Experiment 2: Identifying Unknown Substances by Their Chemical and Physical Behavior

Reading: Chapter 2 of your textbook and this lab handout

Ongoing Learning Goals:

- To use a scientific notebook as a primary record of procedures, data, observations, and example calculations
- To make scientific measurements
- To present your formal results through a laboratory report along with proper citations

Additional Learning Goals for Experiment 2:

- To demonstrate the physical and chemical differences between ionic and molecular compounds
- To become familiar with chemical and analytical techniques for compound identification
- To gain proficiency naming ionic compounds

Introduction

There are many qualitative tests that chemists use to help identify unknown substances. In this experiment, you will learn to identify two unknown compounds, one ionic and the other molecular. These compounds will first have to be separated out of heterogeneous mixtures, and in doing you will gain experience with some simple but commonly used separation techniques. Once separated, you will conduct a series of qualitative tests to gain insight into your unknown compounds, including whether the compound is ionic or molecular, and whether it contains certain diagnostic anions or cations.

Possible Molecular Compounds:	*Possible ionic compound cations:*	*Possible ionic compound anions:*
aspirin acetaminophen ibuprofen	Li^+, Na^+, K^+ Ca^{2+}, Ba^{2+}, Cu^{2+}	NO_3^-, Cl^- CO_3^{-2}, SO_4^{-2}

Part A: Separation of heterogeneous mixtures and identification of strong and non-electrolytes

Filtration is a useful technique to separate soluble compounds from insoluble substances in a heterogeneous mixture. Filter paper is a water-permeable paper mesh that will trap the insoluble compounds as the aqueous solution passes through. For **gravity filtration**, your solution is slowly pulled (drips) through the filter paper due to gravity, while **vacuum filtration** pulls the solution through the paper much more quickly due to a strong pressure gradient.

Procedure

- Weigh out approximately 5 g of the sand/compound mixture into a 125 mL Erlenmeyer flask. Record your mass.
- Add 50 mL of deionized water to your flask and stir the mixture with a magnetic stirrer for 5 minutes.
- Working with your partner, filter one of your mixtures by gravity filtration and the other by vacuum filtration.
- Transfer the filtrate into a 150 mL beaker, measure the sample conductivity, and compare your conductivity to samples of pure water, and a water/sand mixture. Record all three conductivity values and any other observations.
- Based on your conductivity results, determine which mixture contained an ionic compound and which contained a molecular compound. Record your analysis in your notebook.

Part B: Identification of cations using a flame test and anions by diagnostic chemical reactions

When burned in a high temperature flame, certain substances (especially metal cations) will exhibit diagnostic flame colors due to their *emission spectrum* (you will learn about emission spectra later in the semester – Chapter 6 in your textbook). Additionally, certain ions will undergo specific chemical reactions that are diagnostic for that ion's identity. You will perform a few of these types of tests in this experiment.

Procedure

Test for cations (**Do this only in the presence of your instructor!**):

- Take a small amount of your unknown ionic compound on the tip of a clean spatula and carefully hold it in a Bunsen burner flame.
- Observe the color of the flame and record your observations.
- From the list of possibilities that will be provided to you, identify and record the cation that is likely to be present in your compound.

Test for anions:

- Weigh approximately 100 mg of your solid into a test tube and record the mass. Dissolve this solid in 5 mL of deionized water.
- Add a few drops of this prepared solution to a clean well of your spot plate. Then add a few drops of silver nitrate solution to the same well. Formation of a precipitate indicates that you have a halide or carbonate anion. Record your observations.
- Add another few drops of your prepared solution to a clean well of your spot plate. Add a few drops of barium chloride solution to the same well. Formation of a precipitate indicates that you have a sulfate or carbonate anion. Record your observations.
- Using the tip of a spatula, add a small amount of your solid compound into a clean well of the spot plate. Add a few drops of 5% acetic acid (vinegar). Vigorous evolution of a gas (CO_2) indicates that your anion is carbonate. Record your observations.
- If all of the above tests turn out to be negative, then your anion is nitrate. If so, record this identification in your notebook.

After you have identified the cation and anion of the ionic compound, identify your unknown ionic compound in your notebook – name and chemical formula.

Part C: Melting points of molecular compounds

Many molecular compounds have melting points ranges that can be accurately measured with the proper equipment, and for pure substances, melting points are highly diagnostic of compound identity.

Procedure

- Load a melting point tube with pure benzoic acid.
- Load another melting point tube with your unknown molecular compound.
- Simultaneously determine the melting points of both compounds. Record the melting points as range from the temperature when melting begins to the temperature when melting is complete.
- Identify your unknown compound from the list of possibilities given to you. Record your analysis in your notebook.

Part D: Naming ionic compounds

Make sure to obtain a nomenclature sheet before you leave the laboratory.

What should be in your lab notebook (*in addition to title, purpose, procedure, observations, etc.*)?

Please see the individual Parts, above, for specific instructions on what should be in your notebook.

Laboratory report: Use the **Report Form** for Experiment 2.