Lab 1: Exploring the Nature of Matter

Goals:

In this lab you will explore chemical and physical changes of matter. For your first lab experience, you do not need to write a laboratory report. Instead, write thorough observations and answer the questions given on this lab handout. When answering the questions, make sure you address what is happening on the atomic level.

Procedure:

Part One: Physical Changes

1. Add the same number of drops of food coloring to two samples of water, one at room temperature and one at 80°C. Record all observations. Why does the food coloring spread faster in the 80°C water versus the water at room temperature?

2. Add 150 mL of water to a 400-mL beaker and bring the water to a boil. Place a watch glass over the beaker and add ice to the top of the watch glass. Record all observations of the underside of the watch glass. Why do water droplets form on the underside of the watch glass?

3. Add ice and water to a 250-mL beaker. Let stand for a few minutes. Record all observations of the outside of the beaker. Why do water droplets form on the outside of the beaker?

4. Place a piece of dry ice (solid carbon dioxide, CO₂) in a baggie and seal it. Place a piece of dry ice in water. Place a piece of dry ice on the lab bench. (NOTE: Use gloves when handling the dry ice. It is VERY cold and can “burn” your skin.) Record all observations. What is happening to the carbon dioxide in all three scenarios?

5. Place a spatula tip full of solid iodine (I₂) in a 100-mL beaker. Place the beaker on a hot plate. Place a watch glass on the beaker and place ice on the watch glass. Turn the hot plate on the lowest setting. Record all observations. Why does solid iodine form on the underside of the watch glass? (NOTE: When you are finished with the iodine and the beaker has cooled, bring the beaker with the watch glass still ON TOP OF THE BEAKER to your instructor for proper disposal.)

6. Obtain a sample of liquid nitrogen (N₂). Submerge a flower in the liquid nitrogen for a minute. Take out the flower and hit it against the lab bench. Record all observations. Why do the flower petals break off of the stem? Pour a few milliliters of liquid nitrogen onto the lab bench. Pour about 10 mL of liquid nitrogen into a 100-mL beaker. Record all observations. What is happening to the liquid nitrogen when you pour it onto the lab bench or let it sit in a beaker?
Part Two: Chemical Changes

1. React magnesium (Mg) and 1.0 M hydrochloric acid (HCl) in a large test tube. Place a burning match just inside the mouth of the test tube. Record all observations. Was a gas other than the air created in this chemical reaction? How do you know?

2. React 3% hydrogen peroxide (H₂O₂) with a small amount of MnO₂ in a small test tube. Place a smoldering splint into the test tube but not so far in that you put the splint into the liquid at the bottom. Record all observations. Was a gas other than the air created in this chemical reaction? How do you know?

3. Obtain a small amount of 0.10 M lead(II) nitrate [Pb(NO₃)₂] in a small beaker and 0.10 M potassium iodide (KI) in a separate small beaker and take them back to your lab bench. Fill one pipet with 0.10 M lead(II) nitrate [Pb(NO₃)₂] and another with 0.10 M potassium iodide (KI). Do so in the following three ways and record all observations.
   i. Half-fill a Petri dish with deionized water. Add some of each solution at opposite ends of the dish with minimal disturbing of the water. Did a chemical reaction take place? How do you know?
   ii. Half-fill a Petri dish with deionized water. Add some of one solution to the water at one side of the Petri dish. Wait 1 minute. Add some of the other solution to the opposite side. Did a chemical reaction take place? How do you know? How did this scenario differ from part i? Why was it different?
   iii. Half-fill two Petri dishes with deionized water, one cold and the other warm. Add some of each solution at opposite ends of each of the dishes with minimal disturbing of the water. Did a chemical reaction take place in each of the Petri dishes? How do you know? How did the results of the two Petri dishes differ from each other? Why did they differ?

4. React baking soda and vinegar in a beaker and place a watch glass over the beaker. Collect the gas that is created, quickly remove the watch glass and pour the gas on a lit candle (without spilling the liquid). (NOTE: You do not need a lot of vinegar and baking soda to do this! A small amount will work. It works best if you pour the vinegar into the beaker first and then add the baking soda.) Record your observations. Was a gas other than the air created in this chemical reaction? How do you know?

5. Experiment to determine the exact mass of baking soda required to exactly react with 50 mL of vinegar. Some helpful steps are listed below:
   i. Obtain a 50 or 100-mL graduated cylinder (these are more accurate than a beaker).
   ii. Using the electronic scale, determine the mass of 50 mL of vinegar. (Please see an instructor if you have never used an electronic scale before or if it’s just been awhile and you need a refresher on how to use one!)
   iii. Pour the 50 mL of vinegar into a beaker.
   iv. Devise a method to determine the exact mass of baking soda required to exactly react with the 50 mL of vinegar. (HINT: You will probably have to test this more than once to get an exact mass. You do not need to determine the mass of 50 mL of vinegar each time. Just make that measurement once.)
How much baking soda was required to exactly react with 50 mL of vinegar? Why did the reaction eventually stop? Were the masses of each substance identical? In other words, was the same amount of vinegar and baking soda required? In chemical reactions, do the same mass of each substance that is reacting (called the reactants) have to be used in order to make them exactly react?

(Background: You might have found #5 quite tedious. One nice thing about chemistry is that we can actually predict ahead of time how much baking soda would be needed to exactly react with the vinegar so that we don’t waste a lot of chemicals like you probably had to do. You won’t learn how to do this in this course, but I don’t want you to think that all of us chemists are just wasting a lot of chemicals trying to figure out how to make two substances react perfectly!)

Summary Lab Questions:

1. What is the difference between a physical change and a chemical change?
2. Provide an example of a physical change other than what you did in this lab and explain why it is a physical change.
3. Provide an example of a chemical change other than what you did in this lab and explain why it is a chemical change.

Paper Idea 1:
Write a paper discussing the history of chemistry during the 1800’s. Focus specifically on atomic-molecular theory.

Your paper should include a discussion of Dalton, Avogadro, Cannizaro, and Lavoisier (and may include others).

The paper must be typed, should not be longer than 5 pages (double spaced, reasonable margins), and must include at least 2 references (web references are fine). The work must be your own.