DISCOVERY SCIENCE CENTER

FIFTH GRADE

Fifth Grade Science Content Standards: Physical Sciences
Elements and their combinations account for all the varied types of matter in the world.

1. F. Students know differences in chemical and physical properties of substances are used to separate mixtures and identify compounds.
   G. Students know properties of solid, liquid, and gaseous substances, such as sugar, water, helium, oxygen, nitrogen, and carbon dioxide.
   A. Students know that during chemical reactions, the atoms in the reactants arrange to form products with different properties.

Physical and Chemical Changes
To first explore physical and chemical changes of a substance, we need to understand what physical and chemical properties are. To discuss physical properties, use some dried kernels of unpopped popcorn.

Experiment One ~ Physical Properties & Physical Change

Materials:
- Unpopped popcorn kernels
- Microwave oven
- Brown bags
- Graph paper
- Pencils

Distribute a piece of graph paper and 25 dried kernels of unpopped popcorn to each student. Have the students describe or list the physical properties of the popcorn. Ask the students to use as many words as they can to describe the kernels (include the color, the size, the texture, the hardness, the amount, etc.). Then have the students cluster the kernels onto one area of the graph paper and draw around the space that the kernels occupy on the paper. Have them count and record the number of squares on the graph paper that the kernels occupy. Explain that the students have observed and described the physical properties of the unpopped popcorn kernels. [The chemical properties of the popcorn are much more difficult to see, since the chemical properties are a result of the molecular (or even the atomic) composition of the popcorn.]

Next explain that you are going to cause a physical change in the popcorn by introducing heat using the microwave oven. Place the popcorn in bags and pop the corn for the appropriate number of minutes (most microwave ovens have a setting for popping popcorn). Explain that each of the popcorn kernels has a tiny drop of water inside of it that heats up in the microwave oven. When water inside the kernel heats, it expands. The water molecules in the droplet begin to move apart from each other, eventually causing enough pressure for the inside of the kernel to cook and then burst open ~ resulting in the familiar popcorn that we eat.

After the corn is popped, distribute 25 kernels of popped popcorn to each student. Have the students describe or list the physical properties of the popcorn. Again ask the students to use as many words as they can to describe the kernels (include the color, the size, the texture, the hardness, the amount, etc.) comparing the popped popcorn to the unpopped. Then have the students cluster the popped kernels onto one area of the graph paper as before and draw around the space that the popped kernels occupy on the paper. Have them count and record the number of squares on the graph paper that the kernels occupy. Explain that the students have observed and described the physical properties of the popped popcorn kernels and that they have witnessed a physical change in the popcorn. [The chemical properties of the popcorn have not changed. It is still comprised of a large starch (complex carbohydrate) molecule.]

Have the students eat the popcorn and explain that at that point, they are causing first another physical change in the popcorn (grinding the popcorn into smaller bits with their teeth), then a chemical change in the popcorn, since their body is digesting or breaking down the molecules that comprise popcorn.

Experiment Two ~ Chemical Properties & Chemical Change

Materials:

- Vinegar
- Baking soda
- Clear plastic cups or glasses
- Paper towels
- Spoon
- Water
- PH or litmus paper (optional)

This experiment demonstrates a chemical reaction. Chemical reactions result in the formation of a new substance with new physical and chemical properties after two or more substances are combined. A chemical reaction is accompanied by the production of a gas, or a change in temperature, color, pH, or odor.

Have the students describe or list the physical properties of the vinegar (include the color, odor, texture, amount, etc). [Have the students test the vinegar with pH or litmus paper if available in order to test for this chemical property.] Then have the students describe or list the physical properties of baking soda and compare it to the vinegar.

Add a bit of water to the baking soda to create a solution. [Have the students test the baking soda solution with pH or litmus paper if available.]

Next, combine the two liquids and observe the chemical reaction. The chemical reaction is evident in the bubbling or fizzing activity ~ a gas is produced, specifically carbon dioxide. Notice as you swirl the mixture, the reaction may be encouraged to continue by causing more of the molecules that comprise vinegar and baking soda to come in contact with each other. After the reaction is complete, test the combined solution to see what other changes have occurred. [Test the pH of the combined solution, if possible.] Smell the resulting solution to see if you detect the odor of vinegar. This chemical reaction also results in a slight drop in temperature, but the change may not be significant enough for you to detect it. Is it now possible to pull the vinegar back out of the combined solution? No, you have effectively formed a new substance with new properties that are different from the two original substances.

Experiment Three ~ Separating Mixtures

Materials:

- Water-based colored marking pens
- Filter paper or coffee filters
- Water
- Paper towels
- Cups
- Pencils

Chromatography is the separation of a substance across a medium through the use of a solvent. It is often used to identify the components of a combined substance. In this chromatography experiment, the inks used to make up the particular colors of the marking pens can be separated from one another across the length of a coffee filter or other filter paper ~ the solvent used to do this is water.

In advance of the experiment, label each of the marking pens with a number using a small piece of paper taped onto the pen. Distribute a circular-shaped filter to each student. Ask the students: what color of inks do they think brown is made of? How about the color orange? Or the color black?

Following the discussion, instruct the students to poke a hole in the middle of their filter paper. Then select five pens which they can share with a number of other students. Have them write the number of the pen they select on the outside perimeter of the filter paper in pencil and place a dot using that particular pen near the hole in the center of the paper (the number of the pen should correspond to the location of the dot to later aid in identification of the ink pen used).

Once each student has five labeled dots, instruct them to tear a strip of paper toweling about three inches long and one inch wide and to twist it into a stiff wick that can be inserted into the center hole in their filter paper (this should result in their filter paper resembling a small umbrella). Then insert the wick into a cup of water, allowing the filter disk to rest on top of the lip of the cup, so as to not get the disk wet ~ only the wick

should be wet at this point. In a couple of minutes, the water in the cup should wick up the paper toweling and start to travel across the filter paper. As the water hits the marking pen dots, the inks should begin to separate and travel with the water. Remove the wick and set the filter paper disk aside after the water and inks have traveled ½ to 2/3 of the way across the disk.

Discuss the results. Explain that the ink molecules are different sizes and therefore have a tendency to be more easily transported by the water if they are smaller or more inclined to travel. Chromatography is used to separate substances, including inks, for identification purposes. The pattern that each ink travels is recognizable ~ have the students compare their chromatograms to see if they can find someone who used the same numbered ink pen as they did. Review the former answers as to what colors make up the color brown; or the color orange; or the color black. Have the students check to see if there was more than one orange ink pen, for example, did the chromatograms turn out identical? Which color traveled the farthest in the orange chromatograms? Was it always the yellow that traveled the farthest in the color orange?

For other chemistry experiments, check out: http://www.chem4kids.com/

Fifth Grade Science Content Standards: Life Sciences

Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials.

2. A. Students know many multicellular organisms have specialized structures to support transport of materials.
   F. Students know plants use carbon dioxide and energy from sunlight to build molecules of sugar and release oxygen.

Photosynthesis

Unlike animals, green plants do not need to hunt or gather their food. In fact, obtaining food would be much more difficult, since they are rooted in place. Green plants manufacture their own food through photosynthesis, a process by which plants use energy from the sun to produce sugar.

Distribute the diagram of a bean plant and have the students identify the various parts. Review that the roots pick up water and nutrients from the soil. The water is transported up through the stem through specialized cells called xylem…. to the branches… to the leaves.

Mention that the leaves pick up sunlight and carbon dioxide. Sunlight is absorbed directly through the leaf's surface into the chloroplasts where photosynthesis occurs. Chlorophyll, a green pigment, is found in the chloroplasts and absorbs of all of the colors of sunlight (except green light, which chlorophyll reflects) ~ these colors are absorbed into the leaf in the form of light energy. (There are other pigments in the leaves that absorb light energy which chlorophyll cannot.)

Land plants have special structures on the underneath surface of their leaves that can open and close to regulate other materials that flow in and out of the leaf. These special structures are called stomata. When the plant needs carbon dioxide, the stomata open, allowing the gas into the leaf. The stomata cannot remain open because water is lost through the leaf in a process called transpiration while the stomata are open. Two guard cells, one on either side of each stoma, regulate the opening and closing of the stoma. Oxygen, a waste product of photosynthesis, is removed through the stomata as the plant is taking in carbon dioxide. When CO_2 is going into the leaf, water and oxygen (O_2) can escape from the plant. Only 1- 2% of the water brought from the roots is used during photosynthesis. The other 98-99% is lost through transpiration! The chemical reaction in the photosynthetic process is:

$$6\ H_2O + 6\ CO_2 \quad \text{added sunlight results in} \quad C_6H_{12}O_6 + 6\ O_2$$

(water) (carbon dioxide) $\rightarrow$ (glucose) (oxygen)

Photosynthesis occurs when 6 water molecules combine with 6 carbon dioxide molecules to produce one sugar (glucose) molecule and 6 oxygen molecules with the help of sunlight.

During cellular respiration, the plant's cells use oxygen & sugar to generate energy and release carbon dioxide & water as waste products, similar to the process in animal cells. The energy produced through cellular respiration enables the plants to live and grow.

Specialized cells called phloem are responsible for the transport of manufactured food (glucose / sugar) through the plant. Large amounts of this food can be stored ~ this stored energy can be found in seeds to be used by the young plant and in fruits which people and animals can use for food.

Experiment ~ Stomata and Transpiration

Materials:

- Vaseline
- Small Ziplocs
- Permanent marker
- Sun or a light source
- Live plant or plants

Procedure:

1. Label the ziplocs A, B, C, D with the permanent marker.

2. Coat the leaves with Vaseline according to the instructions below. When the leaves are coated, close the ziplocs tightly with each coated leaf inside a ziploc.
   Leaf A: No Vaseline
   Leaf B: Vaseline on the top of the leaf
   Leaf C: Vaseline on the bottom of the leaf
   Leaf D: Vaseline on both sides

3. Make predictions about what will happen inside the ziplocs to each leaf.

4. Take the plant or plants outside or put underneath the light source. Leave for two to three hours.

5. Observe the plants and have students look closely at what happened inside the ziplocs. (They should have different levels of condensation on the inside of the bags.)

Questions:
What is on the inside of the bag? (Answer: Water that has transpired out of the leaves.)

Which leaf transpired the most? Why? (Answer: The stomata, the part of the leaf that allows the water to escape, are often on the bottom of the leaf. The petroleum jelly locked in some of the water and made the leaf transpire less. Therefore, leaves C and D will have the least amount of water on the inside of the Ziploc and leaves A and B will have the most water.)

This experiment can be done with four different plants without the use of the Vaseline in order to see which shape, size, or texture of leaf will transpire the most.

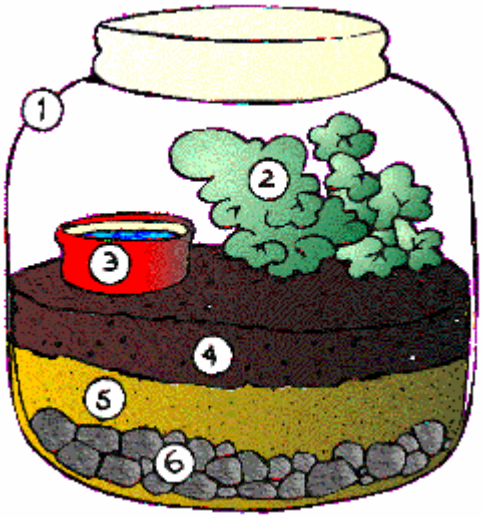
Fifth Grade Science Content Standards: Earth Sciences
Water on Earth moves between the oceans and land through the processes of evaporation and condensation.

3. B. Students know when liquid water evaporates, it turns into water vapor in the air and can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water.
C. Students know water vapor in the air moves from one place to another and can form fog or clouds, which are tiny droplets of water or ice, and can fall to Earth as rain, hail, sleet, or snow.

Water Cycle
The water you drink has been around for a long time. Over 71% of the Earth is covered with water. (Source: http://ga.water.usgs.gov/edu/) That same water has gone through the water cycle many times. Since most of the Earth's water is in the oceans, this is a nice place to start when talking about the water cycle.

1. Water from the ocean (or any other water source) evaporates with the help of the sun. The water is turning into vapor.
2. The water vapor in the air gets cold, changes back into a liquid, and forms clouds. This is called condensation.
3. Gravity and other forces soon make the liquid water fall back to the Earth. This is called precipitation and comes in many forms: rain, hail, snow etc.
4. The water might fall on land and stay there as part of the surface water, such as in a lake or stream, or even freeze at the top of a mountain.
5. Water might flow down the mountain or within the stream and might even find its way back to the ocean.

6. Some of the water might seep into the ground and percolate through the soil. An adult tree can use as much as four full bathtubs of water everyday. The underground "water table" helps supply water to the plants and to the community who might pump the water from the ground.



Experiment ~ Build Your Own Water Cycle

Materials:

- Jar
- Plants
- Bottle cap or shell
- Water
- Soil
- Sand
- Small Rocks

Procedure:

1. Fill the jar with rocks, then sand and then soil.
2. Add plants.
3. Fill shell or bottle cap with water and place inside.
4. Put the lid on, place in a sunny spot and watch the water cycle.

Great Websites:

http://www.epa.gov/OGWDW/kids/index.html
Drinking water information with activities, games and even a section in Spanish.

http://www.tomsnyder.com/
Go to the science court and there are free activities to use.

For a complete unit on the weather, including all content areas:
http://faldo.atmos.uiuc.edu/WEATHER/weather.html