Chemical Reactions: Introduction to Reaction Types

Procedure:

Safety and waste disposal directions are listed with each procedure.

General Directions:

1. Carry out the reactions using the approximate quantities of reagents indicated. Unless otherwise stated, use test tubes. To estimate 2 mL, measure 2 mL of water in a graduated cylinder and pour it into a test tube. Save this test tube for comparison.
2. When combining solutions in a test tube, tap the tube a few times to ensure that the solutions have mixed completely.
3. To heat a solid in a test tube, position the test tube holder near the top of the test tube, and hold the test tube in a slanted position so that the opening of the test tube is pointed away from people. Keep the bottom of the test tube in the hottest part of the burner, but continuously move it back and forth over the flame to avoid "hot spots" (overheating one part of the test tube).
4. There are two concentrations of HCl(aq) and NaOH(aq) used in this lab: 0.1M HCl and 0.1M NaOH to be used in **Section E.1**, 3M HCl to be used in **Section C.2** and 3M HCl and 3M NaOH to be used in **Section E.2**. Check labels carefully!

A. Combination Reactions

1. Heat a piece of copper wire strongly in the Bunsen burner flame (using crucible tongs) until a change in appearance is noted. Record any changes in the appearance of the copper wire in your lab report. Place the cooled wire in the regular trash.

***CAUTION*:** Do not look directly at the Mg ribbon as it burns, or you may damage your eyes.

2. Hold a strip of magnesium ribbon in the burner flame (using crucible tongs). Record any changes in your lab report.
3. Scrape the ash away from any **unreacted** Mg metal and place only the ash in a watch glass. Add a few drops of distilled H_2O, and stir with a stirring rod. Place a drop of the solution on blue litmus paper on the watch glass, and record your observations. Next, place a drop of the solution on red litmus paper on the watch glass, and record your observations. Litmus paper is an acid-base indicator. Acidic substances can turn blue litmus paper red while basic substances can turn red litmus paper blue. Indicate if mixing magnesium oxide ash with water produces an acidic or a basic substance. Dispose of the wet ash and any unreacted Mg in the waste jar in the hood. Rinse off the pieces of litmus paper with water, then dispose of them in the regular trash.

B. Decomposition Reactions

1. Review the demonstration of electrolysis performed by your instructor during the "States of Matter" lab of the decomposition of water by electrolysis. A current was passed through a sample and decomposed the compound.
2. Place approximately half a spatula full (roughly pea-sized) of copper(II) carbonate in a dry test tube. Observe the color of the sample. Using a test tube clamp, heat the test tube over a Bunsen burner until you notice a color change (approximately 30 seconds – 1 minute). Be sure to constantly move the test tube to avoid overheating the glassware! **DO NOT** return the hot test tube to the plastic test tube rack, or it will melt the plastic. Instead, cool the test tube in an **empty**

beaker. Record the color of the solid sample after heating. When cool, dispose of the contents in the waste jar in the hood.

C. Single-Replacement Reactions

***CAUTION*:** $AgNO_3$ will stain skin and clothes!

1. Place a piece of copper wire in a test tube with enough 0.1M $AgNO_3$ to cover it. Allow the test tube to stand for 5-10 minutes. Note changes in the appearance of both the wire and the solution. Dispose of the contents of the test tube in the waste jar in the hood.

***CAUTION*:** 3M HCl(aq) can damage skin and clothing on contact. Rinse any spills on skin immediately with plenty of water for 10 minutes. Neutralize all spills on the lab bench with water or $NaHCO_3$ solution, and rinse your hands thoroughly.

2. Place a small piece of zinc metal in a test tube containing 2 mL of 3M HCl, and record your observations. Dispose of the contents of the test tube in the waste jar in the hood.

D. Double Replacement/Precipitation Reactions

***CAUTION*:** $AgNO_3$ will stain skin and clothing!

1. In 3 separate test tubes, deliver 2 mL of 0.1M $AgNO_3$. In the first test tube add 2 mL of 0.1M $CaCl_2$ solution. In the second test tube, add 2 mL of deionized water. In the third test tube add 2 mL of tap water. Compare the results for test tube **1** with those for test tubes **2** and **3**. What do these comparisons tell you about the ions present in deionized and tap water? Dispose of the contents of the test tubes in the waste jar in the hood.

2. In a small, clean test tube, combine 10 drops of $Pb(NO_3)_2$ with 10 drops of KI. Thoroughly mix the solutions in the vortex machine and record your observations.

Before you begin E, prepare your watch glass for part F by cooling it as described in part F.1. below.

E. Acid-Base Neutralization Reactions

***CAUTION*:** NaOH(aq) and HCl(aq) can damage skin, eyes, and clothes on contact. Rinse off any spills immediately with plenty of water for 10 minutes. Neutralize all spills on the lab bench with water or $NaHCO_3$ solution, and rinse your hands thoroughly.

1a. Place a piece of blue litmus paper and a piece or red litmus paper on a watchglass, leaving a 1-inch gap between them. Place a drop of 0.1M HCl(aq) on the blue litmus paper, and record your observations. Place a drop of 0.1M NaOH on the red litmus paper, and record your observations.

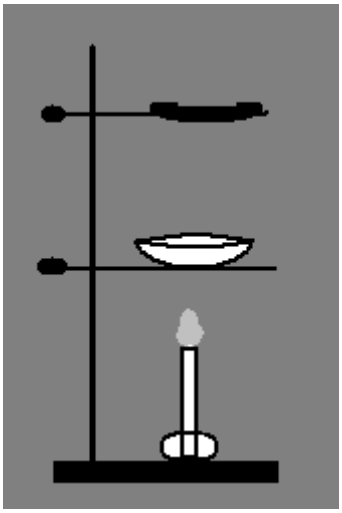
1b. When an acid reacts with a base to produce water, heat is also usually released. Add 10 drops of 3M HCl(aq) to a test tube, then add 10 drops of 3M NaOH to the same test tube. Hold the bottom of the test tube and note any heat energy changes. Record your observations.

2. Place a small amount of solid Na_2CO_3 in a test tube, then add a few drops of 3M HCl(aq) to the test tube. Record your observations.

F. Combustion Reactions

1. Place your watch glass in the Styrofoam cooler in the hood. Make sure the watch glass does not come into contact with water or this will interfere with the reaction in part 2. It can be placed on top of the metal grating in the Styrofoam cooler. This setup will cool your watch glass to facilitate observations in part 2 (below). The watch glass should cool for about 10 minutes before you begin part 2.

2. Place about 10 – 15 drops of isopropyl alcohol (C_3H_7OH) in a small evaporating dish (on a wire gauze and ring clamp – see the figure below). Using a second ring clamp about 8 – 10 inches above the evaporating dish, place a cold watch glass (chilled in the Styrofoam cooler) on the upper ring stand. Also place a few pieces of ice on the watch glass. Note the condensation of water on the bottom of the watch glass. Ignite a wooden splint in the Bunsen burner and use the burning wooden splint to light the alcohol. You may have to repeat this procedure a few times to see the condensation. If you keep the watch glass above the flame too long or if the flames reach too high and touch the watch glass, the condensed water will evaporate!



Chemical Reactions: Introduction to Reaction Types: Lab Report

Name: _____
Partner(s): _____
Section Number: _____

Part A: Video Reactions: Record your observations of the video reactions chosen by your instructor. Your instructor will discuss the reactions with you.

1. Combination:

Reaction equation:

2. Decomposition:

Reaction equation:

3. Single Replacement:

Reaction equation:

4. Double Replacement/Precipitation:

Reaction equation:

5. Acid-Base Neutralization – no video

Reaction equation:

6. Combustion

Reaction equation:

Part B: Record your observations of each starting material, the reaction as it happens, and the final product of each reaction.

A. Combination Reactions

Reaction	Observations
1. Cu metal is heated in O_2	Cu metal: Reaction: Product:

2. Mg metal is heated in O_2	Mg metal: Reaction: Product:
3. Magnesium oxide ash and H_2O	ash + water on blue litmus paper: ash + water on red litmus paper: Magnesium oxide ash + water is: acidic basic

B. Decomposition Reactions

Reaction	Observations
1. Electrolysis of water – see your observations from the "States of Matter" lab	
2. Decomposition of $CuCO_3$	$CuCO_3$ before heating: $CuCO_3$ after heating:

C. Single-Replacement Reactions

Reaction	Observations
1. Cu metal and $AgNO_3$	Copper wire before reaction: _____ $AgNO_3$(aq) before reaction: _____ Color of solution after reaction: _____ Copper wire after reaction: _____
2. Zn metal and HCl(aq)	Zn metal: HCl solution: Reaction: Product:

D. Double Replacement/Precipitation Reactions

Reaction	Observations
1. $AgNO_3$ and $CaCl_2$	$AgNO_3$ + $CaCl_2$: _____ $AgNO_3$ + DI water: _____ $AgNO_3$ + tap water: _____ Tap water must contain _____ ions.
2. $Pb(NO_3)_2$ and KI	$Pb(NO_3)_2$: KI: Product:

E. Acid-Base Neutralization Reactions

Reaction	Observations
HCl(aq) and NaOH	1a. HCl(aq) + blue litmus paper: _____ 1b. NaOH + red litmus paper: _____ 2. HCl(aq) + NaOH:
2. HCl(aq) and Na_2CO_3	HCl solution: Na_2CO_3: Reaction: Product:

F. Combustion Reactions

Reaction	Observations
1. Igniting isopropyl alcohol in O_2	Alcohol: Reaction: Product:

Word Equations and Balanced Chemical Equations

Translate each of the following word equations into a balanced chemical reaction by writing the correct chemical formulas (including physical states) for the reactants and products. Make sure to balance each equation.

Example: Aluminum metal reacts with oxygen to form solid aluminum oxide.

aluminum metal + oxygen gas $\rightarrow$ aluminum oxide

$4\ Al\ (s) + 3\ O_2\ (g) \rightarrow 2\ Al_2O_3\ (s)$

A. Combination Reactions

1. Copper reacts with oxygen to form copper(II) oxide.

copper metal + oxygen gas $\xrightarrow{\Delta}$ copper(II) oxide

2. Magnesium metal reacts with oxygen to form magnesium oxide.

magnesium metal + oxygen gas $\xrightarrow{\Delta}$ magnesium oxide

3. Magnesium oxide (ash) reacts with water to form magnesium hydroxide.

magnesium oxide + water $\rightarrow$ magnesium hydroxide

B. Decomposition Reactions

1. Water decomposes into hydrogen gas and oxygen gas.

water $\rightarrow$ hydrogen gas + oxygen gas

2. Copper(II) carbonate decomposes into copper(II) oxide and carbon dioxide gas.

copper(II) carbonate $\rightarrow$ copper(II) oxide + carbon dioxide gas

C. Single-Replacement Reactions

1. Copper reacts with silver nitrate to form silver metal and copper(II) nitrate.

copper metal + silver nitrate $\rightarrow$ silver metal + copper(II) nitrate

2. Zinc metal reacts with hydrochloric acid to produce zinc chloride and hydrogen.

zinc metal + hydrochloric acid $\rightarrow$ zinc chloride + hydrogen gas

D. Precipitation Reactions

1. Silver nitrate and calcium chloride react to form calcium nitrate and silver chloride.

silver nitrate + calcium chloride $\rightarrow$ silver chloride + calcium nitrate

2. Lead(II) nitrate and potassium iodide react to form Lead(II) iodide and potassium nitrate.

lead(II) nitrate + potassium iodide $\rightarrow$ lead(II) iodide + potassium nitrate

E. Acid-Base Neutralization Reactions

2. Hydrochloric acid reacts with sodium hydroxide to form water and aqueous sodium chloride.

hydrochloric acid + sodium hydroxide $\rightarrow$ water + sodium chloride

3. Hydrochloric acid reacts with sodium carbonate to form water, carbon dioxide gas, and aqueous sodium chloride.

hydrochloric acid + sodium carbonate $\rightarrow$ water + carbon dioxide gas + sodium chloride

F. Combustion Reactions

1. Isopropyl alcohol burns in air to produce carbon dioxide and steam.

isopropyl alcohol, C_3H_7OH (l) + oxygen gas $\xrightarrow{\Delta}$ carbon dioxide gas + steam

Part E: Balancing and Categorizing Chemical Equations:
Balance each of the 12 chemical equations given below, and identify each as one of the six types listed below.

Combination reaction (C)
Decomposition reaction (D)
Single-Replacement reaction (SR)
Double-Replacement/Precipitation reaction (DR)
Acid-Base Neutralization reaction (N)
Combustion reaction (B)

TYPE

_____ 1. _____ $Al_{(s)}$ + _____ $NiCl_{2\ (aq)} \rightarrow$ _____ $Ni_{(s)}$ + _____ $AlCl_{3\ (aq)}$

_____ 2. _____ $Ba(OH)_{2\ (s)}$ + ____ $FeCl_{3\ (aq)} \rightarrow$ ____ $BaCl_{2\ (aq)}$ + ____ $Fe(OH)_{3\ (s)}$

_____ 3. _____ $C_4H_{10\ (l)}$ + _____ $O_{2\ (g)} \rightarrow$ _____ $CO_{2\ (g)}$ + _____ $H_2O_{(g)}$

_____ 4. _____ $KClO_{3\ (l)} \xrightarrow{\Delta}$ _____ $KCl_{(l)}$ + _____ $O_{2\ (g)}$

_____ 5. _____ $Al_{(s)}$ + _____ $I_{2\ (s)} \xrightarrow{\Delta}$ _____ $AlI_{3\ (s)}$

_____ 6. _____ $H_2SO_{4\ (aq)}$ + _____ $Mg(OH)_{2\ (s)} \rightarrow$_____ $H_2O_{(l)}$ + _____ $MgSO_{4\ (aq)}$

_____ 7. _____ $CH_3OH_{(l)}$ + _____ $O_{2\ (g)} \rightarrow$ _____ $CO_{2\ (g)}$ + _____ $H_2O_{(g)}$

_____ 8. _____ $Ca_{(s)}$ + _____ $O_{2\ (g)} \xrightarrow{\Delta}$ _____ $CaO_{(s)}$

_____ 9. _____ $Mg_{(s)}$ + _____ $CO_{2\ (g)} \rightarrow$ _____ $MgO_{(s)}$ + _____ $C_{(s)}$

_____ 10. _____ $Na_3PO_{4\ (aq)}$ + ____ $MgCl_{2\ (aq)} \rightarrow$ ____ $Mg_3(PO_4)_{2\ (s)}$ + ___ $NaCl_{(aq)}$

_____ 11. _____ $HgO_{(s)} \xrightarrow{\Delta}$ _____ $Hg_{(l)}$ + _____ $O_{2\ (g)}$

_____ 12. _____ $H_3PO_{4\ (aq)}$ + ____ $NaOH_{(aq)} \rightarrow$ _____ $H_2O_{(l)}$ + ____ $Na_3PO_{4\ (aq)}$