***Experiment 3***

***Chemical Reactions***

***OBJECTIVES***

The objectives of this experiment are: (a) to observe evidence of chemical reactions, (b) to observe the chemical properties of some gases produced in chemical reactions, (c) to write chemical equations, and (d) to predict the products of some chemical reactions.

***INTRODUCTION***

In a chemical reaction, one or more substances are converted into one or more **different** substances. The substances undergoing the chemical reaction are called reactants, and the substances formed are called products. When certain substances are mixed, nothing happens other than physical mixing. That is, no new substances are produced. Sometimes, however, when substances are mixed, a chemical reaction takes place and new substances are produced. For example, if vinegar is mixed with baking soda, a great deal of **effervescence** **(bubbling)** is observed as carbon dioxide gas is evolved. In the above example, baking soda and a substance in the vinegar known as acetic acid are the reactants and carbon dioxide is one of the products. Two other products are also produced in this chemical reaction: water and a substance known as sodium acetate.

Baking soda + Acetic acid 🡪 Carbon dioxide + Water + Sodium acetate

NaHCO3 + HC2H3O2 🡪 CO2 + H2O + NaC2H3O2

Evidences of chemical reactions are:

* Color change
* Formation of a solid (precipitate)
* Effervescence (production of a gas)
* Heat being absorbed or produced. There are two types of reactions involving heat:
* Endothermic reactions; reactions that absorb heat.
* Exothermic reactions; reactions that release heat.

In this experiment you will examine several examples of chemical reactions.

EXPERIMENTAL PROCEDURE

1. ***Reactions of Acids with Metallic Elements:***

Place one or two small pieces of zinc metal in a large test tube. Add approximately 20 drops of 6.0 M HCl solution to the test tube.

*Question 1: Note any evidence of chemical reaction:*

***Great deal of bubbles. (1pnt)***

*Question 2: When the reaction is going vigorously, bring the flame of an ignited wood splint to the mouth of the test tube. Record your observations.*

***It pops. (1pnt)***

*Question 3: Is the gas produced flammable?*

***Yes. (0.5pnt)***

*Question 4: What are the reactants in this reaction?*

***HCl and Zn (1pnt)***

*Question 5: What are the products in this reaction?*

***ZnCl2 salt and H2 gas (1pnt)***

*Question 6: Write a balanced chemical equation for the reaction. (Unbalanced equations can be found on page 6 of the lab).*

***Zn + HCl 🡪 ZnCl2 + H2 (1pnt)***

1. ***Reactions of Acids with Carbonates:***

Marble is a naturally occurring ionic compound, calcium carbonate (CaCO3). Place two or three small chips of marble in a large test tube. Add approximately 20 drops of 6.0 M HCl solution to the test tube.

*Question 1: Note evidence for any chemical reaction.*

***Great deal of bubbles. (0.5pnt)***

Light a wooden splint and insert the burning end into the test tube.

*Question 2: What do you observe?*

***Flame goes out. (0.5pnt)***

*Question 3: Is the gas produced flammable?*

***No. (0.5pnt)***

*Question 4: What are the reactants in this reaction?*

***CaCO3 and HCl (1pnt)***

*Question 5: What are the products in this reaction?*

***CaCl2 CO2 and H2O (1pnt)***

*Question 6: Write the chemical equation for the reaction.*

***CaCO3 + HCl 🡪 CaCl2 + CO2 + H2O (1pnt)***

*Question 7: How does the gas produced in this reaction compare to the gas produced in part 1 above?*

***Both are colorless and do not have odor. However, the CO2 is not flammable while H2 is flammable. (1pnt)***

There are many other naturally occurring materials composed primarily of calcium carbonate, among which are limestone, oyster shells, chalk, and pearls.

*Question 8: Predict what would happen if you were to swallow a pearl.* (Hint: your stomach contains a fairly strong solution of hydrochloric acid - pH about 1.5 to 3, usually around 2).

***It should dissolve in the stomach. (1pnt)***

1. ***Reactions of Metallic Elements with Compounds of other Metallic Elements:***

Place approximately 3 mL of copper(II) sulfate solution, CuSO4, in a small test tube; add a few drops (1-3 drops) of dilute sulfuric acid. Polish an iron nail using steel wool and then immerse it in the copper(II) sulfate solution. Leave the nail in the solution for about 30 seconds, then pour off the copper(II) sulfate solution. Rinse the nail and examine it. The deposit on the nail is **not rust** but another metal.

*Question 1: What does it appear to be?*

***Copper. (0.5pnt)***

*Question 2: Where did it come from?*

***Copper(II) sulfate solution. (1pnt)***

*Question 3: Write the equation for the reaction.* (The sulfuric acid does not take part in the reaction but serves the purpose of cleaning the surface of the nail).

***CuSO4 + Fe 🡪 FeSO4 + Cu (0.5pnt)***

In general, metallic elements will react with compounds of **less active** metallic elements to produce the less active metallic element involved in the reaction and a compound of the more active metallic element. Metallic elements will not react with compounds of more active metallic elements (review the activity series in your book).

*Question 4: From the above reaction, indicate which of the metallic elements iron or copper is more active*.

***Iron is more active than copper because it is capable of replacing Cu in its compounds. (1pnt)***

*Question 5: Predict what will happen if iron(II) sulfate solution, FeSO4, is allowed to come in contact with a small piece of copper wire.*

***No reaction. (0.5pnt)***

*Question 6: Test your prediction and comment on the result.*

***Correct! (0.5pnt)***

***4. Reactions of Acids and Bases:***

Acids can be distinguished from bases using acid-base indicators. An example of an acid-base indicator is phenolphthalein. This indicator appears **pink** in a basic solution and **colorless** in an acidic solution. Other properties of acids are:

* Have sour taste.
* React with bases.
* Increase concentration of hydronium ion (H3O+) in solution.
* Their aqueous solutions conduct electricity.

Properties of bases are:

* Have bitter taste.
* React with acids.
* Increase concentration of the hydroxide ion (OH-) in solution.
* Their aqueous solutions conduct electricity.

An example of an acid is hydrochloric acid (HCl) and an example of a base is sodium hydroxide (NaOH). Reactions of acids with bases are known as **neutralization** reactions. In neutralization reactions, all the properties of acids and bases disappear as these species neutralize each other.

Place exactly 5.5 mL of 6.0 M HCl in a large test tube and add to it 2-3 drops of phenolphthalein indicator.

*Question 1: Note the color of the solution.*

***Clear. (0.5pnt)***

Place exactly 5.0 mL of 6.0 M NaOH in another large test tube and add to it 2-3 drops of phenolphthalein indicator.

*Question 2: Note the color of the solution.*

***Pink. (0.5pnt)***

Measure and record the temperature of each solution, then mix the two solutions by adding the hydrochloric acid solution carefully and slowly to the sodium hydroxide solution. Mix well then immediately record the temperature of the mixture.

Temp of HCl \_\_\_***.5***\_\_\_\_, Temp NaOH \_\_\_***.5***\_\_\_\_, Temp of mixture \_\_***hotter than both***\_\_\_ ***(1pnt)***

*Question 3: Note any change in the temperature of the mixture.*

***8 degrees or so. (0.5pnt)***

*Question 4: What happened to the pink color of the phenolphthalein in the mixture? Explain your observation.*

***It disappeared because the amount of acid added exceeds the amount of bases existed, so the mixture is acidic. (1pnt)***

*Question 5: Write the chemical equation for the reaction.*

***HCl + NaOH 🡪 NaCl + H2O (0.5pnt)***

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***Unbalanced Chemical Equations for the Reactions that Occurred.***

Zn + HCl 🡪 ZnCl2 + H2

CaCO3 + HCl 🡪 CaCl2 + H2O + CO2

Fe + CuSO4 🡪 Cu + FeSO4

HCl + NaOH 🡪 NaCl + H2O