

Syllabus

Chemistry 204

General Chemistry II

Spring 2017

3 Credit Hours

Instructor:

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Course Description: A continuation of Chemistry 203 with emphasis on introductory organic and biochemistry.

Note for students with visual impairments: This course contains a substantial number of graphics files that cannot be adequately described as text equivalents. If you contact the instructor arrangements can be made to provide the source files for the graphics and/or Braille embossed high resolution graphics.

Since this syllabus is rather long, I have included some hyperlinks to help you find specific information.

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Required Materials:

Text:

The textbook that has been used in the past is fairly expensive and I don't think that you truly need it. I believe that there is sufficient material provided in the Lecture Notes portion of the course for you to understand the concepts and do well on the quizzes and exams. If it turns out that more materials are needed I will either post additional material or I will provide links to internet sites that have supplemental materials. In the worst case scenario the bookstore will be able to provide the old text very quickly. Please be sure to let me know if there are any topics where you think additional materials are needed. We have tried this approach for the last several terms and there was not even one student who submitted a request for more materials.

Calculator:

You will need a basic scientific calculator. You should be able to find a suitable calculator for around \$15 or less. I do not recommend that you buy an expensive calculator. You will be better off with an inexpensive calculator that you can learn to use easily instead of with an expensive calculator with so many capabilities that you have a hard time learning how to use it. The calculator that is installed as a part of Windows is a good example of what you need and, in fact, you may want to use it for the quizzes.

Molecular Models: If you have a hard time visualizing some of the three-dimensional aspects you may want to purchase an inexpensive set of molecular models but I would recommend that you not pay more than about \$15. And, I would suggest that you wait until you find that you really need them before buying them.

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Exam Target Dates and Deadlines

Students in this course have a maximum of one semester to complete the course.

At the beginning you will only see icons for lecture notes for one topic and a quiz for that topic. You must make a score of 8 or more on any quiz before you will be able to see the next topic in the course. When you achieve an 8 the icons for the next topic lecture notes and quiz will automatically appear. You are not eligible to take an exam until you have completed all the quizzes in that Part of the course. For example, you must complete quiz #16 before you can take Exam I.

Each exam has a Bonus Date, a Penalty Date, and a Last Access Date. If you complete an exam on or before the Bonus Date for that exam I will reward you by adding 20 points to your overall grade. If you do not complete the exam on or before the Penalty Date, I will subtract 20 points from your overall grade. If you

do not complete an exam on or before the Last Access Date for that exam you will not be able to take the exam and you will receive a score of zero

If you receive a score of zero on any of the first three exams because you didn't take it before the Last Access date, you will be given access to the first topic in the next Part at that time.

Dates for Spring 2017 are:

Exam	Bonus Date	Penalty Date	Last Access Date
Exam I	Wednesday, February 8, 2017	Wednesday, February 15, 2017	Monday, February 27, 2017
Exam II	Monday, February 27, 2017	Monday, March 6, 2017	Friday, March 17, 2017
Exam III	Thursday, March 30, 2017	Thursday, April 6, 2017	Friday, April 28, 2017
Exam IV	Friday April 28, 2017		Thursday, May 4, 2017
Final Exam	Friday April 28, 2017		Thursday, May 4, 2017

NOTE WELL. A score of zero will be recorded for any quiz or exam not completed on or before Thursday, May 4, 2017.

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Grading:

There will be four hour exams and a final exam in addition to the 64 quizzes. The 64 quizzes are worth 10 points each. The four hour exams are worth 240 points each and the final exam is worth 320 points.

So, it is possible to earn up to 640 points from the quizzes, up to 960 points from the four exams and up to 320 points from the final for a total of 1920 possible points in the course.

Letter grades will be assigned based on the following scale for the total points

- 1728 points or higher = A
- 1536-1727 points = B
- 1344-1535 points = C
- 1152-1343 points = D

- Less than 1152 points = F

Since I want to encourage students to complete this course in a timely manner, I will add 20 points to your total if you take an hour exam on or before the Bonus Date for that exam. On the other side of the coin, I will deduct 20 points from your total if you take an hour exam after the Penalty Date for that exam. I will also add 20 points to your total if you complete the final exam before the Bonus Date for the final. If you take full advantage of this incentive, you can raise your grade by close to half a letter grade. On the other hand, failure to complete the coursework on schedule can cost you severely. I will post reminders of the target dates on the bulletin board from time to time so be sure to check the bulletin board for this.

The hour exams will be given on-line. There is a time limit on the exams and it will be enforced by the computer -- no answers will be accepted after the time limit on an exam. You will get the graded exam back with your score and feedback on your errors. Exams are closed book, closed note. You are on your honor to take the exams without any assistance and without referring to any materials other than a basic periodic table.

The final exam will be handled the same way as the hour exams. You only get one attempt on each exam and the time limit is enforced..

The quizzes are all taken on-line and the scores and the correct answers are available to you as soon as you complete the quiz. Quizzes are designed as learning tools rather than as grading tools so there is no time limit on quizzes. You can retake quizzes as many times as you like and only the highest score will count so you can feel free to retake a quiz as a way of studying for exams without having to worry about it hurting your grade.

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Organization of the Course:

Chemistry is a subject that builds on a foundation. You cannot understand the later topics unless you understand the earlier topics. For this reason, I have used the "topic mastery" model for this course. You cannot go on to a new topic until you have mastered the current one. Each topic has a quiz associated with it and you must make a score of 8 (or higher) on the quiz before you can proceed. You may take the quiz as many times as necessary but only the highest score will count.

When you first start the course, only one topic will be available to you. Whenever you complete a topic, a new one will become available. All of the older ones will stay available so that you can review them as needed.

I divided the course into 64 topics -- essentially starting a new topic at the point where I would normally end a lecture session in a regular course. A normal one hour lecture would cover two or more of these topics so each topic would

represent somewhere between 10 minutes and an hour of lecture time in a regular course. You should be able to complete some topics in a few minutes but a few may take an hour or more.

The course is divided into four roughly equal sized parts. There is an hour exam after you complete each of these parts. You cannot take an exam until after you have completed all of the quizzes in that part of the course and you cannot take the final exam until you have completed Exam 4. Click [here](#) for a detailed list of the topics.

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Course Objectives:

Student Learning Outcomes (by chapter)	How students will practice each outcome in this course	How each outcome will be assessed in this course
Alkanes - Recognize the composition and properties typical of organic and inorganic compounds. - Identify and name simple (straight-chain) alkanes given formulas and write formulas for straight-chain alkanes given their names. - Learn how alkane molecules can have branched chains and recognize compounds that are isomers. - Write condensed structural formulas for alkanes given complete structural formulas. - Draw line-angle formulas given structural formulas. - Name alkanes by the IUPAC system and write formulas for alkanes given IUPAC names. - Identify the physical properties of alkanes and describe trends in these properties - Identify the main chemical properties of alkanes. - Name cyclic alkanes by the IUPAC system and write formulas for cyclic alkanes given IUPAC names - Make reasonable predictions about the overall shape of cycloalkane molecules, especially substituted cyclohexanes. - Identify substituents in cyclohexane structures being axial or equatorial positions.	repeatable online quizzes	quizzes exams

- Name halogenated hydrocarbons given formulas and write formulas for these compounds given names. - Name cycloalkanes given their formulas and write formulas for these compounds given their names. - Describe functional groups and explain why they are useful in the study of organic chemistry.		
Alkenes - Name alkenes given formulas and write formulas for alkenes given names. - Recognize alkenes that <i>can</i> exist as <i>cis-trans</i> isomers. - Classify isomers as <i>cis</i> or <i>trans</i>. - Draw structures for <i>cis-trans</i> isomers given their names. - Identify the physical properties of alkenes and describe trends in these properties. - Write equations for the addition reactions of alkenes with hydrogen, halogens, hydrogen chloride, hydrogen bromide, and water. - Use the Markovnikov rule to predict which isomer will be formed in addition reactions of alkenes with hydrogen chloride, hydrogen bromide, and water - Predict the likely product(s) of reaction of alkenes with strong oxidizing agents - Describe the general physical and chemical properties of alkynes. - Name alkynes given formulas and write formulas for alkynes given names - Describe the bonding in benzene and the way typical reactions of benzene differ from those of the alkenes - Recognize aromatic compounds from structural formulas. - Name aromatic compounds given formulas. - Predict the products of nitration, halogenation, sulfonation, and Friedel-Crafts reactions of aromatic compounds - Predict the products of catalytic hydrogenation of aromatic compounds - Predict the products of oxidation of side chains of aromatic compounds - Write formulas for aromatic compounds given their names.	repeatable online quizzes	quizzes exams

Polymers • Draw structures for monomers that can undergo addition polymerization and for four-monomer-unit sections of an addition polymer. • Use the structure of a section of a polymer to Identify the monomer used to generate that polymer.	repeatable online quizzes	quizzes exams
Alcohols • Identify the general structure for an alcohol. • Identify the structural feature that classifies alcohols as primary, secondary, tertiary • Name alcohols with both common names and IUPAC names. • Explain why the boiling points of alcohols are higher than those of ethers and alkanes of similar molar masses. • Explain why alcohols and ethers of four or fewer carbon atoms are soluble in water while comparable alkanes are not soluble. • Describe how to prepare alcohols from alkenes. • Predict the product of dehydration of an alcohol. • Give examples of reactions of alcohols to form ethers. • Give examples of reactions of alcohols to form esters. • Describe the result of the oxidation of a primary alcohol. • Describe the result of the oxidation of a secondary alcohol. • Describe the structure and uses of some common polyhydric alcohols. • Describe the structure and uses of some phenols. • Describe the structural difference between alcohols and phenols. • Explain why phenols are significantly stronger acids than alcohols. • Describe the structure differences between an alcohol and an ether that affects physical characteristics and reactivity of each. • Name simple ethers. • Identify the more common cyclic ethers. • Describe the structure and uses of some ethers • Predict the starting materials needed to synthesize a particular ether using the Williamson reaction.	repeatable online quizzes	quizzes exams

- Identify thiols (mercaptans) by the presence of an SH group. - Describe the process for interconverting disulfides and thiols.		
Carbonyl Compounds - Identify the general structure for an aldehyde and a ketone. - Use common names to name aldehydes and ketones - Use the IUPAC system to name aldehydes and ketones. - Explain why the boiling points of aldehydes and ketones are higher than those of ethers and alkanes of similar molar masses but lower than those of comparable alcohols. - Compare the solubilities in water of aldehydes and ketones of four or fewer carbon atoms with the solubilities of comparable alkanes and alcohols. - Describe some of the uses of common aldehydes and ketones. - Recognize the different types of oxidation reactions for aldehydes and ketones. - Describe the catalytic hydrogenation reactions of aldehydes and ketones. - Describe the reduction reactions of aldehydes and ketones using sodium borohydride. - Identify aldehydes and ketones that can exhibit tautomerism. - Predict the products of aldehydes and ketones with hydrogen cyanide. - Recognize acetals and ketals and the reactions that form them. - Predict the product(s) of a simple aldol condensation reaction.	repeatable online quizzes	quizzes exams
Carboxylic Acids - Identify the general structure for a carboxylic acid, an ester, an anhydride, and an acyl halide. - Identify the functional group for a carboxylic acid, an ester, an anhydride and an acyl halide. - Name carboxylic acids with common names.	repeatable online quizzes	quizzes exams

• Name carboxylic acids according to IUPAC nomenclature. • Describe the preparation of carboxylic acids. • Compare the boiling points of carboxylic acids with alcohols of similar molar mass. • Compare the solubilities of carboxylic acids in water with the solubilities of comparable alkanes and alcohols in water. • Name the typical reactions that take place with carboxylic acids. • Describe how carboxylic acids react with basic compounds. • Identify the general structure of an ester. • Use common names to name esters. • Name esters according to the IUPAC system. • Compare the boiling points of esters with alcohols of similar molar mass • Compare the solubilities of esters in water with the solubilities of comparable alkanes and alcohols in water. • Identify and describe the substances from which most esters are prepared. • Describe the typical reactions that take place with esters. • Identify the products of an acidic hydrolysis of an ester. • Identify the products of a basic hydrolysis of an ester. • Describe phosphate esters. • Understand why phosphate esters are important in living cells. • Describe the difference between a soap and a detergent • Describe how soaps and detergents promote the formation of micelles when they are in aqueous media.		
Amines and Amides • Identify the general structure for an amine. • Identify the functional group for amines. • Determine the structural feature that classifies amines as primary, secondary, or tertiary • Use nomenclature systems to name amines. • Explain why the boiling point of primary and secondary amines are higher than those of alkanes or	repeatabe online quizzes	quizzes exams

ethers of similar molar mass but are lower than those of alcohols. • Compare the boiling points of tertiary amines with alcohols, alkanes, and ethers of similar molar mass. • Compare the solubilities in water of amines of five or fewer carbon atoms with the solubilities of comparable alkanes and alcohols in water. • Name the typical reactions that take place with amines. • Describe heterocyclic amines. • Identify the general structure for an amide. • Identify the functions group of an amide. • Name amides with common names. • Name amides according to the IUPAC system. • Compare the boiling points of amides with alcohols of similar molar mass. • Compare the solubilities in water of amides of five or fewer carbon atoms with the solubilities of comparable alkanes and alcohols in water. • Describe the preparation procedure for amides. • Identify the typical reactions that amides undergo • Describe how condensation polymers are formed • Recognize the common condensation polymers be able to tell what materials are used to make them.		
Isomers • Identify the difference between constitutional isomers and stereoisomers. • Name the different type of stereoisomers and able to identify the type of isomerism exhibited by a particular pair of structures. • Describe the difference in properties observed for pairs of geometric isomers. • Draw the structure of a chiral compound using wedge-dash symbolism. • Draw the structure of a chiral compound using Fischer projection formulas. • Describe how chemical reactions are different for the two components of a pair of enantiomers. • Describe how the physical properties enantiomeric pairs are the same for most properties but are different with regard to interaction with plane polarized light.	repeatable online quizzes	quizzes exams

• Draw the structures of diastereomers using wedge-dash symbolism. • Draw the structures of diastereomers using Fischer projection formulas. • Describe the differences in chemical and physical properties when comparing a diastereomeric pair.. • Recognize when a compound exhibits meso forms.		
Carbohydrates • Recognize carbohydrates and classify them as mono-, di-, or polysaccharides. • Classify monosaccharides as aldoses or ketoses and as trioses, tetroses, pentoses, or hexoses. • Distinguish between a D sugar and an L sugar. • Identify the structures of the and describe how they differ from each other. • Define what is meant by anomers and describe how they are formed. • Explain what is meant by mutarotation • Identify the physical properties of monosaccharides • Describe how glycosides are formed. • Identify the products of reduction reactions of monosaccharides. • Identify the products of oxidation reactions of monosaccharides. • Describe the difference between aldonic acids and uronic acids. • Describe the formation of phosphate esters of monosaccharides. • Describe the properties of the D and L families of monosaccharides. • Identify the structures of commonly encountered disaccharides • Identify the monosaccharides that are needed to form the disaccharides • Compare and contrast the structures and uses of starch, glycogen, and cellulose. • Compare the structure of chitin with that of cellulose. • Compare the structure of hyaluronic acid with that of cellulose.	repeatable online quizzes	quizzes exams
Lipids	repeatable online quizzes	quizzes exams

• Recognize the structures of common fatty acids and classify them as saturated, monounsaturated, or polyunsaturated. • Explain why fats and oils are referred to as triglycerides. • Explain how the fatty acid composition of the triglycerides determines whether a substance is a fat or oil. • Describe the importance of key reactions of triglycerides, such as hydrolysis, hydrogenation, and oxidation. • Identify the main types of phospholipids. • Identify the distinguishing characteristics of membrane lipids. • Describe membrane components and how they are arranged. • Describe the importance of cholesterol in stabilizing membranes. • Identify the commonly encountered steroids. • Identify the function of steroids produced in mammals.		
Amino Acids and Proteins • Recognize amino acids and classify them based on the characteristics of their side chains. • Explain how an amino acid can act as both an acid and a base. • Explain how a peptide is formed from individual amino acids. • Explain why the sequence of amino acids in a protein is important. • Describe the four levels of protein structure. • Identify the types of attractive interactions that hold proteins in their most stable three-dimensional structure. • Explain what happens when proteins are denatured. • Identify how a protein can be denatured. • Describe how amino acids form zwitterions. • Use pI values to predict the level of ionization of an amino acid at a given pH.	repeatable online quizzes	quizzes exams
Enzymes • Explain the functions of enzymes.	repeatable online quizzes	quizzes exams

• Explain how enzymes are classified and named. • Describe the interaction between an enzyme and its substrate. • Describe how pH, temperature, and the concentration of an enzyme and its substrate influence enzyme activity. • Explain what an enzyme inhibitor is. • Distinguish between reversible and irreversible inhibitors. • Distinguish between competitive and noncompetitive inhibitors. • Explain how vitamins related to cofactors and why they are necessary in the diet.		
Nucleic Acids • Identify the different molecules that combine to form nucleotides. • Identify the two types of nucleic acids and the function of each type. • Describe how nucleotides are linked together to form nucleic acids. • Describe the secondary structure of DNA and the importance of complementary base pairing. • Describe how a new copy of DNA is synthesized. • Describe how RNA is synthesized from DNA. • Identify the different types of RNA and the function of each type of RNA. • Describe the characteristics of the genetic code. • Describe how a protein is synthesized from mRNA. • Describe the causes of genetic mutations and how they lead to genetic diseases. • Explain how viruses reproduce in cells.	repeatable online quizzes	quizzes exams

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Time Requirement

NOTE WELL: In a normal classroom setting for this course you would be expected to attend approximately 45 hours of lectures. You would also be expected to spend roughly double that amount of time studying for the course outside of class. The e-course format does not work magic -- you should expect

to spend at least the same number of hours completing this course. Do not put off working on the course and then expect to be able to complete it in a couple of days. Be sure to try to meet the target dates so that you can successfully complete the course.

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Marshall University Course Policies

By enrolling in this course, you agree to all Marshall University policies published in the current undergraduate catalog. The full text of these policies can be found on-line at www.marshall.edu/academic-affairs/policies

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Computer and Software Requirements:

- You will need ready access to the internet. Home access is highly recommended. Your computer should meet the minimum requirements listed in the link to Computer Hardware / Software. Check Minimum Requirements in the Student Support and Resources box in the opening page for the course in Blackboard. Broadband access such as DSL or cable modem is desirable but modem dialup access at 56K will work. There are very few files that will take more than a minute to download even at 56K.
- You will need a web browser. Blackboard says that you can use Explorer 11 or Edge or Firefox or Chrome on Windows based systems. If you use a Macintosh running OSX you can use Safari 6, 7, or 8
- You may need to download and install Sun Java. Then you need to enable Java and enable cookies. Then turn off anonymous login. You will also need to disable any popup ad killer software since they will interfere with quizzes and other features in Blackboard. Some firewall software and antivirus programs will also block popup windows so you may need to adjust settings on those. If you click on the "Blackboard Help" button in the left side menu of the main course page you will find a link to "Browser Support". Click on that and you will find a link for "Browser Checker" and if you click on that you will get a page showing information about your browser setup. If there are any items that do not have a green check mark, then you may need to make some adjustments in your browser setup.

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Contacting the Instructor:

Whenever you need help with the course or just want to ask a question about anything, you should feel free to contact me. I am semiretired and do not teach any classes other than online courses. I do not have an office on campus and I do not have a campus phone. The only reliable method for contacting me is by e-mail. I tend to check my e-mail about twice a day (even on weekends) and I tend to reply to e-mail as I receive it. I am sometimes out of town for a long weekend from time to time but will normally have access to e-mail. If I am going to be out of town and out of e-mail contact for more than a couple of days at a time I will warn you ahead of time.

You may use the e-mail that is internal to the course by clicking on the Messages button in the menu on the left side of the page. If you select Create Message, then click on the "TO" button, the instructor will be listed as Gary Anderson (Instructor) and will normally be on the first page of the list.

Alternately, you may send e-mail to anderson@marshall.edu by any of the standard internet mail protocols. I will normally respond by whichever method you used to send your message. If you do not receive a response to an e-mail message within 48 hours you should assume that either your original message or my reply has gone astray in the e-mail system and you should resend the message. If you have reason to believe that the Marshall email server is not working properly you may want to try sending the message to me at wv.alchemist@comcast.net but I only check mail at that address about once a week unless the MU server is down.

Please note that while we tend to think of e-mail as being a nearly instantaneous means of communication there are times that there are significant delays in e-mail transmissions. Under certain circumstances it has been known to take as much as 48 hours for an e-mail message to get between a Marshall University account and an account at a local internet service provider. In fact, I had one case where a student sent me an e-mail message from a Marshall address and it did not arrive until 33 days later. If either server is especially busy or if the network is particularly busy you will see these delays. So, be sure to plan ahead and send e-mail messages as early as possible to avoid problems from unpredicted delays.

General announcements are posted on the course bulletin board and a copy of them is emailed to every student in the course at the time they are posted.

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Topics to Be Covered in This Course

Part I

Alkanes

- 01-Introduction
- 02-Basic Structural Concepts
- 03-Additional Structural Concepts
- 04-Functional Groups
- 05-Isomerism
- 06-Alkanes
- 07-Cycloalkanes
- 08-Reactions of Alkanes

Alkenes

- 09-Alkenes
- 10-Geometric Isomerism
- 11-Reactions of Alkenes
- 12-Mechanism of Markovnikov Addition
- 13-Alkynes
- 14-Aromatic Hydrocarbons
- 15-Reactions of Aromatic Compounds

Polymers

- 16-Addition Polymers

Part II

Alcohols

- 17-Alcohols
- 18-Naming Alcohols
- 19-Properties of Alcohols
- 20-Reactions of Alcohols
- 21-Phenols
- 22-Ethers
- 23-Thiols and Disulfides

Carbonyl Compounds

- 24-Aldehydes and Ketones
- 25-Physical Properties of Aldehydes and Ketones
- 26-Oxidations of Aldehydes and Ketones
- 27-Reductions of Aldehydes and Ketones
- 28-Keto-Enol Tautomerism
- 29-Addition Reactions of Aldehydes and Ketones

Part III

Carboxylic Acids

- 30-Carboxylic Acids
- 31-Acidity and Physical Properties of Carboxylic Acids
- 32-Preparation of Carboxylic Acids
- 33-Reactions of Carboxylic Acids
- 34-Esters of Carboxylic Acids
- 35-Reactions of Esters
- 36-Soaps and Detergents
- 37-Esters of Phosphoric Acid

Amines and Amides

- 38-Amides
- 39-Preparation and Reactions of Amides
- 40-Condensation Polymers
- 41-Amines
- 42-Properties and Reactions of Amines

Isomers

- 43-Types of Isomers
- 44-Chirality, Enantiomers, and Optical Activity
- 45-Diastereomers and Meso Compounds

Part IV

Carbohydrates

- 46-Monosaccharides
- 47- D- and L- Families of Carbohydrates
- 48-Cyclic Forms of Monosaccharides
- 49-Disaccharides
- 50-Reactions of Carbohydrates
- 51-Polysaccharides

Lipids

- 52-Simple Lipids
- 53-Triacylglycerides
- 54-Phospholipids, Glycolipids, and Membranes
- 55-Steroids

Amino Acids and Proteins

- 56- The Amino Acids
- 57- Zwitterions and the Isoelectric Point
- 58-Structure of Proteins
- 59-Properties of Proteins

Enzymes

- 60-Enzymes
- 61-Enzyme Kinetics

Nucleic Acids

- 62-Nucleic Acids
- 63-Transcription and Translation
- 64-Applications of Nucleic Acids

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