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Reactions of Household Chemicals and Tests: pH/Lead Testing

Part 1 Household Chemicals

Part 1A Chemicals Properties

For background on this experiment you may read the original journal article cited on the last page.

Chemistry is sometimes called *the central science* because it is the study of matter and its processes and reactions. However, many topics introduced in the classroom can be difficult to relate to your everyday life. In this experiment you will become familiar with several household chemicals and how to identify them using simple chemistry techniques.

Important: even though these are common household chemicals, be sure to wear your gloves and googles when conducting the experiment. Also, some of these chemicals are cooking ingredients, but do not taste any of them.

The eight chemicals you will be given as knowns are listed in the table below.

Substance	Formula	Common applications
Sodium chloride	$NaCl$	Table salt
Sodium bicarbonate	$NaHCO_3$	Baking soda and also a component of the buffer system in your blood.
Sodium borate	$Na_2B_4O_7$	Borax – used as household cleaner.
Sodium hydroxide	$NaOH$	Lye, used as drain cleaner and in soap making. Formerly used for hair straightening products and in preparing the Swedish food lutefisk.
Magnesium sulfate	$MgSO_4$	Epsom salts used as bath salts and other medical applications.
Calcium carbonate	$CaCO_3$	Chalk and limestone. Used as antacid and as a soil additive by gardeners to lower soil acidity.
Calcium sulfate	$CaSO_4$	Gypsum used to make plaster of Paris and to make drywall.
Starch	Carbohydrate polymer	Thickening agent in cooking.

You will discover the properties of the chemical by testing each of common household chemicals with five different testing agents.

For each of the chemicals, you will need five different test tubes. In each test tube, add about a pea size of the chemical. Then follow the instruction below.

a) Water: Fill the test tube ½ full with DI water, stir it, and check for solubility.
b) Iodine. Fill the test tube ½ full with DI water, stir it, add 2-3 drop of the Iodine conc. solution, observe.
c) Universal/ phenolphthalein or pH indicator. Fill the test tube ½ full with DI water, add 2-3 drop of the indicator, observe.

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d) Vinegar. Fill the test tube ½ full with vinegar solution, observe the generation of gas, if any.
e) Sodium hydroxide. Fill the test tube ½ full with sodium hydroxide solution, observe.

Record your observation in the table below.

	Water	Iodine	pH indicator	Vinegar	NaOH sol.
NaCl					
$NaHCO_3$					
$Na_2B_4O_7$					
NaOH					
$MgSO_4$					
$CaCO_3$					
$CaSO_4$					
Starch					

Addition Observation possible: (generation of heat, color, physical states of the chemicals, etc.)

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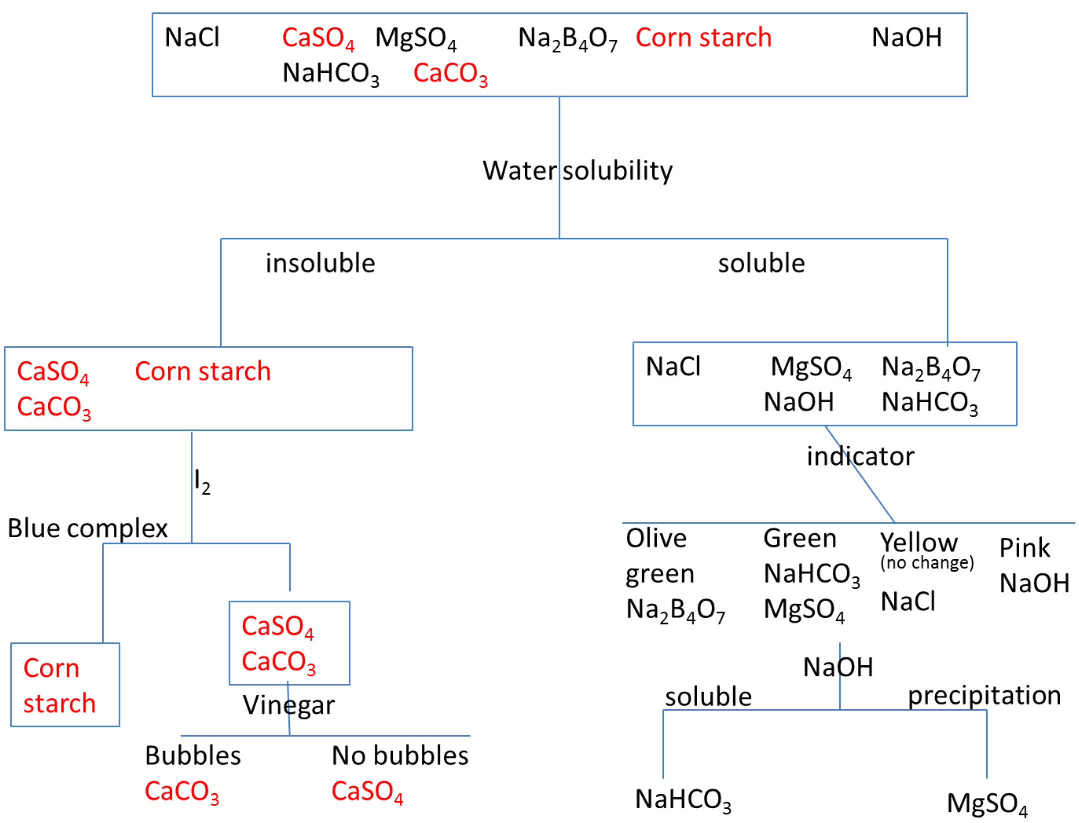
After examining the chemistry of the knowns, you will be given one or two of them as unknown(s) for you to identify.

Part 1B Unknown Chemicals Identification

Chemicals often are mixtures requiring different techniques to identify them. One technique is to separate the water soluble ones from the water insoluble ones and then use various tests to identify them. For the eight chemicals in this experiment, three are water insoluble and five are water soluble and can be separated and identified according to the flow chart below. The idea of the flowchart is to take advantage of the physical and chemical properties of compounds to identify them in mixtures.

In this part of the laboratory, match observations of a given solid sample containing unknown(s) with those of the known chemical(s) above to identify the chemical or chemicals in the solid sample. For example, the unknown A has the set of observations identical with Starch, therefore, unknown A is starch.



You will identify your unknowns by following the flow chart above. Suggested procedures for the different tests are given below:

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Solubility test: For the solubility tests, use 3-4 mL of water and about half of your sample containing the unknown(s). Some insoluble compounds will dissolve quite fast but a few may require stirring. The insoluble compounds should be readily apparent as they settle on the bottom of the test tube and don't lose quantity with stirring.

Separation of liquid from solid: If the unknown(s) sample contains a precipitate after adding water, separate the liquid from the solid. Do not discard the liquid, but test it for one or more of the five soluble compounds using the tests above and outlined below for the knowns.

Universal indicator test: For this test you will need a separate test tube for each water-soluble sample. In a test tube put 2 mL of water and then 2 drops of universal indicator solution. Let the indicator mix with the water (should be amber in color) and then add drops of the solution you prepared with your water-soluble compound. As you add drops you may see the color change. Don't add more than 5-10 drops. Let all five test tubes sit for a few minutes and then compare the colors. Remember that one of your compounds, NaCl, will not cause a color change.

Starch test: Put one drop of I_2 solution in 4.0 mL of water. Add your test substance either as a suspension (solid in water) or as a solid directly into the I_2 solution. Stir to let the solid interact with the iodine. If starch is present you will see a color change that results in a bright blue/ blue.

Vinegar test: Add about 2.0 mL of vinegar to a test tube and add your test substance. If you have already identified starch then you could simply decant your other two samples by pouring off the water in the tubes with the other two insoluble solids and add the 2 mL of vinegar directly. Once they are combined, you can stir to improve the vinegar/solid contact. Let the samples sit and the one that produces bubbles is calcium carbonate.

Precipitation of $Mg(OH)_2$: This test will distinguish sodium bicarbonate from magnesium sulfate. Magnesium sulfate forms a white precipitate; the sodium bicarbonate solution remains the same.

Unknown # __________ **Identified as _________________________**

Observations

Unknown # __________ **Identified as _________________________**

Observations

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Part 2 pH/ Lead Testing

Introduction. In this part of the lab you will use a lead-sensitive indicator solution to test paint chips for the presence of lead. Lead is a dangerous environmental toxin and an everyday source of lead exposure is through household paint present in homes that were constructed before 1978. The lead indicator solution contains a dye named sodium rhodizonate that produces a colored precipitate when it reacts with certain metal cations[1]. The table below lists the colors of this indicator with various metal cations. You will use the indicator solution to evaluate samples of paint chips from the Wichita area.

Reactions with Sodium Rhodizonate

	Metal Salt Solution (1%)			
Metal Ion	Neutral	pH = 2.8	Hydroxide	Oxide
Ag^+	Black	Black	--------------	--------------
Hg^+	Brown-red	Brown-red (disappears on standing)		
Tl^+	Dark brown	Dark brown	--------------	--------------
Pb^{++}	Blue-violet	**Scarlet**	Blue-violet	Blue-violet
Cu^{++}	Orange-red	-------------	--------------	--------------
Hg^{++}	Red-orange	-------------	--------------	--------------
Cd^{++}	Brown-red	Brown-red	Gray-brown	--------------
Bi^{++}	Brown-red	-------------	Brown-red	--------------
Ni^{++}	--------------	-------------	--------------	--------------
Co^{++}	--------------	-------------	--------------	--------------
Zn^{++}	Brown-violet	-------------	Brown-violet	Brown-violet
Mn^{++}	--------------	-------------	--------------	--------------
UO_2^{++}	Brown	-------------	--------------	--------------
Ca^{++}	--------------	-------------	Brown-red	Brown-red
Ba^{++}	Red-brown	Red-brown	Red-brown	Red-brown
Sr^{++}	Red-brown	-------------	Red-brown	Red-brown
Sn^{++}	-------------	Violet	Violet	-------------

Part 2 **Testing Paint Chips for Lead**

Wear gloves when handling lead indicator and paint chips.

For this test obtain a paint chip sample from both bags of paint chips labeled Sample #1 and Sample #2. Both samples are from older homes in College Hill. Your TA will provide you with a paint brush. Use the paint brush to paint indicator onto the paint chip. Spread the indicator and observe any resulting color changes.

Complete the table below for Lead Tests.

Sample Number		Observations upon addition of lead indicator	Lead Present in Paint (Y/N)

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Testing Soil pH

Another useful home test that is easy to conduct is testing the pH of soils. Soil pH is a measure of the acidity or basicity. A value of pH of 7.0 is considered neutral. Values below 7.0 are acidic and above 7.0 are basic. Most plants grow best in soil conditions where the pH is between 5.5 and 7.5.
Soil pH affects the availability of soil minerals. The pH of soil is easily determined, as you will see, and once it is known it can be adjusted by adding amendments to the soil. Common soil amendments to lower pH are organic matter, aluminum sulfate and iron sulfate. To raise pH ground limestone is commonly used.

Equipment Required:

1. Three 100 mL beakers
2. Glass rod
3. Standard pH meter with pH electrodes
4. Buffers (pH 4 and pH 8)
5. Three soil samples: garden soil, compost and potting soil

Procedure:

1. Weigh 10 g of garden soil, 10 g of compost and 5 g of potting soil into three separate 100 mL beakers.
2. Add, respectively, 15 mL, 15 mL and 50 mL of deionized (DI) water into the beakers and stir carefully using a glass rod (when you switch from one sample to another, make sure the glass rod is clean and dry).
3. Cover the beakers with clean watch glasses and let them sit for about 30 minutes or more. This allows the extraction of all the minerals from the soil into the water and also allows the samples to come to room temperature so that we get accurate measurements.
4. While the samples are sitting for 30 minutes, you can work on your lead samples. See instructions on next page.
5. After 30 minutes has passed, most of the solid settles to the bottom of the beaker. Fill three small test tubes, approximately half full with your samples (try getting only liquid as much as possible leaving behind the solid).
6. Centrifuge your samples for about a minute (TA will demonstrate how to properly operate the centrifuge instrument).
7. Calibrate the pH meter with pH 4 and pH 8 buffer solutions (TA will demonstrate this).
8. Transfer liquid from test tubes into small beakers, insert the pH electrode into the beaker containing one of the samples. Once the reading stabilizes, record the pH value of the sample.
9. Repeat this procedure for the other two samples (when you switch your electrode from one soil sample to another, make sure it is cleaned with DI water and wiped with a Kimwipe).
10. Write your results on the chalkboard.
11. In the table provided in the data section, record the measurements from every group in the lab.

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Complete the table below for the three soil samples.

Group #	pH		
	Garden soil	Compost	Potting soil
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
Average pH			
St. dev			

1) Which sample is most acidic and why do you think it is the most acidic sample?

2) Which sample is least acidic and why do you think it is the least acidic sample?

<u>**Cited Literature**</u>

1) Feigl and Suter, Ind. Eng. Chem. Anal. Ed., **14**, 840-842 (1942).