Types of Chemical Reactions

Chemist: _____Per: _____

Background:

There are many kinds of chemical reactions and several ways to classify them. One useful method classifies reactions into four major types. These are: (1) direct combination, or synthesis; (2) decomposition, or analysis; (3) single replacement; and (4) exchange of ions, or double replacement. Not all reactions can be put into one of these categories. Many, however, can.

In a synthesis reaction, two or more substances (elements or compounds) combine to form a more complex substance. Equations for synthesis reactions have the general form A+B→ AB.

A decomposition reaction is the opposite of a synthesis reaction. In decomposition, a compound breaks down into two or more simpler substances (elements or compounds). Equations for decomposition reactions have the form AB→ A+B.

In a single replacement reaction, one substance in a compound is replaced by another, more active, substance (an element). Equations for single replacement reactions have two general forms. In reactions in which one metal replaces another metal, the general equation is X+YB→XB + Y. In those in which one nonmetal replaces another nonmetal, the general form is X+AY→AX+Y

In a double replacement reaction, the metal ions of two different ionic compounds can be though of as "replacing one another." Equations for this type of reaction have the general form AB+CD→AD+CB. Most replacement reactions, both single and double, take place in aqueous solutions containing free ions. In a double replacement reaction, one of the products is a precipitate, and insoluble gas, or water.

All of the types of reactions discussed here may be represented by balanced molecular equations. Reactions involving ion exchanges may be represented by ionic equations also. In this investigation you will be concerned only with molecular formulas and equations. In a balance equation, the number of atoms of any given element must be the same on both sides of the equation. Multiplying the coefficient and the subscript of an element must yield the same result on both sides of the balanced equation.

Purpose: Students will observe seven different chemical reactions, identify the reactants and products of those reactions by both name and formula, and classify the reactions as one of the five basic types of chemical reactions. Students will also practice balancing chemical equations.

Materials:

Bunsen Burner	Wood Splints	Micro Spatula	Zinc, mossy
Crucible Tongs	400ml Beaker (to hold hot test tubes)		Striker
Evaporating Dish	7 Medium Test Tubes		Safety Goggles
Test Tube Holder	1M Copper (II) Sulfate, $CuSO_4$		Copper Wire, 10cm
Test Tube Rack	0.1M Sodium Phosphate, Na_3PO_4		
Copper (II) Carbonate, $CuCO_{3(s)}$			
Magnesium Ribbon, 5cm	1M Sodium Sulfite, Na_2SO_3		6M Hydrochloric Acid, HCl

Procedure: (check off the boxes as you do them!!)

1. Synthesis Reaction

- ☐ a. Obtain a clean piece of copper wire. Note the appearance.
- ☐ b. Using crucible tongs, hold the wire in the hottest part of a burner flame for 1minute.
- ☐ c. Examine the wire and record any change in its appearance.

2. Synthesis Reaction

- ☐ a. Place an evaporating dish near the base of the burner.
- ☐ b. Examine a piece of magnesium ribbon.
- ☐ c. Using crucible tongs, hold the sample in the burner flame until the magnesium starts to burn.

- ☐ d. DO NOT LOOK DIRECTLY AT THE FLAME. HOLD THE BURNING MAGNESIUM AWAY FROM YOU AND DIRECTLY OVER THE EVAPORATING DISH.
- ☐ e. When the ribbon stops burning, put the remains in the evaporating dish. Examine this product carefully.

3. Decomposition Reaction

- ☐ a. Place 1 micro spatula of copper (II) carbonate ($CuCO_3$) in a clean, dry test tube. Don't let it clump in the bottom! Note the appearance of the sample.
- ☐ b. HOLD TESTUBE AT AN ANGLE AWAY FROM EVERYONE. Using a test tube holder, heat the $CuCO_3$ strongly for about 1 minute.
- ☐ c. Insert a *burning* wood splint into the gas at the top of the test tube. **Do NOT drop the splint** into the solid $CuCO_3$. .
- ☐ d. Note any change in the appearance of the residue as well as the results of putting the burning wood splint into the gas.

4. Single Displacement (Replacement) Reaction

- ☐ a. Add about 3 mL (squirts) of 6M hydrochloric acid (HCl) to a test tube.
- ☐ b. **CAUTION**, *Handle acids with care. They can cause painful burns. Do not inhale any HCl fumes.*
- ☐ c. While holding the test tube with a test tube holder, carefully drop a small piece of zinc metal (Zn) into the acid. Record your observations.
- ☐ d. Invert a second test tube over the mouth of the test tube in which the reaction is taking place. Remove the inverted tube after about 30 seconds without flipping it over and quickly insert a burning wood splint into the mouth of the inverted test tube.
- ☐ e. **Hold on tight to the test tube.**
- ☐ f. Note the appearance of the substance in the reaction test tube as well as the results of putting the burning wood splint into the inverted test tube containing the gas.

5. Single Displacement (Replacement) Reaction

- ☐ a. Place a small amount of zinc metal in a test tube.
- ☐ b. Add just enough of the 1M copper (II) sulfate $CuSO_4$ to cover the metal.
- ☐ c. Wait about five minutes. LOOK at the solution and the zinc before and **after the reaction**.

6. Double Displacement (Replacement) Reaction

- ☐ a. Add about 1 mL (squirt) of 0.1M zinc acetate ($Zn(C_2H_3O_2)_2$) to a clean, dry test tube.
- ☐ b. Next, add about 1 mL (squirt) of 0.1M sodium phosphate (Na_3PO_4) solution to the test tube.
- ☐ c. Observe what happens and note any changes in the mixture.

7. Double Displacement (Replacement) Reaction

- ☐ a. Add about 5mL (squirts) of 1M sodium sulfite (Na_2SO_3) solution to a clean, dry test tube.
- ☐ b. To this solution, add about 1mL (squirt) of 6M HCl.
- ☐ c. Wait about five minutes.
- ☐ d. Note the odor given off by wafting some of the gas toward your nose. **DO NOT SMELL THE GAS DIRECTLY.**

Types of Chemical Reactions

Purpose:

Pre-lab Equations

1) Balance the equations, 2) Name the reactants & products, 3) Determine the type of reaction

Part A

1. ____ Cu(s) + ____ O_2(g) → ____ CuO (s) _____

2. ____ Mg (s) + ____ O_2(g) → ____ MgO (s) _____

Part B

3. ____ $CuCO_3$ (s) → ____ CuO (s) + ____ CO_2(g) _____

Part C

4. ____ Zn (s) + ____ HCl(aq) → _____ $ZnCl_2$(aq) + ____H_2(g) _____

5. ____ Zn(s) + _____ $CuSO_4$ (aq) → ____$ZnSO_4$ (aq) + ____ Cu (s)_____

Part D

6. ____$Zn(C_2H_3O_2)_2$ (aq) + ____Na_3PO_4 (aq) → ____ $NaC_2H_3O_2$ (aq) + _____$Zn_3(PO_4)_2$(s)

_____

7. ____ Na_2SO_3 (aq) + ____ HCl (aq) → ____ NaCl (aq) + ____ H_2O (l) + ____ SO_2 (g)

_____

Observations and Data:

Sample	**Before reaction**	**After reaction**
A. Synthesis		
1. Cu		
2. Mg		
B. Decomposition		
3. $CuCO_3$		
C. Single Replacement		
4. Zn + HCl		
5. Zn + $CuSO_4$		
D. Double Replacement		
6. $Zn(C_2H_3O_2)_2$ + Na_3PO_4		
7. Na_2SO_4 + HCl		

Analysis Questions

1. If you measured the mass of magnesium before and after the reaction in part A how would the two masses relate? Why?

2. How do you know that there is one zinc atom in a molecule of zinc acetate and three zinc atoms in a molecule of zinc phosphate?

3. What happen in reaction #7 in part D? How could you classify this as more than one type of reaction!

4. Balance the following questions and classify the type of reaction

1. ___$AgNO_3$ (aq) + ___ Cu(s) → ____ $Cu(NO_3)_2$(aq) + ___ Ag(s) _____

2. ___ $BaCl_2$(aq) + ___ Na_2SO_4(aq) → ____ $BaSO_4$(s) + ___ NaCl(aq) _____

3. ___ Cl_2(g) + ___ NaBr(aq) → ____ NaCl(aq) + ___ Br_2(g) _____

4. ___$KClO_3$(s) → ____ KCl(s)+ ___ O_2(g) _____

5. ___ H_2(g) + ___ O_2(g) → ____ H_2O(g) _____

6. ___ C_6H_{14}(g) + ___ O_2(g) → ____ H_2O(g) + ___ CO_2(g) _____

<u>CLAIM, EVIDENCE, REASONING (CER) CONCLUSION:</u>

CLAIM: <u>Answer</u> the following question: How can chemical reaction types be determined? (1 sentence)

EVIDENCE: <u>Describe</u> the evidence that supports the claim. Use observations and data (with units) from your lab results. (At least 3 sentences)

REASONING: <u>Explain</u> how the evidence that you're describing supports the claim that you made. This is the "because" section. Often you will need to refer back to basic scientific principles. Possibly include indicators of chemical reactions, the differences between chemical and physical reactions, etc. (At least 3 sentences)