Adult Basic Education

Science

Chemistry 1102

Chemical Reactions

Study Guide

Credit Value: 1

Text: *Science 10.* Ritter, Plumb, et al; Nelson 2001.

Chemistry Concentration

Chemistry 1102
Chemistry 2102A
Chemistry 2102B
Chemistry 2102C
Chemistry 3102A
Chemistry 3102B
Chemistry 3102C

Table of Contents

To the Student

I. Introduction to Chemistry 1102

This is the first course in the **'Chemistry Concentration'** in the Adult Basic Education program. If you have not recently completed grade 9 in school or Level II in ABE, you may need to spend some time at the beginning of this course learning about atomic structure and the periodic table.

In this course you will learn about naming and writing formulas for ionic and molecular compounds. You will also learn to write chemical equations. You will be expected to know these topics very well in order to have the necessary foundation to build upon as you continue in the Chemistry concentration in ABE.

It is very important to note that ***this course is a pre-requisite*** to all the other ABE Chemistry courses.

There are 2 required labs for this course. Let your instructor know in advance that you are getting close to being ready to do the labs. The labs require a written report that will be used as part of your final mark for the course. In addition, there is one assignment that you will be asked to submit. This will also be used as part of your evaluation for the course.

You will need lots of practice as you work through the material in this course. There are several worksheets in the Appendix that you should complete. See your instructor for the answers. Your teacher may also provide you with additional worksheets.

The text for this course is ***Science 10;*** Ritter, Plumb, et al; Nelson, 2001.

To the Student

II. Use of Science Study Guides

Before beginning this course, ensure you have the text and any other resources needed *(see the information in the Introduction to this course for specifics)*.

As you work through the Study Guide, you will see that it is divided according to the Units listed in the Table of Contents. When you open a unit it will have the following components:

Reading for this Unit:
Here you will find the chapters, sections and pages of the text you will use to cover the material for this unit. Skim the sections of the textbook, look at the titles of the sections, scan the figures and read any material in the margins. Once you have this overview of the unit, you are ready to begin. Do not be intimidated by the content. You will work through the text, section by section, gaining knowledge and understanding of the material as you go.

References and Notes	**Work to Submit**
This left hand column guides you through the material to read from the text. Read any highlighted notes that follow the reading instructions. The symbols ▶▶ direct you to the questions that you should complete when finished a reading assignment..	You come across three (3) headings in this right hand column. **Writing:** This section comprises your notes for the unit. Here you will find either written questions or references to specific questions or problems from your text. You may want to write out each question followed by the answer. This material should be checked by your instructor before moving on to the next unit. Mathematical problems should have their solutions checked as you go. **Laboratory:** This section indicates if there is a **Core Lab** that should be completed for the unit. Let the instructor know in advance that you will be ready for the lab. A lab report should be submitted for each **Core Lab**. Your instructor will provide guidelines as to how s/he wants the report written. **Assignment:** This section indicates if there is an assignment that should be completed for the Unit. The information in the "References and Notes" column will indicate how you obtain the assignment. These assignments frequently relate the science content to technology, society and the environment.

III. Recommended Evaluation

Written Notes	10%
Labs/Assignments	20%
Test(s)	20%
Final Exam *(entire course)*	50%
	100%

The overall pass mark for the course is 50%.

Unit 1 - Investigating Chemical Reactions

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Science 10*

Chapter 5:	Introduction:	pages 170-171
	Section 5.1:	pages 172-174
	Investigation 5.3:	pages 180-182
Handout 1:	"WHMIS Activity":	Appendix A

References and Notes

Referring to pages 170-174, write answers for questions 1.1 - 1.6.

Work to Submit

Writing:

1.1 Define:
- a) chemistry
- b) matter.

1.2 Define and give two (2) examples of each of the following:
- a) pure substances
- b) element
- c) compound
- d) physical property
- e) chemical property
- f) chemical change
- g) reactant
- h) product

1.3 What are five (5) clues that a chemical change has occurred?

1.4 What is a chemical test and what is its purpose?

Unit 1 - Investigating Chemical Reactions

References and Notes	Work to Submit
	Writing:
	1.5 Briefly describe the chemical tests for: a) oxygen (O_2) b) hydrogen (H_2) c) carbon dioxide (CO_2) d) water vapor (H_2O)
	1.6 Complete Questions 1-2 and 4-5, on page 175.
Before you go into the lab, you should complete the Assignment ▶▶	**Assignment:**
	1.7 Complete the **"WHMIS Activity"** found in Appendix A of this Study Guide.
Note: *Refer to "Safety Conventions and Symbols", page 658, and the MSDS sheet in Appendix A to help you with the assignment.*	
	Laboratory:
Referring to pages 180-182, complete the Laboratory Investigation. ▶▶	1.8 Work carefully through the 5.3 Investigation, "Testing Properties of Substances". Prepare your lab report as outlined by your instructor.
See your instructor to discuss any additional work that you should complete for this unit.	

Unit 2 - Formula Writing

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Science 10*

Chapter 5:	Section 5.5:	pages 184-187
	Section 5.6:	pages 188-189
	Section 5.8:	pages 192-195
	Section 5.9:	pages 196-198
Handout 2:	"Introduction to IUPAC": Appendix A	
Handout 3:	"IUPAC Naming of Compounds and Writing Formulas": Appendix A	
Handout 4:	"Naming Ionic Hydrates": Appendix A	

References and Notes

Referring to pages 184-187, write answers for questions 2.1 - 2.7 ▶▶

NOTE:

Read carefully "Did You Know?" on pages 186 and 187 to make sure you are familiar with the terms:

- *valence shell*
- *valence electron*
- *cation*
- *anion*

Work to Submit

Writing:

2.1 Define and give two examples of electrolyte and nonelectrolyte.

2.2 Define periodic table

2.3 a) Define chemical families.
b) Name the chemical family identified by each of the following group numbers:

Group 1
Group 2
Group 17
Group 18

2.4 Name and describe the three subatomic particles (include the charge on each).

Unit 2 - Formula Writing

References and Notes	Work to Submit
Note: *Study Handout 2,* ***"Introduction to IUPAC"*** *(found in Appendix A) before you go any further. Make sure you are familiar with the following terms and that you can use them as you work through the remainder of this course:* ■ *molecule* ■ *compound* ■ *molecular element (diatomic molecule)* ■ *molecular formula* ■ *empirical formula*	**Writing:**
	2.5 Define ion and explain how ions are formed.
	2.6 When an element forms a negative ion, what happens to its name?
	2.7 Complete questions 2-7 in "Understanding Concepts", page 187.
Referring to pages 188-189, write answers for questions 2.8 and 2.9 ▶▶	
Note: *Molecular compounds are made up of non-metal atoms only.*	2.8 Explain the difference between the types of elements present in ionic and molecular compounds.
	2.9 Complete questions 1-5 in "Understanding Concepts", page 189.
Read pages 192-195 carefully before writing answers for questions 2.10 and 2.11 ▶▶	
	2.10 Define valence.
	2.11 Complete questions 1-9 in "Understanding Concepts", page 195.
Read pages 196-198 carefully before answering question 2.12 - 2.13 ▶▶	
	2.12 Complete questions 1-4, 6 and 7 in "Understanding Concepts", page 198.
Note: *Remember, if there is more than one polyatomic ion, use brackets.* $Mg(NO_3)_2$ *is correct.* $MgNO_{32}$ *is incorrect.*	2.13 What do you think is the formula and charge of the a) chlorite ion b) phosphite ion.

Unit 2 - Formula Writing

References and Notes	Work to Submit
*Read carefully through Handout 4, **"Naming Ionic Hydrates"** before you complete 2.14 and 2.15* ▶▶	**Writing:** 2.14 Define hydrate 2.15 Complete the worksheet, "Naming Ionic Hydrates" in Appendix A.
Read pages 201-204 carefully before completing questions 2.16 - 2.18 ▶▶	2.16 Complete questions 1-6 in "Understanding Concepts", page 204. 2.17 Give the common names of each of the following compounds: a) H_2O b) NH_3 c) CH_4 d) H_2O_2
***Note:** You will find Handout 3, "IUPAC Naming of Compounds and Writing Formulas", in Appendix A of this study guide. It provides a summary of what you should know about naming compounds.* *Study Handout 3 and make sure you understand it before completing 2.19* ▶▶	2.18 Write the formulas for: a) nitrogen b) oxygen c) fluorine d) bromine e) iodine 2.19 Complete the worksheets included with "IUPAC Naming of Compounds and Writing Formulas".
See your instructor to discuss any additional work that you should complete for this unit.	

Unit 3 -Equation Writing

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Science 10*

Chapter 6:	Introduction:	pages 216-217
	Section 6.1:	pages 218-219
	Section 6.3:	pages 222-223
	Section 6.5:	pages 226-229
	Section 6.6:	pages 230-232
	Section 6.7:	pages 233-235
	Section 6.10:	pages 240-241

References and Notes

Read pages 218-219 carefully before completing questions 3.1 - 3.3 ▶▶

Referring to pages 222-223, follow the instructions in 3.4 ▶▶

Work to Submit

Writing:

3.1 Define word equation.

3.2 Complete the activity on page 219.

3.3 Complete questions 1-4 in "Understanding Concepts", page 219.

3.4 Complete questions 1 and 5 in "Understanding Concepts", page 223.

Unit 3 -Equation Writing

References and Notes

Read pages 226-229 carefully before completing questions 3.5 and 3.6 ▶▶

Note:
Notice that the following subscripts are used to indicate the state of each substance:

(s) for a solid;
(l) for a liquid:
(g) for a gas:
(aq) for an aqueous solution (dissolved in water)

Work to Submit

Writing:

3.5 Write definitions for each of the following:
a) skeleton equation
b) balanced chemical equation
c) coefficient

3.6 Complete questions 1-5 in "Understanding Concepts", page 229.

Unit 3 -Equation Writing

References and Notes	Work to Submit
Read pages 230 - 232 carefully before completing questions 3.7 and 3.8 ▶▶	**Writing:** 3.7 a) Define combustion. b) Explain what is meant by incomplete combustion. 3.8 Complete questions 3 - 6 in "Understanding Concepts", page 232.
Read pages 233 - 235 carefully before completing questions 3.9 - 3.11 ▶▶	3.9 a) What are synthesis reactions? b) What is the general formula for synthesis reactions? 3.10 a) What are decomposition reactions? b) What is the general formula for decomposition reactions? 3.11 Complete questions 1 - 5 in "Understanding Concepts", page 235.
Referring to pages 236 -239 *, complete* ***one*** *of the Investigations* ▶▶	**Laboratory:** 3.12 Work carefully through Investigation 6.8 *, "**Putting Things Together"***, or 6.9 *, **"Taking Things Apart"***. Prepare your lab report as outlined by your instructor.

Unit 3 -Equation Writing

References and Notes

Read pages 240 - 241 carefully before completing questions 3.13 - 3.15 ▶▶

Note:

*A **precipitate** is a solid formed from two solutions. It will not dissolve in water.*

For review of the topics covered in Unit 3, complete questions 3.16 and 3.17 ▶▶

See your instructor to discuss any additional work that you should complete for this unit.

Work to Submit

Writing:

3.13 a) What are single displacement reactions?
b) What are the general formulas for single displacement reactions?

3.14 How do you decide which element is replaced in a single displacement reaction?

3.15 a) What are double displacement reactions?
b) What is the general formula for double displacement reactions?

3.16 Complete questions 1 - 6 in "Understanding Concepts", page 247.

3.17 Complete questions 1 - 6 and 17 in the Chapter 6 Review, "Understanding Concepts", page 252 - 253.

Unit 4 - Introduction to Acids and Bases

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Science 10*

Chapter 8:	Introduction:	pages 288 - 289
	Section 8.2:	pages 293 - 295
	Section 8.3:	pages 296 - 299
	Investigation 8.9:	page 314
	Section 8.10:	pages 317 - 319
Handout 5:	"Naming Acids": Appendix A	

References and Notes

Referring to pages 293 - 295 and the glossary, write answers for questions 4.1 - 4.3 ▶▶

Note:
In order for an acid to have acidic properties, it must be dissolved in water. To indicate that it is dissolved in water, the formula of an acid must be followed by the ***(aq)*** *subscript.*

Work to Submit

Writing:

4.1 Copy and complete the following statements:
a) _____can be defined as substances that release Hydrogen (H^+) ions in water.

b) _____can be defined as ionic compounds that release the hydroxide ion (OH^-) in water.

4.2 a) Use the glossary to write definitions for acids and bases.
b) List five (5) properties of acids.
c) List four (4) properties of bases.

4.3 Complete questions 1, 3, and 4 in "Understanding Concepts", page 295.

Unit 4 - Introduction to Acids and Bases

References and Notes

*Study Handout 5, **"Naming Acids"**, found in Appendix A and answer 4.4* ▶▶

Referring to page 296, write answers for questions 4.5 and 4.6 ▶▶

Referring to pages 314 - 319, write answers for questions 4.7 - 4.9 ▶▶

Note:
The general equation for a neutralization reaction is:

ACID + BASE ➜ SALT + WATER
HA + BOH ➜ BA + HOH (H_2O)

A salt does not necessarily mean sodium chloride.

See your instructor to discuss any additional work that you should complete for this unit.

Work to Submit

Writing:

4.4 Complete the worksheet , **"Naming Acids"**. (Appendix A)

4.5 Define pH scale.

4.6 Complete questions 1-7 in "Understanding Concepts", page 299.

4.7
a) Define neutralization (include the general products of a neutralization reaction).
b) What category of reactions is neutralization?
c) Describe two (2) examples of neutralization reactions.

4.8 Define salt.

4.9 Complete questions 3 and 4 in "Understanding Concepts", page 319.

Appendix A

Handout 1 -" WHMIS Activity"

1. What does WHMIS stand for?

2. What is the purpose of using WHMIS symbols?

3. What does MSDS stand for?

4. Identify the nine sections of the MSDS.

I	VI
II	VII
III	VIII
IV	IX
V	

5. What is the name and chemical formula of the chemical?

6. What would happen if you were overexposed to the chemical?

7. When you are using this chemical, how would you protect yourself?

8. How must this chemical be stored?

MATERIAL SAFETY DATA SHEET

ALDON CORPORATION
1533 W.Henriette Rd.
Avon, New York 14414
(716) 226-6177

MSDS No. CC 535
Effective Date February 17, 1999

SECTION I NAME

24 HOUR EMERGENCY ASSISTANCE

CHEMTREC **800-424-9300**
Day 716-226-6177

Product	CUPRIC SULFATE, 5-HYDRATE
Chemical Synonyms	Copper (II) Sulfate, pentahydrate
Formula	$CuSO_4 \cdot 5H_2O$
Unit Size	up to 2.5 Kg.
C.A.S. No.	7758-99-8

NFPA HAZARD RATING (LEAST 0 · SLIGHT 1 · MODERATE 2 · HIGH 3 · EXTREME 4)

HMIS *	
Health	2
Fire	0
Reactivity	0

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Cupric Sulfate, pentahydrate	> 99 %	See Section V.
WARNING! HARMFUL IF SWALLOWED OR INHALED.		
IRRITANT TO SKIN, EYES AND MUCOUS MEMBRANES.		

SECTION III PHYSICAL DATA

Melting Point (°F)	653°C (1207°F)	Specific Gravity (H_2O = 1)	2.28
Boiling Point (°F)	N/A	Percent Volatile by Volume (%)	N/A
Vapor Pressure (mm Hg)	N/A	Evaporation Rate (=1)	N/A
Vapor Density (Air=1)	N/A		
Solubility in Water	Appreciable (>10%).		
Appearance & Odor	Blue crystals or fine blue powder; no odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Non-flammable.	Flammable Limits in Air % by Volume N/A	Lower	Upper
Extinguisher Media	Use any media suitable for extinguishing supporting fire.			

SPECIAL FIREFIGHTING PROCEDURES

In fire conditions, firefighters should wear protective clothing and a NIOSH/MSHA-approved self-contained breathing apparatus.Cupric Sulfate will not burn, nor will it support combustion. Care should be used to keep material out of streams or other water bodies.

(1996 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.7, GUIDE PAGE NO. 171)

UNUSUAL FIRE AND EXPLOSION HAZARDS

Fire or excessive heat may produce hazardous decomposition products as dust or fume.

D.O.T. **RQ, Environmentally hazardous substance, solid, n.o.s., (Cupric sulfate), 9, UN 3077, PG III**

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V HEALTH HAZARD DATA

Threshold Limited Value
(Air) As copper metal (dust): 1.0 mg/m^3.
Copper (fume) TLV 0.2 mg/m^3. Oral, rat: LD50 = 300 mg/kg.

Effects of Overexposure
TARGET ORGANS AFFECTED: Eyes, skin, blood, respiratory system, liver, kidneys. **INGESTION:** Copper salts impart a metallic taste in mouth. May cause gastrointestinal irritation and vomiting. **EYES:** Causes conjunctivitis, swelling of the eyelids, ulceration and burns of the cornea. **SKIN:** Causes irritation. May cause allergic skin reaction. **INHALATION:** Causes upper respiratory irritation and congestion of the nasal and mucous membranes.

Emergency and First Aid Procedures
INHALATION: Remove to fresh air. If breathing has stopped, give artifical respiration. If breathing is difficult, give oxygen. Get medical attention. **EYES:** Flush thoroughly with water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention. **SKIN:** Flush with water, then wash with mild soap and water. **INGESTION:** If swallowed, if conscious, give one or two glasses of water to drink, induce vomiting and call physician. Never give anything by mouth to an unconscious person.

SECTION VI REACTIVITY DATA

Stability	**Unstable**		**Conditions to Avoid**
	Stable	X	Excessive temperature and heat.

Incompatibility (Materials to Avoid) Incompatible with acetylene. Copper salts may react to form explosive acetylides. Copper sulfate can cause ignition upon contact with hydroxylamine due to the release of heat. Reducing agents react vigorously with copper salts.

Hazardous Decomposition Products Combustion may produce irritating copper fumes and toxic gaseous oxides (sulfur oxides).

Hazardous Polymerization		**Conditions to Avoid**
May Occur	**Will Not Occur**	Not applicable.
	X	

SECTION VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled
Ventilate the area. Sprinkle lime or soda ash on spill to form insoluble copper salt. Sweep up and place in a suitable container for disposal. Wash spill area with soap and water. Prevent material from entering sewers and waterways.

Waste Disposal Method
Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.
Dispose of in an approved chemical landfill or contract with a waste disposal agency.

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type) None should be required in normal laboratory use. If dusty conditions prevail, work in a ventilation hood or wear a NIOSH/MSHA-approved dust mask.

Ventilation				
	Local Exhaust	Recommended.	**Special**	No.
	Mechanical (General)	Recommended.	**Other**	No.

Protective Gloves Rubber. **Eye Protection** Chemical safety goggles.

Other Protective Equipment Safety glasses, smock, apron, vented hood, proper gloves, and eye wash station.

SECTION IX SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing
Keep container tightly closed when not in use.
Store in a cool, dry place.
Wash thoroughly after handling.

Other Precautions Read label on container before using. Do not wear contact lenses when working with chemicals.
Avoid contact with skin, eyes and clothing. Avoid breathing dust. Use with adequate ventilation. Remove and wash contaminated clothing.

For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Revision No. 6	Date 2/17/89	Approved Michael Raszeja	Chemical Safety Coordinator	MR

Handout 2 - "Introduction to IUPAC"

Today most compounds are known by their IUPAC names. IUPAC stands for **International Union of Pure and Applied Chemistry.** This organization has determined a set of rules to be used for naming chemicals. Its purpose is to set international guidelines so that all scientists follow the same rules.

Before you start naming compounds and writing formulas, you need to make sure you understand the following:

Molecules are combinations of two or more elements.

*A **molecular element** has all atoms the same.

For example, oxygen gas is a molecule composed of 2 atoms of oxygen. It is called a **diatomic molecule** (because it has 2 atoms).

Table of Diatomic Molecules	
oxygen	O_2
hydrogen	H_2
nitrogen	N_2
fluorine	F_2
chlorine	Cl_2
bromine	Br_2
iodine	I_2

Handout 2 - "Introduction to IUPAC" *(continued)*

A **compound** is a molecule that contains 2 or more **different** types of atoms or ions.

For example, water (H_2O) is a compound because it contains both hydrogen and oxygen.

The formula for water, H_2O, is a combination of **symbols** and **subscripts**.
H and O are the **symbols** for hydrogen and oxygen.
The number 2 is the **subscript**. It indicates that there are 2 atoms of hydrogen in a molecule of water.

A **molecular formula** is a chemical formula that indicates the number and type of atoms in one molecule (i.e. the actual number of atoms of each type in the compound).

An **empirical formula** is the simplest whole number ratio of atoms in the compound.

For example, hydrogen peroxide:

The **molecular formula** is H_2O_2

The **empirical formula** is HO (lowest ratio is 1:1)

Note: In some cases the molecular formula and the empirical formula are the same.

Handout 3 - "IUPAC Naming of Compounds and Writing Formulas"

Rules for Naming Binary Ionic Compounds (simple/multivalent)

1. Name the cation (+) by writing the full name of the metal.

2. Check the attached partial periodic table to see if it is a multivalent species (has more than one possible ionic charge).

   If it has only one ionic charge, proceed to step 3.

   If it has more than 1 possible ionic charge, determine the charge of the anion and pick the metal ion that will result in a net charge of zero. Indicate the identity of the metal ion with roman numerals.

3. Name the anion (-) by shortening the name of the atom and adding the **-ide** ending.

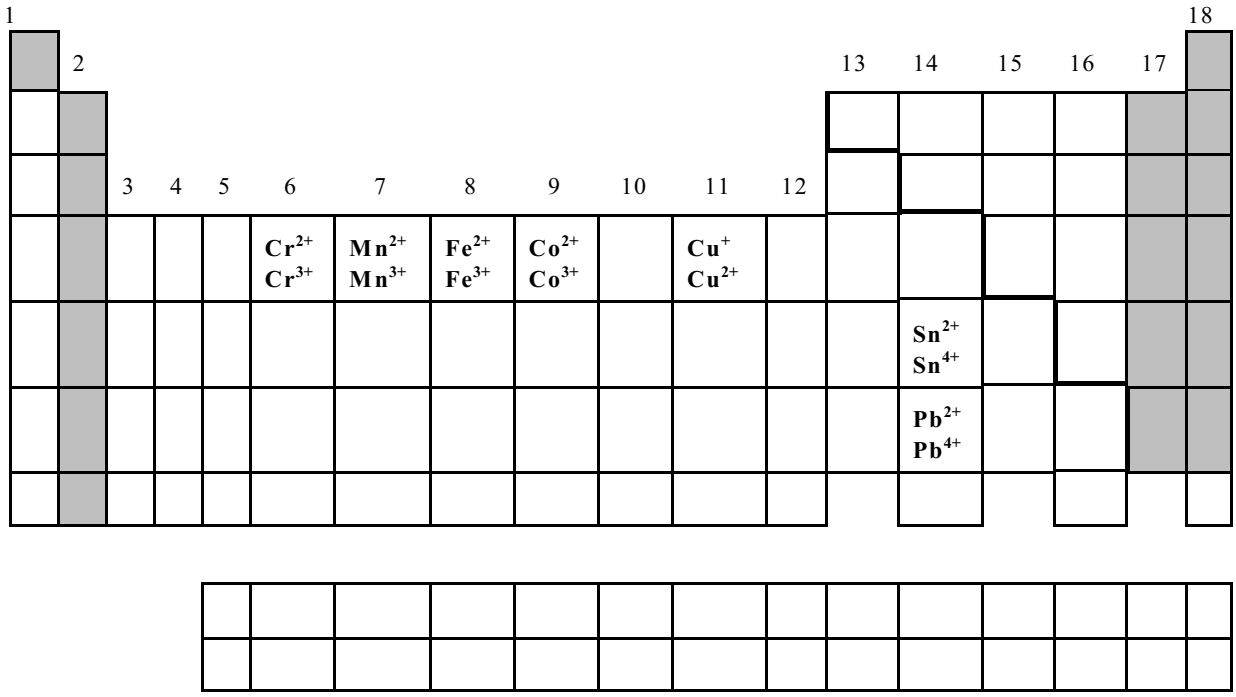
   Examples: NaCl sodium chloride

   K_2O potassium oxide

   CaF_2 calcium fluoride

   $SnCl_4$ tin(IV) chloride

PARTIAL PERIODIC TABLE OF THE ELEMENTS



Handout 3 - "IUPAC Naming of Compounds and Writing Formulas"

Rules for Writing Formulas for Binary Ionic Compounds

1. Write the symbols of the ions involved.

2. Determine the charges of the ions.
   For the cation (positive ion):
   If there is no roman numeral after the name of the metal, the ion has only one ionic charge.
   If there is a roman numeral after the name of the metal, the ion has more than 1 possible ionic charge, and you must use the roman numeral to determine the charge.

   For the anion (negative ion):
   There is only one possible charge (recall group number).

3. Determine the lowest whole number ratio of ions that will give a net charge of zero. This number (if something other than 1) is written as a subscript after the symbol for the ion.

4. Write the formula removing all charges.

Examples: Potassium bromide KBr

Calcium phosphide Ca_3P_2

Iron(II) chloride $FeCl_2$

Copper(I) chloride CuCl

Handout 3 - "IUPAC Naming of Compounds and Writing Formulas"

Rules for Naming Molecular Compounds

1. Write the name of the first element in full.

2. Shorten the name of the second element and add the ide ending.

3. Use prefixes to indicate the number of atoms of each element in the molecular formula.

4. The prefix mono on the first name is optional.

Examples:

CCl_4 Carbon tetrachloride

SiO_2 Silicon dioxide

CO Carbon Monoxide

Handout 3 - "IUPAC Naming of Compounds and Writing Formulas"

Rules for Writing Molecular Formulas

1. Write the symbols for each element in the compound.

2. Use the prefix to determine the number of atoms of each element in the formula and write the appropriate number as a subscript to the right of the element's symbol.

3. If an element lacks a prefix, assume that there is just one atom of that element. It is not necessary to write the numerical subscript 1, since it is implied.

Examples:

Diboron hexahydride B_2H_6

Nitrogen trioxide NO_3

Handout 3 - "IUPAC Naming of Compounds and Writing Formulas"

Worksheet 1

	Name	Formula	Name	Formula
Molecular Compounds	1.	P_4O_6	11. iodine trifluoride	
	2.	S_2F_{10}	12. chlorine dioxide	
	3.	N_2O_4	13. methane	
	4.	ICl_5	14. boron trifluoride	
	5.	SF_6	15 diboron hexahydride	
	6.	CH_3OH	16. phosphorous trihydride	
	7.	S_4N_2	17. ethanol	
	8.	H_2O_2	18. carbon disulfide	
	9.	N_2O_3	19. sulfur trioxide	
	10.	NH_3	20. diarsenic trioxide	
Binary Ionic Compounds – Simple Ions	21.	$CaCl_2$	31. potassium iodide	
	22.	MgO	32. aluminum chloride	
	23.	$NaBr$	33. lithium nitride	
	24.	Al_2O_3	34. barium chloride	
	25.	CaO	35. magnesium hydride	
	26.	ZnO	36. magnesium chloride	
	27.	Ag_2S	37. sodium sulfide	
	28.	CaF_2	38. zinc sulfide	
	29.	CaH_2	39. potassium chloride	
	30.	K_2S	40. silver bromide	

Handout 3 - "IUPAC Naming of Compounds and Writing Formulas"

Worksheet 2

	Chemical Formula	Name of compound
e.g.	Cu_2S	Copper (II) Sulfide
1		Uranium (IV) oxide
2		Lead (IV) sulfide
3	SnO_2	
4		Manganese (IV) oxide
5	Sb_2S_3	
6		Iron (III) oxide
7	HgS	
8	PdS_2	
9		Copper (II) sulfide
10	FeS	
11		Lead (IV) oxide
12	HgO	
13	V_2O_5	
14		Tin (II) fluoride
15		Chromium (III) oxide
16	TiO_2	
17	AuF_3	
18		Uranium (VI) bromide
19	$NiBr_2$	
20		Cobalt Chloride

Directions: Place the symbol for each ion in the space provided, then write the correct chemical formula for the ionic compound. Be sure to balance the charges.

Remember complex ions end in **-ite**, and **-ate**, except for hydroxide and ammonium.

Ex: **potassium**	K^+	**sulfate**	SO_4^{2-}	K_2SO_4
1. aluminum		chloride		
2. calcium		sulfite		
3. sodium		phosphate		
4. copper(II)		nitrate		
5. chromium(II)		nitride		
6. silver		chromate		
7. nickel(III)		Iodide		
8. barium		nitride		
9. sodium		carbonate		
10. zinc		acetate		
11. Magnesium		hydroxide		
12. iron(III)		nitrite		
13. mercury(I)		oxide		
14. copper(II)		chlorate		
15. potassium		tetraborate		
16. aluminum		bicarbonate		
17. lead(II)		bisulfate		
18. beryllium		iodide		
19. mercury(II)		nitride		
20. ammonium		oxide		
21. iron(II)		bromide		
22. strontium		sulfite		
23. nickel(II)		hydroxide		
24. copper(II)		hydrogen sulfate		
25. mercury(I)		chlorate		
26. aluminum		carbonate		
27. potassium		nitrate		
28. calcium		phosphate		

Worksheet 3

Provide the name of the compound or chemical formula.

Chemical Formula	Name of compound	Chemical Formula	Name of compound
1. Li_2CO_3		16.	Potassium hydroxide
2. K_2SO_4		17.	Lithium phosphate
3. $Al(OH)_3$		18.	Iron (III) hydroxide
4. $Fe(ClO)_3$		19.	Sodium bicarbonate
5. H_2SO_4		20.	Calcium chlorate
6. $Ca(HCO_3)_2$		21.	Hydrogen borate
7. $Pb_3(PO_4)_2$		22.	Magnesium silicate
8. $Zn(CH_3COOH)_2$		23.	Ammonium nitrate
9. $Cu(NO_3)_2$		24.	Sodium hypochlorite
10. $Cu(NO_2)_2$		25.	Potassium nitrate
11. $K_2S_2O_3$		26.	Sodium glutamate
12. $CaCO_3$		27.	Potassium thiocyanate
13. $Na_2Cr_2O_7$		28.	Calcium cyanide
14. NaCN		29.	Chromium (III) nitrite
15. KH_2PO_4		30.	Iron (II) chlorite

1. Write the formulas for the following compounds in the space provided.

a) carbon dioxide		k) nitrogen monoxide	
b) silicon dioxide		l) tetraphosphorus decoxide	
c) water		m) silicon carbide	
d) carbon disulfide		n) methanol	
e) ammonia		o) diphosphorus pentabromide	
f) carbon tetrachloride		p) arsenic tribromide	
g) methane		q) carbon monoxide	
h) ozone		r) sulfur dioxide	
i) fluorine		s) neon	
j) diphosphorus trioxide		t) dinitrogen tetroxide	

2. Write the names for the following compounds, in the space provided.

a) CBr_4		k) N_2O	
b) I_2		l) C_2H_5OH	
c) PF_3		m) O_3	
d) N_2O_4		n) Ar	
e) CO		o) P_4	
f) NH_3 g) H_2O_2		p) ClO_2 q) $SiCl_2$	
h) SCl_6		r) BH_3	
i) SO_3		s) C_2S_4	
j) P_4O_6		t) OF_2	

Worksheet 4

Complete the following table. This is a mixture of molecular and ionic !

Name	Formula	Name	Formula
1.	$NaBr$	11. calcium iodide	
2.	$SrCl_2$	12. silver sulfide	
3.	$Zn(BrO_3)_2$	13. beryllium hydride	
4.	$Fe(NO_3)_3$	14. aluminum sulfate	
5.	$RbHCO_3$	15 ammonium carbonate	
6.	$NaOCl$	16. barium phosphide	
7.	SnI_4	17. calcium hydrogen sulfite	
8.	$HgCl$	18. sodium nitrite	
9.	$HgCl_2$	19. manganese(IV) sulfide	
10.	Cu_2O	20. tin(II) perchlorate	
21.	Ca_3N_2	31. nickel(II) chromate	
22.	P_4O_6	32. potassium cyanide	
23.	LiH_2PO_4	33. chromium(III) sulfite	
24.	$Pb(IO_3)_2$	34. zinc zcetate	
25.	$CoCO_3$	35. cadmium oxalate	
26.	$AgSCN$	36. calcium sulfide	
27.	S_2F_{10}	37. sodium hydrogen sulfate	
28.	HBr	38. cadmium cyanide	
29.	HF	39. copper(II) nitrate tetrahydrate	
30.	$Ni_3(PO_4)_2 \cdot 8H_2O$	40. lead(II) dichromate	
41.	KOH	51. bromine	
42.	N_2O_5	52. calcium carbonate	

43.	$Na_2SO_3 \cdot 7H_2O$	53. aluminum nitrate	
44.	S_4N_4	54. beryllium iodate	
45.	HNO_3	55. cadmium oxide	
46.	$HgNO_2$	56. sodium oxalate	
47.	$K_2Cr_2O_7$	57. iron(II) bromide	
48.	Na_2CrO_4	58. cesium hydroxide	
49.	$KMnO_4$	59. ammonia	
50.	$CrPO_4$	60. mercury(II) acetate	
61.	NaOH	68. litium chloride monohydrate	
62.	$Mg(HCO_3)_2$	69. iodine trifluoride	
63.	SF_6	70. Hydrogen hypochlorite	
64.	$HClO_{4(aq)}$	71. Hydrogen phosphate	
65.	NaH	72. hydrogen fluoride	
66.	$BaCO_3$	73. tin(II) hydroxide	
67.	$Mg(BrO_3)_2$	74. chlorine dioxide	

Worksheet 5

Complete the following table. Consult web pages regarding rules for each category of compounds.

	Name	Formula	Name	Formula
molecular	1.	P_4O_6	11. iodine trifluoride	
	2.	S_2F_{10}	12. chlorine dioxide	
	3.	N_2O_4	13. methane	
	4.	ICl_5	14. boron trifluoride	
	5.	SF_6	15 diboron hexahydride	
	6.	CH_3OH	16. phosphorous trihydride	
	7.	S_4N_2	17. ethanol	
	8.	H_2O_2	18. carbon disulfide	
	9.	N_2O_3	19. sulfur trioxide	
	10.	NH_3	20. diarsenic trioxide	
Binary ionic -- simple ions	21.	$CaCl_2$	31. potassium iodide	
	22.	MgO	32. aluminum chloride	
	23.	NaBr	33. lithium nitride	
	24.	Al_2O_3	34. barium chloride	
	25.	CaO	35. magnesium hydride	
	26.	ZnO	36. magnesium chloride	
	27.	Ag_2S	37. sodium sulfide	
	28.	CaF_2	38. zinc sulfide	
	29.	CaH_2	39. potassium chloride	
	30.	K_2S	40. silver bromide	
Binary ionic – more than one charge	41.	SnO_2	51. uranium(IV) oxide	
	42.	Cu_2S	52. lead(IV) sulfide	
	43.	Sb_2S_3	53. Manganese(IV) oxide	
	44.	HgS	54. ferric oxide	
	45.	FeS	55. copper(II) sulfide	
	46.	HgO	56. lead(IV) oxide	
	47.	V_2O_5	57. tin(II) fluoride	
	48.	TiO_2	58. chromic oxide	
	49.	$AuCl_3$	59. uranium(VI) fluoride	
	50.	$NiBr_2$	60. cobalt(III) sulfide	

Binary Ionic – complex ions	61.	K_2CO_3	76. calcium hydroxide	
	62.	$(NH_4)_2S$	77. magnesium silicate	
	63.	$Cr(NO_3)_3$	78. iron(II) chlorite	
	64.	$NaNO_2$	79. potassium dichromate	
	65.	K_3PO_4	80. ammonium sulfate	
	66.	$KMnO_4$	81. sodium bicarbonate	
	67.	$NH_4H_2PO_4$	82. calcium sterate	
	68. 69.	Na_2SO_4 $NaHSO_4$	83. sodium nitrate 84. sodium thiosulfate	
	70.	$NaNO_2$	85. barium perchlorate	
	71.	$Ca(NO_3)_2$	86. sodium hydrogen sulfide	
	72.	Li_3PO_4	87. potassium cyanide	
	73.	$Cr_2(SO_4)_3$	88. potassium thiocyanate	
	74.	$Mn(HPO_4)_2$	89. ammonium phosphate	
	75.	$Na_2B_4O_7$	90. magnesium perchlorate	
Hydrates	91.	$MgSO_4 \cdot 7H_2O$	101. copper(II) sulfate pentahydrate	
	92.	$FeSO_4 \cdot 5H_2O$	102. lithium chloride monohydrate	
	93.	$Na_2SO_3 \cdot 7H_2O$	103. copper(II) nitrate tetrahydrate	
	94.	$Ni_3(PO_4)_2 \cdot 8H_2O$	104. magnesium sulfate heptahydrate	
Acids	95.	$HClO_{3(aq)}$	105. hydrofluoric acid	
	96.	$H_2SO_{3(aq)}$	106. chloric acid	
	97.	$HCN_{(aq)}$	107. nitrous acid	
	98.	$H_2SO_{4(aq)}$	108. hydrobromic acid	
	99.	$CH_3COOH_{(aq)}$	109. nitric acid	
	100.	$H_3BO_{3(aq)}$	110. hypochlorous acid	

Handout 4 - "Naming Ionic Hydrates"

An **ionic hydrate** is a compound that has water associated with it. Water is part of its crystalline structure.

The name of an ionic hydrate can be distinguished from the names of other ionic compounds by the presence of the term **hydrate** with a prefix indicating the number of water molecules.

For example:

The IUPAC formula for calcium chloride dihydrate is $CaCl_2 \cdot 2H_2O$.

The IUPAC formula for calcium magnesium sulfate heptahydrate is $MgSO_4 \cdot 7H_2O$.

(Note the raised dot in front of the water molecules.)

In order to convert IUPAC names for ionic hydrates into chemical formulas, you will need to know the prefixes listed below:

mono	1
di	2
tri	3
tetra	4
penta	5
hexa	6
hepta	7
octa	8
nona	9
deca	10

Handout 4 - "Naming Ionic Hydrates"

Worksheet

Provide the name or formula for each of the following:

Name:	Formula
1. copper (II) sulphate pentahydrate	
2.	$MgSO_4 \cdot 7\ H_2O$
3. potassium carbonate octahydrate	
4.	$MgCl_2 \cdot 6\ H_2O$
5. barium chloride dehydrate	
6. 7. Lithium bromide trihydrate	$Cd(NO_3)_2 \cdot 4\ H_2O$
8.	$Na_2S_2O_3 \cdot 5\ H_2O$
9. cobalt (II) chloride hexahydrate	
10.	$AlCl_3 \cdot 6\ H_2O$
11. zinc sulphate nonahydrate	
12.	$CaCl_2 \cdot 2\ H_2O$
13. barium hydroxide monohydrate	
14.	$Na_2SO_4 \cdot 10\ H_2O$
15. magnesium silicate pentahydrate	

Handout 5 - "Naming Acids"

For this course, when you are given a chemical formula for a hydrogen compound that has the (aq) state of matter subscript, you name it as an acid.

Rules for naming acids:

1. If the ***anion does not contain oxygen***, the acid is named with the prefix ***hydro-*** and the suffix ***-ic*** attached to the root name for the element.

Example: $HCl_{(aq)}$ **hydro**chlor**ic** acid

$HCN_{(aq)}$ **hydro**cyan**ic** acid

$H_2S_{(aq)}$ **hydro**sulfur**ic** acid

2. If the ***anion contains oxygen***, check the ending if the anion.

If the anion has the ***-ite*** ending, the suffix ***-ous*** is used.

Example:
$H_2SO_{3\ (aq)}$ contains the sulf**ite** (SO_3^{2-}) ion and is named sulfur**ous** acid .

If the anion has the ***-ate*** endind, the suffix ***-ic*** is used..

Example:
$H_2SO_{4\ (aq)}$ contains the sulf**ate** (SO_4^{2-}) ion and is named sulfur**ic** acid .

Handout 5 - "Naming Acids"

Worksheet

Rules for naming acids:

Rule #1 **hydrogen _____ide becomes hydro_____ic acid**

Acid formula	ionic name would be	acid name
ex: $HCl_{(aq)}$	hydrogen *chlor*ide	hydro*chlor*ic acid
1.	hydrogen bromide	
2. $HCN_{(aq)}$		
3.		hydrofluoric acid

Rule #2 **hydrogen_____ate becomes _____ic acid**

Acid formula	ionic name would be	acid name
ex: $HClO_{3(aq)}$	hydrogen *chlor*ate	*chlor*ic acid
1.	hydrogen borate	
2. $HNO_{3(aq)}$		
3.		permanganic acid

Rule #3 **hydrogen_____ite becomes _____ous acid**

Acid formula	ionic name would be	acid name
ex: $HNO_{2(aq)}$	hydrogen *nitr*ite	*nitr*ous acid
1. 2. $HClO_{(aq)}$	hydrogen chlorite	
3.		sulfurous acid

NOTE: when naming acids with the root words "sulf" and "phosph", extra syllables are added to make them sound better. Add "ur" to "sulf" and add "or" to "phosph".

therefore $H_2SO_{4(aq)}$ is sulfuric acid NOT sulfic acid

and $H_3PO_{4(aq)}$ is phosphoric acid NOT phosphic acid

Complete the following table.

	Formula	**Name of Acid**
1.	$H_3BO_{3\,(aq)}$	
2.		Hydrochloric acid
3.	$CH_3COOH_{(aq)}$	
4.	$H_2SO_{4\,(aq)}$	
5.	$H_2SO_{3\,(aq)}$	
6.		Oxalic acid
7.		Phosphoric acid
8.		Stearic acid
9.	$H_2CO_{3\,(aq)}$	
10.		Nitric acid
11.	$HClO_{4\,(aq)}$	
12.		Hypochlorous acid
13.	$H_2S_{\,(aq)}$	
14.		Hydrofluoric acid
15.	$HCN_{(aq)}$	
16.		Nitrous acid
17.		Benzoic acid
18.	$H_2SiO_{3\,(aq)}$	
19.		Thiosulfuric acid
20.		Chromic acid

IUPAC naming of Compounds
Is the Compound Ionic or Molecular?
IONIC
Metal & Nonmetal OR Complex Ions
MOLECULAR
Nonmetals
Name the ions present
Are multiple charges possible on Cation?
Use Roman Numerals to indicate ion charge.
Use Anion charge to determine the charge on the Cation (total positives must equal the total negatives).
Stock System
Classical System
IC - Greater
OUS - Lower
Are Complex Ions Present?
Use the complex ion chart
Is it a hydrate?
Add the word hydrate and indicate how many by using the Latin prefixes
Is it an acid?
No
Yes
Name as a molecular compound
Compound Name → BECOMES → Acid Name
hydrogen ___ide ——→ hydro___ic acid
hydrogen ___ate ——→ ___ic acid
hydrogen ___ite ——→ ___ous acid
Does have a common name?
No
Yes
Name each atom present (should be only two). Use Latin prefixes to indicate how many of each.
1 - mono
2 - di
3 - tri
4 - tetra
5 - penta
6 - hexa
7 - hepta
8 - octa
9 - nona
10 - deca
methane - CH_4
ozone - O_3
sucrose - $C_{12}H_{11}O_{22}$
hydrogen peroxide - H_2O_2
ammonia - NH_3
water - H_2O
ethanol - C_2H_5OH
methanol - CH_3OH
acetic acid - $CH_3COOH_{(aq)}$