**Chemicals in Everyday Life**

**Cautions:** You will be using dangerous, caustic (corrosive) chemicals in this lab, so it is important that you are very careful with them. Wash your hands if they are exposed to chemicals.

**Purpose:** It is important for chemists to be able to determine the composition of unknown chemicals. This can often be done by way of chemical tests. In this lab you will determine the chemical composition of some common household chemicals using common chemical tests.

**Background:** One important aspect of chemistry is the identification of substances. The identification of minerals – for example, “fool’s gold”(iron pyrite) as opposed to genuine gold was important to prospectors. The rapid identification of a toxic substance ingested by a child may actually help save the child’s life. Substances are identified either by the use of instruments or by reactions characteristic of the substance*(tests)*, or both. For example, one may *test* for oxygen with a glowing splint; if the splint bursts into flames, oxygen is present. One tests for chloride ions by adding silver nitrate to an acidified solution. The formation of a white precipitate under these conditions suggests the presence of chloride ions. Since other substances may yield a white precipitate under these conditions, one *“confirms”* the presence by observing that the precipitate dissolves in ammonium hydroxide. The area of chemistry concerned with the identification of substances is called *qualitative analysis.*

In this experiment, you will perform tests on or with substances that you are apt to encounter in everyday life, such as table salt, bleach, smelling salts and baking soda. You probably don’t think of these as “chemicals”, and yet they are, even though we don’t refer to them around the home by their chemical names. After observing some reactions of these household chemicals, you will partially identify an unknown. Your task will be to determine whether the substance contains the ammonium ion (NH4+), carbonate ion (CO32-), chloride ion (Cl1−), sulfate ion (SO42-) or iodide ion (I1−).

**Equipment:** 150-mL beaker, full rack of *small* test tubes, one Bunsen burner and hose per table, test tube clamp

**Chemicals:** all chemicals require for each test and unknowns will be at the supply table

**Procedures:**

***A. Testing for ammonium/ammonia***: Put about 15 drops of household ammonia solution in to 150 mL beaker. Hold a *dry* piece of red litmus paper over the beaker, being careful not to touch the sides of the beaker with the paper. Record your observations on the report sheet **(1)**. Repeat using a piece of red litmus paper that has been moistened with water. Did you note any difference in the time required for the litmus paper to change color or the intensity of the color change? **(2)**

Household ammonia is a solution made by dissolving ammonia gas in water to produce the weak base ammonium hydroxide. This weak base immediately starts to dissociate and then decompose back to ammonia and water. This is represented by the equilibrium: NH3 (aq)/(g) + H2O (l) ⇄ NH4+ (aq) + OH− (aq)

This equilibrium can be used to test for the presence of the ammonium (NH4+) in a salt by shifting the equilibrium to the left by the addition of a strong base such as sodium hydroxide. If the salt contains ammonium, upon the addition of sodium hydroxide you can test for NH3 by its familiar odor or by the use of red litmus.

* Ammonium chloride—a stable ammonium salt. Place about 1 mL of 1 M NH4Cl (ammonium chloride) in a test tube and hold a moist piece of red litmus paper over the mouth of the tube for about 1 minute. Record your observations **(3)**. Add 1 mL of 8 M NaOH and agitate carefully to mix. Test with the red litmus paper and record your results. *You may need to carefully warm the reaction by heating the test tube* ***gently*** *by holding it with the clamp over a low flame. (point away tube towards the wall away from your partners)* Record **(4)**.
* Fertilizer. Place a pea size amount of fertilizer in a new test tube and add 1 mL of water. Test as above. Does the fertilizer contain ammonium?
* Smelling salts—a very unstable ammonium salt. Hold a moist piece of red litmus over the mouth of an open container of ammonium bicarbonate [(NH4)HCO3]. Also carefully fan your hand over the jar (waft) to see if you can detect the odor of ammonia. Record your results **(6)**. Most ammonium salts are stable, such as the NH4Cl, should not have any effect on litmus before adding the strong base. (NH4)HCO3 is very unstable and decomposes easily according to this reaction: (NH4)HCO3 (s) → NH3 (g) + CO2 (g) + H2O (l) Smelling salts contain ammonium bicarbonate or carbonate that has been moistened with ammonium hydroxide.

*Dispose of the chemicals used in this part as well as the following parts by washing them down you lab sink with water.*

***B. Testing for carbonate:***  Bicarbonate (HCO3-) and carbonate salts (CO32-) react with acids to form carbon dioxide and water. We can test for the presence of these ions by adding acid (H+) and watching for the evolution of bubbles, that is, CO2 gas. HCO3- (aq) + H+ (aq) → CO2 (g) + H2O (l)

* Baking soda. In a small, clean test tube, place a pea size amount of baking soda (NaHCO3). Carefully add 1-drops of *concentrated* 18M H2SO4 (sulfuric acid). ***CAUTION! This can cause severe burns. If you come in contact with it, immediately wash the area with copious amounts of water.*** Record your observations. **(7)**
* Repeat the procedure using vinegar in place of sulfuric acid. Record the results. **(8)**
* A confirmatory test for carbonate ion is to allow the carbon dioxide gas to react with a solution of barium hydroxide. A white precipitate of barium carbonate will be produced:CO2 (g) + Ba(OH)2 (aq) → BaCO3 (s) + H2O (l) Many substances such as eggshells, oyster shells, chalk and limestone contain the carbonate ion. Place a few small pieces of chalk in a test tube. One partner will prepare a “hang drop” of Ba(OH)2 on the tip of a stirring rod. Add several drops of 2M HCl to the test tube – make sure a good amount of gas is being produced. Quickly hold the hanging drop over the mouth of the test tube. Clouding of the drop is due to the formation of BaCO3 (s). NOTE: Work carefully and quickly with your partner. The drop may cloud if you breath on it! Record **(9).**

***C. Testing for chloride:*** Chloride salts react with sulfuric acid to liberate hydrogen chloride, a pungent and colorless gas that turns moist *blue* litmus red. Cl- (s) + H2SO4 (aq) → HCl (g) + SO42− (aq)

* Place a pea size amount of sodium chloride (table salt) in a small, dry test tube and add 1-2 drops of 18M H2SO4 directly on top of the sodium chloride crystals. Carefully note the color and odor (waft) of the escaping gas. *Do NOT place the mouth of the test tube directly under your nose!*  Hold of piece of moist blue litmus paper near the mouth of the test tube. Record **(10)**. Complete the equation **(11)**.
* A confirming test for chloride ions is the characteristic reaction with silver nitrate (AgNO3) to form silver chloride (AgCl). Although many chloride salts are water soluble, readily dissolving in water, silver chloride is quite insoluble and will precipitate out of the reaction. The reaction is shown below: Cl- (aq) + AgNO3 (aq) → AgCl (s) + NO3- (aq)Place a *very small* amount of NaCl in a test tube and add 15 drops of *distilled* water and one drop of 3 M HNO3. Tap to dissolve. Add 3 drops of a 0.1 M AgNO3 solution and swirl the test tube to mix the chemicals. Record your observations. **(12)** Why must distilled water be used for this test? **(13)**
* Place about 1-2mL of tap water in a clean test tube. Add one drop of 3 M HNO3 and 3 drops of a 0.1 M AgNO3. What does this test indicate about the presence of chloride ions in tab water? **(14)**

Sodium ions impart a yellow color to a flame. When potatoes or pasta boil over on the stove you often see a burst of yellow in the flames. Simply handling a scoopula will contaminate it with sodium from the sweat on your skin enough that it will produce a yellow flame when the tip is placed in your Bunsen burner. Wipe off your scoopula with a paper towel. Obtain a few crystals on the tip of the scoopula. (You may want to wet it first with distilled water so they stick.) Place the tip in the flame of a Bunsen burner for a moment. Record your observation. **(15)**

***D. Testing for sulfate:*** Solutions of Epsom salt (MgSO4 • 7H2O) are used to soak aching feet and as a purgative(laxative).

* Epsom salt. Place a pea size amount of Epsom salt in a small, dry test tube. Add 1-2 drops of 18M H2SO4 directly on top of the crystals. Record **(16). *Note the difference in the behavior of this substance with sulfuric acid as compared to the behavior with baking soda and sodium chloride.***
* Sulfate salts (SO42-) react with barium salts (Ba2+) to form an insoluble precipitate, barium sulfate (BaSO4). Like the chloride salts above, sulfate salts tend to be quite soluble, but barium sulfate is insoluble. The reaction is: BaCl2 (aq) + SO4 2- (aq) → BaSO4 (s) + 2 Cl- (aq) Place a pea size amount of Epsom salt in a test tube and dissolve it in 1 mL of distilled water. Add 1 drop of 3 M HNO3 and then 2 drops of a 0.2 M BaCl2 (barium chloride) solution. Record your observations. **(17)**

***D. Testing for Iodide:*** Commercial bleach is usually a 5% solution of sodium hypochlorite, NaClO. This solution behaves as though only chlorine, Cl2, were dissolved in it. *Since this solution is fairly concentrated, direct contact with the skin or eyes must be avoided!* The element chlorine, Cl2, behaves very differently from the chloride ion. Chlorine is a pale yellow-green gas with an irritating odor, is slightly soluble in water, and is toxic. It is capable of liberating the element iodine, I2, from iodide salts: Cl2(aq) + 2I− (aq) → I2(aq) + 2Cl− (aq)

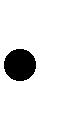
Iodine gives a reddish-brown color to water; it is more soluble in mineral oil than in water, and it imparts a violet color to mineral oil. Thus, chlorine can be used to identify iodide salts.

* In a small test tube, dissolve a small, pea sized amount of sodium iodide, NaI, in 1 mL of distilled water; add 5 drops of bleach. Note the color, and then add several drops of mineral oil, vigorously tap to mix and allow it to separate, which takes about 20 seconds. The mineral oil is the top layer. Record your observations. **(18)** Place the test tube in your rack or a small beaker for several minutes and observe again after the next parts.
* A confirmation test for the iodide ion is that it forms a pale yellow precipitate when reacted with silver nitrate. I- (aq) + AgNO3 (aq) → AgI (s) + NO3- (aq) (similar to the test for Cl-) Dissolve a very small amount of sodium iodide in 1 mL of distilled water and add a drop of 3 M HNO3 and 3 drops of a 0.1 M AgNO3. Record. **(19)**
* Another test for the iodide ion is the reaction with sulfuric acid. Solid iodide salts react with concentrated sulfuric acid by instantly turning dark brown, with a slight evolution of violet gas iodine fumes (toxic). Iodine crystals may deposit on the sides of the test tube. Place a pea sized amount of sodium iodide in a small, dry test tube and take it to the **FUME HOOD**. Add 1-2 drops of 18M H2SO4 directly on top of the crystals. Record **(20)**.

***NOTE:*** Place a pea sized amount of your unknown in a small, dry test tube and test it in the **FUME HOOD** while testing the sodium iodide sample – just in case the unknown contains iodide. Record observations in Part F of the data table.

***F. Determination of an unknown:*** You will be given an “unknown” chemical that is a sulfate, carbonate, chloride, iodide or an ammonium salt. *Record your unknown number in the data table.* You will use the above tests and results from those tests to figure out which type of salt you have. Remember that for a positive test, your results need to match those from above. Other reactions could happen, but will not give you a definitive answer on what you have in the tube.

Put a pea size amount of your unknown into a clean dry test tube and take the sample with the sodium iodide sample from part E to the **FUME HOOD**. Start by adding 1-2 drops of 18M H2SO4 and record **(21)**. Use your observations to determine a confirmation test based on your results. Remember your sample may contain the ammonium ion, this requires concentrated sodium hydroxide to be added to a small sample. *Check with the instructor before completing any confirmation tests.* Record **(22).** Additionally, you may flame test a small sample of your unknown. Some unknowns contain sodium and one contains potassium (flame color?).



Record the ion(s) in your unknown. **(23)**