Identification of an Unknown Compound

An Introduction to Scientific Investigations

Problem solving is not restricted to scientific investigations but is a life-long process that involves every aspect of human endeavor. Although every investigator, being human, approaches each problem with some preconceived ideas, facts are gathered by accurately observing the behavior of a system of interest. Conclusions are based solely on the observed data.

The approach used by scientists is referred to as the **Scientific Method**. *First*, the behavior of matter is observed. *Second*, the results or data are arranged in an orderly fashion. *Third*, the observed data is correlated to form a hypothesis. *Finally*, new experiments are designed to test the hypothesis.

Creativity is an intrinsic part of the scientific investigation; it allows new concepts and technologies to develop.

In this experiment you will determine the identity of an unknown compound by comparing its characteristic reaction with the reactions of four known substances. A chemical reaction can be observed by one of the following changes:

1. The formation or disappearance of a **precipitate**, a solid product formed from the mixture of two aqueous solutions. A precipitate often gives a cloudy appearance due to very small solid particles evenly distributed throughout the solution. A color change may also occur.
2. The formation of a **gas**, indicated by *bubbles*, a process known as **effervescence.** A change in the odor of the solution also indicates that a gas has been produced.
3. Change in **temperature**.

"No change" is also an observation that must be noted.

By carefully observing any changes that occur it should be possible for you to obtain enough data to determine the identity of your unknown solution. Make sure you write down your unknown letter in your lab notebook…. you will need to include it in your lab report.

All data for this lab must be collected in a **lab notebook** (which can be a composition notebook, or a spiral notebook, devoted to the collection of chemical data during lab.) Have your instructor stamp your lab notebook before leaving.

You will create a **typed lab report** for this lab which is essentially a summary of the lab (including the data observed, the conclusions drawn from the data, etc.) It will be due the following week in recitation.

You should also familiarize yourself with the lab space and the other lab people! Get your lab partner(s) names, and if possible, a method to contact them later (email, a text phone number, etc.) You may need to communicate with each other after the lab session is complete!

PROCEDURE: *Work in groups of 2 or 3 while performing labs. Safety glasses should be worn while performing this lab.*

Part A: Testing for Gas Evolution

1. Clean five test tubes and label as: NaCl, Na_2CO_3, Na_2HPO_4, Na_2SO_4, and U (unknown – ***do not use "U"***, use the actual unknown letter on the bottle). Use a clean spatula to place a pea-sized sample of each of the above **solids** in its corresponding test tube. (There is no need to dry test tubes). **Record** your unknown letter.

2. Add 5 drops of HNO_3 solution to each test tube. **Record** your observation.

3. Wash the test tubes and rinse with water. (There is no need to dry the test tubes)

Part B: Testing with Barium Nitrate ($Ba(NO_3)_2$)

1. Place 20 drops of each of the following solutions in their corresponding test tubes: NaCl, Na_2CO_3, Na_2HPO_4, Na_2SO_4, and Unknown. Use the same unknown letter as in part A.

2. Add 3 drops of NH_3 (note that NH_3 is often displayed as "NH_4OH" when in water) to the first test tube. Mix the solution with a clean, dry stirring rod. Place a drop of the solution adhering to the stirring rod to a piece of red litmus paper. If the paper does not turn blue, add three more drops of NH_3 and re-test the solution with litmus. Continue to add NH_3 until the litmus turns blue (it can take more than 20 drops depending on the solution). Repeat with each sample.

3. Add 5 drops of $Ba(NO_3)_2$ to each test tube. Flick the test tube to mix, being careful not to spill the mixture. **Record** if a precipitate (i.e. cloudiness) forms and the color of the precipitate.

4. NOTE: This step only applies to those test tubes that contain precipitates. Add 10 drops of HNO_3 to each test tube that contains a precipitate. **Record** if the precipitate dissolves.

5. Discard the solutions into the waste bottle. Wash and rinse the test tubes.

Part C: Testing with Silver Nitrate ($AgNO_3$)

1. Place 20 drops of each solution into the corresponding cleaned test tube as in part B.

2. Add 5 drops of $AgNO_3$ solution to each test tube. **Record** your observations.

3. NOTE: This step only applies to those test tubes that contain precipitates. Add 10 drops of HNO_3 to each test tube that contains a precipitate. **Record** if the precipitate dissolves.

4. Discard the solutions in the test tubes into the waste bottle. Wash and rinse the test tubes.

Part D: Determination of Unknown Identity

Your unknown is one of the four tested solutions (NaCl; Na_2CO_3, Na_2HPO_4, or Na_2SO_4). Compare your observations to those of the four known experiments to determine the identity of your unknown compound. If there are any discrepancies, you may need to repeat one of the above experiments.

Sample	*Part A:* **+HNO_3**	*Part B3:* **+$Ba(NO_3)_2$**	*Part B4:* **+$Ba(NO_3)_2$ and HNO_3**	*Part C2:* **+$AgNO_3$**	*Part C3:* **+$AgNO_3$ and HNO_3**
NaCl					
Na_2CO_3					
Na_2HPO_4					
Na_2SO_4					
Unknown Letter: ____					

Sample Data Page: This is one possible method to take notes for this experiment. Do not write on this page; all notes should be taken in your lab notebook!

Get a **stamp** or signature for your notebook from the lab instructor before leaving.

POST LAB QUESTIONS: *Answer these questions at the end of your typed lab report. They do not have to be in your lab notebook.*

1. You are given an unknown that contains **two of the four compounds** you tested in this laboratory session. You made the following observations:
    a. No gas evolves when the solid is treated with HNO_3.
    b. A white precipitate forms after the addition of NH_3 and $Ba(NO_3)_2$ to a solution of the unknown. The precipitate does not dissolve after the addition of a solution of HNO_3.
    c. A white precipitate forms after the addition of a solution of $AgNO_3$ to a solution of the unknown. The precipitate does not dissolve after the addition of a solution of HNO_3.

    Use your observations from the lab to **determine the identity of the two compounds** in this hypothetical unknown. *Explain* your answer.
2. **Join** the ***mhchem*** **mailing list** (http://mhchem.org/mhchem) which is used for Chemistry 221 announcements. **Write the email address** you used for your answer.
3. Go to the Chemistry 221 website (http://mhchem.org/221) and select the "Chemical of the Week" entry from the left. What is the title of this week's "Chemical of the Week" entry?
4. What is the URL (address) for the Mt. Hood Community College AVID/Learning Success Center?

Lab Notebook and Lab Report: Please read the CH 221 Companion introduction section for details of lab notebook procedure and lab reports. Information on the Lab Notebook and on how to write a Lab Report can be found here:

http://mhchem.org/lab

Regarding the **Lab Notebook**: While students work in lab groups of 2 or 3 during a lab, each student must have his or her own **lab notebook**. Here are some hints on how to keep a good lab notebook in this class:

- Only use **pen** in your lab notebook; no white out or erasures. If you make a mistake, use a single line to cross out.
- Pages in your lab notebook must be a type that you cannot rip pages out of (composition book) and should be **sequentially numbered** (if they are not, do that now). It is ok to use a lab notebook from a previous course.
- Create a **Table of Contents** at the beginning of your lab notebook (or at the beginning of where you will place your lab information.) The Table should include the title of the lab and the page number at the very least.
- Each lab that you complete should have the **Title** of the lab at the top, followed by your **lab partner or partners** and the **date** that you completed the lab.
- Lab notebooks will be **collected** at some point towards the end of the term for grading.

Lab Reports (which must be typed almost all of the time) are due one week from completion of the experiment unless specified otherwise by the instructor. Each student must write their own lab report. Include all data from the lab report, and show examples of how calculations were made.

Each lab report should include the following:

- your **name**
- your **lab partner(s) name(s) (first AND last)**
- the **title** of the lab
- the **date** that the lab was performed
- a **purpose** section - this is a section with no more than two sentences answering *why* you did this lab.
- a **data** or **results** section - this section should include any relevant data points and calculations obtained within the lab. Make sure you include the **unknown number or letter** if appropriate.
- a **conclusion** section - this section answers the question asked by the purpose
- any **postlab questions**, if any
- In addition, be sure to include any **graphs** or **relevant observations**. If relevant, be sure to include any **averaged values, percent error, parts per thousand (ppt),** etc. All labs must use the correct number of **significant figures** and **units**.

If you have any questions, ask the instructor!