LAD 2.1 (pg 1 of 2) **Chemical or Physical Change?**

Introduction

Determining whether a change you see is physical or chemical can be difficult. It can be tricky because in both cases there can be changes in physical appearance. Water, for example, looks quite different after it freezes (physical change) just as a car looks different after it rusts (chemical change). The freezing of water results from a change in how water molecules are oriented relative to one another, but it is a physical change because liquid and frozen water are still H_2O. The rusting of a car, by contrast, is the result of the chemical reaction of iron (Fe) with oxygen (O_2) to produce rust, more specifically iron(III) oxide (Fe_2O_3). This is a chemical change because iron, oxygen and rust are three different materials.

Just as each substance has a unique set of properties that we classify as physical or chemical properties, each substance can go through changes that can be classified as either physical or chemical.

Definitions and Examples:

- During physical changes a substance changes its appearance, but NOT its identity.
  - ✓ For example, ripping up a piece of paper is a physical change.
  - ✓ In another example, when water evaporates, it changes from the liquid state to the gas state, but is still composed of water molecules. All changes of state (for example from liquid to gas or from liquid to solid) are physical changes.

- In chemical changes (also called chemical reactions) a substance is transformed into a chemically different substance.
  - ✓ For example, as demonstrated in class, when paper burns in air, it undergoes a chemical change because it combines with oxygen to form water and carbon dioxide, and perhaps some unburned carbon ash.

Physical Change

Take one antacid tablet and perform a physical change on it by crushing it up into the plastic dish with the mortar and pestle. Make some observations in the space below reporting what it looked like at the start, and what it looked like after you physically changed it and state what changed and what did NOT change.

Chemical Change

Take the whole antacid tablet and drop it into one of the small beakers (the beaker should be on the tray provided before dropping in the tablet). Make some observations in the space below reporting the evidence that might be indicating that a chemical reaction (and not just a physical change) was occurring. Summarize those indicators with one or two words per line in the chart on the right. We will continue to add to this list as the semester progresses. Remember that is important to realize the evidence that indicates chemical change may be evidence of a physical change – more than one evidence often indicates that it may be chemical rather than physical.

As a comparison, put the crushed tablet into the second beaker. What do you observe as a comparison of reaction rate? Suggest why there might be a difference.

Evidence of chemical (and sometimes physical) change

Write an association statement about surface area and reaction rate.

When you are comfortable with this side, you should read on to the backside for more explanation.

What is that "Plop, plop, fizz, fizz …" caused by the Alka-Seltzer?

Although an acidic stomach is necessary for good health, excessive stomach acidity can produce the discomforts commonly called "acid indigestion" and "heartburn" as well as contribute to the pain of gastric ulcers. Like much of our food, our body tissues and organs, including the walls of the stomach itself, are made of protein molecules. The enzymes of the stomach fluids that help digest protein in the food that you eat, can't discriminate between the protein of food and the protein of the stomach walls. They would digest the stomach itself as easily as a hamburger if it weren't for the alkaline mucous lining that resists the action of the stomach's acid and its enzymes. This barrier keeps the stomach from being eaten away by its own juices. Sometimes, though, things get out of hand. When the body's defenses fail, a combination of stomach acid and pepsin (an enzyme in the stomach used to digest protein), and often accompanied by certain bacteria, can attack the stomach wall in an act of chemical cannibalism. The result is a gastric ulcer.

Relief from the discomforts of excess stomach acid, which can include the pain of ulcers, can often be obtained from antacids such as Alka-Seltzer, Milk of Magnesia, Rolaids, Titralac, and Tums, or simply some baking soda in water Each year Americans buy a quarter of a billion dollars worth of these and other antacid products simply for the relief of pain brought on by maverick acid ions of the stomach.

Each Alka-Seltzer tablet contains sodium bicarbonate and citric acid. When you drop the tablet into water, the sodium bicarbonate dissolves. When an ionic compound such as sodium bicarbonate dissolves, it dissociates (separates).

sodium bicarbonate dissolving in water (not shown) turns into sodium ion and bicarbonate ion (notice that the water is not shown)

$$NaHCO_3 \rightarrow Na^+ + HCO_3^{-}$$

Then the bicarbonate ion reacts with the citric acid producing citrate ion and carbonic acid

$$HCO_3^- + H_3C_6H_5O_7 \rightarrow H_2C_6H_5O_7^- + H_2CO_3$$

The carbonic acid decomposes to form water and carbon dioxide gas, which causes the fun fizz.

$$H_2CO_3 \quad . \quad H_2O + CO_2$$

You can produce the very same effervescence by squeezing a little lemon juice onto some household baking soda, which is sodium bicarbonate. The citric acid of the lemon juice reacts with the sodium bicarbonate to produce carbon dioxide just as it does when you drop an Alka-Seltzer tablet into water.

When you drink what's left in the glass; the sodium ions, the citrate ions and the water, the citrate ion acts as a base in your stomach and neutralizes some of your extra stomach acid.

Why was the solution foamy?

The solution that you worked with in class contained dish soap which makes bubbles or foams when gas is blown through the water/soap mixture, just as when you run water (along with lots of air bubbles) into the sink to do dishes. Just the same way if you were to blow through a straw into the dish tub. The carbon dioxide gas formed provided the method by which the foam could form.

Why was the solution blue then yellow? Why was the other solution pink then colorless?

One of the solutions that you worked with in class was blue because of a chemical called an acid/base indicator (bromothymol blue), which turns color depending on the pH of the solution pH is a measure of the amount of acid or base in a solution - low pH means acid, high pH means basic. The indicator was blue at the start because the solution has soap in it, which is slightly basic (not acidic), and then indicator turned green then yellow as the reaction proceeded (and changed to acidic) because the presence of the carbonic acid.

The other solution that you worked with in class was pink because of a chemical called an acid/base indicator (phenolphthalein), which changes color depending on the pH of the solution. The indicator was pink at the start because the solution has soap in it, which is slightly basic (not acidic), and then indicator turned colorless as the reaction proceeded (and changed to acidic) because the presence of the carbonic acid.