Experiment 5: Identification of Unknowns

Introduction

A variety of chemical tests can be used to identify an unknown substance. In this experiment you will carry out some simple chemical tests to determine the identities of compounds which are unknown to you. You will perform **qualitative analyses**, that is, tests that are done simply to identify the material, but not to determine the amount of that material present. **Quantitative analysis**, on the other hand, involves the determination of the amounts of materials.

In the lab you will be given three compounds (your "unknowns") that will be named only by letters (for example, unknowns A, B, and C). The flow chart on page 2 outlines the chemical tests you will perform in order to identify your unknowns. Follow along on the flow chart as you read the following explanation.

How to use the flow chart (page 44):

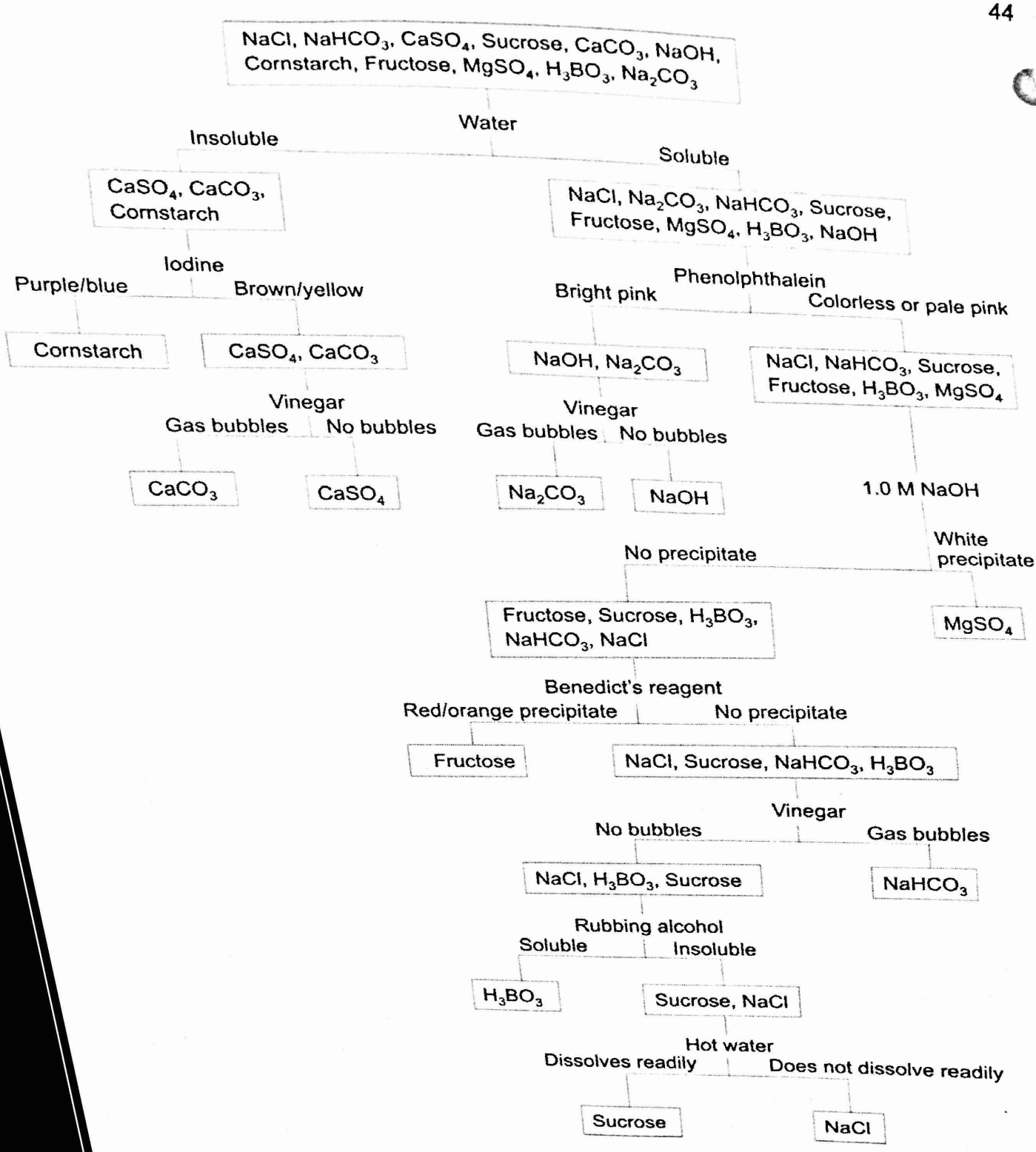
The box at the top lists all the possible identities for the unknowns.

Some of these compounds are soluble in water, and some are not. Therefore, you will first perform a water-solubility test by attempting to dissolve the unknown in water. If the unknown is not soluble in water, you know that it must be one of the 3 non-water-soluble compounds listed in the box on the left. If the unknown is soluble in water, then it must be one of the 8 water-soluble compounds listed in the box on the right.

Suppose you determined that your unknown was not soluble in water. You know that it must be $CaSO_4$, $CaCO_3$, or cornstarch (compounds in box on left). Following the flow chart, you would next perform the iodine test. As the flow chart shows, cornstarch will turn purple when iodine is added, but the other two compounds turn a shade of brown or yellow. If you add iodine to your unknown and it turns purple, you know that the unknown is cornstarch. At that point you can stop the analysis since cornstarch is the only unknown that will turn purple with iodine—you have unambiguously identified the unknown.

However, if you add iodine and your unknown turns brown or yellow, it could be $CaSO_4$ OR $CaCO_3$. In that case, you would need to proceed to the next test to determine which of the two it is. The flow chart shows that you should use the vinegar test to distinguish between the two. If you add vinegar to the unknown and see bubbles of gas rising from the compound, your unknown is $CaCO_3$. If no gas bubbles are produced, your unknown is $CaSO_4$. You can then stop the analysis since you will have unambiguously determined that your unknown was $CaCO_3$ or $CaSO_4$, based on the vinegar test.

The remainder of the flow chart (on the right side), would be followed in a similar manner for any of the water-soluble unknowns.


NaCl, $NaHCO_3$, $CaSO_4$, Sucrose, $CaCO_3$, NaOH, Cornstarch, Fructose, $MgSO_4$, H_3BO_3, Na_2CO_3
Water
Insoluble
Soluble
$CaSO_4$, $CaCO_3$, Cornstarch
NaCl, Na_2CO_3, $NaHCO_3$, Sucrose, Fructose, $MgSO_4$, H_3BO_3, NaOH
Iodine
Purple/blue
Brown/yellow
Phenolphthalein
Bright pink
Colorless or pale pink
Cornstarch
$CaSO_4$, $CaCO_3$
$NaOH$, Na_2CO_3
NaCl, $NaHCO_3$, Sucrose, Fructose, H_3BO_3, $MgSO_4$
Vinegar
Gas bubbles
No bubbles
Vinegar
Gas bubbles
No bubbles
$CaCO_3$
$CaSO_4$
Na_2CO_3
NaOH
1.0 M NaOH
No precipitate
White precipitate
Fructose, Sucrose, H_3BO_3, $NaHCO_3$, NaCl
$MgSO_4$
Benedict's reagent
Red/orange precipitate
No precipitate
Fructose
NaCl, Sucrose, $NaHCO_3$, H_3BO_3
Vinegar
No bubbles
Gas bubbles
NaCl, H_3BO_3, Sucrose
$NaHCO_3$
Rubbing alcohol
Soluble
Insoluble
H_3BO_3
Sucrose, NaCl
Hot water
Dissolves readily
Does not dissolve readily
Sucrose
NaCl

Identification of Unknowns: Prelab

Name _____

1. In this experiment you will do qualitative analyses to determine the identity of unknown compounds.
What does qualitative analysis mean?

What does quantitative analysis mean?

2. Use the flow chart to answer the following questions (A-E).
A. Which non-water-soluble compound produces bubbles of gas when vinegar is added?

B. Which two water-soluble compounds produce bubbles of gas when vinegar is added?

C. Carefully examine the chemical formulas of the three compounds you just named above. What ion do all three have in common? Be sure to include the correct charge on the ion.

D. Suppose that you are working with a water-soluble unknown which does not produce a bright pink colored solution when phenolphthalein is added. Based on this result, which of the unknowns might you have? (list all possible identities)

E. After getting the results of this phenolphthalein test (no pink color; part D), which test should you perform next to narrow down the list of possible identities for your unknown?

3. It is very important not to use too much of the unknown compound when carrying out the water-solubility test. Suppose you are working with an unknown that is actually soluble in water: you take a sample of the unknown that is too large (larger than the amount specified in the experimental procedure) and add some water. What do you think will happen?