predict has happened to it?
> What forms of energy can be found within that system?

It's been 7 months so far, and, as you can see, the plant is thriving.

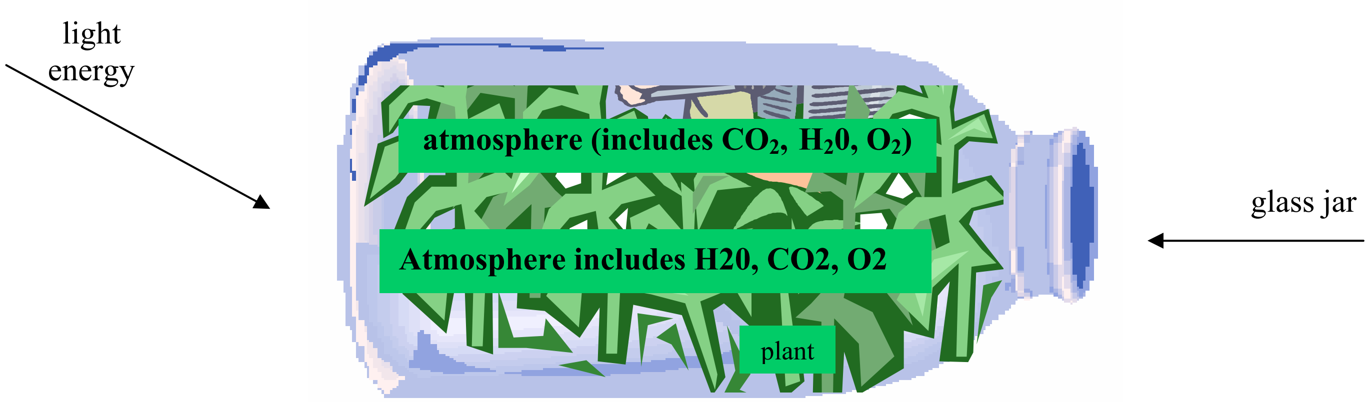
February 26, 2003 system started

System 7 months later

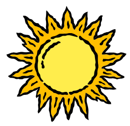
System 7 months later

Energy Flow

Now let's take a closer look at the Plant-in-a-Jar system to see the flow of **energy**.
Here's a diagram of our system:



Photosynthesis within the glass jar models[1] what happens during that process on Earth:

$CO_2 + H_20 +$  $\longrightarrow$ $O_2 + C_6H_{12}O_6$ (sugar)

in the presence of chlorophyll

> This equation tells us that carbon dioxide, water, and sunlight, in the presence of chlorophyll, produce oxygen and glucose (a sugar). Photosynthesis takes place only when light energy from the sun is available to the plant. The atoms of which CO_2 and H_20 are composed are rearranged in the process to form oxygen and glucose.

But what happened to the light energy?

Energy Conversion

The Plant-in-a-Jar system provides an example of **light energy** being converted to stored **chemical energy.** As we know from the law of the conservation of energy, **energy** can neither be created nor destroyed. It can only change in form. If we can keep track of **energy**, we could see that there's no more now than there was a million years ago; it's just changed. Therefore, the "science accountants" have to keep busy, making sure the books balance. A certain amount of **energy** from the sun is involved in photosynthesis. It may appear "used up," but that's not the case. It "reappears" as an end product of the photosynthesis process in the form of stored **chemical energy**. The total amount of **energy** has remained the same; only the form has changed. **Energy** remains in balance.

Let's take a closer look at the concept of stored **chemical energy…**

Stored Chemical Energy

Chemical energy is stored and then released when these two compounds, $C_6H_{12}O_6$ and O2, undergo chemical reactions. At night, for example, in the Plant in the Jar system, sugar ($C_6H_{12}O_6$) reacts with O_2 to release chemical energy that keeps the plant alive during the night. This energy also is used by the plant to synthesize more leaves, stems, roots, flowers, and seeds.

This release of **chemical energy** can be seen as we move up the food chain. For instance, "Cows and other animals eat the energy stored in the grass or grain and convert that energy into stored energy in their bodies. When we eat [these] … animal products, we in turn use oxygen to transform the energy stored in sugars, proteins, and fats to walk, run, ride a bike or even read a page on the Internet."[2]

Your body and the bodies of other animals convert oxygen from the air you breathe and the sugar you eat into other forms of energy that keep your body warm, enable you to move, and synthesize chemical compounds for growth and repair of your body. The sugar and oxygen produced by the plant contain stored chemical energy.

Another important example of stored **chemical energy** is found in fuels. The process of converting **energy** and then releasing the stored **chemical energy** in fuels is parallel to the process in plants; if you remember the **energy** flow diagrams from last week's email, you'll recall that most fuels come from plants, which get their **energy** from the sun:

> "Chemical energy is the energy stored in … wood, coal, petroleum, and other fuels. During photosynthesis, sunlight gives plants the energy they need to build complex chemical compounds. When these compounds, interact with oxygen, the stored chemical energy is released in the form of heat or light. What happens to a wood log in a fireplace? Burning the wood combines oxygen with the compounds in the wood, releasing the stored chemical energy in the form of heat and light energy."[3]

So, like the sugar in the Plant-in-the-Jar, the stored **chemical energy** in gasoline, oil, and coal is released when these compounds react with O_2. Although at first glance we may not recognize the similarities between gas that powers the car we drive, the sugar that provides **energy** to a plant developing flowers, and the energy that allows us to keep warm and move about, the process of **converting energy** and then releasing the stored **chemical energy** is essentially the same in both cases.

Next week we will finish up this examination of energy and work
with another look at the human body.

In the meantime, consider this question:

We've talked about **energy** as the ability to do work, and **work** has been explicitly defined as occurring when:

- a force is applied on an object
- the object moves in the direction of the force *and*
- the force and motion occur simultaneously

With that in mind, consider *isometric exercises*. Are you doing work then?

What do the New York State Standards say?

<u>In the Elementary Core Curricula, Standard 4, The Physical Setting</u>

Major Understandings state:

- 4.1a: Energy exists in various forms: heat, electric, sound, chemical, mechanical, light
- 4.2a: Everyday events involve one form of energy being changed into another
  - animals convert food to heat and motion
  - the Sun's energy warms the air and water

<u>In the Intermediate Core Curricula, Standard 4, The Physical Setting,</u>

Major Understandings state:

- 4.1b Fossil fuels contain stored solar energy and are considered nonrenewable resources…
- 4.1c. Most activities in everyday life involved one form of energy being transformed into another. For example, the chemical energy in gasoline is transformed into mechanical energy in an automobile engine…
- 4.1d: Different forms of energy include heat, light, electrical, mechanical, sound, nuclear, and chemical. Energy is transformed in many ways.

[1]We are using the Plant in a Jar system as a model of photosynthesis because, according to the NYS Elementary and Intermediate Core Curricula, Standard 6, Expanded Process Skills, Key Idea 2: *Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.*

[2] http://www.energyquest.ca.gov/story/chapter05.html

[3]http://www.l earnaboutenergy.org/focus/part1.htm