Classifying Chemical Reactions

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Purpose of the Experiment

- To make observations when reactants are combined and become familiar with indications of chemical change.
- To learn how to classify reactions based on observations of chemical change.
- To recognize when a chemical reaction has occurred and to write the balanced equation correctly

Background Required:
Complete the online prelab assignment for "Classifying Chemical Reactions" BEFORE the start of the lab session. You will work in pairs for this experiment.

Background Information:
Chemical reactions happen when the atoms or ions in the starting substances (reactants) are re-arranged to form substances with different chemical compositions (products). Chemists use chemical equations, which show the starting materials, end products, and sometimes, reaction conditions, to describe what has happened in a reaction. Chemical reactions can occur silently with no visual indication that a reaction has occurred. Reactions can also be quite dramatic, with explosions and color changes, flames and sparks.

We can learn to recognize patterns of reactions and to interpret observations made during a reaction in order to predict the reaction products. We start by learning the 4 general reaction types, which show how the atoms or ions are being re-arranged. These general reaction types are described below:

1. Synthesis: **A + B → AB** Two or more reactants combine to give one product

   Example: $4Fe(s) + 3O_2\ (g) \rightarrow 2Fe_2O_3\ (s)$

2. Decomposition: **AB → A + B** A single reactant is broken down into two or more substances.

   Example: $2NaN_3\ (s) \rightarrow 2Na\ (s) + 3N_2\ (g)$

3. Single-Displacement: **A + BC → AC + B** One element replaces another element in a compound.

   Example: $Br_2\ (l) + 2KI\ (aq) \rightarrow I_2\ (s) + 2KBr\ (aq)$

4. Double-Displacement: **AB + CD → AD + CB** The anions and cations of two compounds are exchanged to produce two different compounds.

   Examples: $2AgNO_3\ (aq) + BaCl_2\ (aq) \rightarrow 2AgCl\ (s) + Ba(NO_3)_2\ (aq)$ precipitation
   $NaOH\ (aq) + HNO_3\ (aq) \rightarrow NaNO3\ (aq) + H2O\ (l)$ acid-base

In today's lab, you will be combining reactants and observing and recording any changes in the reactants or indications of the formation of products. Common indications that a reaction has taken place include color changes, formation of gas (bubbles or vapor), formation of a solid product, temperature changes, disappearance of a reactant as well as change in a chemical indicator, such as pH. Based on your observations, you will write and balance chemical equations for the reactions you observe and classify each reaction into one of the 4 general reaction types.

Equipment and Reagents:

1 M silver nitrate (for instructor demo only)	copper wire ~ 3" long (for instructor demo)
1 M barium chloride	1 M sodium sulfate
Magnesium ribbon cut in ~ 1" strips	1 M hydrochloric acid
3% hydrogen peroxide	Yeast
Wood splints	1 M Ammonia solution
Dry ice (approximately ¾ inch pieces)	Universal indicator solution (pH 4-11)
3 large test tubes	10 mL graduated cylinder
150 and 100 mL beakers	Glass stir rod with rubber policeman

Safety: Always wear your safety goggles while in the lab room. Do not dispose of anything in the drain unless specifically directed to by your instructor. When combining chemicals in a test tube, use a test tube holder or a beaker. Dry ice (solid carbon dioxide) can cause frostbite; do not touch with your bare hands!

Procedure:
There will be four stations set-up in the lab, one for each of the reactions. You do not have to do the reactions in order. Obtain three clean, dry large test tubes from your drawer, and set them in your test tube holder. Set out a 150 mL beaker for the collection of waste. The combined waste will go into the labeled waste container at the very end of the lab session. You do not have to do the reactions in order.

Station 1: Barium Chloride and Sodium Sulfate
1. Carry ONE of your large test tubes in a 250 mL beaker to station 1. Add 1-2 mL (~1 cm high) of 1 M barium chloride to the test tube.
2. With the test tube sitting propped up in the 250 mL beaker, add about the same amount of 1 M sodium sulfate to the test tube.
3. Touch the outside of the test tube to note any temperature change.
4. Record your detailed observations in the data section.

Station 2: Magnesium and Hydrochloric Acid
1. Bring a 10 mL graduated cylinder and 1 large test tube in a 250 mL beaker to Station 2.
2. Roll three magnesium strips into loose balls and drop them into the empty test tube.
3. Measure about 2 mL of 1 M hydrochloric acid into your10 mL graduated cylinder.
4. BEFORE you add the 1 M hydrochloric acid to the magnesium, have your lab partner light a wooden splint.
5. When ready with the splint, add the acid to the test tube with the magnesium ribbon, and quickly have your partner hold the lit end of the splint inside the top of the test tube. NOTE: The flame should <u>not</u> be placed so far down that it reaches the liquid!
6. Touch the outside of the test tube to note any temperature change.
7. Record your detailed observations in the data section.

Station 3: Hydrogen Peroxide and Yeast

1. Bring a 10 mL graduated cylinder, your spatula, and 1 large test tube in a 250 mL beaker to Station 3.
2. Using your spatula, add a pea size amount of yeast to the test tube.
3. Measure about 2 mL of 3% hydrogen peroxide into your 10 mL graduated cylinder.
4. BEFORE you add the hydrogen peroxide to the yeast have your lab partner light a wooden splint. Allow it to burn for a few seconds, and then gently blow out the flame so that it leaves some red glowing embers.
5. With the test tube sitting propped up in the 250 mL beaker, add the hydrogen peroxide to the yeast and immediately bring the red glowing embers in contact with the bubbles coming out of the test tube. NOTE: You do not want to get the wood splint wet. You just want to bring it into contact with the gas in the bubbles.
6. Touch the outside of the test tube to note any temperature change.
7. Record your detailed observations in the data section.

Station 4: Dry Ice and Water
At Station 4 you will use a color-changing indicator to show the pH of the solution as the reactions proceed. A color scale will be provided to you in the lab, but the colors will change as follows:

pH 4 (acidic) = orange
pH 7 (neutral) = green
pH 10 (basic) = blue

1. Carry your 100 mL beaker and stir rod to station 5.
2. Fill the beaker about one-fourth full of deionized water. Add 7-10 drops of the universal indicator and stir. Note the color, and record your observations in the data section.
3. Add 7-10 drops of the ammonia solution (possibly labeled as ammonium hydroxide). Again, note the color and record your observations in the data section.
4. Using the tongs provided, place 1-2 small pieces of dry ice (total size about that of a quarter) into your beaker and observe for about 1 minute. Do NOT take excess dry ice!
5. After 1 minute has passed, note the color and record your observations in the data section.

All solutions from stations 1-4 can be combined into your 150 mL waste beaker, and then collected in the labeled waste container in the hood. All wood splints go in the regular trashcan; wet them to make sure they are not still glowing.

Data, Observations and Discussion:
Complete your data tables by writing balanced chemical equations for each reaction and classifying each reaction according to the 4 general reaction types:

1. Start by writing the correct chemical formulas and states of the reactants.
2. Next, review your observations for what types of products were produced and their states.
3. Exchange, combine or separate the ions/atoms of the reactants to give products that are consistent with your observations.
4. Finally, balance the equation and add the states of the products.

Your instructor must check your data and discussion questions before you leave the lab. Staple and turn in only the Data Tables and Discussion Questions on the due date.

Name______________________ **Partner**______________________ **Section #**________

Data
Demo: Silver Nitrate and Copper
Observations:
Chemical Equation (with states)
General Reaction type:

Station 1: Barium Chloride and Sodium Sulfate
Observations:
Chemical Equation (with states)
General Reaction type:

Station 2: Magnesium and Hydrochloric Acid
Observations:
Chemical Equation (with states)
General Reaction type:

Station 3: Hydrogen Peroxide and Yeast
Observations:
Chemical Equation (with states) HINT: The yeast is just a catalyst, _not_ a reactant.
General Reaction type:

Station 4: Dry Ice and Water
Color and pH of water: Color and pH with ammonia solution: Color and pH with dry ice: Observations:
Chemical Equation (with states) HINT: The reaction is between dry ice and water only.
General Reaction type:

Discussion Questions (complete with your partner before leaving lab)

1. Did you observe a difference in the reaction of the flaming or glowing splint with the gases formed at Stations 2 and 3?

   Can you explain any differences based on the properties of the gaseous products that were formed?

2. How would you explain the change in the pH of the water when the dry ice was added?

3. A solution of sulfuric acid is added to a piece of iron ore. Look over your reaction data to answer the following questions.
   a. Would you expect to see any bubbles given off in this reaction?

   b. How would you classify this reaction according to the 4 general reaction types?

   c. If you put a glowing or flaming splint in the test tube, what would you expect to see and why?

4. Were any of the reactions exothermic (heat was given off)?