AP Chemistry
Summer Assignment 2012-2013

Welcome to AP Chemistry. Our mission this year is to understand Chemistry molecularly and to focus on understanding why Chemistry is the way it is rather than on memorizing different types of problems. You will learn to think analytically about the chemistry and be able to tackle any problem. That is the rigor of AP Chemistry.

As AP Chemistry students, this course is designed to be a rigorous college-level course that provides in-depth instruction in chemistry and in laboratory experiences. This course is demanding and will require your full commitment. It is expected that students spend at least 4-5 hours per week completing homework assignments and studying. Nothing can be forgotten in AP Chemistry, so a regular study session to refresh skills is very important. I would suggest forming a neighborhood study group to begin preparing. We will work diligently to prepare for the AP exam. It is my goal and expectation that each of you will receive a 3 or higher on the exam.

To prepare for the year ahead, this summer you will begin thoroughly reviewing your chemistry knowledge and reviewing the basics of how to speak "Chemistry". This assignment will cover all of the background material required. Please pay close attention to the assignment details to ensure all work is completed and turned in on-time. I have also attached a guide to writing in Chemistry. This should provide a clear expectation of the level of writing that is required for the course.

I'm very excited about working with each and everyone one of you to find great success in AP Chemistry. This course WILL be challenging, yet by the time you are ready for the exam, you will understand chemistry. If at any time you have a question regarding the assignments or the content itself, please feel free to email me at Justin.lambert@cmcss.net.

Mr. Justin W. Lambert
AP Chemistry Teacher

Summer Assignment:

1. Email me by June 1st. In this email please include your email address, extra-curricular and work commitments, your greatest fears in AP, and what your strength in Chemistry is.
2. We will be using a Moodle site to complete HW quizzes, share answers and provide important information. As soon as the website becomes functional, I will email each of the web address for the site. Please be watching your email for this.
   a. There will be HW quizzes for each section of the text you complete. In that email, I will outline the due dates for those quizzes to be completed.
3. Attached is a writing guide for AP. Please keep these guidelines in mind, as you write your lab reports next year.
4. From the textbook, read, take notes, and complete these homework problems:
   a. I will be collecting the HW when you return in August.
   b. Starting in August, I will have all the HW answers completed in a binder in my room for you to compare.
   c. This is designed to prepare you for the HW quizzes on Moodle.
   d. There will be a TEST over this material during the 1st week of school.

Chapter 1 - All	5, 7, 11, 14, 17, 18, 20, 22, 26, 31, 32, 33, 36, 38, 46, 50, 62, 64, 76, 100
Chapter 2 - All	1, 5, 12, 15, 16, 18, 24, 30, 36, 38, 44, 46, 47, 50, 58,

	60, 62, 69, 73, 86, 88, 90, 94, 96, 100
Chapter 3 - All	4, 5, 6, 12, 14, 18, 20, 24, 26, 28, 29, 30, 32, 34, 37, 40, 41, 42, 43, 44, 45, 46, 50, 52, 54, 58, 59, 60, 66, 68, 70, 71, 72, 76, 78, 84, 86, 89, 90, 94, 98, 100, 102, 103, 106, 117, 126, 132, 136, 140, 144, 146

5. It is also vital that you are able to SPEAK the language of Chemistry. There will be a test over this material in the first week of school. This summer, you must memorize and know this information:
    a. Determining Oxidation Numbers
    b. Variable Valences for Transition Metals
    c. Rules for Naming Acids
    d. Rules for Naming Ionic Compounds
    e. The Solubility Rules
    f. Polyatomic Ions
6. By August 1st, on Moodle, you need to take the AP Chemistry Diagnostic Exam. Please complete the attached worksheets and read the attached info on Organic Chemistry to review for this Exam.

APPENDIX 2:

A BRIEF GUIDE TO WRITING IN CHEMISTRY

This document is a guide to assist students in chemistry courses with writing and formatting laboratory reports and research reports. An important goal of the Department is for our students to organize and communicate research results effectively and to write with acceptable scientific style. We hope that by providing many of the common stylistic, grammatical and organizational points in this single document, student can use this advice throughout their study of chemistry.

A. Formatting a Report

Layout. Use 12 point Times New Roman font and double spacing to allow space for comments and corrections. Number all pages, including those in appendices.

Organization. A standard lab report or research paper should be formatted with sections.

1. TITLE. List the title of the experiment or meaningful name for your research report. This is followed by your name and the date submitted. If you worked with partners, list their names next to yours, but put an asterisk after your name* to indicate that you wrote the report.

2. ABSTRACT. The abstract should be able to "stand alone." This means that someone should be able to read *only* your abstract and understand the basic nature of your report. For this reason, a good abstract clearly identifies the purpose of the experiment and the important results. Repeat: *a good abstract contains a summary of your results.*

Avoid pedagogical comments such as "this experiment helped us learn about the nature of chemical reactions" or "the goal of this experiment was to learn about dyes." Although those ARE important aspects and goals of the lab experience, the lab/research report should focus only on the data and results. Avoid starting your abstract with "The purpose of this experiment was..."

Background information on the theory or applications of your experiment belongs in the Introduction section. Avoid referencing any other sources or parts of the report, because the abstract should be able to "stand alone."

Be specific about what was done: name the reagents or types (not models) of instruments that were used, the products of a reaction, numerical values that were measured or calculated, etc. Avoid vague statements such as "a metal complex was prepared and the percent yield was calculated." A better abstract would read "hexaammine cobalt(III) chloride was prepared from cobalt (II) chloride, ammonia, ammonium chloride and hydrogen peroxide. The yield was 8.45 g (64 % based on cobalt)."

The best way to learn how to write a good abstract is to READ some published abstracts. These can be found in chemistry journals (for example, *The Journal of the American Chemical Society*) which are in the library.

TIP: When writing a full report, write the Abstract last.

3. INTRODUCTION. The introduction section explains to the reader what basic scientific question is being addressed. It includes general background material or a brief historical perspective on the topic being investigated. It presents brief summaries, with references, of previous work. An effective introduction funnels the reader from a larger area of research, through examples of progress in the field to a clear statement of the research problem or approach being addressed in the current report.

4. EXPERIMENTAL. This section includes a description of your experimental procedure, and names of instruments used. For lab courses, the procedure can simply reference the lab manual, listing any changes to the published procedure. DO NOT REWRITE THE LAB MANUAL. For advanced labs or independent research, the experimental section should provide all the necessary detail for someone to be able to reproduce your work. Often, an Experimental section is subdivided into **Materials** (sources and purity of reagents used), **Preparation of Compounds** (with procedure, and summary of characterization by NMR, IR, UV-Vis spectroscopy, melting point, chromatography, or elemental analysis) and **Instrumentation** (manufacturer, description of any adaptation or sample preparation) sections. Consult *JACS* to see examples of Experimental sections for various types of reports.

TIP: a good experimental section should allow another person, using what you have written and a lab manual, to completely reproduce what you did in the lab.

5. RESULTS & DISCUSSION. (may be single or separate sections) The Results should include a summary of your raw data (preferably in tabular form) and important observations. Do NOT include long tables of raw data; for those experiments simply present the results of your calculations. Calculations may be included in this section or in an Appendix, and a description of equations used in your calculations must be presented. Handwritten calculations are acceptable for lab reports.

A Discussion section should take the form of an analysis of your results. Comment on the purpose of the experiment. What do the results indicate? What are sources of error (experimental uncertainty/precision)? What additional experiments could help address any dangling ends? Do the results agree with what others have found? Do the results support a model or hypothesis? For some lab courses, you can use this section to answer any questions presented in the manual or in class. Although you should answer the questions in the lab manual, this section should have the style of flowing prose, not simply answers to numbered questions.

6. CONCLUSION. Summarize your results and discussion with a short conclusion that is more than simply a reiteration of your results. Phrase it in terms of the broader questions addressed in the Introduction.

7. REFERENCES. Citations of the literature used in the previous sections (see section F)

8. APPENDIX. Graphics may appear here, along with lengthy calculations or additional material not needed when reading through the report.

Graphics. Graphics include Tables, Figures, Schemes and chemical structures. Tables are columns of measured and/or calculated values or observations. All quantities should have units and be expressed using proper significant figures and scientific notation. Important experimental conditions should be listed as footnotes, especially when the table includes data obtained under different experimental conditions. Figures include: spectra, graphs, cartoons of experimental set-up or other drawings intended to show an *object*. Schemes include: reaction mechanisms, experimental flow charts or other drawings that are intended to show a *process*. All Tables, Figures and Schemes should be numbered sequentially and must be mentioned in the text. All graphics should be a full page in size and included at the end of the manuscript in the Appendix. Chemical structures can appear in the text and should be labeled with the same name, formula or compound number that appears in the text.

B. Sentence Structure and Writing Style

1. Beginning a sentence. Avoid beginning a sentence with a symbol, numeric value or equation.

incorrect: 315.6 mg of ammonium chloride was added to the solution, which was then heated to 50 °C.
correct: After the addition of 315.6 mg of ammonium chloride, the solution was heated to 50 °C.

incorrect: ν is both the vibrational frequency and the IR radiation frequency.
correct: The frequency ν refers to both the vibrational frequency and the frequency of IR radiation.

2. Dangling Modifiers and Illogical Construction. Check that a modifier phrase or the pronoun "it" actually refers to the intended subject. (see also: subject-verb agreement.)

incorrect: Being coated with grease, I cleaned the flask before adding reagents
was I coated with grease or was the flask?
correct: Because the flask was coated with grease, it was cleaned before...

incorrect: After transferring to a larger flask, the solution was heated to a boil.
did the solution transfer itself?
correct: The solution was transferred to a larger flask and heated to a boil.

incorrect: A diagram of the influenza virus is now available. To obtain it, contact the instructor. *The instructor is making the influenza virus available?*
correct: A diagram of the influenza virus is now available from the instructor.

incorrect: To prevent decomposition, the reaction flask must be purged of air.
does the flask want to prevent decomposition?
correct: To prevent decomposition, purge all air from the reaction flask.

3. Equations. Equations typically appear as a separate line from the text and are numbered sequentially throughout the manuscript. Equations can then be referred to by number.

example:
"The quenching rate constant can be calculated using the Stern-Volmer equation:

$$\Phi_0/\Phi_q = 1 + k_q\tau_0[Q] \qquad (2)$$

4. Hyphens. Hyphenate compound adjectives.

5-mL aliquots were added but, aliquots of 5 mL were added
crystal deposited from the slowly-cooled solution.

5. Spaces. There should be a space between a quantity and its units and between a quantity or word and subsequent parenthetical phrase.

6.626 J s
25.15 K = 298.15 °C
45 mL
456 nm (34,000 M^{-1} cm^{-1})

6. Personal Pronouns. By tradition, scientists avoid using the personal pronouns "I" and "we" and "you" in most technical communications. The use of third person instead of first person is preferred when reporting results. (see also: active voice)

first person: I heated the solution at 100 °C for 1 h. and I noticed that it turned blue.
third person: When heated at 100 °C for 1 h., the solution turned blue.

7. Pedagogical comments. Avoid including pedagogical comments in a report or scientific communication. Phrases such as "this experiment helped us learn about the nature of chemical reactions" or "the goal of this experiment was to learn about dyes" are addressing the process of learning not the science of the experiment. Although those ARE important aspects and goals of the lab experience, the lab report should focus only on the data and results.

Also, try to avoid starting your abstract with "The purpose of this experiment was..."

8. Personification. Molecules and equipment are not people, so do not personify them in your writing.

incorrect: Sugar really wants to dissolve in water.

correct: Sugar is very soluble in water.

incorrect: Sodium wants to lose one electron to form Na^+.
correct: Oxidation of Na to Na^+ is thermodynamically favorable.

incorrect: The spectrum shows two bands of equal intensity
correct: Two bands of equal intensity appear in the spectrum.

9. Plural nouns. "Data" is plural for "datum," "spectra" is plural for "spectrum," "phenomena" is plural for "phenomenon," and "formulae" is plural of "formula." The amount of chemical reagent is singular, so use the correct verb tense.

incorrect: Data was acquired and a spectra is in the appendix.
correct: Data were acquired and a spectrum is in the appendix

incorrect: While the solution boiled, 5.0 g of KBr were added.
correct: While the solution boiled, 5.0 g of KBr was added.

10. Prepositions. Don't forget "of" between quantities and substance name.

incorrect: "... and 10 mL MeOH was added."
correct: "... and 10 mL of MeOH was added."

11. Redundant or unnecessary phrases (pleonasm).

incorrect: A photon of light having a wavelength of 530 nm...
if not "of light," what was the photon made of?
correct: Light having a wavelength of 530 nm...

incorrect: In this experiment, aspirin was prepared from oil of wintergreen.
If not this experiment, then in which experiment?
correct: Aspirin was prepared from oil of wintergreen.

12. Subject-verb agreement. Are you stating that an inanimate object is drawing a conclusion, or suggesting a strange cause and effect? (see also: dangling modifers)

incorrect: The IR spectrum implies that water is in the aspirin sample. *(spectra don't imply, people do)*
correct: The presence of water in the aspirin sample is inferred from the IR spectrum.

incorrect: Water was present in the aspirin product because of the peak at 3200 cm^{-1} in the IR spectrum. (*the peak in the spectrum didn't cause water to be present*)
correct: The peak at 3200 cm^{-1} in the IR spectrum indicates that water was present in the aspirin product. (*water caused the peak in the spectrum)*

C. Verbs

1. Active voice. By avoiding personal pronouns, scientists often depend excessively on the passive voice, which can weaken the writing style. *When possible,* replace passive voice with active voice.

passive voice:	A vapor was observed when the solution was heated.
active voice:	A vapor formed above the hot solution.

passive voice:	There was some solid that did not dissolve.
active voice:	Some solid did not dissolve.

2. Subject-verb agreement. Based on whether the subject is singular or plural, use the correct verb tense. A quantity used is a singular subject, even when that quantity is in a plural form of units.

incorrect:	12 g **were** added
correct:	12 g **was** added

3. Verb tense. Past tense is used to describe a procedure that you followed in an experiment. Present tense is used to describe a scientific fact, such as the properties of a molecule.

examples: Hydrochloric acid was added to the flask slowly in order to prevent decomposition of the product. Hydrochloric acid is a caustic substance that must be used with caution.

4. "Verbing" a Noun. Don't turn nouns into verbs.

incorrect: ammonia complexes to cobalt ions
correct: ammonia forms complexes with cobalt ions.

incorrect: the mixture was centrifuged to separate the solid.
correct: The solid was separated from the mixture using a centrifuge.

incorrect: The solution was rotovapped to dryness
correct: The solvent was removed by rotary evaporation

D. Abbreviations, Formulae and Numerals

1. Standard Abbreviations. Use standard *JACS* abbreviations (note: not all journals use exactly the same abbreviations:

examples: mL = milliliter; μg = microgram; nM = nanomolar
h = hour; min = minute; s = second
K = degrees Kelvin, °C = degrees Celsius

2. Chemical Formulae. Use subscripts, superscripts, parentheses, and symbols appropriately in chemical formulae.

<u>examples:</u>

Cr^{3+}(*aq*)
$K_2[PtCl_4]$
$[Ru(bpy)_3{}^{2+}](PF_6)_2$

3. Compound Numbers. Compounds can be numbered if repeated long compounds names become cumbersome. The number should be defined (usually in bold or underlined) somewhere early in the manuscript, often when it is first presented. The numbers should appear in parenthesizes when used as adjectives, but not when used as nouns.

<u>example:</u>

"Investigations into the fluorescence of 8-hydroxyquinoline (**1**), 4-iodo-8-hydroxyquinoline (**2**) and 2-methyl-4-iodo-8-hydroxyquinoline (**3**) are described in this paper. Recrystallization of **1** and **2** afforded analytically pure samples, but vacuum sublimation of the methyl derivative (**3**) was necessary to remove fluorescent impurities."

4. Decimal Places. For values less than unity, use a leading zero. Avoid writing values having too many zero; use scientific notation.

<u>examples:</u>

"0.15 μL" not ".15 μL"
"2.3 x 10^{-5} M" not "0.000024 M"

5. Defining Abbreviations. Abbreviations for chemical compounds, ligand, instruments or methods should be defined in the text before using throughout the manuscript.

<u>examples:</u>

"The complex cation $Ru(bpy)_3{}^{2+}$, where bpy = 2,2'-bipyridine, is luminescent . . ."
"Surfactants such as sodium dodecyl sulfate (SDS) lead to lower drag . . ."
"Peptide structures were minimized using the empirical force filed (EFF) method."
"The American Chemical Society (ACS) sponsors two annual national meetings."

6. Organic Abbreviations. Standard organic abbreviations can be used in text and formulae.

<u>examples:</u>

Me = methyl
Et = ethyl
iPr = *iso*-propyl
tBu = *tert*-butyl
Ch – cyclohexyl

7. Reagents and Solvents. Use chemical formulae for standard reagents and solvents, but not when the name is shorter or more precise

<u>examples:</u>	NaOH (*aq*)	in place of "sodium hydroxide"
	H_2SO_4 (*aq*)	in place of "sulfuric acid"
	CH_2Cl_2	in place of "dichloromethane"
	"caffeine"	in place of $C_8H_{10}N_4O_2$

E. Chemical Terms and Expressions

1. Chemical names. The names of chemicals are not capitalized, unless they are trade names such as "Tylenol" or "Viagra."

incorrect:	The reaction of aqueous Cobalt(II) with Aspirin was investigated.
correct:	The reaction of aqueous cobalt(II) with aspirin was investigated.

2. Create. Chemistry involves "synthesizing" new compounds, "preparing" solutions, "characterizing" products. Avoid using phrases such as "products were *created.*" Too divine.

3. Measurements. Spectra are measured "with" or "using" a spectrometer, not "on" a spectrometer (ouch!)

4. Machines. Spectrometers (UV-Vis, IR, NMR, etc.) are "instruments," not "machines."

5. React. As an intransitive verb, "react" should not have an object and should not have a passive voice. Chemical reagents react with each other, they are not reacted.

<u>incorrect:</u> "Potassium hydroxide and hydrochloric acid were reacted to produce water and potassium chloride."
<u>correct:</u> "The reaction of potassium hydroxide and hydrochloric acid produced water and potassium chloride."

6. Tested. A hypothesis can be "tested" and a student can be "tested." For most laboratory work, the terms "measured," "investigated," "determined," "calculated" or "obtained" often work better.

<u>incorrect:</u> The absorbance of the solution was tested using the UV-vis machine.
<u>correct:</u> The absorbance of the solution was measured using a UV-vis spectrophotometer.

F. References

There are numerous styles for formatting references. Unless otherwise instructed, citations should be formatted in the *JACS* style and appear as endnotes. Alternatively, article titles can also be included. Most important is to prepare citations with a uniform style.

Last name, initials; Last name, initials *Journal Title* **year**, *volume (issue)*, starting page.
or
Last name, initials; Last name, initials "Article Title" *Journal Title* **year**, *volume (issue)*, starting page.

<u>examples:</u>

Schlabach, M.; Limbach, H.-H.; Shu, A.; Bunnenberg, E.; Tolf, B.; Djerassi, C. *J. Am. Chem. Soc.* **1993**, *115*, 4554.

Additional Materials for Writing Lab/Research Reports

Davis, Martha *Scientific papers and presentations* San Diego : Academic Press, **1997**

Dodd, Janet S. (ed.)*The ACS style guide : a manual for authors and editors* ACS, **1997**.

Eisenberg, Anne "Strategies five productive chemists use to handle the writing process." *J. Chem. Educ.* **1982,** *59,* 566.

Potera, Carol "The Basic Elements of Writing a Scientific Paper: The Art of Scientific Style" *J. Chem. Educ.* **1984,** *61,* 247.

Spector, Thomas "Writing a Scientific Manuscript: Highlights for Success" *J. Chem. Educ.* **1994,** *71,* 47.

> "To avoid criticism, do nothing, say nothing, be nothing."
> *-Elbert Hubbard*

Determining Oxidation Numbers

Oxidation Number: The oxidation number of an element indicates the number of electrons lost, gained, or shared as a result of chemical bonding. The change in the oxidation state of a species lets you know if it has undergone oxidation or reduction.

Oxidation can be defined as "an increase in oxidation number". In other words, if a species starts out at one oxidation state and ends up at a higher oxidation state it has undergone oxidation.

Reduction can be defined as "a decrease in oxidation number". Any species whose oxidation number is lowered during the course of a reaction has undergone reduction.

Example:

- $Na + Cl_2$ -----> 2NaCl
- The Na starts out with an oxidation number of zero (0) and ends up having an oxidation number of 1+. It has been **oxidized** from a sodium atom to a positive sodium ion.
- The Cl_2 also starts out with an oxidation number of zero (0), but it ends up with an oxidation number of 1-. It, therefore, has been **reduced** from chlorine atoms to negative chloride ions.

The substance bringing about the oxidation of the sodium atoms is the chlorine, thus the chlorine is called an **oxidizing agent**. In other words, the oxidizing agent is being reduced (undergoing reduction). The substance bringing about the reduction of the chlorine is the sodium, thus the sodium is called a **reducing agent**. Or in other words, the reducing agent is being oxidized (undergoing oxidation). Oxidation is **ALWAYS** accompanied by reduction. Reactions in which oxidation and reduction are occurring are usually called **Redox reactions.**

Rules for Assigning Oxidation Numbers

There are several rules for assigning the oxidation number to an element. Learning these rules will simplify the task of determining the oxidation state of an element, and thus, whether it has undergone oxidation or reduction.

1. The oxidation number of an atom in the elemental state is zero.
   Example: Cl_2 and Al both are 0
2. The oxidation number of a monatomic ion is equal to its charge.
   Example: In the compound NaCl, the sodium has an oxidation number of 1+ and the chlorine is 1-.
3. The algebraic sum of the oxidation numbers in the formula of a compound is zero.
   Example: the oxidation numbers in the NaCl above add up to 0
4. The oxidation number of hydrogen in a compound is 1+, except when hydrogen forms compounds called hydrides with active metals, and then it is 1-.
   Examples: H is 1+ in H_2O, but 1- in NaH (sodium hydride).
5. The oxidation number of oxygen in a compound is 2-, except in peroxides when it is 1-, and when combined with fluorine. Then it is 2+.
   Example: In H_2O the oxygen is 2-, in H_2O_2 it is 1-.
6. The algebraic sum of the oxidation numbers in the formula for a polyatomic ion is equal to the charge on that ion.
   Example: in the sulfate ion, SO_4^{2-}, the oxidation numbers of the sulfur and the oxygens add up to 2-. The oxygens are 2- each, and the sulfur is 6+.

Variable Valences for Transition Metals

Name Symbol	Charge	Stock Name
Chromium Cr	+2	Chromium (II)
	+3	Chromium (III)
Manganese Mn	+2	Manganese (II)
	+3	Manganese (III)
Iron Fe	+2	Iron (II)
	+3	Iron (III)
Cobalt Co	+2	Cobalt (II)
	+3	Cobalt (III)
Copper Cu	+1	Copper (I)
	+2	Copper (II)
Lead Pb	+2	Lead (II)
	+4	Lead (IV)
Mercury Hg	+1	Mercury (I)
	+2	Mercury (II)
Tin Sn	+2	Tin (II)
	+4	Tin (IV)
Gold Au	+1	Gold (I)
	+3	Gold (III)
Silver Ag	+1	Silver
	+2(rarely)	Silver (II)
Bismuth Bi	+3	Bismuth (III)
	+5	Bismuth (V)
Antimony Sb	+3	Antimony (III)
	+5	Antimony (V)
Cadmium Cd	+2	Cadmium
Zinc Zn	+2	Zinc

Rules for Naming an Acid

1. When the name of the anion ends in –ide, the acid name begins with the prefix hydro-, the stem of the anion has the suffix –ic and it is followed by the word acid.

-ide becomes hydro _____ic Acid

Example: **Cl^- is the Chloride ion so HCl = hydrochloric acid**

2. When the anion name ends in –ite, the acid name is the stem of the anion with the suffix –ous, followed by the word acid.

-ite becomes ______ous Acid

Example: **ClO_2^- is the Chlorite ion so $HClO_2$. = Chlorous acid.**

3. When the anion name ends in –ate, the acid name is the stem of the anion with the suffix –ic, followed by the word acid.

-ate becomes ______ic Acid

Example: **ClO_3^- is the Chlorate ion so $HClO_3$ = Chloric acid.**

Solubility Rules

Salt Solubility Rules

1. Salts of ammonium (NH_4^+) and Group IA are always soluble.

2.
   a. All chlorides (Cl^-) are soluble except AgCl, Hg_2Cl2, and $PbCl_2$ which are insoluble.
   b. All bromides (Br^-) are soluble except AgBr, Hg_2Br_2, $HgBr_2$, and $PbBr_2$ which are insoluble.
   c. All iodides (I^-) are soluble except AgI, Hg_2I_2, HgI_2, and PbI_2 which are insoluble.

3. Chlorates (ClO_3^-), nitrates (NO_3^-), and acetates (CH_3COO^-) are soluble.

4. Sulfates (SO_4^{-2}) are soluble except $CaSO_4$, $SrSO_4$, $BaSO_4$, Hg_2SO_4, $HgSO_4$, $PbSO_4$, and Ag_2SO_4 which are insoluble.

5. Phosphates (PO_4^{-3}), and carbonates (CO_3^{-2}) are insoluble except NH_4^+ and Group IA compounds.

6. All metallic oxides (O^{-2}) are insoluble except NH_4^+ and Group IA compounds.

7. All metallic hydroxides (OH^-) are insoluble except NH_4^+ and Group IA and Group IIA from calcium down.

8. All sulfides (S^{-2}) are insoluble except NH_4^+ and Groups IA and IIA.

Polyatomic Ions

Name	Symbol (& Charge)
ammonium	NH_4^{+1}
acetate	$C_2H_3O_2^{-1}$
bromate	BrO_3^{-1}
chlorate	ClO_3^{-1}
chlorite	ClO_2^{-1}
cyanide	CN^{-1}
dihydrogen phosphate	$H_2PO_4^{-1}$
hypochlorite	ClO^{-1}
hydrogencarbonate(bicarbonate)	HCO_3^{-1}
hydrogen sulfate (bisulfate)	HSO_4^{-1}
hydrogen sulfite (bisulfite)	HSO_3^{-1}
hydroxide	OH^{-1}
iodate	IO_3^{-1}
nitrate	NO_3^{-1}
nitrite	NO_2^{-1}
perchlorate	ClO_4^{-1}
permanganate	MnO_4^{-1}
thiocyanate	SCN^{-1}
carbonate	CO_3^{-2}
chromate	CrO_4^{-2}
dichromate	$Cr_2O_7^{-2}$
oxalate	$C_2O_4^{-2}$
selenate	SeO_4^{-2}
silicate	SiO_3^{-2}
sulfate	SO_4^{-2}
sulfite	SO_3^{-2}
phosphate	PO_4^{-3}
phosphite	PO_3^{-3}

Rules for Naming Ionic Compounds

1. Balance Charges (charges should net zero)
2. Cation is always written first (in name and in formula)
3. Change the ending of the anion to -ide (unless polyatomic ion, then named as given above).

AP Chem Summer Assignment Worksheet #1

Measurements and Calculations

Mixed Metric and American Conversions: Show ALL work, using dimensional analysis, and answer in scientific notation.

1. 0.014 kilograms to centigrams
2. 4.305 liters to milliliters
3. 61.2 microliters to milliliters
4. 5.48 centimeters to millimeters
5. 3.80 km to meters
6. 40.6 decimeters to decameters
7. 3.88 miles to hectometers
8. 2.994 ounces to milligrams
9. 926 tons to Megagrams
10. How many centimeters are there in 7.88×10^2 feet?
11. Convert 6.775 yards to picometers.
12. Convert 5.47×10^{-2} hectograms to ounces
13. How many centimeters are there in 51.004 miles

Density: Show ALL work, use dimensional analysis when necessary.

14. If an unknown solid weighs 84.0 grams and occupies 30.0 cm^3 of space, what is its density?

15. What is the mass of a liquid having a density of 1.50 g/ml and a volume of 3.5 liters?

16. What volume would a 200 gram sample of gold have if its density is known to be 20.5 g/cm^3?

17. A solid block of substance is 74.0 cm by 55.0 cm by 29.0 cm and it weighs 625 kg. Assuming that it did not chemically react with water nor dissolve in it, would it float in water? Show your work.

18. A gas has a volume of 7.0 liters and a mass of 4.44×10^5 micrograms. What is its density?

19. A certain liquid has a density of 0.855 g/ml. How many LITERS would weigh 1.00 kg?

Dimensional Analysis (Exercising Problem Solving Skills): Show ALL work, using dimensional analysis, Report answers using the correct number of significant figures.

20. The record long jump is 349.5 inches. Convert this to meters. There are 2.54 cm in an inch.

21. A car traveling 55.0 miles per hour. Convert this to meters per second. 1 mile = 1.61 km.

22. How many milligrams are there in a 5.00 grain aspirin tablet? 1 grain = 0.00229 ounces. There are 454 grams/pound and 16.0 ounces/pound.

23. Mercury has a density of 13.54 g/mL. How many milliliters would 100. grams fill?

24. In 1980, the US produces 18.4 billion pounds (1.84 X 1010 lbs) of phosphoric acid to be used in the manufacture of fertilizer. The average cost of the acid is $318/ton. (1 ton = 2000 lbs) What was the total value of the phosphoric acid produced?

25. On planet Zizzag, city Astric is 35.0 digs from city Betrek. The latest in teenage transportation is a Zeka which can travel a maximum of 115 millidigs/zip. On Zizzag their time system divides each dyne into 25.0 zips. How many dyne will it take Pezzi to get from Astric to Betrek to see his girlfriend?

26. While prospecting in the North Woods, Joe found a gold nugget which had a density of 19.2 g/cm3. Joe dropped the gold into water in a graduated cylinder, the water level increased by 15.0 mL. How many grams of gold did he have?

27. Light travels at a speed of 3.00 X 1010 cm/sec. What is the speed of light in km/hr?

28. A cheetah has been clocked at 112 km/hr over a 100. meter distance. What is this speed in m/sec?

AP Chem Summer Assignment Worksheet #2

Stoichiometry

Complete the following problems using dimensional analysis. Balance all of the equations that need to be balanced. The answers are given in parenthesis at the end of each problem.

1. In the decomposition of sodium hydroxide, how many moles of sodium hydroxide are needed to produce 30.0 moles of water? (60.0 moles NaOH)

2. In the single replacement reaction of lithium and magnesium nitrate, what mass of lithium combines with 75.0 grams of magnesium nitrate? (7.02 g Li)

3. How many grams of lead (II) nitrate are needed to produce 60.0 grams of potassium nitrate in the double replacement reaction of potassium iodide and lead (II) nitrate. (98.3 g lead (II) nitrate)

4. In the synthesis reaction of zinc(II) and sulfur, what mass of zinc (II) sulfide is produced from 100.0 grams of sulfur? (303.9 g ZnS)

5. A synthesis reaction of calcium and oxygen was completed in a lab and 234.9 grams of calcium oxide were produced from 75.00 grams of oxygen. What is the percent yield? (89.36%)

6. In the single replacement reaction of magnesium and aluminum phosphate, if 7.00 moles of magnesium react, how many moles of aluminum phosphate would be needed? (4.67 mol $AlPO_4$)

7. When methane and oxygen react (complete combustion reaction) how many grams of water would be produced from 25.0 grams of methane? (56.1g water)

8. A 26.3 gram sample of potassium chlorate decomposed and produced 9.45 grams of oxygen. What is the percent yield for oxygen? (91.7%)

9. If 7.40 grams of calcium hydroxide react with nitric acid to produce 2.01 grams of water, what is the percent yield? (55.8%)

10. Lime, CaO, reacts with hydrochloric acid to form calcium chloride and water. How many moles of HCl would be required to react with 7.5 moles of lime? How many moles of water would be formed? (15 mol HCl; 7.5 mol water)

For each of the following write balanced chemical equations and then solve the problem.

11. What is the maximum number of grams of PH_3 that can be formed when 6.2 g of phosphorus reacts with 6.0 g of hydrogen to form PH_3?

12. Copper is formed when aluminum reacts with cupric sulfate in a single-replacement reaction. How many grams of copper can be obtained when 29.0 g of Al reacts with 156 g or cupric sulfate?

13. If you begin with 1250 g of N_2 and 225 of H_2 in the reaction that forms ammonia gas (NH_3), how much ammonia will be formed? What is the limiting reagent? How much of the reagent is left when the maximum amount of ammonia is formed?

AP Chem Summer Assignment Worksheet #3

Composition

Complete the following problems showing all work and with answers using the correct significant digits.

1. A 0.941 gram piece of magnesium metal is heated and reacts with oxygen. The resulting oxide weighed 1.560 grams. Determine the percent composition of each element in the compound.

2. Determine the empirical formula given the following data for each compound:
   a) Fe = 63.53%, S = 36.47%
   b) Fe = 46.55%, S = 53.45%

3. A compound contains 21.6% sodium, 33.0% chlorine, 45.1% oxygen. Determine the empirical formula of the compound.

4. A 2.500 gram sample of uranium was heated in air. The resulting oxide weighed 2.949 gram. Determine the empirical formula of the oxide. {Hint: Carry out the calculations to four decimal places}.

5. When 1.010 g of zinc vapor is burned in air, 1.257 grams of the oxide is produced.
   a) What elements are present in the oxide?
   b) Determine the percent composition of each element in the oxide.
   c) Determine the empirical formula of the compound.

6. A compound has the empirical formula of CH_3Br and a vapor density of 6.00 g/L, at 375 K and 0.983 atm. Using these data, determine the following:
   a) The molar mass of the compound.
   b) The molecular formula of the compound.

7. A compound containing the elements C, H, N, and O is analyzed. When a 1.2359 gram is burned in excess oxygen, 2.241 g of $CO_2(g)$ is formed. The combustion analysis showed that the sample contained 0.0648 g of H.
   a) Determine the mass, in grams, of C in the 1.2359 g sample of the compound.
   b) When the compound is analyzed for N content only, the mass percent of N is found to be 28.84%. Determine the mass, in grams, of N in the original 1.2359 g sample of compound.
   c) Determine the mass, in grams, of O in the original 1.2359 g sample of the compound.
   d) Determine the empirical formula of the compound.

AP Chem Summer Assignment Worksheet #4

Naming Chemical Compounds

The following are a good mix of naming and formula writing problems to help you get some practice. I will expect that you know how to name both ionic and covalent compounds in your work.

Name the following chemical compounds:

1) $NaBr$ ____

2) $Ca(C_2H_3O_2)_2$ ____

3) P_2O_5 ____

4) $Ti(SO_4)_2$ ____

5) $FePO_4$ ____

6) K_3N ____

7) SO_2 ____

8) $CuOH$ ____

9) $Zn(NO_2)_2$ ____

10) V_2S_3 ____

Write the formulas for the following chemical compounds:

11) silicon dioxide ____

12) nickel (III) sulfide ____

13) manganese (II) phosphate ____

14) silver acetate ____

15) diboron tetrabromide ____

16) magnesium sulfate heptahydrate ____

17) potassium carbonate ____

18) ammonium oxide ____

19) tin (IV) selenide ____

20) carbon tetrachloride ____

AP Chem Summer Assignment Worksheet #5

Predicting Reaction Products

Balance the equations and predict the products and states of matter (assumer reactions are taking place at STP) for the following reactions. If no reaction occurs write 'NR'.

1) ____ Na + ____ $FeBr_3$ →

2) ____ NaOH + ____ H_2SO_4 →

3) ____ $C_2H_4O_2$ + ____ O_2 →

4) ____ NH_3 + ____ H_2O →

5) ____ $PbSO_4$ + ____ $AgNO_3$ →

6) ____ PBr_3 →

7) ____ HBr + ____ Fe →

8) ____ $KMnO_4$ + ____ $ZnCl_2$ →

9) ____ MnO_2 + ____ $Sn(OH)_4$ →

10) ____ O_2 + ____ $C_5H_{12}O_2$ →

11) ____ H_2O_2 →

12) ____ $PtCl_4$ + ____ Cl_2 →

III. Chemical Reactions

In AP Chemistry, most of the reaction we write are called "net ionic." But before we can do that, you need to review and memorize some basic reaction types. For some basic review, go to the following website:
http://misterguch.brinkster.net/6typesofchemicalrxn.html

Now try these sample problems from the website:

Give the type for each of the following reactions:

1) $NaOH + KNO_3 \rightarrow NaNO_3 + KOH$ ____________________

2) $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$ ____________________

3) $2\ Fe + 6\ NaBr \rightarrow 2\ FeBr_3 + 6\ Na$ ____________________

4) $CaSO_4 + Mg(OH)_2 \rightarrow Ca(OH)_2 + MgSO_4$ ____________________

5) $NH_4OH + HBr \rightarrow H_2O + NH_4Br$ ____________________

6) $Pb + O_2 \rightarrow PbO_2$ ____________________

7) $Na_2CO_3 \rightarrow Na_2O + CO_2$ ____________________

You will also need to learn which acids and bases are strong and which are weak. See this document online:
http://spiepho.sbc.edu/worksheets/Gen_Chem_2/Chp15.Acids_and_Bases.doc
It takes awhile to read, but it is very complete! Strong acids are: HCl, HBr, HI, HNO_3, $HClO_4$ and H_2SO_4. All other acids are considered weak. Strong bases are group 1A or 2A metal hydroxides.

Learn these types of decomposition reactions:

1. Metallic carbonates, when heated, form metallic oxides and $CO_{2(g)}$.

   EX. $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

2. Most metallic hydroxides, when heated, decompose into metallic oxides and water.

   EX. $Ca(OH)_{2(s)} \rightarrow CaO_{(s)} + H_2O_{(g)}$

3. Metallic chlorates, when heated, decompose into metallic chlorides and oxygen.

   EX. $2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$

4. Some acids, when heated, decompose into nonmetallic oxides and water.

EX. $H_2SO_4 \rightarrow H_2O_{(l)} + SO_{3(g)}$

5. Some oxides, when heated, decompose.

EX. $2HgO_{(s)} \rightarrow 2Hg_{(l)} + O_{2(g)}$

6. Some decomposition reactions are produced by electricity.

EX. $2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$

EX. $2NaCl_{(l)} \rightarrow 2Na_{(s)} + Cl_{2(g)}$

Now try these: (Rewrite as a balanced equation with the products predicted):

1. barium hydroxide (heated)

____

2. sodium carbonate (heated)

____

3. lithium chlorate (heated)

____

4. electrolysis of aluminum oxide

____

5. sulfuric acid heated gently

____

Learn these types of synthesis reactions:

1. Metal + oxygen → metal oxide

EX. $2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

2. Nonmetal + oxygen → nonmetallic oxide

EX. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

3. Metal oxide + water → metallic hydroxide

EX. $MgO_{(s)} + H_2O_{(l)} \rightarrow Mg(OH)_{2(s)}$

4. Nonmetallic oxide + water → acid

   EX. $CO_{2(g)}$ + $H_2O_{(l)}$ → ; $H_2CO_{3(aq)}$

5. Metal + nonmetal → salt

   EX. 2 $Na_{(s)}$ + $Cl_{2(g)}$ → $2NaCl_{(s)}$

6. A few nonmetals combine with each other.

   EX. $2P_{(s)}$ ÷ $3Cl_{2(g)}$ → $2PCl_{3(g)}$

Now try these: (Rewrite as a balanced equation with the products predicted):

1. magnesium burned in oxygen

___

2. hydrogen gas + nitrogen gas

___

3. sulfur burned (complete combustion)

___

4. calcium oxide added to water

___

Organic Chemistry-Just the basics:
http://www.visionlearning.com/library/module_viewer.php?mid=60

Hydrocarbon prefix	# of carbon atoms
Meth	1
Eth	2
Prop	3
But	4
Pent	5
Hex	6
Hept	7
Oct	8
Non	9
Dec	10

Organic Chemistry

The classification of chemical compounds in to the general areas of organic and inorganic derives from the use of the "mineral, vegetable and animal" designation by the early workers in chemistry. Those compounds derived from living systems were termed **organic** (about 1777) whereas those derived from mineral sources were termed **inorganic**. In modern times, organic compounds are classified as compounds of carbon containing either carbon-carbon or carbon-hydrogen bonds or both. Originally, organic compounds were thought to be imbued with a "vital essence" attainable only from God. Thus, it was believed that organic compounds could be prepared from sources that had once lived, as this would be the only way that this vital essence could be obtained by man. In 1828, Freidrich Wöhler prepared the organic compound urea (found in human urine) from entirely nonliving sources, thereby destroying the theory of organic vitalism. Since Wöhler's time, approximately 5 million organic compounds have been synthesized and characterized, many of which are not found in nature.

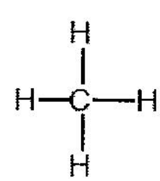
Why are there so many organic compounds? The reason is that carbon atoms have the ability to link to other carbon atoms (concatenate) to produce chains or rings of almost infinite size. Other elements do not concatenate nearly as well due to such factors as poor orbital overlap and lone pair-lone pair electronic repulsions. Other elements can also combine with carbon to form hetero-species, including hydrogen, oxygen, nitrogen, sulfur and the halogens.

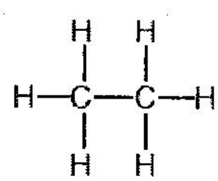
The distinction between the organic and inorganic disciplines is not very sharp. The bonding of metals to carbon has resulted in the large, important and fast growing area of **organometallic chemistry**. Organometallic compounds containing metals and metalloids such as lithium, magnesium, copper, iron, boron, silicon, and other elements play major roles as synthetic reagents.

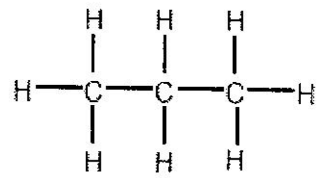
The purpose of this experiment is to prepare models of the more common organic compound types to enhance their three dimensional nature. Bond angles between atom groupings will become apparent as you build the models.

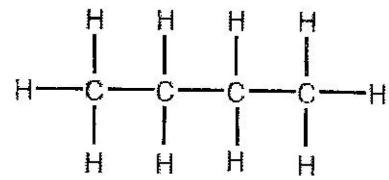
Saturated Hydrocarbons: The Alkanes

Alkanes are **hydrocarbons** (compounds with hydrogen and carbon atoms) linked with single bonds. All the carbon atoms are sp^3 hybridized and are tetrahedrally bonded to four other carbon or hydrogen atoms. Members of this class have the general formula $\mathbf{C_nH_{2n+2}}$, where **n** is an integer. Examples of this class of organic compound include methane (CH_4, n=1), ethane (C_2H_6, n=2) and propane (C_3H_8, n=3). Structures of the first four straight chain compounds are shown below.

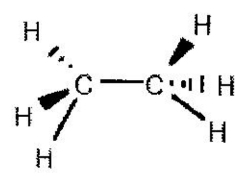
methane  CH_4

ethane  CH_3CH_3

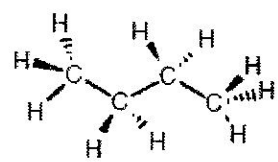
propane  $CH_3CH_2CH_3$

butane  $CH_3CH_2CH_2CH_3$

These representations do not show the actual geometrical structure of these compounds. Due to the sp^3 hybridization of the carbon atoms, all the bond angles in the molecules are close to 109.5 ° (tetrahedral) and thus, the carbon chain is nonlinear. The **wedge-dash** notation can be used to represent the nonlinear nature of these molecules. Examples of ethane and butane are given below using the wedge-dash notation.



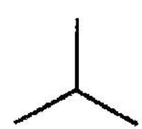
ethane



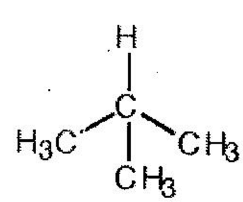
butane

As you prepare models of the alkanes, note that each carbon atom can rotate about its respective carbon-carbon bond. Some conformations (arrangements of the bonds and groups relative to each other) are more stable than others, since in these arrangements there is less interference (steric repulsion) between the hydrogen atoms attached to nearby carbons.

An interesting aspect of the alkanes is that **structural isomers** can exist in compounds having more than three carbon atoms. Structural isomers are species that have the same molecular formula but possess different physical properties due to different arrangements of the carbon backbone. The two compounds below are an example of an isomeric pair of hydrocarbons. Both are butanes and have the formula C_4H_{10}, but their structures are different.



$CH_3CH_2CH_2CH_3$

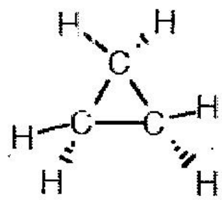


butane

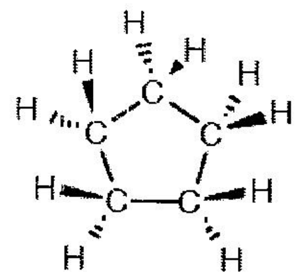
methylpropane (isobutane)

This figure relates several new points. First is the use of the **skeleton formula**. These structures represent the carbon backbone without the hydrogen atoms being shown and are often used as a shorthand method of representing the structures. The second point is the use of substituents in naming compounds. We can see that in methylpropane, one of the CH_3 groups is a "twig" off of the main "branch" of the compounds. Such twigs are called **alkyl groups**. In the figure, the **methyl group** (CH_3) name is derived from the hydrocarbon methane (CH_4) having lost a hydrogen. The number of possible isomers increases rapidly as the number of carbon atoms increases in a compound. For example, the pentane system (five carbons) has three isomers, the heptane system (seven carbons) has nine isomers, and the decane system (ten carbons) has seventy-five isomers!

Alkanes can also exist as **cyclic** hydrocarbons where the carbon atoms are arranged in rings. The general molecular formula is $\mathbf{C_nH_{2n}}$, where **n** is an integer. These carbons are named identically to the alkanes except for the additional prefix *cyclo*. The structures for two cyclic hydrocarbons are given below.



cyclopropane



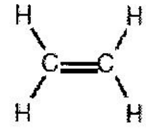
cyclopentane

In the smaller rings such as cyclopropane and cyclobutane, smaller bond angles (60° and 90°, respectively) are evident. Such angles are seen as being strained from their normal tetrahedral angle, and these compounds have less stability than their larger counterparts. The most stable cyclic compounds contain rings of five and six carbons (cyclopentane and cyclohexane, respectively).

Unsaturated Hydrocarbons: The Alkenes

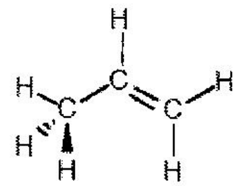
Alkenes are hydrocarbons in which there are one or more carbon-carbon double bonds, C=C. The carbon atoms attached to the double bond are sp^2 hybridized. One of the double bonds is a **sigma** bond (oriented along the internuclear axis) and the other is a **pi** bond (oriented perpendicular to the internuclear axis). Members of this class have the general formula $\mathbf{C_nH_{2n}}$, where **n** is an integer (note that this is the same formula as for the cycloalkanes.) Examples of alkenes include ethene (C_2H_4, n=2, also known as ethylene), propene (C_3H_6, n=3, also known as propylene) and butene (C_4H_8, n=4). Structures of several of the alkenes are shown below. Alkenes are named in the same fashion as the alkanes except that the ending *-ene* replaces the ending *-ane*. In cases where more than one structural isomer exists (such as butane, below), it is necessary to indicate the location of the double bond by numbering the carbon atoms in the longest chain containing the double bond, and then giving it the lowest possible number.

ethene (ethylene)



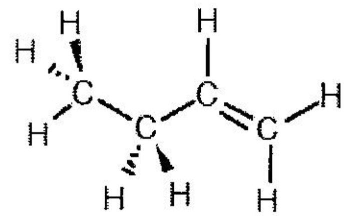
$CH_2=CH_2$

propene (propylene)



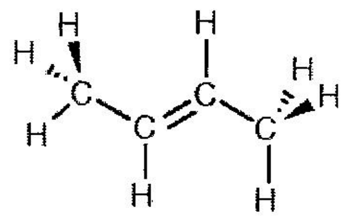
$CH_3CH{=}CH_2$

1-butene



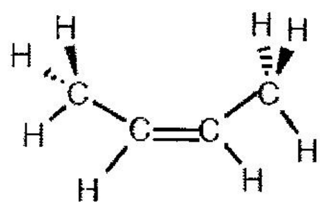
$CH_3CH_2CH{=}CH_2$

trans-2-butene

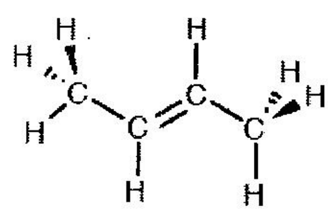


$CH_3CH{=}CHCH_3$

Many kinds of isomerism exist in organic compounds. Since carbon atoms are free to rotate around the C-C single bonds but <u>not</u> around a C=C double bond (this disrupts the overlap of the pi part of the double bond), it is possible to have two separate geometrical isomers of 2-butene. These are known as the *cis*- and *trans*- isomers and are shown below:

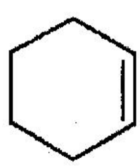


cis-2-butene

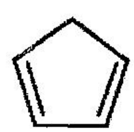


trans-2-butene

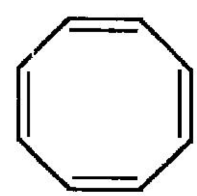
Cyclic structures containing C=C bonds are also possible, and three examples follow.



cyclohexene



1,3-cyclopentadiene



1,3,5,7-cyclooctatetraene

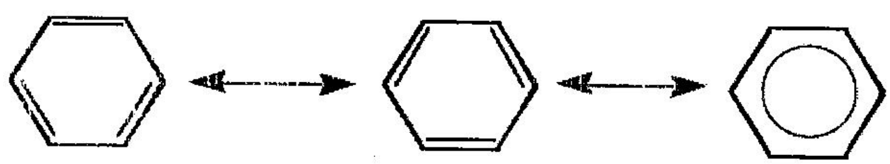
Unsaturated Hydrocarbons: The Alkynes

Hydrocarbons containing a carbon-carbon triple bond are named **alkynes**. The two carbon atoms forming the triple bond are joined by one sigma and two pi bonds and are sp hybridized. The alkynes have the general molecular formula C_nH_{2n-2}. Several representatives of this class are shown below. Alkynes are names in the same manner as alkenes except that the ending *-yne* replaces the ending *-ene*.

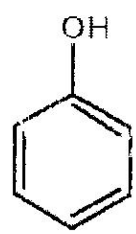
H-C≡C-H	CH_3-C≡C-H	CH_3-C≡C-CH_3
ethyne (acetylene)	propyne	2-butyne

Aromatic Hydrocarbons

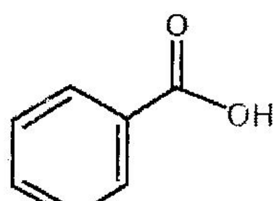
Benzene, C_6H_6, is the most crucial member of this important class of hydrocarbons. The molecule contains a ring of six sp^2 hybridized carbon atoms with the unhybridized p orbitals perpendicular to the ring system. The six electrons in the pi parts of the bonds are **delocalized** (spread evenly over the six carbon nuclei). Such molecules are often unusually stable. There are two equally valid ways of representing the structure of benzene. These two ways are called resonance forms, and the molecule is a **resonance hybrid** with the "true structure" of benzene lying midway between the two resonance forms. As an example, a mule is a genetic hybrid descendant of a male donkey and a female horse. The mule does not change back and forth, being a donkey half the time and a horse the other half. Thus, the properties of a resonance hybrid (such as benzene) are fixed.



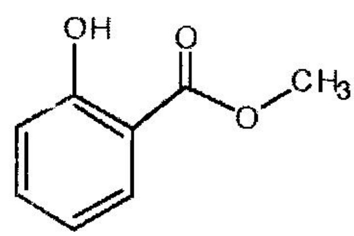
There are many familiar hydrocarbon species which are based on the benzene structure that contain various functional groups. A few representative examples are given below. Note that the delocalized pi electrons can be represented by a circle in the ring. This is an alternate representation of the ring often used by chemists.



phenol



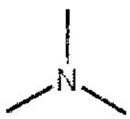
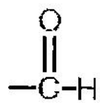
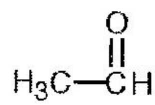
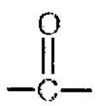
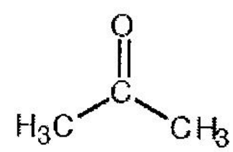
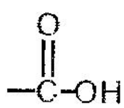
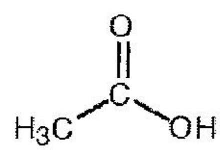
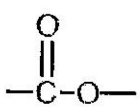
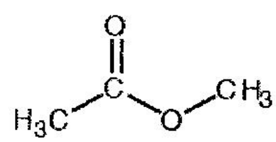
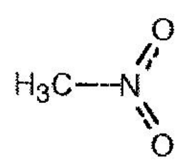
benzoic acid



oil of wintergreen

Hydrocarbons Containing Functional Groups

The basic types of hydrocarbon compounds outlined above may have one or more of their hydrogen atoms replaced by a **functional group**. The substituted benzenes earlier illustrated a number of functionalities ($-CH_3$, -OH, etc.) attached to the aromatic ring. Additional examples are shown in the table below.

Functional Group	Class of Compound	Example	Name
-OH	alcohol	H_3C-CH_2-OH	ethanol (ethyl alcohol)
-O-	ether	$H_3C-O-CH_3$	dimethyl ether
	amine	H_2N-CH_3	methylamine
	aldehyde		ethanal (acetaldehyde)
	ketone		propanone (acetone)
	carboxylic acid		ethanoic acid (acetic acid)
	ester		methyl acetate
$-NO_2$	nitro		nitromethane
-X (X = F, Cl, Br, I)	haloalkane	H_3C-CH_2-Cl	chloroethane (ethyl chloride)

Identify the functional group and/or class of compound in each of the following molecules.