Identification of a Halide

Introduction

The halogens are one of the main groups in the periodic table. In their elemental state, these elements are quite hazardous to handle because they are all extremely reactive. They are most commonly found in nature in the form of ions of –1 charge in salts collectively called **halides**. Some of the halides are essential to life. In this lab, you will be studying four halides: fluoride, chloride, bromide, and iodide. The heaviest halogen, astatine (At), is radioactive and will not be studied in this lab. Using the different chemical properties of the halides, you will attempt to identify a sample containing a solution of one of these halides. You will investigate the chemical properties of the halide by performing a series of tests on known solutions that consist of 0.2 *M* of the salts NaF, NaCl, NaBr, and NaI.

Three of the four halides (represented by the letter "X") form an insoluble salt with silver(I). You will test this by adding 0.1 *M* $AgNO_3$ to each of the known solutions and looking for the formation of a precipitate. If a precipitate forms, the precipitation reaction is:

$$AgNO_3(aq) + NaX(aq) \longrightarrow AgX(s) + NaNO_3(aq)$$

Insoluble silver salts may be dissolved by the addition of aqueous ammonia to the solution. Ammonia forms a complex with the silver(I) ion which causes the salt to dissolve according to the reaction:

$$AgX(s) + 2\ NH_3(aq) \longrightarrow Ag(NH_3)_2^+(aq) + X^-(aq)$$

The amount of $NH_3(aq)$ solution needed to dissolve the precipitate will differ with the identity of the halide.

The next test to be performed is the halide's reaction with chlorine water. Chlorine water is dissolved chlorine gas, $Cl_2(aq)$. Elemental chlorine is an oxidizing agent. It will oxidize halides that are stronger reducing agents than the chloride ion. This reaction has the stoichiometry:

$$Cl_2(aq) + 2\ NaX(aq) \longrightarrow X_2(aq) + 2\ NaCl(aq)$$

The aqueous solution will be brought into contact with mineral oil so that the halogen will go into the mineral oil and impart a color to it.

Equipment

6 large test tubes, stopper, 10-mL graduated cylinder

Procedure

1. Place 4 mL of each of the known solutions (NaF, NaCl, NaBr, and NaI) in separate labeled test tubes.
2. Place 4 mL of your unknown solution in the fifth test tube. Be sure to write the number of the unknown sample on your data sheet.
3. Add 2 drops of 0.1 M $AgNO_3$ to each test tube. Observe and record you observations as to the precipitate formed (if any) in each of the appropriate boxes.
4. Add 15 M NH_3 dropwise with stirring to the solutions in the test tubes with a precipitate. Record the number of drops required to dissolve the precipitate in the appropriate box on your data sheet. If the precipitate does not dissolve with the addition of 60 drops, write "60+" on your data sheet.
5. Discard the solutions in all of the test tubes.
6. Once again, place 4 mL of each of the known solutions and 4 mL of the unknown solution in separate labeled test tubes.
7. Add 2 mL of mineral oil to each test tube.
8. Cover each test tube with a stopper and mix the contents thoroughly.
9. Let the contents settle into two layers and record the color of the mineral oil layer (on top).
10. Add 2 mL of chlorine water to each test tube.
11. Stopper the test tube and mix the contents thoroughly.
12. Let the contents settle into two layers and record the color of the mineral oil layer. Look at your observations for the knowns and compare them to the results of your unknown. You should be able to identify the unknown from this comparison.
13. Write the identity of the unknown on your data sheet.

Name: _____ Section: _____

Partner: _____ Date: ___/___/___

Report Sheet: Identification of a Halide

Unknown number: _____

Known Solutions

	NaF	NaCl	NaBr	NaI	unknown
Addition of 0.1 *M* $AgNO_3$					
How many drops of 15 *M* NH_3?					
Color of mineral oil layer before addition of Cl_2*(aq)*					
Color of mineral oil layer after addition of Cl_2*(aq)*					

Identity of Unknown solution _____