

EXPERIMENT #1 — QUALITATIVE ANALYSIS OF ELEVEN HOUSEHOLD CHEMICALS

Reference: S. Solomon, A. Fulep-Poszmik, and A. Lee, *J. Chem. Ed.*, Vol 68, No. 4, 328, (1991).

Discussion: Most chemical investigations are related to the properties of matter. A physical property of a substance can be observed or measured without altering the identity of the material. A chemical property refers to the ability of a substance to undergo a change that alters its identity. The whole collection of properties of a given substance enables us to identify a compound and to determine if it is identical to another compound.

In this investigation we shall begin with eleven white solids — sodium carbonate, sodium bicarbonate, sodium chloride, calcium carbonate, magnesium sulfate, cornstarch, fructose, sucrose, calcium sulfate, boric acid, and sodium hydroxide — all of which, as well as the other reagents used in this investigation, are readily available in most drugstores, supermarkets or variety stores. Using a series of chemical and physical tests, a qualitative analysis scheme is designed to identify characteristic properties of each of the white solids. Once the identification scheme has been established, each student will be asked to identify two unknowns from the group of eleven compounds.

Materials: Unknowns: sodium carbonate, sodium bicarbonate, sodium chloride, calcium carbonate, magnesium sulfate, cornstarch, fructose, sucrose, calcium sulfate, boric acid, and sodium hydroxide

Reagents: phenolphthalein, tincture of iodine, vinegar, copper sulfate, sodium hydroxide.

Procedure:

Test with Water: Each solid to be identified is first tested for solubility in water. To perform the solubility test, a pea-sized amount of material is placed in a test tube with 5 mL of water. Each is mixed thoroughly. Record your observations making note of anything unusual or different. In order for a compound to be considered soluble, look for: (a) the formation of a clear, homogeneous solution, or (b) an obvious reduction in the amount of material that remains at the bottom of the test tube after several minutes of mixing, or (c) the appearance of “oily” swirls coming from the solid when the mixture is gently stirred. Of the solids that are available, three will not dissolve readily in water. These three compounds constitute GROUP A. The other eight solids are in GROUP B. Save the test tubes from this first series of tests for the next step.

FOR COMPOUNDS IN GROUP A:

Reaction with Iodine: Add a drop or two of iodine to each test tube containing the compounds in GROUP A. Record your observations making note of anything unusual or different.

Reaction with Vinegar: Place a small amount of the unknown solid in a clean test tube. Add 2–3 mL of vinegar. Record your observations making note of anything unusual or different.

FOR COMPOUNDS IN GROUP B:

Reaction with Phenolphthalein: Add 3–4 drops of the phenolphthalein solution to each of the test tubes containing the eight water soluble solids that were saved from the first step. Record your observations making note of anything unusual or different.

Reaction with Vinegar: Two of the eight water soluble solids will yield different results when tested with phenolphthalein. Place a small amount of each of these two solids into clean test tubes and add 2–3 mL of vinegar. Record your observations making note of anything unusual or different.

Reaction with Aqueous Sodium Hydroxide: For the remaining six compounds, dissolve a pea-sized sample of each in six clean test tubes containing ~5 mL of water. To each test tube add a few drops of aqueous sodium hydroxide. Record your observations making note of anything unusual or different. Save the samples for the next step.

Reaction with Copper Sulfate: For the remaining five compounds, add a small piece of copper sulfate (about the size of a kernel of corn) to each of the five test tubes saved from the previous step. Heat the tubes in a boiling hot water bath for several minutes. Record your observations making note of anything unusual or different.

Reaction with Vinegar: For the remaining four compounds, place a small amount of each into clean test tubes and add 2–3 mL of vinegar. Record your observations making note of anything unusual or different.

Flame Test: For the remaining three solids, perform a flame test as follows: Place a sample of the unknown solid in one well of the 24-well plate. Soak a clean, cotton tipped wooden applicator (or Q-tip) in deionized water and then dip the applicator in the sample of the solid salts. Heat the tip of the applicator in the bright blue cone of a Bunsen burner. Observe the color of the flame. Record your observations making note of anything unusual or different.

Effect of Heat: For the remaining two solids, place a small sample of each into a clean, dry porcelain evaporating dish. Place the dish on a hotplate (setting 4 to 5). Heat gently. Record your observations making note of anything unusual or different.

At this point, you should have a completed flow chart that includes the observations in the identification scheme for each of the eleven white solids. Have your instructor check your flow chart before proceeding. Obtain two unknowns from the instructor and identify each using the scheme you have devised. Record all of your observations and conclusion for each step in the identification of the two unknowns. Turn in your results (including your step-by-step observations) to your instructor.

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| Unknowns: | |
| A. sodium chloride | F. sodium hydroxide |
| B. sodium bicarbonate | G. cornstarch |
| C. calcium sulfate | H. fructose |
| D. sucrose | I. magnesium sulfate |
| E. calcium carbonate | J. boric acid |
| | K. sodium carbonate |





