Chapter One

Systems and Feedback Loops

Day One:

Today, your child should complete their reading and practice problems for the week.

Below are the supplies for this week's lab:

¼ tsp (1.5 g) baking soda
Liquid dish soap
*Plastic syringe w/out needle (20+ mL)
Spoon for stirring
Handful of spinach or ivy leaves
Hole punch
1 large drinking glass
2 small clear cups/drinking glasses
Timer or clock with second hand
Lamp

*Large syringes can be found in most medical, veterinary, or farm/ranch supply stores

National Science Education Standards covered this week:

Interactions among the solid earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the earth system.

Definitions

carbon dioxide (CO_2)	the waste gas that animals exhale into the air; the source of nearly all the carbon within plants
closed systems	only allow energy to pass through reservoirs
ecology	the study of the relationships between living organisms and their environment
flux	amount and rate of matter and energy transfer
Law of Conservation of Matter	fundamental law which states that matter cannot be created or destroyed, only changed into different forms
negative feedback loop	a situation when the stimulus produces an action which acts to lower the stimulus itself; A produces B which produces C which in turn causes A to stop producing B
open systems	allow for the transfer of both matter and energy among reservoirs
oxygen gas (O_2)	gas required for most life on earth; can be created from the process of photosynthesis
photosynthesis	a process in which plants use the energy of the sun to synthesize food through the combination of carbon and water
positive feedback loop	a situation when a stimulus causes an action that result in the continuation of the stimulus; A produces more of B which in turn produces more A
reservoirs	earth's spheres; a system of large compartments which are constantly receiving and transferring both matter and energy to and from other spheres
residence time	amount of time a substance remains within a system
sink	the status of a reservoir when the volume of flux flowing into a reservoir is greater than what is flowing out
source	the status of a reservoir when the volume of flux flowing into a reservoir is less than what is flowing out
static	does not alter

steady state	when the volume of flux flowing out of a reservoir matches that which is flowing in
system	a set of components linked together which function as a whole

Sample questions to ask your child after completing the weekly reading.

What element is used by trees for the majority of their growth and where does this element originate within the earth?

Trees use the element carbon to grow to magnificent heights. However, this element comes from the air, not the ground. Carbon dioxide (CO_2), the waste gas that animals exhale into the air, is the source of all the carbon within a tree.

Where does the thermal and light energy released from the burning of wood come from?

It comes from the energy of the sun that was originally used to split water during the process of photosynthesis.

What is the difference between open and closed systems?

Open systems allow for the transfer of both matter and energy among reservoirs while closed systems only allow energy to pass through.

What is a positive feedback loop?

Generally speaking, positive feedback loops take place when a stimulus causes an action that result in the continuation of the stimulus.

What is the difference between a source and a sink?

Sometimes, the amount and/or rate of energy and matter flowing into a reservoir are greater than what is flowing out. When this occurs, the reservoir is known as a sink. Oppositely, when more matter/energy is flowing out of a reservoir than is coming in, it is known as a source.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the lab activity and start collecting all of the necessary materials!

Answer Key for Practice Problems

1) Law of Conservation of Matter
2) negative feedback loop
3) ecology
4) photosynthesis
5) system
6) closed systems
7) oxygen gas (O_2)
8) open systems
9) source
10) sink
11) steady state
12) residence time
13) positive feedback loop
14) reservoirs
15) flux
16) static
17) carbon dioxide (CO_2)

1) b
2) e
3) e
4) b

5a) positive feedback
5b) positive feedback
5c) negative feedback

6) A closed system is one that is isolated and self-contained. It is hypothetical and allows scientists to grapple with complex systems. An open system is one that exchanges energy, matter, and information with another system. The Mississippi River is an open system that interacts with all aquatic systems, terrestrial systems, and atmospheric systems from its origin to the Gulf of Mexico. It is affected by all sources of pollution, fertilizer, temperature change, and other human impacts that can access its waters. Closed systems do not exist in nature. Even a system as closed as a desktop computer becomes an open system when plugged into the wall socket that is in contact with the electricity that runs through an entire local community. Matter may recycle through a system, but energy must be constantly input from an external source, such as the sun.

Day Three: Lab Activity

Your child should have already read through this lab and has been reviewing all of this week's vocabulary words.

Vacuuming Leaves

A photosynthetic dance for your salad greens

Photosynthesis will be observed taking place within this controlled experiment.

Materials:

¼ tsp (1.5 g) baking soda
Liquid dish soap
*Plastic syringe w/out needle (20+ mL)
Spoon for stirring
Handful of spinach or ivy leaves
Hole punch
1 large drinking glass
2 small clear cups/drinking glasses
Timer or clock with second hand
Lamp

*Large syringes can be found in most medical, veterinary, or farm/ranch supply stores

Procedure:

1) Add ¼ tsp (1.5 g) baking soda to 1.25 cups (300 mL) of water. Stir until dissolved. Add 2 drops of dish detergent to the solution and stir gently. There should be no bubbles afterward.
2) Punch out 20 disks from the leaves.
3) Remove the plunger from the large syringe and insert the leaf disks. They should all rest near the tip-end of the syringe. Reinsert the plunger and depress it towards the layer of leaf disks. Try not to mangle any of the disks with the plunger.
4) Insert the tip of the syringe into the baking soda solution and draw 15-20 mL into the syringe. This should cause the leaf disks to float within the syringe. *If your syringe is smaller than 60ml fill it about one third full with the baking soda solution.

5) Hold the syringe tip upward and expel the air by depressing the plunger carefully. Do not allow any solution to leave the syringe.
6) Seal the tip of the syringe with your finger. Pull back on the plunger until you see bubbles coming from the edge of the leaf disks and hold for ten seconds. If done correctly, it should be difficult to pull and hold the plunger in place.
7) Release your finger and the plunger and the same time. Some of the leaf disks should start to sink. Tap the side of the tube to break any bubbles on the edges of the disks.
8) Repeat the last two steps until all the disks sink within the syringe. If all of the disks do not sink within 3-4 trials, add another drop of detergent to the baking soda solution and start the process over again with new leaf disks.
9) Remove the plunger from the syringe and divide the solution and disks equally into two small cups which are to contain the remaining baking soda solution. Make certain that the 10 disks in each cup sink to the bottom.
10) Remove one of the cups and place in a dark area for the duration of the experiment. Place the second cup under the lamp, approximately 6-8 inches below the light.
11) Begin timing the experiment as soon as the light is turned on. Bubbles will soon begin to form on the disks. Record the number of disks that are floating every minute in each cup.
12) After each recording, tap the side of the cup to make sure the disks are not attaching to the container walls.

Explanation:

A partial vacuum is created when the sealed plunger is pulled within the syringe. This vacuum forces the air out of the interior spaces of the leaf disk (mesophyll) which is replaced with the baking soda solution. The detergent is added to this solution to break down the waxy leaf coating (cuticle) on the disks. If this coating is not broken down sufficiently, the transfer of solution into the disks cannot begin and more detergent must be added. The increased mass of this solution within the disks causes them to sink and provides an additional source of carbon dioxide into the leaf cells which stimulates photosynthesis.

Photosynthesis is a process in which plants convert carbon dioxide, water, and light energy (sunlight) into usable chemical energy (glucose) and oxygen gas. In the presence of light, this process is increased within the disks, causing them to float on the solution's surface. Thus, the cup that was restricted from light should not have produced any floating disks.