

# Course Syllabus Fall 2017

## Chemistry 205: General, Organic and Biological Chemistry

Department of Chemistry, Marshall University

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Office Hours: 9-9:30 and 11:30-1 M, W, F; 3:15-3:30 M, W; 11- 11:30 T or by appointment

Credit Hours: 3.00 hours

### **Course Times and Locations:**

8-8:50 AM M, W, F Science Building 473 (CRN: 1362 – CHM 205 – Section 101)

1-1:50 PM M, W, F Science Building 276 (CRN: 1363 – CHM 205 – Section 102)

2-3:15 PM M, W, F Science Building 473 (CRN: 1364 – CHM 205 – Section 103)

**Catalog Description:** Introductory course for health professions students and non-science majors covering basic chemical principles with applications in organic chemistry and biochemistry.

### **Required Materials:**

**Text:** The text for this course is Ball, Hill and Scott, “The Basics of General, Organic and Biological Chemistry” Flat World Knowledge, Inc. ISBN: 9781453311097. Versions of the book are available at flatworldknowledge.com ranging from \$24 to \$89 (+\$50 for color if you must) and ranging from online only to ebook, soft cover printed book and study aids. A black and white version at \$71.50 (without any electronic access) is available at the bookstore.

**Calculator:** You will need a basic nonprogrammable scientific calculator. You should be able to find a suitable calculator for around \$15 or less. Calculators with alphanumeric and/or graphing capabilities are **not permitted** during quizzes or exams.

**Online Homework:** Sapling Learning online homework access which can be purchased online for about \$40 or at the bookstore for \$52.50 is required.

**Determination of Course Grade:** Five tests will be given composed of multiple choice and possibly free response (including problems) questions. The tests will make up 60% of the final grade. The final exam will count as 20% of the grade. Quizzes will be given and will represent 10% of the final grade. Approximately 1 in 5 quizzes will be dropped. Sapling Learning online homework will represent 10% of the grade. The grading scale will be no higher than **A**  $\geq$  90%, **B** 80 to 89%, **C** 70 to 79%, **D** 60 to 69%, and **F** < 60%.

**Course Curriculum:** Lectures and assignments will cover chapters 1 through 19 in the text.

**Attendance:** Regular attendance is expected. See me for makeup tests or quizzes. No makeup tests or quizzes will be given unless prompt arrangements are made (complete before next class). Otherwise makeup days are 10/12 or 12/7 (sign up and a university excuse are required).

Sapling Learning online homework problems will be assigned for each chapter and may be discussed in class. Problems similar to those on the homework will be included on the tests and quizzes. Attendance, reading, and working the homework are essential for successful completion of this course. Plan on 2 hours out of class work for each hour in class. **Please seek me out if you want or need help.** Should attendance problems arise contact me before you miss if at all possible. Please be on time and do not disrupt class by coming in late. Any student involved in an official school function or an unavoidable commitment to his or her employer can arrange to take an exam at another time than the scheduled time.

**Electronic Device Policy:** All cell phones and pagers must be turned to vibrate during class. Recording of lectures without the instructor's permission is prohibited. During examinations, all electronic devices except calculators must be inaccessible. Students **MUST BRING A CALCULATOR** to class for all lectures and exams. Calculators that are part of a cell phone or PDA are not acceptable during an exam or quiz.

**University Policies:** All university policies, which can be found at this link <http://www.marshall.edu/academic-affairs/policies/>, will be observed.

**Important Dates:**

8/21 First Day of Class, 9/4 Labor Day Holiday, 10/9 Freshman D & F midterm grades  
10/27 Last day to drop individual courses, 11/20-11/25 Fall Break,  
12/4-12/8 Dead Week, 12/9 Final Exam **Saturday** 9:50 AM

**Tentative class schedule\***

Week of	Chapters
8/21	1, 2
8/28	2, 3
9/4	3, 4, 5
9/11	5, 6
9/18	6, 7, 8
9/25	8, 9, 10
10/2	10, 11
10/9	12, 13
10/16	13, 14
10/23	14, 15
10/30	15, 16
11/6	17, 18
11/13	18, 19
11/20	break
11/27	19
12/4	review

**Tentative exam schedule\***

Exam	Week of	Chapters
Exam I	9/11	1-4
Exam II	9/24	5-7
Exam III	10/9	8-11

Exam IV	11/6	12-15
Exam V	12/4	16-19

**\*The exam and lecture schedule may change based on the rate the class is progressing.**

Final exam: **Saturday 12/9/15, 9:50 AM** (Chapters 1-19)

**Students will be able to practice the following objectives presented in class with required and graded online homework and with homework problems from the text.**

**Students will be assessed on the following objectives presented in class using quizzes and exams.**

### **Chemistry 205 Learning Objectives**

#### Chapter 1

Define chemistry in relation to other sciences.

Identify the general steps in the scientific method.

Use chemical and physical properties, including phase, to describe matter.

Identify a sample of matter as an element, a compound, or a mixture.

Express quantities properly, using a number and a unit.

Express a large number or a small number in scientific notation.

Identify the number of significant figures in a reported value.

Use significant figures correctly in arithmetical operations.

Recognize the SI base units and explain the system of prefixes used with them.

Convert a value reported in one unit to a corresponding value a different unit.

#### Chapter 2

Define a chemical element and give examples of the abundance of different elements.

Represent a chemical element with a chemical symbol.

Explain all matter is composed of atoms.

Describe the modern atomic theory.

Describe the three main subatomic particles.

State how the subatomic particles are arranged in atoms.

Define and differentiate between the atomic number and the mass number of an element.

Explain how isotopes differ from one another.

Define atomic mass and atomic mass unit.

Describe how electrons are grouped within atoms.

Explain how elements are organized into the periodic table.

Describe how some characteristics of elements relate to their positions on the periodic table.

#### Chapter 3

Define the octet rule.

Describe how ionic bonds are formed.

Define the two types of ions.

Use Lewis diagrams to illustrate ion formation.

Write the chemical formula for a simple ionic compound.

Recognize polyatomic ions in chemical formulas.

Use the rules for naming ionic compounds.

Determine the formula mass of an ionic compound.

#### Chapter 4

Describe how a covalent bond forms.

Determine the chemical formula of a simple covalent compound from its name.

Determine the name of a simple covalent compound from its chemical formula.

Recognize molecules that are likely to have multiple covalent bonds.

Compare covalent bonds in terms of bond length and bond polarity

Determine the molecular mass of a molecule.

Predict the general shape of a simple covalent molecule.

Define *organic chemistry*.

Identify organic molecules as alkanes, alkenes, alkynes, alcohol, or carboxylic acids.

#### Chapter 5

Correctly define a law as it pertains to science.

State the law of conservation of matter.

Define *chemical reaction*.

Use a balanced chemical equation to represent a chemical reaction.

Calculate the amount of one substance that will react with or be produced from a given amount of another substance.

Classify a given chemical reaction into a variety of types.

Identify a chemical reaction as an oxidation-reduction reaction.

Identify oxidation-reduction reactions with organic compounds.

#### Chapter 6

Define the mole unit.

Learn how the masses of moles of atoms and molecules are expressed.

Convert quantities between mass units and mole units.

Use a balanced chemical reaction to determine molar relationships between the substances.

Convert from mass or moles of one substance to mass or moles of another substance in a chemical reaction.

#### Chapter 7

Define *energy* and *heat*.

Relate heat transfer to temperature change.

Determine the heat associated with a phase change.

Define *bond energy*.

Determine if a chemical process is exothermic or endothermic.

Relate the concept of energy change to chemical reactions that occur in the body.

#### Chapter 8

Define *phase*.

Identify the type of interactions between molecules.

Describe the solid and liquid phases.

Describe the gas phase.

Predict the properties of gases using the gas laws.

## Chapter 9

Understand what causes solutions to form.

Express the amount of solute in a solution in various concentration units.

Use molarity to determine quantities in chemical reactions.

Determine the resulting concentration of a diluted solution.

Describe the dissolution process at the molecular level.

Describe how the properties of solutions differ from those of pure solvents.

## Chapter 10

Recognize a compound as an Arrhenius acid or an Arrhenius base.

Recognize a compound as a Brønsted-Lowry acid or a Brønsted-Lowry base.

Illustrate the proton transfer process that defines a Brønsted-Lowry acid-base reaction.

Write chemical equations for water acting as an acid and as a base.

Describe the difference between strong and weak acids and bases.

Describe how a chemical reaction reaches chemical equilibrium.

Define the pH scale and use it to describe acids and bases.

Define *buffer* and describe how it reacts with an acid or a base.

## Chapter 11

Define and give examples of the major types of radioactivity.

Define *half-life*.

Determine the amount of radioactive substance remaining after a given number of half-lives.

Express amounts of radioactivity in a variety of units.

Learn some applications of radioactivity.

Explain where nuclear energy comes from.

Describe the difference between fission and fusion.

## Chapter 12

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 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.

## Chapter 13

Name alkenes given formulas and write formulas for alkenes given names.

Recognize that alkenes that can exist as cis-trans isomers.

Classify isomers as cis or trans.

Draw structures for cis-trans 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, and water.

Draw structures for monomers that can undergo addition polymerization and for four-monomer-unit sections of an addition polymer.

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.

Write formulas for aromatic compounds given their names.

## Chapter 14

Describe functional groups and explain why they are useful in the study of organic chemistry.

Identify the general structure for an alcohol.

Identify the structural feature that classifies alcohols as primary, secondary, or 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.

Give two major types of reactions of alcohols.

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 structure difference between an alcohol and an ether that affects physical characteristics and reactivity of each.

Name simple ethers.

Describe the structure and uses of some ethers.

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.

Name the typical reactions that take place with aldehydes and ketones.

Describe some of the uses of common aldehydes and ketones.

Identify thiols (mercaptans) by the presence of an SH group.

## Chapter 15

Identify the general structure for a carboxylic acid, an ester, an amine, and an amide.

Identify the functional group for a carboxylic acid, and ester, an amine, and an amide.

Name carboxylic acids with common names.

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 for 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 reaction that takes 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.

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 points of primary and secondary amines are higher than those of alkanes or 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 functional group for 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 reaction that amides undergo.

## Chapter 16

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 D-glucose, D-galactose, and D-fructose 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 and chemical properties of monosaccharides.

Identify the structures of sucrose, lactose, and maltose.

Identify the monosaccharides that are needed to form sucrose, lactose, and maltose.

Compare and contrast the structures and uses of starch, glycogen, and cellulose.

## Chapter 17

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 distinguishing characteristics of membrane lipids.

Describe membrane components and how they are arranged.

Identify the functions of steroids produced in mammals.

## Chapter 18

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.

Explain the functions of enzymes.

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 why vitamins are necessary in the diet.



## Chapter 19

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.

## Topics for CHM 205

### Exam I

#### Chapter 1

01-Introduction

02-Scientific Notation

03-Significant Figures

04-Measurements and Units

05-Unit Conversions

06-Density

#### Chapter 2

07-The Elements

08-Atomic Structure

09-Nuclei of Atoms

10-Arrangement of Electrons

11-Periodic Table

#### Chapter 3

12-Ionic Bonding

13-Formulas of Ionic Compounds

14-Naming Ions and Ionic Compounds

#### Chapter 4

15-Covalent Compounds

16-Multiple Covalent Bonds

17-Covalent Bond Characteristics

18-Formula Mass, Molecular Mass  
19-Introduction to Organic Chemistry

## **Exam II**

### Chapter 5

20-Chemical Equations  
21-Types of Reactions  
22-Redox Reactions

### Chapter 6

23-The Mole  
24-Stoichiometry-Moles  
25-Stoichiometry-Mass

### Chapter 7

26-Heat and Energy  
27-Phase Changes  
28-Heat in Chemical Reactions

## **Exam III**

### Chapter 8

29-Intermolecular Forces  
30-Gases and Pressure Units  
31-PVT Relationships  
32-Ideal Gas Law

### Chapter 9

33-Solutions  
34-Concentrations  
35-Colligative Properties

### Chapter 10

36-Arrhenius Acids and Bases  
37-Bronsted-Lowery Acids and Bases  
38-Acid and Base Strengths and Buffers

### Chapter 11

39-Radioactivity  
40-Radiation Units and Half Life  
41-Uses of Radiation and Nuclear Chemistry

## Exam IV

### Chapter 12

42-Alkanes

44-IUPAC Nomenclature

45-Cycloalkanes

46-Chemical and Physical Properties of Alkanes

### Chapter 13

46-Alkenes and Alkynes

47-Geometric Isomers

48-Properties of Alkenes and Alkynes

49-Polymers

50-Aromatic Compounds

### Chapter 14

51-Alcohols

52-Formation and Properties of Alcohols

53-Phenols, Ethers, and Organosulfur Compounds

54-Aldehydes and Ketones

### Chapter 15

55-Carboxylic Acids

56-Formation and Properties of Carboxylic Acids

57-Esters

58-Formation, Properties, and Reactions of Esters

59-Amines

60-Properties of Amines

61-Amides

# Exam V

## Chapter 16

62-Carbohydrates and Stereoisomers

63-Monosaccharides

64-Di- and Polysaccharides

## Chapter 17

65-Fatty Acids

66-Fats and Oils

67-Membranes and Membrane Lipids

68-Steroids

## Chapter 18

69-Amino Acids

70-The Isoelectric Point

71-Peptides

72-Proteins

73-Properties of Proteins

74-Enzymes

75-Enzyme Activity

76-Enzyme Inhibition

## Chapter 19

77-Nucleotides

78-Nucleic Acids

79-Replication and Transcription

80-Mutations and Viruses