Physical and Chemical Properties of Matter Lab

Purpose

To introduce the student to physical and chemical properties of matter and their use for the identification and separation of compounds. Each student will become familiar with melting point, solubility, pH, fluorescence, and color change. Solubility will be used for the separation for two substances.

Introduction

Compounds are distinguished by their physical and chemical properties. Physical properties can be determined without changing the chemical identity of the substance. Please properties include color, texture, hardness, boiling point, etc. A chemical property requires a change in the identity of the substance; the substance must undergo a chemical reaction producing a new substance. The new substance is used to describe the chemical property. For example, a chemical property of methamphetamine is it will react with sodium nitroprusside producing a deep blue colored product called the Simon-Awe complex. This chemical property (recognized as a color change) helps forensic scientists to identify unknown substances such as methamphetamine.

Other properties such as melting point, solubility, pH, and florescence are also used by forensic scientists to identify and clarify unknown substances. Melting point describes the temperature at which a solid changes to a liquid. For ice it is 0°C, however for copper it is 1085°C. Solubility is the ability of a substance to be dissolved into another substance such as water. Salt, alcohol, and baking soda are soluble in water, while vegetable oil is not. pH describes the hydrogen ion concentration of aqueous (water containing) solutions. Some compounds increase pH (i.e., bases), while others decrease pH (i.e., acids) or maintain constant pH. Fluorescence is the ability of emitting visible light upon being radiated with ultraviolet light. This ability and the color of the emitted light are both physical properties of the substance.

Physical properties are also commonly used to separate substances from each other. In this lab, salt will be separated from sand and a salt-sand mixture based upon differing solubilities, i.e., salt is soluble in water and sand (SiO_2) is not.

Procedures

Part A: Appearance as a Physical Property

1. Obtain three white powders prepared by your instructor.

2. Examine these powders closely and **record** their appearance. Notice any color, texture, or granular (e.g., small crystals, flaky, clumpy, etc.) differences. Take your time and be as detailed as possible.

Part B: Solubility

1. Add 400-500 mL of water to a 600-mL beaker and heat to a boil on a hot plate.

2. While waiting for your water to boil, add approximately 0.01 g sugar to a 150-mL beaker. In two separate 150-mL beakers add approximately 0.01 g starch and 0.01 g salicylic acid.

3. Next, pour approximately 100 mL of the warmed water into each of the prepared 150-mL beakers. Stir each solution with a glass stir rod for one minute. **Record** if the compound (sugar, starch, or salicylic acid) completely dissolved in the water and how quickly.❖

    ❖ Many compounds may appear to dissolve but are actually finely dispersed throughout the solution. If you do not see solid compound on the bottom of the beaker or floating on top of the water, you may need to hold the beaker up to the light and look for particles floating *in* the solution to determine whether or not the compound has completely dissolved.

4. Do not dispose of these solutions yet. You will use them in part C.

Part C: pH

1. Open the removable drive and watch the video file titled, "How to Use a pH Meter." Rewatch this video as needed for this section of the lab.

2. Measure and **record** the pH of all three of these solutions prepared in part B. Compare the pH of these solutions to that of pure water.❖

   ❖ pH is defined as the negative logarithm of the hydrogen ion concentration of a solution (more about this the Acids, Bases, and Solutions Unit). This property of an aqueous (water containing) solution can be altered by the addition of a compound. Compounds that decrease the pH of water are called acids, while compounds that increase the pH of water are called bases. Many compounds do neither. The ability of a compound to change the pH of water is one of its chemical properties.

3. Dispose of the liquids in the 150-mL beakers down the drain and then clean and hang the beakers on the drying rack near the entrance to the room.

Part D: Fluorescence

1. Place a small pea-size amount of each dry compound on a separate watch glass. In the hood labeled FLORESCENCE, radiate the three samples with ultraviolet light lamp. Close the hood door and open the flap to look inside and **record** your observations.

2. Retain these compounds on their watch glasses for part E.

Part E: Reaction with Iodine Solution and Sulfuric Acid

1. Place a couple drops of iodine solution on each compound found in the watch glasses prepared in part D. **Record** any changes in appearance immediately after adding the drops of iodine solution. Wait 2 minutes and **record** the appearance of all three samples again.

2. Clean and hang the watch glasses in the sink.

3. Due to the dangers associated with concentrated sulfuric acid, Mrs. Williams will demonstrate this part via video. Open the removable drive and watch the video file titled, "Physical and Chemical Properties of Matter Lab: Part E." Rewatch this video as needed for this section of the lab. You will **record** any changes in appearance immediately after the drops of sulfuric acid were added and then **record** again after 2 minutes have passed.

Part F: Melting Point

1. Use the melting point apparatus video to measure and **record** the melting point range of a pea-sized sample of sugar, starch, and salicylic acid up to 200°C . If one of the compounds does not melt record "did not melt". Many compounds have a melting point range. They begin to melt at a lower temperature and finish at a higher temperature. Be sure to **record** the entire range.

Part G: Unknown

1. Obtain an unknown from your instructor and **record** its number.

2. Repeat parts A-F and attempt to identify the unknown as sugar, starch, salicylic acid, or something else (the concentrated sulfuric acid section of part E and all of part F can be viewed on the video titled "Unknown Tests" for safety reasons). In forensic science sometimes a determination of what a substance is *not* is just as important as a determination of what a substance is. Eliminating possible identities of an unknown compound also serves as a preliminary step to identification.

Part H: Separation of Sand from a Salt-Sand-Iron-Sawdust Mixture

1. Obtain an unknown salt-sand-iron-sawdust mixture and record its number.

2. Measure and **record** the mass of a salt-sand-iron-sawdust mixture sample by first measuring the mass of a 50-mL beaker and then measuring the mass of the beaker containing the sample.

3. A property of iron is that it is magnetic. Select a tool from your bucket that will allow you to remove the iron only.

4. A property of sawdust is that it floats in water. Add approximately 15-20 mL of water to the 50-mL beaker containing the salt-sand-sawdust sample. Select a tool from your bucket that will allow you to remove the sawdust only.

5. A property of salt is that it is soluble in water. Gently swirl the solution for 1-2 minutes. Carefully pour off the liquid into the sink being careful to keep the sand on the bottom of the beaker. Don't worry about removing every drop of water from the beaker, it is more important that sand is left behind.

6. Add 15-20 mL of water to the beaker, gently swirl the solution for 1-2 minutes, and then carefully pour off the liquid into the sink being careful to keep the sand on the bottom of the beaker. Repeat this one more time.

7. Place the beaker into an oven at about 110°C for 10 minutes or until the sand is completely dry. Allow the beaker to cool and then measure and **record** the mass of the beaker and sand.

8. Clean and then hang the beaker.

Abstract (HONORS ONLY)

Provide a summary that contains a brief statement of what you did (technique or reaction) and is supported by your actual data/results. See the examples of good and bad abstract examples if needed.

Results and Observations

Part A: Appearance as a Physical Property

Visual Observations

Sugar	Starch	Salicylic acid
• White • Grainy • Slightly shinny • Feels gritty	• White • Powder • Feels soft	• White • Powder • Feels soft

Part B: Solubility

Solubility Observations

Sugar	Starch	Salicylic acid
Dissolved quickly	Made the water cloudy, but over time the starch settled to the bottom of the beaker	Didn't dissolve, some floated and some sank to the bottom of the beaker

Part C: pH

pH of Solutions

	pH
Warm water	7.00
Sugar solution	6.98
Starch solution	6.98
Salicylic acid solution	1.62

Part D: Fluorescence

Fluorescence Observations

Sugar	Starch	Salicylic acid
Appeared slightly purple	Bright purple glow	Bright purple glow

Part E: Reaction with Iodine Solution and Sulfuric Acid

Chemical Reaction Observations

---	Sugar	Starch	Salicylic acid
Initial observations with iodine solution	• Brown • Quickly absorbed into sugar	• Dark brown • Sat on top of starch	• Dark brown • Beaded up and rolled down • Some beads were absorbed after rolling
Observations after 2 minutes with iodine solution	• Brown • Some sugar may have dissolved	• Dark purple • Mixed a little with starch	• Dark brown • Mixed a little with salicylic acid
Initial observations with sulfuric acid	• Opaque white • Quickly absorbed into sugar	• Cloudy white • Absorbed by starch	• Beaded up and rolled down
Observations after 2 minutes with sulfuric acid	• Opaque white • Some sugar may have dissolved	• Cloudy white • May have dissolved	• White • Paste like consistency • Doesn't seem to be dissolving

Part F: Melting Point

Chemical Reaction Observations

---	Sugar	Starch	Salicylic acid
Melting-point range	Didn't melt	Didn't melt	148.6-166.7°C
Melting-point observations	Didn't melt	Didn't melt	Turned clear upon melting

Part G: Unknown

Observations *Unknown C was used*

---	Unknown
Visual observations	• *White* • *Powder* • *Feels soft*
Solubility observations	*Didn't dissolve, some floated and some sank to the bottom of the beaker*
pH	*1.72*
Fluorescence observations	*Bright purple glow*
Initial observations with iodine solution	• *Dark brown* • *Beaded up and rolled down* • *Some beads were absorbed after rolling*
Observations after 2 minutes with iodine solution	• *Dark brown* • *Mixed a little with salicylic acid*
Initial observations with sulfuric acid	• *Beaded up and rolled down*
Observations after 2 minutes with sulfuric acid	• *White* • *Paste like consistency* • *Doesn't seem to be dissolving*
Melting-point range and observations	*155.2-169.5˚C* *Turned clear when it melted*

Part H: Separation of Salt from a Salt-Sand-Iron-Sawdust Mixture

Unknown #: *855*

Mass of beaker: *26.5 g*

Mass of beaker and salt-sand-iron-sawdust mixture: *58.3 g*

Mass of beaker and sand after cooling: *57.4 g*

Follow-up Questions

1. Report your unknown number for part G and identify the compound. Explain what indicated the compound was sugar, starch, or salicylic acid (be sure to mention your data).

2. Report the percentage of sand in the unknown mixture.

$$\% = \frac{mass\ of\ the\ substance}{total\ mass\ of\ the\ mixture}\ x\ 100$$

3. If you didn't dry all of the water out of your beaker, so that all of the sand was dry, in part H, would this increase or decrease your calculated percent sand in the mixture? Explain.

4. Did we test all possible properties that a compound could have in this lab? Explain.

5. If an unknown compound shared all of the properties of sugar as tested in this lab, could you identify the compound as sugar *if it didn't match the property results for starch and salicylic acid*? Explain (Hint: Think back to your answer for #4).

6. Many compounds will melt upon heating as demonstrated in this lab. However, some compounds upon heating decompose (breakdown into different and smaller compounds or elements) at high temperatures by breaking bonds and/or forming new compounds. Is melting a physical or chemical property? Decomposition? Explain for both.