Alkaline Earth Metals and the Halogens

Introduction: The alkaline earth metals include magnesium, calcium, strontium and barium. The halogens include chlorine, bromine and iodine. Some members of these families are left out because they are too unstable or too dangerous to use in our laboratory. When one member of each of these families form an ionic bond together the formula of the compound is MX_2. In this experiment we will examine properties and reactions of these families and use that information to determine the identity of an unknown compound. Each of the tests we will perform will provide valuable information towards our goal.

Part One: Solubilities of Salts of Alkaline Earth Metals

We will add nitrate salts of alkaline earth metals to a variety of substances and look for evidence of the formation of a precipitate. If a precipitate does form it is important to observe its color, texture, tendency to settle or stay suspended in solution and particle size. Is no precipitate forms then this means the salts formed in the reaction are all soluble. We will be using about 1mL of a 0.1 M solutions of each of the nitrate salts for each test.

Copy the following data table into your laboratory notebook and fill it out:

	1 M H_2SO4 (12 drops)	1 M Na_2CO_3 (1 mL)	0.25 M $(NH4)_2C_2O_4$(1 mL)	0.1 M KIO_3 (1mL)
$Ba(NO_3)_2$				
$Ca(NO_3)_2$				
$Mg(NO_3)_2$				
$Sr(NO_3)_2$				

Look over all of your data. Do any two of these metals have exactly the same results?

Part Two: Activity Series for the Halogens

Halogens exist in two common oxidation states; as diatomic molecules (i.e. chlorine, bromine and iodine) and as ions with a negative one charge (i.e. chloride, bromide and iodide). When the diatomic molecule of one halogen is reacted with the negative ion of a different halogen one of two things will occur; either a single replacement redox reaction will occur and the diatomic halogen will oxidize the halide ion or there will be no reaction at all. What happens depends on the activity or relative oxidizing power of the halogen. In this part of the experiment we will look for a reaction between a halogen and a halide ion in all combinations possible.

Step by step procedure:

Step One: Obtain three test tubes. Place a few milliliters of bromine-saturated water (bromine water) into the first test tube, chlorine water in the second test tube and iodine water in the third test tube. Add 1 mL of heptane or hexane to each test tube. Stopper the test tube and shake it gently. **You must use a stopper. Using your finger is dangerous as these chemicals are very irritating to the skin.** Take note of any color changes to the organic layer. In a non-polar organic solvent the diatomic halogens have different colors. It is important to notice which color indicates which halogen.

Step Two: Obtain three clean, fresh test tubes. Put 1 mL bromine water and 1 mL of organic solvent (heptane or hexane) into each tube. Add the following:

test tube # 1: add 1 mL 0.1 M NaCl
test tube #2: add 1 mL 0.1 M NaBr
test tube # 3: add 1 mL 0.1 M NaI

Stopper each test tube and shake it. You will see one of two results. Either the color of bromine will remain in the organic layer or it will change to another color. If the color doesn't change then no reaction occurred. If the color changes then a reaction occurred of the form: $X_2 + 2NaY \rightarrow Y_2 + 2NaX$ where X and Y are two halogens. A reaction will occur only if X has more oxidizing power than Y (is more active).

Once you've completed this test for bromine you will need to repeat the entire test for chlorine and for iodine. Write down your observations directly in your laboratory notebook in a chart like this:

	Br-	Cl-	I-
Br_2			
Cl_2			
I_2			

Whenever a reaction takes place write down the initial and final color of the organic layer. If no change occurs then write: no reaction.

Rank the halogens in order of oxidizing power. Which halogen has the strongest oxidizing power? the weakest?

REMINDER: Dispose of all organic waste in the special organic waste disposal container.

Part Three: Identification of an Unknown Alkaline Earth Halide

You will be given a single unknown but it will have the formula MX_2 where M is one of the alkaline earth metals and X is one of the halogens. Divide your unknown into two portions then use the procedure described in Part One to deduce the identity of the alkaline earth metal in your unknown. Use the procedure described in Part Two to deduce the identity of the halide in your unknown. You will need to add a sample of your unknown to each of the halogen waters plus 1mL of the organic layer. When you are satisfied that you know the identity of your unknown please report the result to your instructor.

Note: All substances in this laboratory are potentially toxic, some more than others. Wear your goggles, transfer solutions carefully and wash your hands well after laboratory AND UNDER NO CIRCUMSTANCES SHOULD YOU BITE YOUR NAILS!!! If you wish you may request nitrile gloves.

When you write your conclusion for this laboratory it is important to explain how you reasoned when you decided which ions where in your unknown.