CSI Greeley

Name: _____ Group: _____

In this lab, you will play detective and use your chemistry knowledge to try to solve a "crime" involving cookies that took place in an elementary school kitchen. This lab simulates the basic principles and some common techniques used by forensic chemists to solve real-world mysteries in crime labs.

Supplies:

- 6 vials of white powders of known identity
- 6 vials of white powders of unknown identity (labeled #1 ~ #6).
- 1 pipet of vinegar
- 1 pipet of iodine solution
- 1 bottle of deionized (DI) water
- a 24-well plate
- a spot plate (a ceramic plate with small wells in it)
- a 250-mL beaker
- a plastic cup for waste water
- a magnifying glass
- a plastic stirrer
- a straw scoop
- a Beral pipet
- 1 vial of blue litmus paper
- 1 vial of red litmus paper

Safety:

- **Goggles must be worn throughout the lab.**
- Never taste **ANY** chemical, even those that could be found in a kitchen. **Tasting a substance should NEVER be used as a technique for identifying a substance!!!!!**
- The chemicals used in this lab are very dilute and safe when handled carefully. Everything can be disposed of down the drain.
- When you are done, rinse the 24-well plate and all the glassware. Dry them as much as you can. Wipe down your bench with paper towels.
- **Wash your hands before leaving the lab.**

Part A: THE COOKIE MYSTERY

While you are visiting a friend of yours, the principal of the Ooblek Elementary School, she told you that someone has broken into the cafeteria kitchen and taken ALL the cookies that were prepared for the kindergarten class. "What kind of person would steal cookies from the kindergarteners?" you asked. Outraged, you offered to help catch the "cookie culprit" using the chemistry knowledge you learned in SCI 265L. You investigated the "crime scene" first. The culprit must have accidentally spilled the baking powder, since it is all over the floor. The principal told you that there is only one room for each grade in this small school, which made the investigation a bit easier. Then you asked each teacher to send to you any student who left the classroom in the morning. The teachers of grades 1 through 6 each sent one student. Because the entire school is doing art projects for the holidays, all six students had some white powder on his or her shoes. You collect the powders and label them 1 through 6 (just like the ones that were provided to you in this lab. Of course, in a real crime situation, you would have only a tiny bit of each powder), representing the grade levels. You then interviewed the teachers and found out that the students are using salt, corn starch, sugar, cream of tartar, and baking soda in the art projects. No class was working with baking powder.

You are now ready to analyze the powders found on the students' shoes. You set up a workspace in the science room and started examining their physical and chemical properties of the powders. For comparison, you gathered all the white powders that can be found in the kitchen. In an earlier lab, you learned about physical and chemical changes. Based upon your previous experience, **write a statement below that summarizes each of these processes**:

1. Physical change:

2. Chemical change:

Procedure:

Perform the following five tests on the six powders found in the school's kitchen as well as the six unknown powders collected from the six students. Record your observations on the report sheets. You will identify each of the unknown powders by matching its properties to one of the known powders. You will then identify the grade level of the cookie culprit.

1. Appearance test

IMPORTANT: You will use the same straw scoop to get different powders. To avoid cross-contaminating the powders, the straw scoop must be cleaned before it is used to get the next powder. Otherwise, the validity of the analysis could be compromised. To clean the straw scoop, put some DI water in the 250-mL beaker. Dip the straw scoop in the DI water to rinse off any leftover powder. Wipe it dry with a piece of paper towel before using it to get the next powder.

Using the straw scoop, put a small amount of each powder into a well in the 24-well plate. Keep track of which powder is in which well. Use the magnifying class to examine the appearance of each known and unknown powder. Do they have any characteristic shape? If so, either describe the shape or draw a sketch of the shape on the observation sheets.

2. Solubility test

IMPORTANT: You will use the same plastic stirrer to stir all the solutions during the solubility test. To avoid cross-contaminating the solutions, the plastic stirrer must be cleaned before it is used to stir the next solution. Otherwise, the validity of the analysis could be compromised. Follow the same procedure above for cleaning the plastic stirrer. You might want to change out the DI water.

Test the solubility of each known and unknown powder. Fill a well about half full using DI water. Stir for at least one minute using the plastic stirrer. On the observation sheet, indicate whether the substance is "soluble" or "insoluble". A substance is considered soluble if it dissolves in water (the solution becomes clear after stirring). If the solution looks cloudy, label the substance insoluble. Note any other changes, such as color changes or formation of a gas that bubbles out of the solution. **The formation of gas bubble requires careful observation and additional testing, if necessary**. Pay close attention to what happens after the addition of DI water. Save the solution or mixture for the next test.

3. Litmus paper test

IMPORTANT: You will use the Beral pipet to get a drop of different solutions for the litmus paper test. To avoid cross-contaminating the solutions, the Beral pipet must be cleaned before it is used to get the next solution. Otherwise, the validity of the analysis could be compromised. Rinse out the 250-mL beaker with some tap water first, followed by a rinse with some DI water. Put some fresh DI water in the beaker. To clean the Beral pipet, suck some water into the pipet. Discard the water in the plastic cup labeled "waste water". Repeat a couple of times.

Tear a strip of red litmus paper into four smaller pieces. Put a small piece in each well of the spot plate. Using the Beral pipet, carefully place a drop of each solution (12 in total) onto a piece of red litmus paper. This will be demonstrated in class by your instructor. Note any color changes of the litmus paper.

Discard the red litmus papers in the trash can. Rinse the spot plate with tap water first, followed by DI water. Dry the wells. Repeat the litmus paper test for all 12 solutions, this time with blue litmus paper.

4. Iodine test

Iodine reacts with starch (and only starch) to form a dark blue complex. Therefore, a dark blue color is used in crime labs as an indicator for the presence of starch. Using the Beral pipet containing iodine solution, add 2 drops of iodine solution to each of the 12 wells in the 24-well plate. Stir with the plastic stirrer. Record your observations on the report sheets.

5. Vinegar test

Vinegar is a dilute solution of acetic acid, $HC_2H_3O_2$. Using the Beral pipet containing vinegar, add 3 drops of vinegar to each of the 12 wells and record your observations. Report whether or not a chemical change has taken place. **Explain your answer**. (To answer this question, you might need to refresh your memory about observations that typically accompany a chemical change.)

Observation sheet for known powders

	Appearance	Solubility test	Red litmus paper	Blue litmus paper	Iodine test	Vinegar test
Baking Powder						
Baking Soda						
Corn Starch						
Cream of Tartar						
sugar						
Table salt						

Observation sheet for unknown powders

	Appearance	Solubility test	Red litmus paper	Blue litmus paper	Iodine test	Vinegar test
#1						
#2						
#3						
#4						
#5						
#6						

IDENTIFICATION

At this point, discuss your observations within your group and determine the identity of each unknown powder. Identify them below and give the reasons for your decisions.

Unknown #1:

Unknown #2:

Unknown #3:

Unknown #4:

Unknown #5:

Unknown #6:

What is the grade level of the cookie culprit? _____

FOLLOWUP QUESTIONS

1. From the list of powders with known identify, which powder, if any, is acidic? _____ Explain how you decided.

2. From the list of powders with known identify, which powder, if any, is basic? _____ Explain how you decided.

3. You are given a mixture containing two of the powders. You carry out the tests above and find these results:

	Appearance	**Solubility test**	**Red litmus paper**	**Blue litmus paper**	**Iodine test**	**Vinegar test**
The mystery mixture	**No particular shape**	**Cloudy solution, No bubbles seen**	**Blue/purple**	**Blue/purple**	**Dark blue**	**Bubbles appear**

Which two powders are present in the mixture? Explain how you decided.

Part B. REPLACING THE BAKING POWDER

Since all the cookies are gone, the kitchen lady, Ms. Pillsbury, needs to make some more cookies for the kindergarten class. FAST. But there is a problem. There is no more baking powder! The cookie culprit spilled it all. Since you have done such a good job so far and have developed a pretty good idea about the nature of baking powder while testing the powders, Ms. Pillsbury is really counting on you to make some baking powder using the substances already available in the kitchen. Reflect on the nature of baking powder and think about how you can save the day. Here is some information that might help!

1. Sodium hydrogen carbonate (*aka* sodium bicarbonate), $NaHCO_3$, is commonly called baking soda. The rising action of baking soda in bread and dough occurs when a weak acid, HA (a generic formula that represents any acid), reacts with the hydrogen carbonate ion (HCO_3^-) in the baking soda:

$$NaHCO_3\ (aq) + HA\ (aq) \rightarrow NaA\ (aq) + H_2O\ (l) + CO_2\ (g)$$

   The release of CO_2 gas causes the dough to rise.

Which of the following substances can you use in a recipe to react with baking soda to make the dough rise? Circle all your choices:

vinegar cornstarch sugar lemon juice salt

2. Baking powder contains a solid weak acid as well as the sodium hydrogen carbonate. When water is added, the acid reacts with the hydrogen carbonate ion (HCO_3^-) and carbon dioxide is released. Cornstarch is added to the mixture to keep the reagents from reacting in the dry powder. Which of the following mixtures could you use to make baking powder?

   a) corn starch, baking soda, and salt

   b) corn starch, baking soda, and cream of tartar

   c) corn starch, baking soda, and sugar

3. Make up a baking powder by mixing approximately equal amounts of each of the three powders you selected above. Test your improvised baking powder by conducting the following tests and record your observations:

	Appearance	**Solubility test**	**Red litmus paper**	**Blue litmus paper**	**Iodine test**	**Vinegar test**
Your baking powder						

Compare your observations with those for the baking powder you tested earlier. Based on the comparison, will your baking powder work? If not, suggest an explanation for any differences.

4. Which tests above involve a chemical change?

5. Which test(s) involve only physical properties or changes?