Experiment 8 - Chemical Changes

When a chemical change occurs, the chemicals that you start with are changed into different chemicals. We know when this happens because the new chemicals have different properties from the old ones. Thus, if bubbles appear in a liquid (and the liquid is not simply boiling), we know that a gas has been produced by some chemical change (a reaction). If an odor appears where there had been none, that also tells us that a new substance has been made. Appearance of a new color is also a sign of a chemical change. Many chemical reactions produce enough heat to be easily noticed, and that can alert us that a chemical change has occurred. (Other processes besides chemical reactions also involve heat, such as phase changes. Therefore, a temperature change does not *necessarily* mean that a chemical reaction has occurred, just that a chemical reaction might be what caused the temperature change.)

Safety Precautions:

- Wear your safety goggles at all times.
- Sodium metal, sodium hydroxide, and hydrochloric acid are dangerous and should not be touched with your bare skin. If you skin or clothes accidentally come into contact with these chemicals, rinse them off immediately with lots of water.

Waste Disposal:

- Place the liquid waste in the **inorganic waste** container (which has a blue label) in one of the fume hoods.
- Solids such as used litmus paper and wood splints should be placed in the waste basket.

Part 1 – A Gas-Producing Reaction

The chemical reaction of sodium metal with water produces hydrogen gas and a solution of sodium hydroxide. The instructor will demonstrate this. The process also produces heat. Any process that produces heat is said to be "exothermic." The information about the process that you observe can be summarized by the following "word equation":

Sodium + water → hydrogen gas + sodium hydroxide $_{(aq)}$ + heat

[(aq) means "dissolved in water". It stands for "aqueous".]

If we boil off the water, we will be able to see the sodium hydroxide crystals. The sodium hydroxide is one of the two new substances produced by this chemical change. The other is hydrogen gas. The instructor might demonstrate how we test for that gas.

Part 2 – Turning Fat Into Soap

Sodium hydroxide is the active ingredient in the granulated type of drain cleaner, and can also be used to make soap. The following reaction occurs in both cases:

$$\text{Sodium hydroxide}_{(aq)} + \text{fat} \rightarrow \text{glycerol}_{(aq)} + \text{soap}_{(aq)}$$

The glycerol and the soap both mix with the water, in contrast with the fat, which does not mix with water. This is one of the chemical reactions that occur when "Drano" cleans out the drain.

Procedure – Part 2

1. Put a tiny, pea sized piece of margarine or other food fat in the bottom of a test tube, to represent fat lodged in a sink drain. (In a real case of plugging, other wastes would by mixed with the fat.) Add 2 or 3 mL of pure water to the fat, then poke and stir it with a glass stirring rod. Notice that the fat does not dissolve.
2. Put 2 or 3 pellets of sodium hydroxide into the tube, handling the pellets with tweezers, **NOT WITH YOUR FINGERS**. This substance is highly corrosive: it burns skin, hair, and eyes. Make sure you are wearing your safety goggles. Poke and stir the mixture. Feel the outside of the tube. If it is hot, this means that heat is being produced. After several minutes you should see the fat has disappeared. You may be able to produce a little bit of suds in the tube, showing that some soap has been make. (To make usable soap in larger amounts, a more complex procedure is necessary.)
3. Dump the liquid out of the tube into the sink, and wash out the tube with tap water while holding the tube with a test tube holder, so that none of its contents get on your skin. Then give the tube a good wash with liquid soap and water, using a test tube brush.

Part 3 – The Effect of Catalysts on the Rate of a Reaction

Hydrogen peroxide is another common household chemical. It is an "oxidizing agent". This means that it works to supply oxygen atoms for chemical reactions, such as those involved in bleaching hair or in cleansing a wound. The hydrogen peroxide turns into water and oxygen gas when it is used:

Hydrogen peroxide → water + oxygen gas

Actually, this decomposition reaction goes on slowly all the time a bottle of the chemical is just standing on the shelf, so that the contents lose their "strength, because there is less and less hydrogen peroxide left (and thus more and more water present). In the following procedure, the oxygen that is produced will cause foaming of the liquid being tested.

Procedure – Part 3

1. Put 2 or 3 mL of hydrogen peroxide (3 % solution) in a clean test tube. There should be no bubbling, because decomposition of too slow to see.
2. Add a pinch of manganese dioxide, which is a black powder. Bubbles of oxygen are seen at once. Manganese dioxide is a catalyst for this reaction. (A catalyst is a chemical that speeds up a chemical reaction.)
3. To test the oxygen, lower a glowing splint into the tube (but not into the liquid). A glowing splint is prepared by lighting a wood splint, then blowing it out. The glowing splint should burst into flame if there is much extra oxygen gas in the test tube.
4. Wet the end of the splint to make sure it is not still burning or glowing, and discard it in the wastebasket. Dump the liquid wastes in the sink and wash out your test tubes.

Part 4 – A Reaction that Involves Heat

Many chemical reactions require a constant input of energy to make them occur. Cooking is the most common everyday example of an "endothermic" (energy-absorbing) reaction; in this case, a stove or oven is used to supply heat to the chemical reactions that are going on in the food. However, for this reaction, it is not necessary to put heat into it. This reaction requires an input of energy, but it takes the energy it needs from its surroundings. As a result, the surroundings get cooler as heat is removed from them. The "surroundings" in this case will the watch glass on which you mix the two crystalline substances.

Procedure – Part 4

1. Get a clean, dry watch glass or small beaker.
2. Place about one teaspoon each of barium hydroxide and ammonium thiocyanate on the watch glass or in the small beaker. Use a stirring rod to mix them thoroughly. The reaction is:

barium hydroxide + ammonium thiocyanate → ammonia gas + water + barium thiocyanate

Evidence that a reaction has occurred will be the odor of ammonia, one of the products.

3. Feel the underside of the container; it should be cold. This is proof that the chemical reaction that occurred was one that absorbed heat in order to occur.
4. Discard the contents of the watch glass in the sink, and wash it with soap and water.

Part 5 – A Neutralization Reaction

Sodium bicarbonate (baking soda) can be taken (mixed with water) to relieve acid indigestion. In this experiment, we will have the "stomach acid" (0.1 M hydrochloric acid) in a large beaker, rather than in the stomach, so we can observe it.

Procedure – Part 5

1. Measure out 25 mL of 0.1 M hydrochloric acid in a graduated cylinder, then pour it into the largest beaker you have. Rinse out the cylinder, shake it out, and put it away.
2. Add 1/4 teaspoon of baking soda to the acid in the beaker. Caution: keep your face back and wear safety goggles! The mixture may foam up vigorously. Feel the outside of the beaker to see if it gets warm. The foaming is caused by the production of carbon dioxide gas:

   sodium bicarbonate + hydrochloric acid → water + carbon dioxide gas + sodium chloride
3. Stir the beaker contents with your glass stirring rod. If any of the sodium bicarbonate remains in the beaker, add 5 mL of hydrochloric acid (or more, if necessary) to use it up. One proof that a chemical change occurred is the obvious bubbling of the gas produced. To see another product of the reaction, do step 4.
4. Set up a ring stand with an iron ring supporting a piece of screen. Stand the beaker on the screen.
5. Light the Bunsen burner. (The instructor will demonstrate how the burner operates if this is the first time you have used it.)
6. Warm the beaker of liquid until it is simmering gently. Do not heat it so much that the liquid boils over.

7. Continue warming the beaker until nearly all the liquid has evaporated. Turn off the burner, and let the rest of the liquid evapreate using the heat that remains on the iron ring and the screen.
8. When all the liquid is gone, you should see a white deposit of sodium chloride. This is the chemical we call table salt.
9. Rinse out the beaker in the sink with soap and water.

Part 6 – The Acidity of Breath

Procedure

1. First, get acquainted with the way litmus paper indicates the presence of an acidic solution by dipping a piece of blue litmus paper (from a vial in your drawer) into some 0.1 M hydrochloric acid. It will turn pink or red. Dip the other (still dry) end of the blue litmus paper into some deionized water; no color change should occur. In other words, blue litmus only turns red in acidic solutions.
2. Drop half a piece of blue litmus into one Erlenmeyer flask and the other half into a different Erlenmeyer flask. Add about 25 mL of deionized water to each flask. Neither piece of litmus paper should change color.
3. Use a clean soda straw to bubble your breath into one of the samples. The litmus should change color because of the acid produced in the following chemical change:

   carbon dioxide + water → carbonic acid

   Carbon dioxide is a normal constituent of your breath, so don't be alarmed!
4. Discard the litmus paper in the wastebasket, not the sink! Wash the Erlenmeyer flasks and return them to your drawer.