In this experiment, you will know WHAT the six solutions are, but you won't know WHICH BOTTLE contains which solution. Observations such as those described above for reactions AMONG the six solutions you are given can be related to the known chemistry of the given ions. Small portions (approx. 0.5 mL) of the six solutions are mixed, pairwise, and observations recorded and COMPARED to KNOWN reactions of the solutions involved.

Procedure

Safety Precautions

CAUTION! WEAR SAFETY GLASSES AT ALL TIMES!!

- Silver nitrate, $AgNO_3$ —toxic and corrosive, may stain skin
- Hydrochloric acid, HCl —toxic and corrosive, can cause skin burns
- Nitric acid, HNO_3 —corrosive and toxic
- Barium nitrate, $Ba(NO_3)_2$ —toxic by ingestion
- Calcium chloride, $CaCl_2$ —no major health risks
- Sodium carbonate, Na_2CO_3 —no major health risks

Equipment

- Well plate
- Pasteur pipets
- Rubber pipet bulbs

Chemicals

- Silver nitrate
- Hydrochloric acid
- Nitric acid
- Barium nitrate
- Calcium chloride
- Sodium carbonate

1. Obtain a 24-hole well plate. Rinse it several times with distilled water to make sure it is clean.

2. Obtain about 2 mL (1/2-inch high) of each solution in its appropriate test tube.

3. Place a pipet in each test tube, and be careful not to switch pipets between solutions (thus contaminating them) during the following procedure.

4. Also obtain some rubber bulbs from the table in your lab (there may not be enough for each student to take six; if this is the case, move the bulb from pipet to pipet as needed).

5. Add about eight drops of the first solution to an empty well. Then add about eight drops of a second solution

to this well. Observe what happens. Record your observations in your lab notebook. If no reaction occurs, swirl your well plate gently to mix the solutions. If still nothing has happened, write NR in your lab notebook for this combination.

6. Repeat this process until all possible combinations have been mixed.

A total of only 15 such tests is needed. (Note that mixing, e.g., solution A with solution B, is the same as mixing solution B with solution A.) You only need to complete Table II either above or below the diagonal; you can then complete the other half of the table by referring to the first half.

By comparing your results in Table II with the predictions made in Table QIA.1 from your pre-lab, you should be able to unambiguously identify each substance. Note in Table QIA.1 that each substance reacts IN A UNIQUE WAY with the other five substances. (For example, sodium carbonate forms THREE PRECIPITATES and evolves GAS TWICE with the other reagents, and is the ONLY substance of the six to do this.)

REMEMBER TO TURN IN THE YELLOW COPY OF YOUR LAB NOTEBOOK TO YOUR TA.

Disposal

Discard the contents of your well plate and test tubes in the beaker labeled WASTE SOLUTIONS. Rinse your well plate and test tubes twice with a small amount of water and discard into the WASTE SOLUTIONS beaker.

Dispose of the Pasteur pipets in the red plastic sharps-biohazard container. Return the pipet bulbs to the bag that they came from.

The six solutions provided to you are listed in REPORT Table QIA.1. Indicate whether the products are solids, liquids, or gases (based on what was said above). If NO reaction is to be expected based on the substances to be mixed, write "N.R." in the box.

Check REPORT Table QIA.1 by completing the pre-lab in Labflow.

Report Table QIA.1: Possible Combinations of Six Solutions

	Na_2CO_3	$CaCl_2$	$Ba(NO_3)_2$	$AgNO_3$	HCl	HNO_3
Na_2CO_3						
$CaCl_2$						
$Ba(NO_3)_2$						
$AgNO_3$						
HCl						
HNO_3						

Complete Report Table QIA.2 during the lab period.

Report Table QIA.2: Experimental Results from your 15 Tests

Solution Letters						

Write NET IONIC EQUATIONS (there are seven) for all REACTIONS (precipitate formation and gas evolution) you have listed in Report Table QIA.1.

1.

2.

3.

4.

5.

6.

7.

Report Table QIA.3: Identification of Solutes

Code	Formula

Post-Lab Questions

1. One aspect of qualitative inorganic analysis involves the study of reactions between ions in solution. Evidence for reactions when two solutions are mixed is based on observations. Name two observations one might observe to indicate that a reaction has occurred when two solutions are mixed.

2. What are spectator ions?

3. What ions are formed when the following substances are dissolved in water?
   A Na_2SO_4

   B $CoCl_2$

   C Lithium carbonate

4. Complete the following reactions and then write the net ionic equation for each reaction.

   A $Ba(NO_3)_2 + K_2SO_4 \rightarrow$

   B $K_2CO_3 + HNO_3 \rightarrow$

5. An aqueous sample is known to contain Pb^{2+}, Cu^{2+}, or Na^{+} ions. Treatment of the sample with both NaOH and LiCl solution produces a precipitate.

   A Which of the metal cations does the solution contain? Explain your reasoning.

   B Write all net ionic equations that could occur to justify your reasoning.