Equations
hedule

Name:

Students gain an understanding of chemical formulas, solutions, molecular formulas, and balanced equations and reactions.

Objectives: Demonstrate knowledge of the mole concept/stoichiometry.
Upon completion of the reading and problems, and when asked to demonstrate their understanding either orally or on a written test, students will:

1. Define or identify the following:
   chemical equation, coefficient, double replacement, single replacement, decomposition, products, reactants, synthesis, activity series
2. Write chemical equations
3. Balance chemical equations
4. Identify types of chemical equations
5. Balance redox equations
6. Determine the energy within a given equations

Monday 11/18 **What is an equation? What has to be true?**

1. Intro to equations (ws 1)
2. Formula equations
3. Balancing equations (ws 2)
4. cw/hw: worksheets 1 & 2
   - Read Chapter 9 (Chemical Reactions)

Pre-labs are needed for labs B, D, & E. You will NOT be allowed to participate without a pre-lab. You must complete a formal lab report before May 17.

Tuesday 11/19 **What are the types of reactions?**

1. Go over homework
2. Balancing Equations
   - Trial and Error vs. Algebraically
3. Follow The Yellow Brick Road (A)
4. Word Equations (ws 3)
5. cw/hw - balancing (ws 4)
   - Classification of chemical reactions (ws 5)

Wednesday 11/20 **What are the products of combustion reactions?**

1. Quiz – Polyatomic Ions
2. Race - Balancing Chemical Equations
3. Synthesis
4. Decomposition
5. Combustion
6. cw/hw – Synthesis and Decomposition worksheet 6
   - combustion ws 7
   - Pre-lab To form or not to form (B)

Thursday 11/21 **Why is an activity series needed for single replacement reactions?**

1. Go over homework
2. Single replacement/displacement
3. Activity series
4. Lab Activity — To Form or Not To Form(B)
5. Single Replacement (ws 8)

Friday 11/22 **What are the solubility rules used for? How?**

1. Go over homework
2. double replacement/displacement (ws 9)
4. Lab Activity — Typhoid who? (C)
5. cw/hw: worksheet 4 and 10 (identify the type of reaction for worksheet 4 - complete worksheet 10)
   Pre-LAB - TYPES OF CHEMICAL REACTIONS (D)

Monday 11/25 **What is the activity series?**

1. Go over homework
2. Net Ionic Equations (ws 11)
3. Lab activity — Types of Chemical Reactions (D)
4. cw/hw: Complete types of reactions lab
   - Pre-LAB - COPPER CYCLE (E)

Tuesday 11/26 **Why are pre-labs required? What is a copper cycle?**

1. Go over homework
2. Writing Complete Equations Practice
3. Lab activity — Copper cycle (E)
4. cw/hw: Study for test
   -Complete labs

Wednesday 11/26 **How do I prepare for a test on chemical reactions?**

Thursday 11/26 **How do I demonstrate my understanding and knowledge of chemical equations?**
TEST ☺

Worksheet 1

Use your text to complete the following worksheet.

chemical equation	chemical reaction	synthesis
coefficient	decomposition	subscript
double displacement	products	reactants
single displacement		

1. The starting substances in a chemical reaction are _____.
2. Two or more substances combine to form one new substance in _____ reactions.
3. The process by which one or more substances are changed into different substance(s) is called _____.
4. In the chemical reaction known as _____, one element displaces another in a compound.
5. The breaking up of substances into simpler substances upon the supplying of energy is called _____.
6. The term referring to the substances formed by a chemical reaction, is _____.
7. The positive and negative portions of two compounds are interchanged in _____ reactions.
8. The number appearing before the formulas in a chemical equation that stands for the ratio of the substances involved is the _____.
9. A(an) _____ is used to show how many ions of each type are in the formula and should NEVER be changed to balance an equation.

Write the following word equation, but do not balance them.

1. A compound composed of 52.5% potassium and 47.5% chlorine reacts with silver nitrate to yield potassium nitrate and silver chloride

$$KCl + AgNO_3 \rightarrow KNO_3 + AgCl$$

2. sodium and bromine yields sodium bromide.

$$Na + Br_2 \rightarrow NaBr$$

3. zinc metal and oxygen gas produces zinc oxide.

4. sodium chloride yields chlorine gas and sodium metal

5. sodium bromide plus chlorine yields sodium chloride and bromine.

6. sodium hydrogen carbonate yields sodium carbonate and carbon dioxide plus water

$$NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

Worksheet 2
Balancing Equations

1) 2 HNO_3 + 1 $Ba(OH)_2$ → 2 H_2O + 1 $Ba(NO_3)_2$

2) 2 C_2H_3OH + 5 O_2 → 4 CO_2 + 4 H_2O

3) 3 SiF_4 + 3 H_2O → 2 H_2SiF_6 + 1 H_2SiO_3

4) 1 Mg_3B_2 + 6 H_2O → 3 $Mg(OH)_2$ + 1 B_2H_6

5) 2 $*_2\$_3$ + 4 % → 4 *% + 3 $\$_2$

6) 1 SiO_2 + 4 HF → 1 SiF_4 + 2 H_2O

7) _____ XeF_6 + _____ SiO_2 → _____ SiF_4 + _____ $XeOF_4$

Write and balance equations for each of the following:

8) Iron(III) iodide reacts with copper(II) nitrate to produce iron(III) nitrate and copper(II) iodide.

9) Ammonium phosphate reacts with lithium hydroxide to produce ammonium hydroxide and lithium phosphate.

$(NH_4)_3PO_4 + 3LiOH \rightarrow 3NH_4OH + Li_3PO_4$

Worksheet 3
Writing and Balancing Equations

1. Hydrogen plus oxygen yields water.

$2H_2 + O_2 \rightarrow 2H_2O$

2. Nitrogen plus hydrogen yields ammonia.

3. Aluminum bromide plus chlorine yields aluminum chloride and bromine.

$2AlBr_3 + 3Cl_2 \rightarrow 2AlCl_3 + 3Br_2$

4. Hydrochloric acid plus sodium hydroxide yields sodium chloride plus water.

5. Iron plus lead(II) sulfate react forming iron(II) sulfate plus lead.

$Fe + PbSO_4 \rightarrow FeSO_4 + Pb$

6. Potassium chlorate is heated to produce potassium chloride and oxygen gas.

7. Sulfuric acid decomposes to form sulfur trioxide gas plus water.

$H_2SO_4 \rightarrow SO_3 + H_2O$

8. Sodium oxide combines with water to make sodium hydroxide.

9. Potassium iodide reacts with bromine forming potassium bromide and iodine.

$KI + Br_2 \rightarrow KBr + I_2$

10. Sodium phosphate reacts with calcium nitrate to produce sodium nitrate and calcium phosphate.

Worksheet 4

Write and balance equations for each of these reactions. Classify each as a single replacement, double replacement, decomposition, or synthesis reaction.

1. aluminum nitrate(aq) + sodium hydroxide(aq) → aluminum hydroxide(s) + sodium nitrate(aq)

DR $Al(NO_3)_3 + 3NaOH \rightarrow Al(OH)_3 + 3NaNO_3$

2. potassium chlorate(s) → potassium chloride(s) + oxygen(g)

3. phosphoric acid(aq) + magnesium hydroxide(aq) yields magnesium phosphate(s) + water(l)

DR $2H_3PO_4 + 3Mg(OH)_2 \rightarrow 3H_2O + Mg_3(PO_4)_2$

4. ammonium nitrite(s) yields nitrogen(g) + water(l)

5. ammonia(g) + oxygen(g) → nitrogen monoxide(g) + water(l)

SR or Combustion $NH_3 + O_2 \rightarrow NO + H_2O$

6. barium chloride(aq) + sodium sulfate(aq) → sodium chloride(aq) + barium sulfate(s)

7. iron(III) oxide(s) + carbon monoxide(g) yields iron(s) + carbon dioxide (g)

SR ish $Fe_2O_3 + CO \rightarrow Fe + CO_2$

8. magnesium hydroxide(aq) + ammonium phosphate(aq) yields magnesium phosphate(s) + ammonia(g) + water(l)

9. iron(III) bromide(aq) + ammonium sulfide(aq) → iron(III) sulfide(s) + ammonium bromide(aq)

DR $2FeBr_3 + 3(NH_4)_2S \rightarrow Fe_2S_3 + 6NH_4Br$

10. calcium oxide(s) + diphosphorous pentoxide(s) → calcium phosphate(s)

11. magnesium chloride(aq) + silver nitrate(aq) yields magnesium nitrate (aq) + silver chloride(s)

DR $MgCl_2 + 2AgNO_3 \rightarrow Mg(NO_3)_2 + 2AgCl$

12. sodium carbonate(aq) + sulfuric acid(aq) yields sodium sulfate(aq) + carbon dioxide(g) + water(l)

13. aluminum hydroxide(s) + acetic acid(aq) → aluminum acetate(g) + water(l)

DR $Al(OH)_3 + 3HC_2H_3O_2 \rightarrow Al(C_2H_3O_2)_3 + 3H_2O$

14. lead(II) nitrate(aq) + copper(II) sulfate(aq) yields lead(II) sulfate(s) + copper(II) nitrate(aq)

$Pb(NO_3)_2 + CuSO_4 \rightleftharpoons PbSO_4 + Cu(NO_3)_2$

15. aluminum(s) + copper(II) chloride(aq) → aluminum chloride(aq) + copper(s)

16. iron(s) + silver acetate(aq) → (iron(II) acetate(aq) + silver(s)

17. aluminum acetate(aq) + sodium hydroxide(aq) yields aluminum hydroxide(s) + sodium acetate(aq)

DR $Al(C_2H_3O_2)_3 + 3NaOH \rightarrow Al(OH)_3 + 3Na(C_2H_3O_2)$

18. bromine(l) + calcium iodide(aq) yields calcium bromide(aq) + iodine(s)

19. copper(s) + sulfuric acid(aq) → copper(II) sulfate(aq) + sulfur dioxide(g) + water(l)

SR $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$

20. calcium hydroxide(aq) + phosphoric acid(aq) → calcium phosphate(s) + water(l)

21. magnesium nitrate(aq) + sulfuric acid(aq) → magnesium sulfate(aq) + nitric acid(aq)

DR $Mg(NO_3)_2 + H_2SO_4 \rightarrow MgSO_4 + 2HNO_3$

22. potassium carbonate(aq) + barium chloride(aq) yields potassium chloride(aq) + barium carbonate(s)

23. aluminum chloride(aq) + sulfuric acid(aq) yields aluminum sulfate(aq) + hydrogen chloride(g)

DR $2AlCl_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6HCl$

24. cadmium phosphate(s) + ammonium sulfide(aq) yields cadmium sulfide(s) + ammonium phosphate(aq)

25. sodium hydroxide(aq) + sulfuric acid(aq) → sodium sulfate(aq) + water(l)

DR $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Worksheet 5

Identify the following reactions as synthesis, decomposition, single replacement, or double replacement.

1. $2KClO_3 \rightarrow 2KCl + 3O_2$ D
2. $HCl + NaOH \rightarrow NaCl + H_2O$
3. $Mg + 2HCl \rightarrow MgCl_2 + H_2$ SR
4. $2H_2 + O_2 \rightarrow 2H_2O$
5. $2Al + 3NiBr_2 \rightarrow 2AlBr_3 + 3Ni$ SR
6. $4Al + 3O_2 \rightarrow 2Al_2O_3$
7. $2NaCl \rightarrow 2Na + Cl_2$ D
8. $CaCl_2 + F_2 \rightarrow CaF_2 + Cl_2$
9. $AgNO_3 + KCl \rightarrow AgCl + KNO_3$ DR
10. $N_2 + 3H_2 \rightarrow 2NH_3$
11. $2H_2O_2 \rightarrow 2H_2O + O_2$ D
12. $(NH_4)_2SO_4 + Ba(NO_3)_2 \rightarrow BaSO_4 + 2NH_4NO_3$
13. $MgI_2 + Br_2 \rightarrow MgBr_2 + I_2$ SR
14. $SO_3 + H_2O \rightarrow H_2SO_4$
15. $6KCl + Zn_3(PO_4)_2 \rightarrow 3ZnCl_2 + 2K_3PO_4$ DR

Worksheet 6

Synthesis and Decomposition Problems Write and balance the following equations.

1. potassium oxide plus water → potassium hydroxide
   $K_2O + H_2O \rightarrow 2KOH$
2. sodium plus fluorine
3. carbon dioxide plus water → carbonic acid
   $CO_2 + H_2O \rightarrow H_2CO_3$
4. hydrogen plus chlorine
5. potassium bicarbonate (heated) → potassium carbonate + water + carbon dioxide
   $2KHCO_3 \rightarrow K_2CO_3 + H_2O + CO_2$
6. sodium chloride (electrolyzed)
7. magnesium chlorate(heated) → magnesium chloride + oxygen
   $Mg(ClO_3)_2 \rightarrow MgCl + 3O_2$
8. calcium hydroxide(heated)
9. aluminum chloride(electrolyzed) → Aluminum + chlorine
   $2AlCl_3 \rightarrow 2Al + 3Cl_2$
10. water(electrolyzed)
11. Lithium bromide dihydrate (heated) → lithium bromide + H_2O
    $LiBr(H_2O)_2 \rightarrow LiBr + 2H_2O$
12. lead(IV) oxide(heated)

Worksheet 7

Balance these combustion reactions.

1) 1 $C_3H_8(g)$ + 5 O_2 → 3 CO_2 + 4 H_2O

2) _____ CH_3OH + _____ O_2 → _____ CO_2 + _____ H_2O

3) _____ $CH_4(g)$ + _____ O_2 → _____ CO_2 + _____ H_2O

4) 2 $C_4H_{10}(g)$ + 13 O_2 → 8 CO_2 + 10 H_2O

Worksheet 8
Single-Replacement Reactions

Step 1 - Write the formulas of the reactants on the left of the yield sign
Step 2 - Look at the Activity Series to determine if the replacement can happen
Step 3 - If the replacement can occur, complete the reaction and balance it. If the reaction cannot happen, write N.R. (no rxn) on the product side.

1. lead + zinc acetate → ~~lead~~ NR lead is below zinc on the activity series

2. iron + aluminum oxide →

3. silver nitrate + nickel → nickel(II) nitrate + silver (assume +2 for transition metals if not told otherwise)

$$2AgNO_3 + Ni \rightarrow Ni(NO_3)_2 + 2Ag$$

4. sodium bromide + iodine →

5. aluminum bromide + chlorine → aluminum chloride + bromine

$$2AlBr_3 + 3Cl_2 \rightarrow 2AlCl_3 + 3Br_2$$

6. sodium iodide + bromine →

7. calcium + hydrochloric acid → calcium chloride + hydrogen

$$Ca + 2HCl \rightarrow CaCl_2 + 2HCl$$

8. magnesium + nitric acid →

9. silver + sulfuric acid → NR see page 7 on reference table, silver doesn't react with acids

10. potassium + water →

11. sodium + water → sodium hydroxide + hydrogen

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

Worksheet 9

Double-Replacement Reactions

solubility rules are on page 6 in ref table

In these reactions, all you do is look at the names of the reactants, and "switch partners". Just be sure that the new pairs come out with the positive ion named first, and paired with a negative ion.

1. aluminum iodide + mercury(II) chloride → ~~→~~ soluble aluminum chloride + soluble mercury(II) iodide
No Precipitate formed :(

2. silver nitrate + potassium phosphate →

3. copper(II) bromide + aluminum chloride → ~~→~~ soluble copper(II) chloride + soluble Aluminum Bromide
No Precipitate formed :(

4. calcium acetate + sodium carbonate →

5. ammonium chloride + mercury(I) acetate → soluble ammonium acetate + insoluble mercury(I) chloride
precipitate :)

6. calcium nitrate + hydrochloric acid →

7. iron(II) sulfide + hydrochloric acid → soluble iron(II) chloride + gas hydrogen sulfide

reaction occurs if a ppt, water, or insoluble gas forms

8. copper(II) hydroxide + acetic acid →

9. calcium hydroxide + phosphoric acid → insoluble calcium phosphate + water
water

10. calcium bromide + potassium hydroxide →

Examine the products of the reactions on this page, and determine in each whether a gas, water, or a precipitate is formed. Use solubility table to determine the solubilities of the reaction products. If there is no gas, water, or precipitate produced, put an "X" through the yield sign, because no reaction occurs.

Worksheet 10

Classify each as a single replacement, double replacement, decomposition, synthesis, or combustion reaction. Predict the products of each reaction (If no products form, write "no reaction."). Then, write and balance equations for each reaction.

1. magnesium (s) + oxygen (g) → magnesium oxide

S

$2\,Mg + O_2 \rightarrow 2\,MgO$

2. aluminum (s) + hydrochloric acid (aq) →

3. sodium oxide (s) + sulfur dioxide (g) → sodium sulfite

*This one is tricky

S

$Na_2O + SO_2 \rightarrow Na_2SO_3$

4. phosphoric acid (l) → dinitrogen pentoxide (s) + water (l)

5. sodium chlorate (s) → sodium chloride + oxygen

D

$2\,NaClO_3 \rightarrow 2\,NaCl + 3O_2$

6. zinc chloride (aq) + ammonium sulfide (aq) →

7. zinc sulfide (s) + oxygen (g) → zinc oxide (s) + sulfur dioxide (g)

SR

$2ZnS + 5O_2 \rightarrow 2ZnO + 2SO_2$

8. calcium carbonate (s) →

9. sodium nitrate (aq) + ammonium sulfate (aq) → ammonium nitrate + sodium sulfate

soluble soluble

DR

NO Reaction

10. iron (s) + copper(II) sulfate (aq) → (assume iron has an oxidation # of 2+ if it forms a compound)

11. zinc (s) + sulfuric acid (aq) → zinc sulfate + hydrogen

SR

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

12. dinitrogen pentoxide (s) + water (l) →

13. chlorine(g) + magnesium iodide(aq) → iodine + magnesium chloride

SR $Cl_2 + MgI_2 \rightarrow I_2 + MgCl_2$

14. chlorine(g) + hydrogen fluoride(g) →

15. potassium(s) + water(l) → potassium hyroxide + hydrogen

SR $2K + 2H_2O \rightarrow 2KOH + H_2$

16. iron(s) + hydrochloric acid(aq) → (assume iron has an oxidation # of 2+ if it forms a compound)

17. cobalt(III) hydroxide(aq) + nitric acid(aq) → (assume the transition metal keeps the same oxidation number) cobalt(III) nitrate + water

DR $Co(OH)_3 + 3HNO_3 \rightarrow Co(NO_3)_3 + 3H_2O$

18. bromine(l) + sodium iodide(aq) →

19. sodium hydroxide(aq) + phosphoric acid(aq) → sodium phosphate + water

DR $3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$

20. gold(s) + water(l) →

21. ammonium sulfate(aq) + calcium hydroxide(aq) → ammonium hydroxide (soluble) + calcium sulfate (precipitate, insoluble)

DR $(NH_4)_2SO_4 + Ca(OH)_2 \rightarrow 2NH_4OH + CaSO_4$

22. silver nitrate(aq) + potassium chloride(aq) →

23. magnesium hydroxide(aq) + phosphoric acid(aq) → magnesium phosphate + water

DR $3Mg(OH)_2 + 2H_3PO_4 \rightarrow Mg_3(PO_4)_2 + 6H_2O$

24. iron(II) nitrate(aq) + hydrochloric acid(aq) →

25. ammonium sulfide(aq) + iron(II) nitrate(aq) → iron(II) sulfide (insoluble, precipitate) + ammonium nitrate (soluble)

DR $(NH_4)_2S + Fe(NO_3)_2 \rightarrow FeS + 2(NH_4)NO_3$

26. magnesium bromide(s) + chlorine(g) →

aluminum is higher on activity series so this occurs

27. aluminum(s) + iron(III) oxide(s) → aluminum oxide + iron

SR $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$

28. silver nitrate(aq) + zinc chloride(aq) →

29. hydrogen peroxide(aq) → ~~$H_2O + O_2$~~ water + oxygen

D $2H_2O_2 \rightarrow 2H_2O + O_2$

30. zinc(s) + hydrochloric acid(aq) →

31. hydrochloric acid(aq) + sodium hydroxide(aq) → sodium chloride + water

DR $HCl + NaOH \rightarrow NaCl + H_2O$

32. sodium(s) + hydrogen(g) →

copper (II) chloride + hydrogen

33. hydrochloric acid(aq) + copper(s) → (assume copper has an oxidation number of 2+ if it forms a compound)

SR $2HCl + Cu \rightarrow CuCl_2 + H_2$

34. methane(g) + oxygen(g) →

35. glucose(s) + oxygen(g) → carbon dioxide + water

C $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

36. propane(g) + oxygen (g) →

37. sucrose(s) + oxygen(g) → carbon dioxide + water

C $C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O$

mmm... roasted marshmallow anyone?

38. octane(l) + oxygen(g) → (the formula for octane is C_8H_{18})

Worksheet 11

Write the net ionic equation for each of the double replacement reactions below.

1. $MgCl_2\ (aq) + 2NaOH\ (aq) \rightarrow Mg(OH)_2 + 2NaCl\ (aq)$ (insoluble)

$Mg^{2+} + 2OH^- \rightarrow Mg(OH)_2$

2. $H_2SO_4\ (aq) + 2LiOH\ (aq) \rightarrow Li_2SO_4\ (aq) + 2H_2O\ (l)$

3. $AgNO_3\ (aq) + KCl\ (aq) \rightarrow AgCl\ (s) + KNO_3\ (aq)$

$Ag^+ + Cl^- \rightarrow AgCl$

4. $Na_2SO_4\ (aq) + MgCl_2\ (aq) \rightarrow 2NaCl\ (aq) + MgSO_4\ (aq)$

5. $HCl\ (aq) + NaOH\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$

$H^+ + OH^- \rightarrow H_2O$

6. $2NaI\ (aq) + Pb(NO_3)_2\ (aq) \rightarrow 2NaNO_3\ (aq) + PbI_2\ (s)$

Lab A

Follow the Yellow Brick Road

For this activity you must complete each part in order. When you finish a part, please have your teacher check your work before moving on to the next section.

Part I. Write and balance each of the following equations. If it is already balanced, write the word "balanced" to the right of the equation. For the word equations given below, write the chemical equation on the line provided to the right of the word equation.

Hydrogen peroxide reacts to produce water and oxygen gas. $H_2O_2 \rightarrow H_2O + O_2$

$HCl + NaOH \rightarrow NaCl + H_2O$

$CaCl_2 + F_2 \rightarrow CaF_2 + Cl_2$

Potassium chlorate decomposes upon heating to form potassium chloride and oxygen gas. $KClO_3 \rightarrow KCl + O_2$

$(NH_4)_2SO_4 + Ba(NO_3)_2 \rightarrow BaSO_4 + NH_4NO_3$

$C_6H_6 + O_2 \rightarrow CO_2 + H_2O$

Nitrogen gas and oxygen gas combine to form dinitrogen pentoxide. $N_2 + O_2 \rightarrow N_2O_5$

$SO_3 + H_2O \rightarrow H_2SO_4$

$C_8H_{18} + O_2 \rightarrow CO_2 + H_2O$

$Na_2O + H_2O \rightarrow NaOH$

Potassium iodide and bromine react to form potassium bromide and iodine. $KI + Br_2 \rightarrow KBr + I_2$

$C_4H_8 + O_2 \rightarrow CO_2 + H_2O$

$Zn + FeCl_3 \rightarrow ZnCl_2 + Fe$

$CaCO_3 \rightarrow CaO + CO_2$

Phosphoric acid combines with calcium hydroxide to form calcium phosphate and water. $H_3PO_4 + Ca(OH)_2 \rightarrow Ca_3(PO_4)_2 + H_2O$

Part II. Using the balanced equations, try to group them into five separate groups. Each group must contain exactly three equations that are related to one another in some way. You must explain why you grouped them into your categories.

Group 1 Synthesis

Why did you group these three together?

Group 2 Decomposition

Why did you group these three together?

Group 3 single replacements

Why did you group these three together?

Group 4 double replacements

Why did you group these three together?

Group 5 combustion

Why did you group these three together?

Part III. Using your textbook decide what type of reaction is actually depicted in each grouping. Put the actual name of that type of reaction next to the group number in **Part II**.

Lab B

To Form or Not to Form

Problem: Can you predict when a reaction will take place and write the correct equation when a reaction occurs?

Safety: Avoid ingestion and skin contact with all of the chemicals used in this lab.

Procedure:

1. Place an acetate sheet or microwell plate down on the lab table in front of you over the data table.

2. Add solutions and metals to the acetate sheet or microwell plate as described below.
   (A) Place a few drops of copper(II) nitrate solution in rows 2 through 4 in the first column (marked $Cu^{2+}(aq)$).
   (B) Put a few drops of magnesium nitrate in rows 1, 3, and 4 of the second column (marked $Mg^{2+}(aq)$).
   (C) Put a few drops of lead(II) nitrate in rows 1, 2, and 4 of the third column (marked $Pb^{2+}(aq)$).
   (D) Put a few drops of zinc nitrate in rows 1, 2, and 3 of the fourth column (marked $Zn^{2+}(aq)$).
   (E) Put a few drops of silver nitrate in rows 1, 2, 3, and 4 of the fifth column (marked $Ag^{+}(aq)$).

3. Put a small piece of copper metal in each of the squares containing solution in the first row. Add magnesium metal to the solutions in the second row, lead to the third row, and zinc to the fourth row.

   Allow to react for at least 3 minutes.

4. Observations & Conclusions
   (A) Determine if a reaction has occurred in each well by observing if a metal precipitate has formed or if the surface of the metal has become coated or corroded.
   (B) If a metal ion is reduced by a metal then the reverse reaction should not occur.
   (C) One metal is more reactive than another if the metal will replace the metal ion (reduce it) in its compounds.
   (D) Record your observations in the data table below.

	Cu^{2+} (aq)	**Mg^{2+} (aq)**	**Pb^{2+} (aq)**	**Zn^{2+} (aq)**	**Ag^{+} (aq)**
Cu	X				
Mg		X			
Pb			X		
Zn				X	

Lab C

Typhoid Who?

Select a test tube.
Draw up about 1 mL of solution into a pipette.
At your teacher's direction, exchange the solution with a peer.
Repeat with 2 more students.

Get a drop of $AgNO_3$ from the instructor.

Who was originally contaminated?

Lab D

Types of Chemical Reactions

In this experiment, you will learn to differentiate among five general types of chemical reactions. You will carry out certain reactions yourself, while others will be demonstrated by your teacher. From your observations you will attempt to identify the products of each reaction and to determine the type of reaction that has taken place. The types of reactions you will consider are the following: combination reactions, decomposition reactions, single-replacement reactions, double-replacement reactions, and combustion reactions. The majority of common chemical reactions can be classified as belonging to one of these categories. A brief description of each reaction type is provided below. Sometimes there is a need to speed up a reaction. One way to do this is to heat the reaction. For most types of reactions, when heat is provided, the reaction speeds up. Another way to speed up the reaction is to use a catalyst. A catalyst is a compound or element that speeds up a reaction without being used up in the reaction. One type of catalyst your body uses is called enzymes. In this lab you will see a reaction that uses a catalyst that is an enzyme called catalase found in potatoes.

Combination Reactions are reactions in which two or more substances combine to form a single product. The reactants may be elements or compounds, but the product is always a single product. An example of a combination reaction is the reaction of sulfur trioxide and water to form sulfuric acid.

$$SO_3 + H_2O \rightarrow H_2SO_4$$

*Decomposition Reaction*s are reactions in which a single substance breaks down into two or more simpler substances. There is always just a single reactant in a decomposition reaction. An example of a decomposition reaction is the breakdown of calcium carbonate upon heating:

$$CaCO_3 + \text{heat} \rightarrow CaO + CO_2$$

Single-replacement Reactions are reactions in which an element within a compound is displaced by a separate element. This type of reaction always has two reactants, one of which is always an element. An example of a single-replacement reaction is the reaction of zinc metal with hydrochloric acid.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Double-replacement Reactions are reactions in which a positive ion from one ionic compound exchanges with the positive ion of another ionic compound. These reactions typically occur in aqueous solution and result in either the formation of a precipitate, the production of a gas, or the formation of a molecular compound such as water. An example of a double-replacement reaction is the reaction that occurs between aqueous silver nitrate and aqueous sodium chloride. A precipitate of solid silver chloride is formed in this reaction.

$$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$$

Combustion Reactions are reactions in which an element or compound reacts rapidly with oxygen gas to liberate heat and light energy. Commonly, the compounds combining with oxygen in these reactions are hydrocarbons, compounds consisting wholly of hydrogen and carbon. The well-known combustible fuels kerosene and gasoline, for instance, are hydrocarbon mixtures. The complete combustion of hydrocarbon yields carbon dioxide and water as the reaction products. If insufficient oxygen is available, combustion is not complete and carbon monoxide and elemental carbon may be obtained as additional products of the reaction. An example of a combustion reaction is the burning of methane gas to give water (in the form steam), carbon dioxide, heat, and light.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat} + \text{light}$$

When testing for the identity of a gas you will be asked to use a glowing wooden splint or a burning splint to identify the gas. The gases you will be testing for are the following:

Hydrogen, H_2 = An explosion accompanies this reaction. It is an example of a combustion reaction. It sounds somewhat like a little dog barking

Oxygen, O_2 = A glowing splint will glow brighter and possibly burst into flame.

Carbon dioxide, CO_2 = A burning wooden splint will go out.

OBJECTIVES:

1. To observe chemical reactions in order to determine the reaction type.
2. To write balanced chemical equations for each reaction.
3. To learn how to use the computer to type a lab report.

EQUIPMENT:

5 test tubes (1 must be large)
1 test tube holder
1 gas burner
1 ring stand
1 utility clamp (test tube clamp)
1 dropper pipet
1 set of crucible tongs
2 beakers
matches

Mg ribbon
Mg turnings
1-M HCl, hydrochloric acid
3% peroxide solution
raw potato piece
wooden splints
$CuSO_4$ (aq)
NaOH (aq)
$KClO_3$ (s)

Teacher demo:
Iron fillings sulfur test tube gas burner magnet

SAFETY:

1. Wear safety goggles.
2. Hydrochloric acid is corrosive and can cause severe injury. If you spill acid on yourself, immediately flush the affected area with water for 2-3 minutes and notify the teacher. If acid should get into your eyes, begin flushing your eyes with water immediately and continue doing so for at least 20 minutes. Use the eyewash.

   If acid is spilled on the laboratory bench or on the floor, neutralize the spill with solid sodium bicarbonate, $NaHCO_3$, before wiping it up with sponges or paper towels. The acid will be neutralized when bubbles of gas no longer form after addition of sodium bicarbonate. If you need to dispose of a small quantity of acid, neutralize the sample with sodium bicarbonate before pouring it down the drain.

PROCEDURE:

As you perform the experiment, record your observations in a data table.

1. Copper (II) sulfate and sodium hydroxide. Place about 2mL of copper (II) sulfate in a test tube (1 dropper full). Place about 2mL of sodium hydroxide in a test tube. Mix – pour one test tube into other. Record your observations in data table.
   Discard the solution into the sink with plenty of water.

2. Magnesium metal and hydrochloric acid. Fill one medium size test tube ¼ full with 1-M Hydrochloric acid. Place the test tube in a test tube rack. Put several magnesium turnings into the acid solution. If you observe a gas forming, test for its identity by collecting the gas and then holding a burning wood splint into the mouth of the test tube. Do not put the splint into the solution. Record your observations. Decant the liquid portion of the test tube contents into the sink; discard the solid into the waste container provided.

3. Action of heat on potassium chlorate. Add approximately 5 grams of potassium to a medium test tube. Use a utility clamp to secure the tube to a ring stand. CAUTION: Make sure that the mouth of the tube is pointed away from you and away from everyone else. Heat the potassium chlorate with a Bunsen burner. If you observe a gas forming, test for its identity by inserting a glowing wood splint into the mouth of the test tube. Do not drop the splint into the liquid. Record your observations. Allow the test tube to cool. Rinse the solid potassium chloride product out of the test tube and into the sink.

4. The action of a catalyst on hydrogen peroxide. Fill the large test tube one-third with 3% hydrogen peroxide. Add a slice of raw potato that you can obtain form your teacher. Place the potato into the test tube and observe. Look specifically for bubbles of gas. You may test for the presence of oxygen with a glowing splint. Oxygen should be detected but sometimes the water present in the bubble foam prevents a spectacular ignition.

5. The action of magnesium burning in air. WARNING: You must not look directly at this reaction. DO NOT TOUCH ANY PART OF THE MAGNESIUM RIBBON DURING THIS EXPERIMENT. You can see what you need to without looking directly at this reaction, perhaps by video recording. Using tongs, obtain a piece of magnesium, 1 to 2 inches long, from the teacher. Hold the magnesium in a burner flame until it ignites. Still using tongs, hold the magnesium over a watch glass. Once it finishes burning, mix some water with the white magnesium oxide product and test the pH with pH paper. Write down all observations. Discard the remaining product into the waste container provided.

6. Teacher demo: the reaction iron filings and sulfur. Observe the properties of each substance before heating and alter.

RESULTS:

- Decide which type of reaction is represented by each reaction observed in this experiment and write a balanced chemical equation for each reaction observed.

- Label each of the chemical equations you just wrote as one of the 5 reaction types.

- Although no combustion reactions were described in the procedure section, one combustion reaction did occur in the course of this experiment. (Actually, more than one occurred.) What was this reaction? Write the equation for this reaction.

Lab E

CU Again!
A Copper Cycle

Problem: What happens when copper is recycled in the laboratory?

Caution: Wear safety goggles at all times.
Avoid skin contact with solids and solutions.
Dispose of all solutions properly.
Wash your hands before leaving the lab.

Procedure

1. Begin heating approximately 400 mL of water in a 600 mL beaker on a hot plate for Step 4.
2. Your instructor will demonstrate for the class the reaction of metallic copper with concentrated nitric acid. This must be done in a well-ventilated area.

Caution: Avoid breathing poisonous gases.
Nitric acid will burn skin and clothing - avoid contact

One student will be asked to feel the side of the demonstration beaker and report to the group.
The products formed are copper(II) nitrate solution, and nitrogen dioxide gas and water.

3. A solution of copper(II) nitrate was prepared earlier. Transfer two full pipets of this solution into a test tube.
Locate the sodium hydroxide solution. Transfer 3 full pipets of this solution to your test tube. Add the sodium hydroxide slowly to the copper(II) nitrate in the test tube. This reaction is exothermic.
Caution: Avoid contact with sodium hydroxide; it burns skin.
Tap the tube firmly to mix.
Add about one half of a pipet of distilled water to your test tube. Tap to mix.
The products are solid copper(II) hydroxide and sodium nitrate.

4. Place your test tube in a hot water bath. Remove the test tube when you see no further reaction occurring.
The products are solid copper(II) oxide and water.
Run cold water along the outside of the test tube to cool it.
Allow the material to settle.
Decant to remove the clear liquid (supernatant liquid) above the copper(II) oxide.
DO NOT REMOVE ANY OF THE SOLID
Discard the supernatant liquid. Wash the precipitate by adding about half a pipet of distilled water. Tap to mix. Allow the solid the settle once again. Then remove and discard the supernatant liquid.

5. To the precipitate, add 3 full pipets of the hydrochloric acid solution.
Caution: Avoid contact of skin and clothing with hydrochloric acid.
Tap to mix.
The products are copper(II) chloride and water.

6. Add the precut piece of aluminum wire to the test tube. Curl the bottom of the wire around like a spring and bend the top of the wire like a fish hook to hook over the top of the test tube.
Place the test tube in a cold water bath. This reaction is very fast! And is exothermic!
The products formed are aluminum chloride solution and metallic copper.

7. When the reaction is finished, remove and discard the supernatant liquid.
Wash the solid with a pipet of distilled water. Decant the supernatant liquid.

Wash the solid again with a pipet of fresh distilled water, and filter the contents of the test tube.

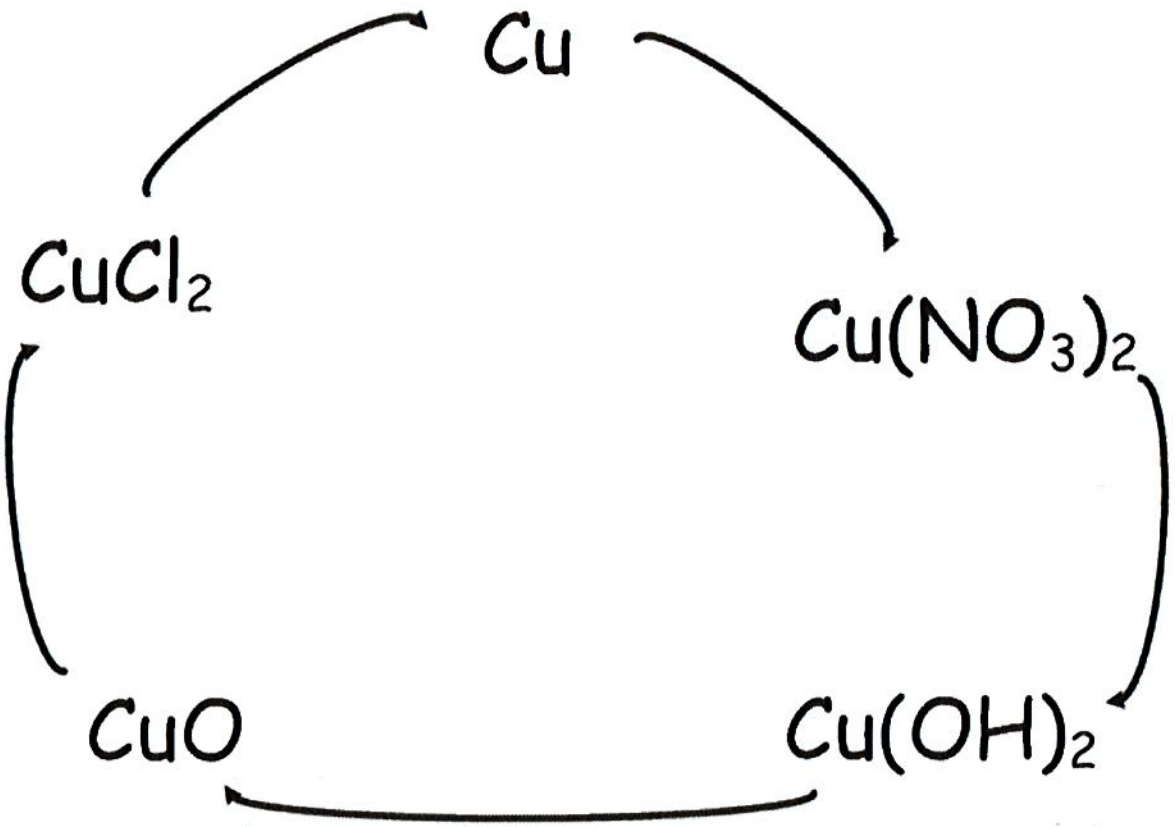
8. Open the filter paper and remove any leftover pieces of aluminum wire. Observe the final product.
Take the filter paper with your product to the fume hood. Your instructor will test a small sample of your product with nitric acid.

9. Clean the test tube, filter funnel and beaker.

10. Wash your hands thoroughly before leaving the laboratory.

Data Analysis and Concept Development

1. Use your observations to complete the drawing below. Alongside each arrow, write in the formulas for the chemicals used. Also near each arrow, write in key words to convey what you saw.



2. What happened to the hydrogen gas generated in the last reaction? Add hydrogen to the cycle.

3. What happened to the aluminum chloride? Show this on the cycle.

4. In Step 5, Aluminum metal was used to displace the copper ions from the solution in this activity. Using the activity series:

A) List two other metals that might also displace copper ions from the solution.

1)_____ 2)_____

B) List two metals that would not displace the copper ions from solution.

1)_____ 2)_____

5. Reread the title of the laboratory activity. Why is this series of reactions often called the "copper cycle"?

6. How did the last part of the procedure (Step 7) complete the cycle?

7. Recycling is one important way to conserve precious natural resources.

A) What common metals have you observed being collected for recycling?

B) Think about all types of materials that you know are recycled. Compose a list of these materials:

C) What types of materials might prove too difficult or costly to recycle?

EQUATIONS

A. Write a balanced chemical equation for each of the following reactions in the copper cycle.

B. Identify each equation by type of reaction (synthesis, decomposition, hydrocarbon combustion, single displacement, double replacement, redox, or unable to classify.)

1. metallic copper plus nitric acid type:_____

2. copper(II) nitrate solution plus sodium hydroxide solution type:_____

3. solid copper(II) hydroxide plus heat type:_____

4. solid copper(II) oxide plus hydrochloric acid type:_____

5. copper(II) chloride solution plus solid aluminum type:_____