Adult Basic Education

Science

Chemistry 1102

Chemical Reactions

Curriculum Guide

Credit Value: 1

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

Table of Contents

To the Instructor

I. Introduction to Chemistry 1102

This is the first course in the **'Chemistry Concentration'** of the Adult Basic Education program. It assumes that students already have some understanding of atomic structure and the periodic table. This is not a safe assumption for most ABE students. You may, therefore, need to spend some time teaching these concepts before students proceed with this course.

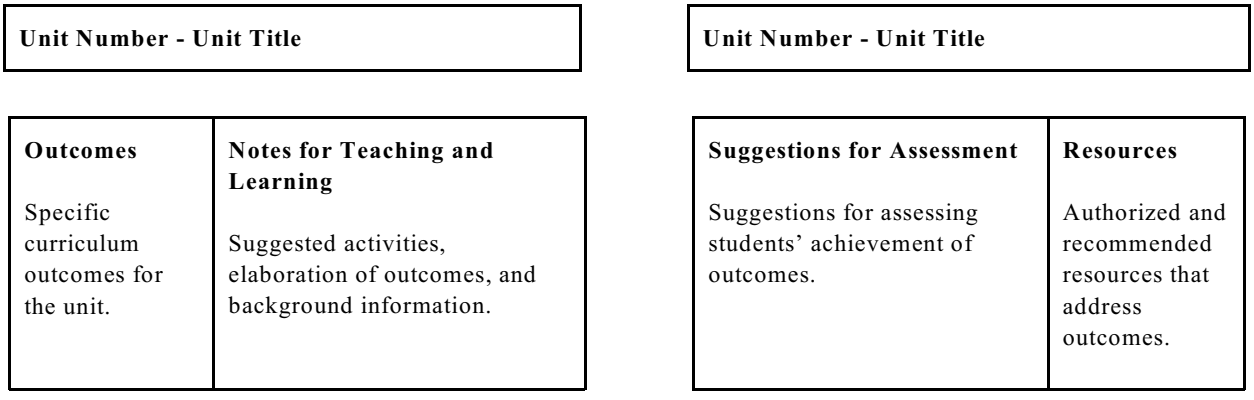
In this course students will learn about naming and writing formulas for ionic and molecular compounds. They will also learn to write and balance a variety of equation types. Students should be expected to show a high level of mastery of these topics in order to have the necessary foundation to build upon as they continue in the Chemistry concentration in ABE.

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

II. Curriculum Guides

Each new ABE Science course has a Curriculum Guide for the instructor and a Study Guide for the student. The Curriculum Guide includes the specific curriculum outcomes for the course. Suggestions for teaching, learning, and assessment are provided to support student achievement of the outcomes. Each course is divided into units. Each unit comprises a **two-page layout of four columns** as illustrated in the figure below. In some cases the four-column spread continues to the next two-page layout.

Curriculum Guide Organization:
The Two-Page, Four-Column Spread



III. Study Guides

The Study Guide provides the student with the name of the text(s) required for the course and specifies the sections and pages that the student will need to refer to in order to complete the required work for the course. It guides the student through the course by assigning relevant reading and providing questions and/or assigning questions from the text or some other resource. Sometimes it also provides important points for students to note. (See the *To the Student* section of the Study Guide for a more detailed explanation of the use of the Study Guides.) The Study Guides are designed to give students some degree of independence in their work. Instructors should note, however, that there is much material in the Curriculum Guides in the *Notes for Teaching and Learning* and *Suggestions for Assessment* columns that is not included in the Study Guide and instructors will need to review this information and decide how to include it.

IV. Resources

Essential Resources

Science 10
Nelson Science 10 Teacher's Resource for Unit 2 - Chemical Processes

Recommended Resources

Science 1206: Curriculum Guide:

http://www.ed.gov.nl.ca/edu/sp/sh/sci/sci1206/unit3.PDF

Nelson Publishing Web Site:

http://www.science.nelson.com

Computerized Assessment Bank for Nelson Science 10, Nelson.

Other Resources

Center for Distance Learning and Innovation: http://www.cdli.ca/

V. 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%.

Chemical Reactions

Unit 1 - Investigating Chemical Reactions

Outcomes

1.1 Understand that science and technology are an integral part of everyday life.

- 1.1.1 Define chemistry and matter.
- 1.1.2 Identify examples of chemistry and technology in everyday life.

1.2 Explain how matter is classified.

- 1.2.1 Name and define the two categories of matter (pure substances and mixtures).
- 1.2.2 Name and define the two categories of pure substances.
- 1.2.3 Name and define the two categories of mixtures.

1.3 Evaluate and select appropriate methods/tests to investigate the presence of chemicals.

- 1.3.1 Explain the difference between physical and chemical properties.

Notes for Teaching and Learning

Students who have recently completed Intermediate Science (Grade 9) should be familiar with the terms and concepts at the beginning of this unit (Outcomes 1.1 - 1.3). For other students, this material will be new and may require extra practice for reinforcement.

Students will be introduced to many new terms throughout this course. Instructors could suggest that students start a vocabulary list and add to it regularly as they work through the course.

Unit 1 - Investigating Chemical Reactions

Suggestions for Assessment

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback.

Instructors should ensure that all necessary terms are being added to the student's vocabulary list and provide students with ideas about how to successfully remember definitions.

The CDLI (Center for Distance Learning and Innovation) site was developed for distance delivery of selected high school courses. It contains lots of useful materials that could be used for reinforcement in the Adult Basic Education program.

Note: You will need a username and password to enter the CDLI site.

There are numerous web sites that have instructional materials that instructors could use to assist their teaching of Chemistry. A few of these are listed in Resources.

Resources

The center for distance learning and innovation website:

http://www.cdli.ca/

Textbook website:
http://www.science.nelson.com/

Other useful websites:

www.chemtutor.com

http://www.dbhs.wvusd.k12.ca.us/webdocs/

Science 10 , Chapter 5, pages 170 - 182.

*Science 10 Teacher's Resource***,** *Unit 2, "Chemical Processes"***.**

*Science 10 Teacher's Resource***,** *Applied Supplement.*

Science 10 , *Computerized Assessment Bank.*

Unit 1 - Investigating Chemical Reactions

Outcomes

1.3.2 Explain the difference between physical and chemical change.

1.3.3 Determine the physical and chemical properties of selected substances.

1.3.4 Define electrolyte and nonelectrolyte.

1.4 Demonstrate a knowledge of WHMIS standards.

1.4.1 Describe the WHMIS information system and its use.

1.4.2 Identify the eight WHMIS symbols.

1.4.3 Describe the MSDS sheet and its use.

1.4.4 Identify the nine categories on a MSDS sheet.

Notes for Teaching and Learning

Students should complete the work for outcome 1.4 before working in the lab. This can be achieved by having students complete the "*WHMIS Activity*" found in Appendix A. Instructors should review with students the following from the Skills Handbook (page 657): B: *Safety in the Laboratory*, Q: *Lab Reports*, and Figure 3: *Common Laboratory Equipment*, before students begin work in the lab.

Safe practices and proper use of equipment are very important in the laboratory. For all laboratory activities, instructors should ensure that students recognize WHMIS standards.

Any chemicals purchased will come with an MSDS sheet that students can investigate. One example of an MSDS sheet is provided in the Appendix.

Lab safety procedures should be reviewed with students before they begin work in the lab. Instructors should use Skills Handbook, A, *"Safety Conventions and Symbols"*, and B, *"Safety in the Laboratory"* for a review of safety.

Outcome 1.3.3 can be achieved by carrying out Investigation 5.3, *"Testing Properties of Substances"*.

Instructors should review the relevant sections of the Skills Handbook, K *"Planning an Investigation"*, with students before they begin working in the lab.

Instructors should explain to students what is expected to be submitted for their lab report. Blackline Master 5.3b could be provided to the students to record their observations.

Suggestions for Assessment

Questions 1.1 - 1.8 in the Study Guide should be assigned to cover Outcome1.1, 1.2, 1.3.1, and 1.3.2. Students will find the answers to these questions in the Introduction and Section 1.5 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback. Instructors should assign additional practice and/or review as needed.

The **Assignment**, "*WHMIS Activity*", and the **Laboratory**, *"Testing Properties of Substances"* , from the study guide, should be assigned marks and used as part of the evaluation for the course.

Blackline Masters 5.1c, "Safety Symbols", and 5.1d, "Lab Safety Concept Map", could be used for assessment of student's knowledge of safety procedures.

Instructors should refer to the Teacher's Resource for suggestions and notes for delivery of the lab.

Resources

"*WHMIS Activity*", Appendix A of this guide.

Science 10, Skills Handbook, K: Planning an Investigation.

Science 10, pp. 180 -182, ***Core Lab #1****,* "*Testing Properties of Substances*".

Blackline Master 5.1c,"Safety Symbols".

Blackline Master 5.1d, "Lab Safety Concept Map".

Unit 2 - Formula Writing

Outcomes

2.1 Describe the structure of the periodic table.

2.1.1 Define periodic table.

2.1.2 Define chemical families and identify the chemical families (alkali metals, alkaline earth metals, halogens, noble gases) in the periodic table.

2.2 Describe the structure of atoms and ions.

2.2.1 Name and describe the three main parts of the atom.

2.2.2 Define ion and explain how ions are formed.

2.2.3 Draw Bohr diagrams of atoms and ions.

Notes for Teaching and Learning

Students who have recently completed Intermediate Science (Grade 9) should be familiar with the terms and concepts at the beginning of this unit (Outcomes 2.1, 2.2). For other students, this material will be new and may require extra practice for reinforcement.

Blackline Master 5.5a, "Periodic Table of Elements", can be copied and given to students to use as they work through the remainder of this course.

The Teacher's Resource has a good explanation of the concepts in Outcomes 2.1 and 2.2 in the background information for Section 5.5.

The answers for all questions from the text can be found in the Teacher's Resource.

Unit 2 - Formula Writing

Suggestions for Assessment	Resources
Questions 2.1 - 2.5 in the Study Guide should be assigned to cover Outcomes 2.1. and 2.2. Students will find the answers to these questions in Section 5.5 of the text.	*Science 10, Chapter 5, pages 184 - 214.*
Activity 5.7 "*Ionic Charges and Chemical Families*", pages 190 - 191, may be assigned and used for assessment of students' understanding of the kinds of ions formed by elements of the major chemical families and their ionic charges.	*Blackline Master 5.5a, "Periodic Table of Elements".*
Blackline Master 5.5b, "Elements, Compounds, and the Periodic Table Crossword", can be used for assessment of this section.	*Blackline Master 5.5b, "Elements, Compounds, and the Periodic Table Crossword".*

Unit 2 - Formula Writing

Outcomes

2.3 Describe the usefulness of IUPAC scientific nomenclature system to convey chemical information.

2.3.1 Define molecule, compound, molecular element (diatomic molecule), molecular formula, empirical formula.

2.3.2 Differentiate between ionic and molecular compounds.

2.4 Name and write formulas for some common ionic compounds (both binary and complex).

2.4.1 Define valence.

2.4.2 Define polyatomic ion.

2.4.3 Using IUPAC rules, determine the **formulas** for common ionic compounds (including simple and polyatomic ions, ions that can form multiple charges, and ionic hydrates) .

Notes for Teaching and Learning

Students who have recently completed Intermediate Science (Grade 9) should be familiar with the terms covered in outcome 2.3.1. For other students, this material will be new and may require extra practice for reinforcement.

It is also important to note that the terms in outcome 2.3.1. are not defined in the text and students will need to be provided with these definitions. These are covered in Handout 2 - "Introduction to IUPAC", found in Appendix A of this guide.

Students need lots of practice with naming and writing formulas for ionic compounds. Instructors should assess student needs and provide worksheets as necessary.

The explanations in the text for naming ionic compounds of different types are very brief.

Naming ionic hydrates is not covered in the text. Instructors should use Handout 2 - "Naming Ionic Hydrates", in Appendix A, to teach this topic and provide students with the worksheet in Handout 3 for practice.

This topic is important for chemistry courses that follow.

NOTE: A periodic table of ions as well as a table of polyatomic ions should be provided to students.

Unit 2 - Formula Writing

Suggestions for Assessment

Questions 2.8 - 2.12 in the Study Guide should be assigned to cover Outcome 2.4. Students will find the answers to some of these questions in Sections 5.8 and 5.9 of the text.. They will also need to refer to Handout 3 (found in Appendix A of their Study Guide).

Blackline Masters 5.8 "Ionic Compounds: Names and Formulas Worksheet", and 5.9, "Polyatomic Compounds: Names and Formulas Worksheet", can be used to assess students' understanding of naming ionic compounds.

The Nelson Science website has links that students can access for additional practice. There are also many computer software programs that can be used to provide extra practice.

Resources

Blackline Master 5.8, "Ionic Compounds: Names and Formulas Worksheet".

Blackline Master 5.9, "Polyatomic Compounds: Names and Formulas Worksheet".

Handout 3 - "Naming Ionic Hydrates", in Appendix A.

Unit 2 - Formula Writing

Outcomes	Notes for Teaching and Learning
2.4.4 Using IUPAC rules, determine the **names** of ionic compounds (including simple and polyatomic ions, ions that can form multiple charges, and ionic hydrates).	
2.5 Name and write **formulas** for common molecular compounds, including the use of prefixes.	Students need lots of practice with naming and writing formulas for molecular compounds. Instructors should assess student needs and provide worksheets as necessary.
2.5.1 Define covalent bond.	
2.5.2 Using IUPAC rules, determine the **names** of binary molecular compounds.	A summary of rules for naming compounds and writing formulas is found in the handout , "IUPAC Naming of Compounds and Writing Formulas", in Appendix A. Instructors should ensure that students review it carefully and complete the worksheets that are included. Many computer software programs are available for additional practice.
2.5.3 Using IUPAC rules, determine the **formulas** of binary molecular compounds.	
2.5.4 Write **formulas** for several common molecular compounds using trivial (common) names.	

Unit 2 - Formula Writing

Suggestions for Assessment

Questions 2.13 - 2.14 in the Study Guide should be assigned to cover Outcome 2.5. Students will find the answers to these questions in Section 5.11 of the text.

Blackline Master 5.11, "Molecular Compounds: Names and Formulas Worksheet", can be used to assess the student's ability to apply knowledge and understanding of these concepts.

The worksheets included with the handout , "IUPAC Naming of Compounds and Writing Formulas", should be checked by the instructor to assess the student's understanding. Extra explanation and practice should be provided, if needed.

A quiz might be useful here to ascertain if students have mastered the concepts covered so far. The mark for this quiz may be used as part of the evaluation of the course.

Resources

Blackline Master 5.11, "Molecular Compounds: Names and Formulas Worksheet".

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

Science 10 , Computerized Assessment Bank.

Unit 3 - Equation Writing

Outcomes

3.1 Represent chemical reactions using word equations.

3.1.1 Define word equation.

3.1.2 Write word equations to represent a variety of reactions.

3.2 Represent chemical reactions and the conservation of mass, using balanced symbolic equations.

3.2.1 Define the Law of Conservation of mass.

3.2.2 Write and balance reactions that illustrate a variety of reaction types; including combustion, synthesis (combination), decomposition, single and double displacement (replacement).

3.2.3 Recognize and predict the products of different types of chemical reactions; including combustion, synthesis, decomposition, single and double displacements.

Notes for Teaching and Learning

Instructors should ensure that students understand the format for writing equations.

Students often don't realize that the arrow (→) signifies produces or yields and must not be substituted with the equals sign (=).

Students often try to balance equations by changing the subscripts in the chemical formulas. Instructors should emphasize that subscripts in correctly written formulas are never changed during the balancing process.

Instructors will likely need to work through several examples of balancing equations with students, in addition to those in the text.

If possible, have students working in pairs to complete the core lab. Provide students with Blackline Masters 6.8 and/or 6.9 to record their observations when completing the lab.

The Teacher's Resource should be consulted for information on the lab that is chosen.

Unit 3 - Equation Writing

Suggestions for Assessment

Questions 3.1 - 3.2. in the Study Guide should be assigned to cover Outcome 3.1. Students will find the answers to these questions in Section 6.1 of the text.

Questions 3.3 - 3.15 in the Study Guide should be assigned to cover the rest of the outcomes for this unit. Students will find the answers to some of these questions in Sections 6.3, 6.5, 6.6, 6.7, and 6.10 of the text.

Students should also complete and submit a report for either Investigation 6.8 or 6.9.

Writing and balancing equations is usually difficult for students and instructors will need to assess their success and assign additional practice as needed. Chapter 6 Review provides some additional practice. Other resources should also be used.

Blackline Masters 6.5a, "How to Count Atoms Review" and 6.5b, "Counting Atoms Worksheet", should be used to review concepts and to help students prepare for learning how to balance equations.

Blackline Master 6.13, "Types of Chemical Reactions Worksheet", and Blackline Master Chapter 6 Review, "Chemical Reactions Word Search", can be used to assess students' understanding of the outcomes for Unit 3.

Instructors may give a quiz on Unit 3 to ascertain if students have mastered the concepts covered in Unit 3. The mark for this quiz may be used as part of the evaluation of the course.

Resources

Science 10, Chapter 6, pages 216 -252.

Science 10, pp. 236 - 237, ***Core Lab #2****, "****Putting Things Together****"*

or

Science 10, pp. 238 - 239, , ***"Taking Things Apart"***.

Blackline Master 6.5a "How to Count Atoms Review".

Blackline Master 6.5b, "Counting Atoms Worksheet".

Blackline Master 6.8, "Putting Things Together".

Blackline Master 6.9, "Taking Things Apart".

Blackline Master 6.13, "Types of Chemical Reactions Worksheet".

Blackline Master Chapter 6 Review, "Chemical Reactions Word Search".

Unit 4 - Introduction to Acids and Bases

Outcomes

4.1 Classify simple acids, bases, and salts on the basis of their names and formulas.

4.1.1 Name and write formulas for some common acids and bases, using the periodic table, a list of ions, and rules for naming acids.

4.1.2 Define acids as molecules that ionize in water to produce hydrogen ions (H^+).

4.1.3 Identify the physical properties of acids.

4.1.4 Define bases as ionic compounds that contain the hydroxide ion (OH^-).

4.1.5 Define salts as ionic compounds.

Notes for Teaching and Learning

The text does not explain the details of how to name acids. The handout, "Naming Acids", in Appendix A, covers the naming acids part of outcome 4.1.1. Students should be provided with a copy of this handout.

There is no need for special instruction for naming bases and salts. Students will use the rules that they have already learned for naming compounds.

Students should be provided with worksheets to practice naming acids and bases. Instructors can find worksheets on the CDLI site or on numerous other web sites or in resource packages.

A detailed study of acids, bases, pH and so forth is not expected at this point.

Unit 4 - Introduction to Acids and Bases

Suggestions for Assessment

Review sheets can be used for assessment of students' ability to recognize substances as acids or bases and name them properly.

Resources

Science 10, Chapter 8, pages 288-289, 293 - 299, 314, 317 - 319.

Handout 5, "Naming Acids and Bases", in Appendix A

Unit 4 - Introduction to Acids and Bases

Outcomes

4.2 Classify substances as acids, bases, or salts, on the basis of their characteristic properties.

4.2.1 Define pH scale in terms of a measure of acidity or alkalinity or neutrality.

4.2.2 Define acids and bases operationally in terms of their effect on litmus paper, pH, sour and bitter taste, reaction with active metals, and reaction with each other.

4.2.3 Define salts operationally in terms of the conductivity of the aqueous solutions.

4.3 Describe how neutralization involves tempering the effects of an acid with a base and vice versa.

Notes for Teaching and Learning

The definitions for acids and bases found in the glossary can be used to achieve outcome 4.2.2.

Investigation 8.9, "Reacting Acids and Bases", may be done as an optional lab. Students should read through it for content even if they will not complete the lab.

Unit 4 - Introduction to Acids and Bases

Suggestions for Assessment

Questions 4.6 - 4.8 in the Study Guide should be assigned to cover Outcomes 4.2.3 and 4.3. Students will find the answers to these questions in Investigation 8.9 and Section 8.10 of the text.

Instructors may assign additional questions from the Chapter 8 Review.

A final examination should be given to cover the whole course.

Resources

Science 10 , *Computerized Assessment Bank.*

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.

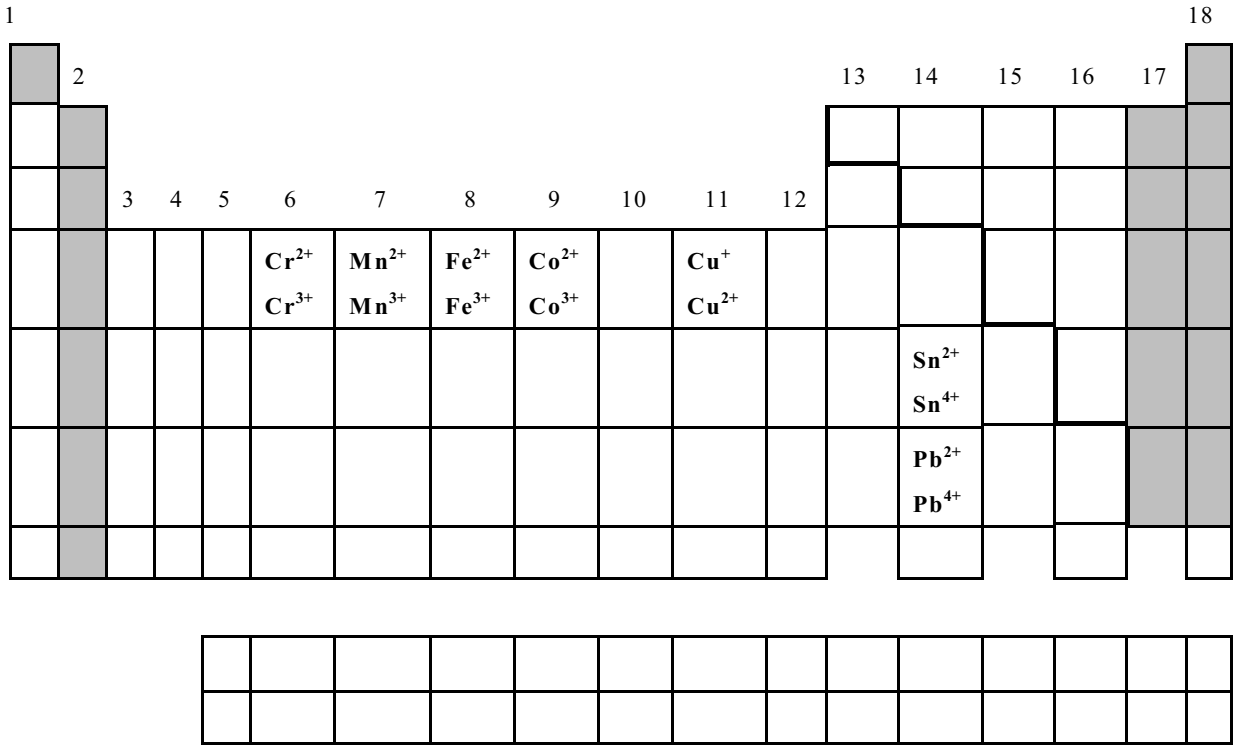
   Examples: NaCl sodium chloride

   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.	$Cd(NO_3)_2 \cdot 4\ H_2O$
7. Lithium bromide trihydrate	
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 Anion charge to determine the charge on the Cation (total positives must equal the total negatives)
Stock System
Use Roman Numerals to indicate ion charge.
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?
Yes
No
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 - $CH_3COOH_{(aq)}$