**Organic Chemistry (Chem210) Experiments**  
Go To Experiment: [VSEPR](http://www.miracosta.cc.ca.us/home/dlr/210vsepr.htm) [1a](http://www.miracosta.cc.ca.us/home/dlr/210exp1a.htm) [1b](http://www.miracosta.cc.ca.us/home/dlr/210exp1b.htm) [1c](http://www.miracosta.cc.ca.us/home/dlr/210exp1c.htm) [2](http://www.miracosta.cc.ca.us/home/dlr/210exp2.htm) [3](http://www.miracosta.cc.ca.us/home/dlr/210exp3.htm) [4](http://www.miracosta.cc.ca.us/home/dlr/210exp4.htm) [5](http://www.miracosta.cc.ca.us/home/dlr/210exp5.htm) [6](http://www.miracosta.cc.ca.us/home/dlr/210exp6.htm) [7](http://www.miracosta.cc.ca.us/home/dlr/210exp7.htm) [8](http://www.miracosta.cc.ca.us/home/dlr/210exp8.htm) [9](http://www.miracosta.cc.ca.us/home/dlr/210exp9.htm) [10](http://www.miracosta.cc.ca.us/home/dlr/210exp10.htm)  
http://www.miracosta.cc.ca.us/home/dlr/images/new28.gif [**Useful Formulas for Experimental Calculations: %Yield, %Error, etc.**](http://www.miracosta.cc.ca.us/home/dlr/yield.htm)

*(To view the protocol, click on the Experiment Name)*

*The information contained here briefly introduces the experiment. To obtain the entire experimental protocol, which must be printed prior to coming to class for each experiment, click on the experiment name.*

[**VSEPR and Molecular Models**](http://www.miracosta.cc.ca.us/home/dlr/210vsepr.htm)

In this experiment, you will refresh your understanding of VSEPR (Valence Shell Electron Pair Repulsion) theory.  You will draw Lewis Dot Structures of several compounds, make models of these structures and predict some physical properties, such as polarity.

These suppplemental pages describe what VSEPR is, and how to use VSEPR to make molecular models, how to predict molecular shapes (molecule geometry), and how to predict molecule polaity, based on the number of electron domains and their arrangement around the center atom.  Please note, that an electron domain is a single electron region, a pair of electrons (either lone pairs or bonded pairs), multiple pairs of electrons (such as double and triple bonds).

You should print a table using VSEPR to predict molecule geometry (shape), polarity, and electron domain arrangments for molecules having [Three to Six Electron Domains](http://www.miracosta.cc.ca.us/home/dlr/other/Three-to-Six-Domains.html).  This table is more complete than the table found in your experimental protocols.

You *must* print the worksheets, which are available [online](http://www.miracosta.cc.ca.us/home/dlr/pdf/210vsep.pdf) to record your results.

[**Exp Ia: Separations: An Introduction**](http://www.miracosta.cc.ca.us/home/dlr/210exp1a.htm)

During the first three labs, Experiments Ia, Ib, and Ic, we will be performing several different separation techniques.  We will isolate solids from each other, we will recrystallize an organic solid from water as a means of purification, and we will separate some liquid organic chemicals from each other using extraction procedures.  Each of these separation techniques will be used at other times during the lab as well.  This is merely an introduction to these procedures.

We will also initiate our use of the computers for access to online information and structures.  You are expected to use several sources for chemical information, including texts, reference manuals and chemical catalogs to get the information you will need for the chemicals used in this experiment.  You will also use *chemfinder.com* as a source of chemical information as well.  Username is ***mccchem*** and password is ***mccmcc*** if you are asked to enter these values.

[**Exp Ib: Separation of Solids: Recrystallization and Melting Points**](http://www.miracosta.cc.ca.us/home/dlr/210exp1b.htm)

Reading (in The Organic Chem Lab Survival Manual, by Zubrick): Ch 12 (pp. 102-108); Ch 13 (pp. 122-132, 136-138)

**Part A**--Purify benzoic acid by recrystallization from water. Test the purity of the recrystallized solid by measuring its melting point.

**Part B**--Determine the best solvent for recrystallizing an unknown solid, purify the solid, and determine the identity and relative purity of the unknown compound by measuring its melting point (*optional, at instructor's discretion*).

[**Exp Ic: Separation of Solutions: Liquid Extractions**](http://www.miracosta.cc.ca.us/home/dlr/210exp1c.htm)

Reading (in Zubrick): Ch 15 & 16 (all)

Outline: Separate a solid-phase mixture of 2-methoxynaphthalene, *m*-nitroaniline, and benzoic acid by dissolving the entire mixture in a suitable solvent, and then selectively extracting each solute from the original solution into other solvents, and finally isolating the separated solids.

[**Exp II: Chromatography 1: Thin-Layer Chromatography**](http://www.miracosta.cc.ca.us/home/dlr/210exp2.htm)

Reading (in Zubrick): Ch 26, 27 & 28 (all)

You are asked to read chapter 28 (Wet-column Chromatography), even though we are not performing a column chromatography experiment. Determine the components of some over-the-counter medicines using thin-layer chromatography.

[**Exp III: ChemDraw and Chem3D Assignment**](http://www.miracosta.cc.ca.us/home/dlr/210exp3.htm)

You will work on these with your lab partner.  You may ask questions of the instructor, and no one else. Print out only one copy of your finished work, with both of your names on it, and hand it in for grading.  Both partners will receive the same grade.

A chemical drawing program, similar to ChemDraw, is available for download free from the Internet.  This program, ISISDraw, can be downloaded from my website: [Click Here to Download ISIS Draw](http://www.miracosta.cc.ca.us/home/dlr/files/draw25.exe) http://www.miracosta.cc.ca.us/home/dlr/images/new02.gif. We will use ChemDraw in the lab.

[**Exp IV: Chromatography 2: Gas Chromatography**](http://www.miracosta.cc.ca.us/home/dlr/210exp4.htm)

Reading (in Zubrick): Ch 31 (all)

Determine the percent composition of a mixture of hydrocarbons.

*http://www.miracosta.cc.ca.us/home/dlr/images/ar7-r.gifPreparation for Experiment V Fermentation: During Experiment V you will do a distillation of ethanol from a fermentation mixture.  You will prepare your own fermentation mixture but you must start the fermentation during the second day of Experiment IV in order to allow the one week period for this fermentation to take place.  Please look at the protocol for Experiment V to see how this fermentation mixtures is to be set up.  Remember, it must be done on the last day of this experiment in order to let the fermentation proceed for one week.*

[**Exp V: Liquids: Distillation, Boiling Points and the Fermentation and Distillation of Ethanol**](http://www.miracosta.cc.ca.us/home/dlr/210exp5.htm)

**Part A:** Purify 2-propanol by simple distillation. This technique shows how to purify by distillation a volatile organic compound.  This procedure is good for purification of volatile compounds from compounds that are not volatile, but not very successful for mixtures of compounds, each of which is volatile.  Part B describes how to fractionate these compounds.

**Part B:** Separate ethanol from water by fractional distillation.  Compounds which are volatile will each distill at temperatures well below their actual boiling points (e.g., remember the vapor pressure of water?).  There we need to have a procedure that allows for more efficient separation, and this is the process of fractional distillation.

**Part C:** We will prepare a fermentation of glucose to produce ethanol.  The ethanol from this fermentation will be isolated by fractional distillation (using the procedure described in Part B).

[**Exp VI: Elimination Reactions: Acid-Catalyzed Dehydration of 2-Pentanol**](http://www.miracosta.cc.ca.us/home/dlr/210exp6.htm)

Analyze the mixture by gas chromatography in order to determine the identities and relative amounts of the products. Dehydration of an alcohol can follow either the E2 or the E1 mechanism. However, in each case, acid is required as a catalyst, because OH- is a poor leaving group:

Adding a strong acid, such as H2SO4, to the mixture allows protonation of the alcoholic -OH group (to produce the alkyloxonium ion; R-OH2+) to give water (a weak base) as the leaving group.  Once this protonation occurs, the mechanism that is followed depends on the nature of R-group.  For a primary alcohol, such as 1-pentanol, the dissociation of water, if it occurred, would produce the very unstable 1° carbocation, so we would project that elimination via an E1 mechanism (with carbocation intermediate) will not occur.  As a result, reaction would be expected to proceed via the E2 elimination mechanism.  However, for 2-pentanol, dissociation of water produces the more stable 2° carbocation. Because water is not a very strong base, the competing E2 mechanism will be slow, which will allow the E1 mechanism to proceed faster for 2-pentanol.

[**Exp VII: Fischer Esterification: Preparation of Isopentyl Acetate (Isoamyl Acetate)**](http://www.miracosta.cc.ca.us/home/dlr/210exp7.htm)

Esterification is a straightforward reaction that utilizes several key techniques in synthetic organic chemistry. One direct approach, known as the Fischer esterification reaction, involves the acid-catalyzed condensation of an alcohol and a carboxylic acid, yielding an ester and water. Esters can also be formed by the reaction of the alcohol with the acid chloride rather than the acid itself. Or, the acid anhydride may be used instead of the acid. In this experiment, we will create the ester isopentyl acetate (banana oil) via the Fischer esterification reaction.

[**Exp VIII: 2nd Order Nucleophilic Substitution: The Preparation of 1-bromobutane from 1-butanol**](http://www.miracosta.cc.ca.us/home/dlr/210exp8.htm)

Reading (in Zubrick): Ch 11 (all); Ch 22 (pp. 228-229); Chap 29 (all)

Synthesize 1-bromobutane from 1-butanol using an SN2 reaction. Separate and purify the product using simple distillation, and determine its relative purity by measuring its index of refraction.

[**Exp IX: Diels-Alder Cycloaddition: The Reaction of Cyclopentadiene with Maleic Anhydride**](http://www.miracosta.cc.ca.us/home/dlr/210exp9.htm)

The formation of new carbon-carbon bonds is one of the most important aspects of synthetic organic chemistry. Many reactions, such as the Grignard reaction and the use of acetylide ions in SN2 reactions, have been developed with this one goal in mind. One problem associated with most of these C—C bond-forming reactions is the necessity for exotic conditions--the Grignard reaction requires completely water-free conditions and acetylide ions must be generated in liquid ammonia solution.

When a synthetic sequence calls for the formation of a ring of carbon atoms, this problem is compounded. Fortunately, the formation of six-membered carbon rings is much simpler than it would first appear. As described in Organic Chemistry by Carey (Section 10.12), the Diels-Alder reaction was discovered in 1928. This reaction forms a six-membered ring from two pieces: a conjugated "diene" (which provides four of the ring atoms) and a "dieneophile" (which provides two of the ring atoms). The main requirements for these species are that the conjugated diene must be somewhat electron rich (which is normally the case for dienes) and able to achieve the *s-cis* conformation, and that the "dieneophile" have a two-atom p system that is relatively electron poor.

In this experiment you will react cyclopentadiene (the diene) with maleic anhydride (the dienophile) to produce the bicyclic compound, *endo-*bicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic anhydride.

[**Exp X: Electrophilic Aromatic Substitution: Nitration of Methyl Benzoate**](http://www.miracosta.cc.ca.us/home/dlr/210exp10.htm)

Benzene rings are components of many important natural products and other useful organic compounds. Therefore, the ability to put substituents on a benzene ring, at specific positions relative to each other, is a very important factor in synthesizing many organic compounds. The two main reaction types used for this are both substitutions: Electrophilic Aromatic Substitution (EAS) and Nucleophilic Aromatic Substitution (NAS). The benzene ring itself is electron-rich, which makes NAS difficult, unless there are a number of strongly electron-withdrawing substituents on the ring. EAS, on the other hand, is a very useful method for putting many different substituents on a benzene ring, even if there are other substituents already present. Chapter 12 in Organic Chemistry, by Carey, describes the factors involved in the regioselectivity for EAS reactions using benzene rings which already have substituents on them.