This course supports the assessments for AIT1. The course covers 13 competencies and represents 4 competency units.

Introduction

Overview
Organic chemistry is the study of compounds that contain carbon. As you progress through this course, you will come to realize that organic compounds are everywhere. Do not be fooled into thinking organic chemistry is simple because it studies only compounds that contain carbon; there have been more than 10 million organic compounds discovered. Much of the study of organic chemistry is learning how to organize and group organic compounds so that you can predict their structure, behavior, and reactivity based on common bonds found within an organic compound.

Through successfully completing this course, you will show a high level of competence in the study of chemistry. You will be prepared to enter a secondary classroom and lead students in an organized and meaningful learning experience in their study of organic chemistry.

Watch the following video introduction for this course:

Competencies
This course provides guidance to help you demonstrate the following 13 competencies:

- Competency 208.1.1: Introduction to Organic Chemistry
  The graduate constructs standards-based lessons on the history and nature of organic chemistry, demonstrates how organic chemistry relates to the world, and introduces students to careers in organic chemistry.
- Competency 208.1.2: Carbon Compounds and Chemical Bonds
  The graduate can calculate formal charges and organic shorthand notation, and demonstrate basic concepts of chemical bonding.
- Competency 208.1.3: Organic Compounds
  The graduate can solve problems using critical concepts of orbital structure, molecular formula, boiling, and solubility.
- Competency 208.1.4: Organic Reactions: Acids and Bases
  The graduate can solve acid/base problems, and determine equilibrium concentration, using Bronsted-Lowry and Lewis acid-base concepts.
- Competency 208.1.5: Stereochemistry Chiral Molecules
  The graduate can apply concepts of stereochemistry to real-life situations, construct models of chiral and achiral molecules, and determine structure of molecules.
- Competency 208.1.6: Alkanes and Cycloalkanes-Conformations
  The graduate can analyze, draw, and solve problems concerning the conformations of alkanes and cycloalkanes.
- Competency 208.1.7: Ionic Reactions, Nucleophilic Substitutions, and Elimination Reactions of Alkyl Halides

The graduate can determine the structures of compounds and solve reaction problems with alkenes.

- Competency 208.1.8: Alkenes and Alkynes Reactions
  The graduate demonstrates the importance of alkenes in organic chemistry, and solves reaction problems of alkenes.
- Competency 208.1.9: Alcohols and Ethers
  The graduate can solve reaction equations and draw structures for alcohols and ethers.
- Competency 208.1.10: Mass Spectrometry and Other Lab Techniques in Organic Chemistry
  The graduate can demonstrate how mass spectrometers work, how they provide key information about molecular structure, and demonstrate other important lab techniques.
- Competency 208.1.11: Aromatic Compounds
  The graduate can explain the relationship between aromatic compounds and conjugated systems, construct models and identify structures, and solve problems of aromatic compounds.
- Competency 208.1.12: Aldehydes and Ketones I
  The graduate can construct chemical models, write chemical equations for common aldehyde and ketone reactions, and distinguish between aldehydes and ketones.
- Competency 208.1.13: Carboxylic Acids and Their Derivatives
  The graduate can draw chemical structures of carboxylic acids and their derivatives, name, solve problems involving carboxylic acids, and use tests to distinguish acids.

Teaching Dispositions Statement
Please review the Statement of Teaching Dispositions.

Course Instructor Assistance
As you prepare to successfully demonstrate competency in this subject, remember that course instructors stand ready to help you reach your educational goals. As subject matter experts, mentors enjoy and take pride in helping students become reflective learners, problem solvers, and critical thinkers. Course instructors are excited to hear from you and eager to work with you.

Successful students report that working with a course instructor is the key to their success. Course instructors are able to share tips on approaches, tools, and skills that can help you apply the content you're studying. They also provide guidance in assessment preparation strategies and troubleshoot areas of deficiency. Even if things don’t work out on your first try, course instructors act as a support system to guide you through the revision process. You should expect to work with course instructors for the duration of your coursework, so you are welcome to contact them as soon as you begin. Course instructors are fully committed to your success!

Preparing for Success

The information in this section is provided to detail the resources available for you to use as you complete this course.

Learning Resources

The learning resources listed in this section are required to complete the activities in this course.

For many resources, WGU has provided automatic access through the course. However, you may need to manually enroll in or independently acquire other resources. Read the full instructions provided to ensure that you have access to all of your resources in a timely manner.

Enroll in Learning Resources

You will need to enroll in or subscribe to learning resources as a part of this course. You may already have enrolled in these resources for other courses. Please check the “Learning Resources” tab and verify that you have access to the following learning resources. If you do not currently have access, please enroll or renew your enrollment at this time.

WileyPLUS

This resource provides access to the following e-text:

- Brown, W. H., & Poon, T. (2010). Introduction to organic chemistry (4th ed.). Hoboken, NJ: Wiley. ISBN-13 978-0470129234.

This organic chemistry text is designed for science majors and emphasizes the applications of organic chemistry to the world around you.

Additional Preparations

Graphing Calculator

Acquire a graphing calculator and familiarize yourself with how to use it. Refer to the WGU Calculator and Scratch Paper Guidelines document for calculators permitted on WGU exams. If you are in a secondary mathematics program, refer to the WGU Calculator Recommendations for Secondary Math and Science Programs document for calculator suggestions for your degree program.

Introduction to Organic Chemistry

Organic chemistry is the study of the compounds of carbon. Carbon compounds are central to life. They are important in DNA and the proteins that catalyze the reactions in the human body. In this subject, you will review background information that is essential to a successful study of organic chemistry. You will review atoms, bonding, and molecules. As you progress through this subject, you should be able to use electronegativity to predict bond characteristics predict the three-dimensional structure of molecules using the valence shell electron pair repulsion model and molecular orbital theory. You will also be introduced you to the concept of families of organic molecules and discuss the importance of these groups in predicting chemical reactions.

Basic Lab Techniques

In this section, you will review the most basic organic chemistry lab technique – thin layer chromatography. You will review more advanced organic chemistry lab techniques further in this course.

This topic addresses the following competencies:

- Competency 208.1.1: Introduction to Organic Chemistry
  The graduate constructs standards-based lessons on the history and nature of organic

chemistry, demonstrates how organic chemistry relates to the world, and introduces students to careers in organic chemistry.
- Competency 208.1.2: Carbon Compounds and Chemical Bonds
  The graduate can calculate formal charges and organic shorthand notation, and demonstrate basic concepts of chemical bonding.
- Competency 208.1.3: Organic Compounds
  The graduate can solve problems using critical concepts of orbital structure, molecular formula, boiling, and solubility.

Thin Layer Chromatography

Review the following website:

- "Thin Layer Chromatography"

As you learn about thin layer chromatography (TLC), consider that in a laboratory setting it is often used as a quick way of determining if reaction has gone to completion. By comparing starting material to the reaction materials, scientists can learn if any starting materials are still present in the sample. If there is no more starting material present on the TLC plate, the scientist knows the reaction can be stopped.

Atoms, Bonding, and Molecules

An understanding of the electronic structure of atoms and molecules is essential in all branches of chemistry. You will begin your study of organic chemistry with a review of atoms and then proceed into a review of chemical bonds and molecules, including the shapes of molecules. As you progress through these activities, you should notice that there are a variety of different ways to represent molecules. These structural formulas are used to show how the individual atoms are bonded together. You will review several different types of structural formulas. These structural models will be essential as you progress through your study of organic chemistry.

This topic addresses the following competencies:

- Competency 208.1.1: Introduction to Organic Chemistry
  The graduate constructs standards-based lessons on the history and nature of organic chemistry, demonstrates how organic chemistry relates to the world, and introduces students to careers in organic chemistry.
- Competency 208.1.2: Carbon Compounds and Chemical Bonds
  The graduate can calculate formal charges and organic shorthand notation, and demonstrate basic concepts of chemical bonding.
- Competency 208.1.3: Organic Compounds
  The graduate can solve problems using critical concepts of orbital structure, molecular formula, boiling, and solubility.

Structure of Atoms and Bonding

Read the following sections in *Introduction to Organic Chemistry*:

- section 1.1 ("How do we Describe the Electronic Structure of Atoms?")

- section 1.2 ("What is the Lewis Model of Bonding?")

Complete the example problems included in these sections.

Answer the following questions in your study notebook:

- What are ions, anions, and cations?
- What is the connection between the octet rule and ions?

In order to quickly and easily identify ions, you need to have at least the most common elements memorized. Review the periodic table shown in table 1.5 of *Introduction to Organic Chemistry*. Make sure that you have memorized the position of the nonmetals, noble gases, and main group metals. If you need additional assistance, search the Internet for another periodic table format.

Review the organic chemistry tutorial website for a prelecture review of Lewis structures. (video length = 21:31)

Molecular Shape

Read the following sections in *Introduction to Organic Chemistry*:

- section 1.3 ("How do we Predict Bond Angles and the Shapes of Molecules?")
- section 1.4 ("How do we Predict If a Molecule is Polar or Nonpolar?")
- section 1.5 ("What is Resonance?")
- section 1.6 ("What is the Molecular Orbital Model of Covalent Bonding?")

Complete the example problems included in these sections.

Memorize table 1.8.

In your study notebook, write an explanation of the VSEPR (valence shell electron pair repulsion) model in your own words.

Review the prelecture tutorial (VSEPR) that describes how orbitals are created and hybridized. (video length = 29:18)

Review the examples at the "VSEPR Examples" website.

The WileyPLUS resource also has Video Mini Lectures listed for chapter 1 to help with your understanding.

Answer the following question in your study notebook:

- What are the rules for writing acceptable resonance contributing structures?

Introduction to Functional Groups

Read the following section in *Introduction to Organic Chemistry*:

- section 1.7 ("What are Functional Groups?")

Complete the example problems included in the section.

Answer the following questions in your study notebook:

- What is a functional group?
- Why are functional groups important in the study of organic chemistry?

Note the colors and sizes they use to represent carbon, hydrogen, oxygen, and nitrogen in ball-and-stick models in section 1.7 of *Introduction to Organic Chemistry*.

Using household products, practice making molecules. View your model from different angles so that you can better visualize molecules in three dimensions.
For this model, atoms can be represented by objects you have available, such as dry pasta, marshmallows, candy, colored paper, or clay. Bonds between atoms could be represented by objects such as toothpicks, string, or wire.
Structural Formulas

The Lewis structure shows the symbol for the element surrounded by the dots that represent the electrons in the valence shell (i.e., outer shell).

Practice drawing Lewis structures for various compounds.

In condensed structural formulas, each carbon atom is written separately, and the other atoms that are bonded to that carbon atom are listed following each carbon atom.

Review the following website for more examples of condensed structural formulas:

- **Condensed Structural Formulas**

Practice writing condensed structural formulas for some of the common functional groups.

A skeletal structural formula simply removes the hydrogen atoms. Review the following website for examples:

- **Skeletal Structural Formulas**

Take a peek ahead at section 3.2 in *Introduction to Organic Chemistry*. Review how line-angle formulas are used to represent molecules. This will be one of the more common methods of representing molecules in this text.

Watch the following Video Mini Lecture in chapter 1 of the WileyPLUS resource:

- "3D Perspective Drawings: Visualizing in 3D

Practice making wedge-dash formulas given various compounds.

At the organic chemistry tutorial website, review the "Representing Organic Molecules" prelecture for a review of the most important structural formulas. (Video length = 17:35)
Check Your Understanding of Chapter 1 Concepts

Complete the chapter 1 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the "Submit Answer" button to check your answer.

Acids and Bases

Acid-base reactions are important in organic chemistry. Many of the reactions that take place in organisms involve acid-base reactions. The rate at which you breathe is influenced by the acidity of your blood. Carbonic anhydrase, an organic enzyme, regulates the acidity of your blood. Acid-base reactions also allow you to discuss the importance of solutions and molecular structure in chemical reactions.

Acid-Base Reactions

Many reactions that occur in organic chemistry are acid-base reactions. You will review acids, bases, and acid-base reactions while being introduced to some of the aspects of reactions that you will cover throughout this course. This topic will introduce you to the rules for using curved arrows to show changes in electron positions.

This topic addresses the following competencies:Competency 208.1.4:

- Organic Reactions: Acids and Bases
  The graduate can solve acid/base problems, and determine equilibrium concentration, using Bronsted-Lowry and Lewis acid-base concepts.

Acids and Bases

Read the following sections in *Introduction to Organic Chemistry*:

- section 2.1 ("What are Arrhenius Acids and Bases?")
- section 2.2 ("What are Bronsted-Lowry Acids and Bases?")
- section 2.3 ("How do we Measure the Strength of an Acid or Base?")

Review the following table:

- table 2.1

Review the Arrhenius definitions and the Brønsted-Lowry definitions.

Watch the following videos:

Acid/Base Definitions: Bronsted-Lowry and Lewis Definitions

Ka and pKa Derivation: A review of Keq, Ka, and pKa

Drawing Mechanisms

After reviewing section 2.1 (“What are Arrhenius Acids and Bases”), answer the following question in your study notebook:

- What are the rules for using curved arrows to show changes in electron positions?

Practice drawing the mechanism of how an Arrhenius acid works. Practice drawing the mechanism of how a Brønsted-Lowry acid works.

This skill will be used throughout the organic chemistry course.

Acidity and Equilibrium

Read the following sections in *Introduction to Organic Chemistry*:

- section 2.4 ("How do we Determine the Position of Equilibrium in an Acid-Base Reaction?")
- section 2.5 ("What are the Relationships Between Acidity and Molecular Structure?")

Complete the example problems included in these sections.

Practice drawing the resonance mechanism of carboxylic acid. Think about the following questions:

- What is a strong acid?
- What is a strong base?
- What are the four steps used to determine the position of an acid-base equilibrium?
- What is the most important factor in determining the relative acidities of organic compounds?
- How do the electronegativity of an atom, the resonance, and the inductive effect determine the relative stability of anions?

Lewis Acids and Bases

Read the following section in *Introduction to Organic Chemistry*:

- section 2.6 ("What are Lewis Acids and Bases?")

Review the following table:

- table 2.3 ("Some Organic Lewis Bases and Their Relative Strengths in Proton-Transfer Reactions")

Watch the following videos:
Acid/Base Definitions: Bronsted-Lowry and Lewis Definitions

Ka and pKa Derivation: A review of Keq, Ka, and pKa

Answer the following question in your study notebook:

- What makes a Lewis base strong?

Complete the example problems included in this section.
Acid-Base Misconceptions

The following examples are a few misconceptions regarding acids and bases. For at least two of the misconceptions, write an explanation of why it is a misconception.

- To test for an acid, see if it will eat material away.
- A base is something that makes up an acid.
- An acid will burn you.

Post what you have written to the message board and review and respond to one or more postings by other students.
Check Your Understanding of Chapter 2 Concepts

Complete the chapter 2 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the "Submit Answer" button to check your answer.

Alkanes and Cycloalkanes

You will begin your study of organic compound families with the study of alkanes, the simplest of all organic compounds. As this is the first family of organic compounds you will cover, you will spend much of your time on general concepts such as structure and nomenclature.

Alkanes and Cycloalkanes

You will begin your study of functional groups by reviewing hydrocarbons. You will then begin a thorough study of alkanes and cycloalkanes. You will learn how single carbon-to-carbon bonds make alkanes very stable. You will also learn that the primary source of alkanes comes from petroleum.

This topic addresses the following competencies:

- Competency 208.1.6: Alkanes and Cycloalkanes-Conformations
  The graduate can analyze, draw, and solve problems concerning the conformations of alkanes and cycloalkanes.

Hydrocarbons and Degree of Unsaturation

Hydrocarbons are compounds that contain only carbon and hydrogen atoms. It is important that you understand the different classes of hydrocarbons.

Read the section following in *Introduction to Organic Chemistry*:

- section 3.1 ("What are Alkanes?")

Pay special attention to figure 3.1 in the chapter opener.

Review the following website so that you can determine the degree of saturation of hydrocarbons:

- Calculating Degrees of Unsaturation

Alkanes and the IUPAC System

Alkanes are hydrocarbons in which all of the carbon to carbon bonds are single bonds.
Read the following sections in *Introduction to Organic Chemistry:*

- section 3.2 ("What is Constitutional Isomerism in Alkanes?")
- section 3.3 ("How do we Name Alkanes?")

There are more than 10 million known organic compounds. Even if you could name them all, it would be impossible to memorize their names, and it would take an impressive resource to index and reference them. To avoid this, chemists created the International Union of Pure and Applied Chemistry (IUPAC) system for naming organic compounds. This system allows a chemist to determine the name of a compound from its structure and to determine the structure of a compound from its name.

Practice naming complicated branch chains that require you to memorize table 3.2 and table 3.3 in *Introduction to Organic Chemistry*, along with all seven rules of the IUPAC system for naming alkanes.

Functional Group Table

Create a table called "Functional Groups." You will use this table to record the information you learn about the various functional groups as your progress through this course.

The table should list the functional group in the first column (the actual group of atoms), the name of the functional group in the second column (the name of the group of atoms), the family that includes the functional group in the third column (e.g., alcohol, amine), and the naming rules in the fourth column.

Complete this activity on the computer so that you can add additional rows and columns later. Add the alkanes functional group to your table.

The alkyl group (discussed in section 3.3) is an alkane with one of its hydrogen atoms removed.

Functional groups combine with an alkyl group to form families of organic compounds. For example, an alcohol is a molecule that contains one or more hydroxyl groups (OH) bonded to alkyl groups. Add the alkyl group to your functional group table.

Cycloalkanes

Cycloalkanes are alkanes that contain one or more carbon rings.

Read the following sections in *Introduction to Organic Chemistry*:

- section 3.4 ("What are Cycloalkanes?")
- section 3.5 ("What is the IUPAC System of Nomenclature?")

Complete example problems in these sections.

Add cycloalkanes to your "Functional Groups" table.

Alkane and Cycloalkane Nomenclature

Now that you've learned about alkanes and cycloalkanes, review these videos on naming these types of compounds. Having a strong foundation in naming organic molecules by learning this information now will allow for easily naming organic molecules in the future.

alkane and cycloalkane nomenclature I:

alkane and cycloalkane nomenclature II: Correction: 2,2,6,6,7-pentamethyloctane is the correct name. I put a dash instead of a comma between the 6 and the 7 on the video.

alkane and cycloalkane nomenclature III:

Conformations of Alkanes and Cycloalkanes

Read the following section in Introduction to Organic Chemistry:

- section 3.6 ("What are the Conformations of Alkanes and Cycloalkanes?")

Watch the following videos on the conformations of alkanes and cycloalkanes:

conformations of ethane and propane:

conformations of cyclohexane I: chair and boat:

Isomers of Cycloalkanes

Read the following section in *Introduction to Organic Chemistry*:

- section 3.7 ("What is Cis-Trans Isomerism in Cyclokanes?")

Constitutional isomers are also called structural isomers.

Watch the following video about disubstituted cycloalkanes:

conformations of cyclohexane III: disubstituted:

Answer the following question in your study notebook:

- How are constitutional and cis-trans isomers different?

Complete example problems in this section.

Alkanes and Cycloalkanes Physical Properties

Read the following section in *Introduction to Organic Chemistry*:

- section 3.8 ("What are the Physical Properties of Alkanes and Cyclokanes?")

Answer the following questions in your study notebook:

- What are dispersion forces?
- Given two alkanes, how can you determine which one has the highest boiling point?

Review table 3.4 and note the fairly uniform increase in boiling points from methane (-164 degrees Celsius) to decane (174 degrees Celsius).

Answer the following question in your study notebook:

- By approximately how much does the boiling point of each different alkane increase?

Create a fifth column in your "Functional Groups" table. Label this column "Physical Properties." In this column, you will include information about the boiling point, melting point, polarity, and solubility of each functional group as you continue to work through this course.

Update your "Functional Groups" table to include the physical properties of alkanes and cycloalkanes.

Answer the following question in your study notebook:

- How are alkanes and cycloalkanes related?

Alkanes and Cycloalkanes Reactions

Read the following section in *Introduction to Organic Chemistry*:

- section 3.9 ("What are the Characteristic Reactions of Alkanes?")

Answer the following questions in your study notebook:

- Why are alkanes and cycloalkanes so inherently stable?
- What is their most important reaction with oxygen?

Add a sixth column to your "Functional Groups" table. The new column should be labeled "Reactions." As you progress through this course, you will add information about important reactions for each functional group that you study.

Keep in mind that you need to know more than just what the key reactions are for each functional group; you also need to understand how the reaction takes place.

Add the key alkane reactions to your "Functional Groups" table.

Alkanes and Cycloalkanes Applications

Read the following section in *Introduction to Organic Chemistry*:

- section 3.10 ("What are the Sources of Alkanes?")

Answer the following questions in your study notebook:

- Where do most of the alkanes come from?
- What are common applications of alkanes?

Add a seventh column to the "Functional Groups" table you created earlier. The new column should be labeled "Applications." As you progress through this course, you will add information in this column about important applications for each functional group that you study.

Add important alkane applications to your "Functional Groups" table.

Check Your Understanding of Chapter 3 Concepts

Complete the chapter 3 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the "Submit Answer" button to check your answer.

Alkenes and Alkynes

You will now study two additional functional groups: alkenes and alkynes. Alkenes have important applications in biology. For example, ethene, the simplest alkene, is a plant hormone that affects seed germination, flowering, and fruit ripening. There are only a few natural occurrences of alkynes, one of which is ichthyothereol, which has been used for poisoned arrowheads.

Alkenes and Alkynes

Alkenes contain carbon-to-carbon double bonds and alkynes contain carbon-to-carbon triple bonds. The double carbon bonds of alkenes are easily broken, which makes the addition reaction their most characteristic reaction.

This topic addresses the following competencies:

- Competency 208.1.8: Alkenes and Alkynes Reactions
  The graduate demonstrates the importance of alkenes in organic chemistry, and solves reaction problems of alkenes.

Alkenes and Alkynes Structure and Nomenclature

Read the following sections in *Introduction to Organic Chemistry*:

- section 4.1 ("What are the Structures and Shapes of Alkenes and Alkynes?")
- section 4.2 ("How do we Name Alkenes and Alkynes?")

Watch the following videos on naming alkenes and alkynes:
Cis-Trans and E-Z Naming Scheme for Alkenes: Cis-Trans and E-Z Naming Scheme for Alkenes

alkyne nomenclature:

Add alkenes and alkynes to your "Functional Groups" table and complete columns 1-4. Add examples of the uses of alkenes and/or alkynes to your table.

Complete example problems in these sections.

Make sure you know if the configuration is Z or E and how to assign priorities to groups bonded to each carbon.

Alkenes and Alkynes Physical Properties

Review the following section in *Introduction to Organic Chemistry*:

- section 4.3 ("What are the Physical Properties of Alkenes and Alkynes?")

Answer the following question in your study notebook:

- How do the physical properties of alkenes and alkynes compare with those of alkanes?

Update your "Functional Groups" table to include the physical properties of alkenes and alkynes.

Complete example problems in this section.

Applications of Alkenes

From chapter 4 (“Alkenes and Alkynes”) in *Introduction to Organic Chemistry*, open the chapter opener and find the link to the following:

- Chemical Connections 4A Ethylene, a Plant Growth Regulator

Search the Internet for more applications of ethene (ethylene), the simplest alkene. Create a list of uses of ethylene and add them to your "Functional Groups" table.

After reading this information, write down more applications of these products.

Check Your Understanding of Chapter 4 Concepts

Complete the chapter 4 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the “Submit Answer” button to check your answer.

Alkenes and Alkynes Reactions

Read all sections within the following chapter of *Introduction to Organic Chemistry*:

- chapter 5 ("Reactions of Alkenes and Alkynes")

Complete the example problems included in these sections.

Review the key reactions at the end of the chapter 5.

Answer the following question in your study notebook:

- What is the most common and most important reaction of alkenes?

Update your "Functional Groups" table to include the important reactions for alkenes.

Electrophilic Addition Reactions to Alkenes

After reading section 5.3 in Introduction to Organic Chemistry, use the following videos to enhance your learning and understanding of the material.

Watch the following video about Alkene reactions of Halogen Halides**.**

Introduction to Reaction Mechanisms: Introduction to Reaction Mechanisms . Addition reaction to an alkene

Watch the following video about Markovnikov’s rule:

Markovnikov's Rule and Carbocations: Markovnikov's Rule and Carbocations. Figuring out which addition reaction is more likely.

Answer the following questions in your study notebook:

- How is Markovnikov's rule important in the addition of hydrogen halides and in the addition of water?

Alkenes are important because they allow a stable carbocation.

Answer the following questions in your study notebook:

- How does the double-bond allow for this?
- Why are some carbocations more stable than others?

Make sure you can identify which carbocation is most stable.

Watch the following video about the Acid-Catalyzed Addition of Water to alkenes:

Addition of Water (Acid-Catalyzed) Mechanism: Addition of Water (Acid-Catalyzed) Mechanism

In your study notebook, draw out the following mechanism

- the acid catalyzed hydration of butane.

Watch the following video about Halogenation of alkenes:

halogenation:

Answer the following question in your study notebook:

- What does the addition of chlorine or bromine do to a cycloalkene yield?

Hydroboration-Oxidation and Ozonolysis of Alkenes

After reading sections 5.6 and 5.6 in Introduction to Organic Chemistry, use the following videos to enhance your learning nd understanding of the material.

Watch the following video about Hydroboration-Oxidation reactions:
hydroboration-oxidation:

Watch the following video about Ozonolysis reactions:
Ozonolysis: Alkene cleavage using ozone

Reduction of Alkenes

After reading section 5.7 in Introduction to Organic Chemistry, use the following video to enhance your understanding of the material.
hydrogenation:

Answer the following questions in your study notebook:

- What are the three important points regarding heat of hydrogenation?

Alkyne Acidity

After reading section 5.8 in Introduction to Organic Chemistry, use the following video to enhance your understanding of the material.
alkyne acidity and alkylation:

Alkyne Reactions

After reading sections 5.10-5.11 in Introduction to Organic Chemistry, use the following videos to enhance your understanding of the material.
hydration of alkynes:

reduction of alkynes:

Check Your Understanding of Chapter 5 Concepts

Complete the chapter 5 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the "Submit Answer" button to check your answer.
Reaction Concept Map

Create a concept map that links the following terms together:

- reaction mechanism
- energy diagram
- reaction coordinate
- heat or reaction
- exothermic
- endothermic
- transition state
- activation energy
- reaction intermediate
- rate-determining step

Make sure you know the definitions of these terms, as well as how they relate to each other.
Classification of Reactions

There are a number of different ways that you can classify reactions. For example, you can classify reactions based on the functional group that frequently has the reaction (alkene, amine, etc.). You could also classify reactions based on the structural change that takes place (i.e., addition, elimination, substitution, or rearrangement).

Review the following website for an excellent overview of organic reactions"

- Chemical Reactivity

You do not need to read and understand everything on this website today, but the better grounded you are with the concepts discussed on the website, the more easily you will complete the activities to come.

Isomers

You will now take a break from studying specific families of organic compounds so that you can study a more general concept: isomerism. Isomers are compounds with the same molecular formula but with different arrangements of atoms. Isomers often have different chemical and physical properties. Isomers cause a few complications in the study of organic chemistry because the naming convention needs to account for both the molecular formula and the physical arrangement.

Isomers

Isomers are compounds with the same molecular formula but different arrangements of atoms. Constitutional isomers (also known as structural isomers) differ in the way their atoms are connected. Stereoisomers differ in the way their atoms are arranged in space. As you complete the activities within this topic, make sure you understand the difference between all the various types of isomers and chirality.

This topic addresses the following competencies:

- Competency 208.1.5: Stereochemistry Chiral Molecules
  The graduate can apply concepts of stereochemistry to real-life situations, construct models of chiral and achiral molecules, and determine structure of molecules.

Stereoisomers

Review the following sections in *Introduction to Organic Chemistry*:

- section 6.1 ("What are Stereoisomers?")
- section 6.2 ("What are Enantiomers?")

Complete the example problems included in these sections.

If a mirror image of a molecule is superposable with the original molecule, then they are the exact same molecule and are not isomers at all. This is in contrast to diastereomers, which are not mirror images, and enantiomers, which are mirror images but are not superposable.

Review this video on Chirality and Stereoisomers:
chirality centers and stereoisomers:

Answer the following questions in your study notebook:

- When a carbon is chiral, how many different groups must be present?
- Demonstrating chirality is done in two dimensions by using special symbols to represent bonds. What do these symbols mean (the bold triangle and dashed triangle)?

Isomer Concept Map

Create a concept map for isomers. Start with figure 6.1 in *Introduction to Organic Chemistry*. It shows some of the relationships among isomers.

Add the following terms to your concept map:

- cis-trans isomers
- chiral
- achiral
- plane of symmetry
- stereocenter
- stereoisomer
- enantiomer
- diastereomer

Construct a Model

Using household products, create a model of 2-bromobutane and its mirror image. Manipulate the two models so that you can see that this molecule and its mirror image are not superposable.

Take pictures of your models, you will need to submit them for the assignment on nomenclature (Task 2).

Create a model of 2-propanol and its mirror image. Manipulate the models so that you can see that 2-propanol and its mirror image are superposable.

Naming Stereocenter

Review the following section in *Introduction to Organic Chemistry*:

- section 6.3 ("How do we Designate the Configuration of a Stereoisomer?")

Review the following website for a simple rule that can be used to identify stereoisomers:

- Stereochemistry: The Basics of Solving Problems

Watch the following video to clarify your understanding of the R/S naming system for chiral

carbons.
R,S system for determining absolute configuration:

For more examples of the R/S naming system, you can find additional videos here:
More
R/S
Naming
System
Exampl
es (http://www.khanacademy.org/video/cahn-ingold-prelog-system-for-naming-enantiomers)

Do not assume that this is as easy as it looks. Make sure you practice.

Complete the example problems included in this section.
Multiple Stereocenters

Briefly review the following sections in *Introduction to Organic Chemistry*:

- section 6.4 ("What is the 2n Rule?")
- section 6.5 ("How do we Describe the Chirality of Cyclic Molecules With Two or More Stereocenters?")
- section 6.6 ("How do we Describe the Chirality of Molecules With Three or More Stereocenters?")

Focus on how to identify the number and locations of molecules with multiple stereocenters. The maximum number of possible stereoisomers is 2n, where n equals the number of stereocenters. For example, a molecule with two stereocenters would have a maximum of four stereoisomers.
Chirality Applications

Review the following in *Introduction to Organic Chemistry*:

- section 6.9 ("What is the Significance of Chirality in the Biological World?")
- section 6.10 ("How can Enantiomers be Resolved?")
- "Chiral Drugs" Chemical Connections 6A within section 6.10

Answer the following questions in your study notebook:

- How does an enzyme distinguish between a molecule and its enantiomer?
- What are the advantages and disadvantages to using enantiomerically pure drugs?

Check Your Understanding of Chapter 6 Concepts

Complete the chapter 6 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the "Submit Answer" button to check your answer.

Alkyl Halide (Haloalkanes)

You will now continue your study of organic compounds by reviewing alkyl halides (also known as haloalkanes). Alkyl halides are alkanes with one or more hydrogen atom replaced with members of the halogen group. Chlorofluorocarbons are a member of the haloalkane functional group that received a lot of attention in the 1970s when it was discovered that they were causing the depletion of the ozone layer. Since that time, chlorofluorocarbons have been replaced in air conditioners and other such devices with hydrofluorocarbons and other more environmentally-friendly chemicals.

Alkyl Halide

Hydrocarbons contain only hydrogen and carbon atoms. However, most organic compounds contain more than just carbon and hydrogen atoms. Most of these substances can be viewed as hydrocarbon derivatives, which are organic compounds that are primarily a hydrocarbon but have an additional atom or group of atoms called a functional group. For example, alkyl halides (also known as haloalkanes) are alkanes with one or more hydrogen atom replaced with members of the halogen group (F, Cl, Br, I). Complete the activities within this topic to gain an understanding of haloalkanes.

This topic addresses the following competencies:

- Competency 208.1.7: Ionic Reactions, Nucleophilic Substitutions, and Elimination Reactions of Alkyl Halides
  The graduate can determine the structures of compounds and solve reaction problems with alkenes.

Alkyl Halide Structure and Nomenclature

Review the following section in *Introduction to Organic Chemistry*:

- section 7.1 ("How are Haloalkanes Named?")

Review the following video on Naming Alkyl Halide compounds:
Naming Alkyl Halides: Naming Alkyl Halides

Add information about haloalkanes to your "Functional Groups" table.

Introduction to Haloalkanes Reactions

Review the following section in *Introduction to Organic Chemistry*:

- section 7.2 ("What are the Characteristic Reactions of Haloalkanes?")

Answer the following question in your study notebook:

- What is the difference between a nucleophilic substitution and a ß-elimination?

Haloalkanes Substitution Reactions

Review the following sections in *Introduction to Organic Chemistry*:

- section 7.3 ("What are the Products of Nucleophilic Aliphatic Substitution Reactions?")
- section 7.4 ("What are the SN2 and SN1 Mechanisms for Nucleophilic Substitution?")
- section 7.5 ("What Determines Whether SN1 or SN2 Predominates?")
- section 7.6 ("How Can SN1 and SN2 Be Predicted Based on Experimental Conditions?")

Watch the following videos on SN1 and SN2 reactions as well as a video on the effects of solvents in these reactions.
Sn2 Reactions: Sn2 Reactions

williamson ether synthesis:

Sn1 Reactions: Introduction to Sn1 reactions

Solvent Effects on Sn1 and Sn2 Reactions: Solvent Effects on Sn1 and Sn2 Reactions

Answer the following questions in your study notebook:

- Why are 3° haloalkanes never involved in SN2 reactions?
- Why are 1° (primary) haloalkanes never involved in SN1 reactions?
- Why does an SN2 reaction result in the opposite stereoisomer while SN1 reactions result in a mixture of stereoisomers?

Haloalkanes Elimination Reactions

Review the following sections in *Introduction to Organic Chemistry*:

- section 7.7 ("What are the Products of ß-Eliminations?")
- section 7.8 ("What are the E1 and E2 Mechanisms for ß-Elimination?")

Watch the following videos about elimination reactions and Zaitsev’s rule.
E2 Reactions: E2 Elimination Reactions

E1 Reactions: E1 Elimination Reactions

Zaitsev's Rule: Zaitsev's Rule for E2 and E1 reactions

Answer the following question in your study notebook:

- How is Zaitsev's rule applied to an elimination reaction?

Substitution or Elimination

Review the following section in *Introduction to Organic Chemistry*:

- section 7.9 ("When Do Nucleophilic Substitution and ß-Elimination Compete?")

Review the following table:

- table 7.7

Review the following website:

- Elimination Versus Substitution in Halogenoalkanes

Review the following video:
Comparing E2 E1 Sn2 Sn1 Reactions: Comparing E2 E1 Sn2 Sn1 Reactions

Relative Strength of Nucleophiles

Review the following video about the strength of nucleotides:

Nucleophilicity (Nucleophile Strength): Nucleophilicity (Nucleophile Strength)

(*please embed*)

Answer the following questions in your study notebook.

- What makes a good nucleophile?
- How does the leaving group and the solvent influence the type of reaction that occurs?

Make sure you know why the reactions occur. If you have any questions, post them to the message board.
Strong Bases

In order to determine the type of reaction that occurs, you need to know some of the common strong bases, such as OH, CH3CH2O, and NH2.

To refresh your memory, you can review the following in *Introduction to Organic Chemistry*:

- section 2.4
- table 2.2 in section 2.3

Watch this video comparing nucleophilicity and basicity in order to enhance your understanding.

Nucleophilicity vs. Basicity: Nucleophilicity vs. Basicity . The difference between what it means to be a nucleophile and a base

Summary of Haloalkanes Reactions

Review the following in Introduction to Organic Chemistry:

- the key reactions at the end of the chapter 7

Add the key haloalkane reaction to your "Functional Groups" table.

Check Your Understanding of Chapter 7 Concepts

Complete the chapter 7 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the “Submit Answer” button to check your answer.

Alcohols and Ethers

You will now study two additional families of organic compounds called alcohols and ethers. There are many important applications of alcohols. For example, methanol is used as a starting material for adhesives, fibers, and plastics. It has also become increasingly used as motor fuel. Ethanol is used to make alcoholic beverages.

Alcohols and Ethers

Alcohols are hydrocarbon derivatives that contain the hydroxyl functional group (-OH). Ethers are organic compounds that contain the ether functional group, which is a C-O-C linkage defined by a bond angle of about 120 degrees. Complete the activities within this topic to gain an understanding of the structure, nomenclature, physical properties, and key reactions of alcohols and ethers.

This topic addresses the following competencies:

- Competency 208.1.9: Alcohols and Ethers
  The graduate can solve reaction equations and draw structures for alcohols and ethers.

Alcohols and Ethers Structure and Nomenclature

Read the following sections in *Introduction to Organic Chemistry*:

- section 8.1 ("What are Alcohols?")
- section 8.3 ("What are Ethers?")

Review the following videos about alcohol and ether nomenclature:

Alcohols: Naming alcohols

Ether Naming and Introduction: Ether Naming and Introduction

Complete all the example problems associated with the reading.

Add alcohols and ethers to your "Functional Groups" table.

Alcohols and Ethers Physical Properties

Review the following videos on alcohol and ether physical properties:

Alcohol Properties: Alcohol Properties

Properties of ethers and crown ethers:

Answer the following questions in your study notebook:

- What is hydrogen bonding?
- Why does the polarity of an alcohol's OH group raise its boiling point?
- How does this polarity affect its solubility?
- Why are the boiling points of ethanol and dimethyl ether so different?

Update your "Functional Groups" table to include the physical properties of alcohols and ethers, including the acidity of alcohol.

Alcohols and Ethers Reactions

Read the following section in *Introduction to Organic Chemistry*:

- section 8.2.F

Complete example and practice problem 8.6 from the textbook.

Answer the following question in your study notebook:

- How are secondary alcohols oxidized to ketones?

Aromatic Compounds

The term aromatic compound was derived from the fact that most aromatic compounds have a sweet smell. The six-carbon ring in an aromatic compound is called a benzene ring. It is named after the simplest of all aromatic compounds: benzene. Benzene is an organic compound with the molecular formula C6H6. It is colorless, flammable, and has a sweet smell. You will study the structure of benzene and then generalize what you have learned to understand the structure of aromatic compounds.

Benzene and Aromatic Systems

Complete the activities within this topic to gain an understanding of the physical properties and key reactions of benzene and the structure, nomenclature, physical properties, and key reactions of other aromatic systems.

This topic addresses the following competencies:

- Competency 208.1.11: Aromatic Compounds
  The graduate can explain the relationship between aromatic compounds and conjugated systems, construct models and identify structures, and solve problems of aromatic compounds.

Benzene and Aromatic Systems Structure and Nomenclature

Review the following sections in *Introduction to Organic Chemistry*:

- section 9.1 ("What is the Structure of Benzene?")
- section 9.2 ("What is Aromaticity?")
- section 9.3 ("How are Benzene Compounds Named, and What are Their Physical Properties?")

Work through example problems in these sections.

Watch the following videos:

Naming Benzene Derivatives Introduction: Naming Benzene Derivatives Introduction

Add benzene to your "Functional Groups" table.

Review the following website:

- **Introductory Organic and Biochemistry**

Answer the following questions in your study notebook:

- How do you apply Hückel's criteria to determine if a ring is aromatic?
- What atomic orbitals do the unshared electrons of pyridine, furan, and pyrrole occupy?

Molecular Orbital Models

Review the molecular orbital model of aromatic molecules at the following websites:

- Introduction to Molecular Orbital Theory
- Aromaticity and Hückel's Rule
- Benzene and Other Aromatic Compounds

Watch the following videos:

Aromatic Compounds and Huckel's Rule: Aromatic Compounds and Huckel's Rule

intro to molecular orbital (MO) theory:

Resonance: Resonance in benzene and the carbonate ion

Aliphatic and Aromatic Hydrocarbons

Note that while this text uses aliphatic as a synonym for alkane, the term aliphatic is typically understood to refer to hydrocarbons that are not aromatic, which includes alkanes, alkenes, and alkynes.

Answer the following questions in your study notebook:

- How are alkanes and cycloalkanes related?
- What is an aromatic compound?
- Why are cycloalkanes not an aromatic compound?

Aromatic Reactions

Review the following sections in *Introduction to Organic Chemistry*:

- section 9.4 ("What is the Benzylic Position, and How Does It Contribute to Benzene Reactivity?")
- section 9.5 ("What is Electrophilic Aromatic Substitution?")
- section 9.6 ("What is the Mechanism of Electrophilic Aromatic Substitution?")
- section 9.7 ("How do Existing Substituents on Benzene Affect Electrophilic Aromatic Substitution?")

Complete example problems in sections 9.4, 9.5, 9.6, and 9.7.

Watch the following video on Electrophilic Aromatic Substitution:

Electrophilic Aromatic Substitution: Electrophilic Aromatic Substitution

Answer the following questions in your study notebook:

- What is the most characteristic reaction of aromatic compounds?
- What are the three general steps in an electrophilic aromatic substitution?
- What is the intermediate during a chlorination or bromination of an aromatic compound?
- What are the reagents for the nitration and sulfonation of benzene?
- Why is the order of electrophilic aromatic substitutions important?
- What are the most activating substituents?

Review the key reactions at the end of chapter 9 in *Introduction to Organic Chemistry*.

Add the key aromatic reactions to your "Functional Groups" table.

Check Your Understanding of Chapter 9 Concepts

Complete the chapter 9 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the "Submit Answer" button to check your answer.

Amines

Amines are characterized by unpleasant odors such as the odor associated with the decay of animal and human tissues. Many amines are carcinogenic, but if handled properly, they are often used to make dyes and drugs, and for the treatment of gases, such as the removal of CO2.

Amines

An amine is an organic compound that contains the amine functional group (NH2). Complete the activities within this topic to gain an understanding of the structure, nomenclature, physical properties, and key reactions of amines.

Amines Structure and Nomenclature

Read the following sections in *Introduction to Organic Chemistry*:

- section 10.1 ("What are Amines?")
- section 10.2 ("How are Amines Named?")

Complete example problems in these sections.

Review the following video:

Amine Naming Introduction: Amine Naming Introduction

Answer the following questions in your study notebook:

- How is ammonia involved in the classification of amines?
- How do you determine primary, secondary, and tertiary amines?

Add amines to your "Functional Groups" table.

Amines Physical Properties

Read the following section in *Introduction to Organic Chemistry*:

- section 10.3 ("What are the Characteristic Physical Properties of Amines?")

Review the following table:

- table 10.1

Answer the following question in your study notebook:

- How do amines compare with hydrocarbons?

Update your "Functional Groups" table to include the physical properties of amines.

Complete example problems in section 10.3.

Organic Chemistry Laboratory Techniques

Many of the lab techniques used in a general chemistry lab will also be used in an organic chemistry lab. However, there is typically an increased focus in an organic chemistry lab on distillation and a few of new lab techniques, namely infrared (IR) spectroscopy and nuclear magnetic resonance (NMR) spectroscopy. You will cover these lab techniques in this section.

IR and NMR

Infrared (IR) spectroscopy provides a relatively simple technique that uses infrared light to determine the presence of different functional groups. Nuclear magnetic resonance (NMR) spectroscopy uses radiation to detect the presence of functional groups.

This topic addresses the following competencies:

- Competency 208.1.10: Mass Spectrometry and Other Lab Techniques in Organic Chemistry
  The graduate can demonstrate how mass spectrometers work, how they provide key information about molecular structure, and demonstrate other important lab techniques.

How IR Works

Read the following sections in *Introduction to Organic Chemistry*:

- section 11.1 ("What is Electromagnetic Radiation?")
- section 11.2 (“What is Molecular Spectroscopy?")
- section 11.3 ("What is Infrared Spectroscopy?")
- section 11.4 ("How do we Interpret Infrared Spectra?")

Write a paragraph that explains how IR spectroscopy works. Keep it at a level that a high school chemistry student would understand.

What are the frequencies of common peaks?

You should be able to identify functional groups in IR spectra.

Identification of IR Spectra Peaks

What are the frequencies of common peaks, such as C-H stretching and bending, C-H peaks that arise from aromatics, and functional groups such as alcohols, aldehydes/ketones, amines, and ethers?

You should be able to identify functional groups in IR spectra. Practice identifying the groups found in the IR spectra on this webpage

- “Benzene Containing IR Spectra”.

Use section 11.4 in *Introduction to Organic Chemistry* to view examples and you can also use this “Table of Characteristic IR Absorptions” to see likely locations for the different functional groups.

Watch this video to seen an example of your course instructor interpreting the spectra for 2-bromo-1-phenylethanol:

This is a skill you will use in performance task 3.

How NMR Works

Read the following sections in *Introduction to Organic Chemistry*:

- section 12.1 ("What are the Magnetic Properties of Nuclei?")
- section 12.2 ("What is Nuclear Magnetic Resonance?")
- section 12.3 ("What is Shielding?")
- section 12.4 ("How is an NMR Spectrum Obtained?")

Write a paragraph that explains how NMR spectroscopy works. Keep it at a level that a high school chemistry student would understand.

Hydrogen Groups correspond to NMR Peaks

The number of peaks in an NMR spectrum is related to the number of hydrogen groups in a compound. Read about how to determine the number of hydrogen groups and resulting peaks in *Introduction to Organic Chemistry*:

- section 12.5 (“How Many Resonance Signals Will a Compound Yield in its NMR Spectrum”)

Signal Integration Corresponds to Number of Hydrogens

The number of hydrogens that give rise to an NMR peak can be determined by looking at the integration of the peak, or area under the peak. The greater the area under the peak results in a greater number of hydrogens giving rise to that peak (i.e. a CH2 peak will have a smaller area than a CH3 peak). Read about this important component of NMR spectra:

- section 12.6 (“What is Signal Integration?”)

Chemical Shift Corresponds to Nearby Functional Groups

The location or shift of a peak on an NMR spectra is related to the functional groups located nearby a given hydrogen group. Read the following section in *Introduction to Organic Chemistry* to learn about the chemical shift of hydrogen groups:

- section 12.7 (“What is Chemical Shift?”)

Review the following website to see a table of shift ranges:

- Proton Chemical Shift Table

Signal Splitting Corresponds to Number of Adjacent Hydrogens

The signal split, or number of peaks within a peak, corresponds to the number of hydrogens on an adjacent carbon. Review the following section in *Introduction to Organic Chemistry*:

- section 12.8 ("What is Signal Splitting?")

Answer the following question in your study notebook:

- What is the n + 1 rule?

Complete practice problem 12.6 from the textbook.

Interpreting NMR Spectra

When interpreting NMR spectra, you will combine what you know about signal splitting, chemical shift, and signal integration to correlate each peak with a hydrogen group in your given compound. Read the following sections in *Introduction to Organic Chemistry*:

- Section 12.10 (“How Do We Interpret NMR Spectra?”)
- Section 12.11 (“How Do We Solve an NMR Problem?”)

When interpreting NMR spectra, try to follow these rules:

1. Identify hydrogen groups. With an NMR spectrum in hand, you know how many hydrogen groups you will need to identify as that is the number of peaks in your spectrum.
2. Identify adjacent hydrogens and the signal split. Using the n+1 rule, you will be able to identify the split of a hydrogen group before looking at the NMR spectra.
3. Use chemical shift and signal integration to identify peaks on the spectrum. Chemical shift will allow you to identify where functional groups will force a peak to fall. If there is more than one peak within a certain shift range, signal integration will help you identify the different peaks.

Watch the following video of your course instructor interpreting the IR and NMR spectra of 2-bromo-1-phenylethanol to see how to go about completing the interpretation of an NMR spectrum.

Nuclear Magnetic Resonance Spectroscopy

Read the following section in *Introduction to Organic Chemistry*:

- section 12.9 ("What is 13C-NMR Spectroscopy, and How Does It Differ from 1H-NMR

Spectroscopy?")

Memorize the chemical shift for the various types of carbons as presented in table 12.2.

Applications: MRI

Review the following in section 12.9 in *Introduction to Organic Chemistry*:

- Chemical Connections 12A "Magnetic Resonance Imaging"

Answer the following questions in your study notebook:

- Which atoms are most commonly used for MRIs?
- How is cancer detected with an MRI?
- How are X-rays and MRIs complementary?

Write a paragraph explaining how an MRI works. Keep it at a level that a high school chemistry student would understand.

IR and NMR Review

Complete the problems at the following website to practice identifying the molecule from an IR or NMR spectrum:

- **Spectroscopy Problems**

Use the information at the following websites to complete these practice problems:

- **Spectroscopy Problems**
- **Infrared Spectroscopy**

Distillation

Distillation is essentially the process of heating a substance until it boils and then cooling it so that it condenses back into a liquid. The purpose of distillation is to use the differences in boiling points of two different substances to separate them from each other.

This topic addresses the following competencies:

- Competency 208.1.10: Mass Spectrometry and Other Lab Techniques in Organic Chemistry
  The graduate can demonstrate how mass spectrometers work, how they provide key information about molecular structure, and demonstrate other important lab techniques.

Distillation Lab Technique

Review the following website to learn about distillation:

- **Distillation**

Answer the following questions in your study notebook:

- What is the goal of distillation?
- How does distillation work?
- When would you use fractional distillation instead of simple distillation?

Distillation Video

Watch the following video to see how to properly set up a distillation:

- **Organic Chemistry Lab Demo: Distillations**

Answer the following question in your study notebook:

- What is the difference in the setup between a simple and a fraction distillation?

Aldehydes and Ketones

You will continue your study of organic chemistry by taking a look at two additional families of organic compounds: aldehydes and ketones. Aldehydes and ketones often have a pleasant fragrance, which has resulted in their use in perfumes. Ketones also often have solvent properties that make them useful for applications such as nail polish remover.

Aldehydes and Ketones

Aldehydes and ketones contain the carbonyl functional group, which is carbon double-bonded to oxygen. In ketones, the carbonyl group is bonded to two carbon atoms. In aldehydes, the carbonyl group is bonded to at least one hydrogen atom. Complete the activities within this topic to gain an understanding of the structure, nomenclature, and physical properties of aldehydes and ketones.

This topic addresses the following competencies:

- Competency 208.1.12: Aldehydes and Ketones
  The graduate can construct chemical models, write chemical equations for common aldehyde and ketone reactions, and distinguish between aldehydes and ketones.

Aldehydes and Ketones Structure and Nomenclature

Read the following sections in *Introduction to Organic Chemistry*:

- section 13.1 ("What are Aldehydes and Ketones?")
- section 13.2 ("How are Aldehydes and Ketones Named?")

Watch the following videos on naming aldehydes and ketones:

Aldehyde Introduction: Aldehyde introduction

Ketone Naming: Ketone Naming

Add aldehydes and ketones to your "Functional Groups" table.

Make sure you know the common names that the IUPAC system retains.

Aldehydes and Ketones Physical Properties

Read the following section in *Introduction to Organic Chemistry*:

- section 13.3 ("What are the Physical Properties of Aldehydes and Ketones?")

Review the following tables:

- table 13.2
- table 13.3

Answer the following questions in your study notebook:

- What is the boiling point trend?
- How do the boiling points of aldehydes and ketones compare to other organic compounds?
- What are the solubility trends?
- How does the solubility of aldehydes and ketones compare to other organic compounds?
- What causes these trends, relative boiling points, and solubility?

Update your "Functional Groups" table to include the physical properties of aldehydes and ketones.

Aldehydes and Ketone Reactions

Ketones and aldehydes are often produced by the oxidation of alcohols. The oxidation of a primary alcohol results in the formation of an aldehyde, and the oxidation of a secondary alcohol results in a ketone. Complete the activities within this topic to gain an understanding of the key reactions of aldehydes and ketones.

This topic addresses the following competencies:

- Competency 208.1.12: Aldehydes and Ketones
  The graduate can construct chemical models, write chemical equations for common aldehyde and ketone reactions, and distinguish between aldehydes and ketones.

Addition of Grignard Reagents

Read the following sections in *Introduction to Organic Chemistry*:

- section 13.4 ("What is the Most Common Reaction Theme of Aldehydes and Ketones?")
- section 13.5 ("What are Grignard Reagants, and How do They React With Aldehydes

and Ketones?")

Complete example problems in these sections.

Watch the following video:

synthesis of alcohols using grignard reagents I:

Answer the following questions in your study notebook:

- What is the mechanism of the Grignard reaction?
- What is a Grignard reagent?
- What does the treatment of formaldehyde with a Grignard reagent followed by hydrolysis in an aqueous acid yield?

Formation of Hemiacetals and Acetals

Read the following sections in *Introduction to Organic Chemistry*:

- section 13.6 ("What are Hemiacetals and Acetals?")

Complete all of the practice problems within this section.

Answer the following questions in your study notebook:

- What adds to the carbonyl carbon and carbonyl oxygen during the formation of a hemiacetal?
- How does the formation of a hemiacetal differ from the formation of an acetal?

Addition of Ammonia, Amines, and a Halogenation

Read the following sections in **Introduction to Organic Chemistry**:

- section 13.7 ("How do Aldehydes and Ketones React with Ammonia and Amines?")
- section 13.8 ("C. ?-Halogenation")

Complete all of the practice problems within these sections.

Answer the following questions in your study notebook:

- What is an imine?
- What is formed from the addition of ammonia or a primary amine to the carbonyl group of aldehydes?

Recall that an ?-carbon is the first carbon attached to a functional group.

Oxidation and Reduction Reactions

Read the following sections in *Introduction to Organic Chemistry*:

- section 13.9 ("How are Aldehydes and Ketones Oxidized?")
- section 13.10 ("How are Aldehydes and Ketones Reduced?")

Complete all of the practice problems within these sections.

Review the following video:

preparation of alcohols using NaBH4:

Answer the following questions in your study notebook:

- What reaction makes a silver mirror?
- What happens when chromic acid reacts with hexanal?
- What does Tollens' reagent cause?
- What are common oxidizing agents?
- What are common reactants and catalysts during a catalytic reduction and a metal hydride reduction?
- What are some of the reagents used to oxidize aldehydes to carboxylic acids?

Look at section 8.2F in *Introduction to Organic Chemistry* for a review of the oxidation of primary and secondary alcohols to form aldehydes and ketones.

Note how alcohols can be oxidized to form aldehydes and ketones, and how aldehydes and ketones can be reduced to form alcohols.

Answer the following questions in your study notebook:

- What are the needed reactants and catalysts going in each direction?
- What is an important characteristic of using the pyridinium chlorochromate (PCC) reagent during the oxidation of an alcohol?

Summary of Aldehydes and Ketones Reactions

Review the following in *Introduction to Organic Chemistry*:

- the key reactions at the end of chapter 13

Add the key aldehydes and ketones reactions to your "Functional Groups" table.

Check Your Understanding of Chapter 13 Concepts

Complete the chapter 13 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the "Submit Answer" button to check your answer.

Organic Chemistry Laboratory Performance Task

Now that you have completed the readings and videos associated with the reactions that occur with alkenes, haloalkanes, aldehydes and ketones and the spectroscopy techniques of IR and NMR, you are ready to complete a performance task.

Review your notes and contact the course instructor if you have any questions as you work on the task.

Complete Summative Performance Assessment Task 3

Complete the following in **TaskStream**:

- Task 3

Before submitting, check that you have covered all the requirements in the rubric. If you need help, contact the course instructor.

Carboxylic Acids and Their Derivatives

The penicillin antibiotic is a derivative of carboxylic acid. It is thought to react with an enzyme necessary for the synthesis of the bacterial cell wall. Penicillin-resistant bacteria have become a serious problem. They produce penicillinase, which reacts with the penicillin, allowing the enzyme necessary for the syntheses of the bacterial cell wall to remain active.

Carboxylic Acids

Carboxylic acids are defined by the presence of the carboxyl functional group, which is a carbon atom double-bonded to an oxygen atom and single-bonded to an OH molecule. The general formula is RCOOH. Complete the activities within this topic to gain an understanding of the structure, nomenclature, physical properties, and key reactions of carboxylic acids and their derivatives.

This topic addresses the following competencies:

- Competency 208.1.13: Carboxylic Acids and Their Derivatives
  The graduate can draw chemical structures of carboxylic acids and their derivatives, name, solve problems involving carboxylic acids, and use tests to distinguish acids.

Carboxylic Acids Structure and Nomenclature

Read the following sections in *Introduction to Organic Chemistry*:

- section 14.1 ("What are Carboxylic Acids?")
- section 14.2 ("How are Carboxylic Acids Named?")

Complete all of the practice problems within these sections.

Review the following videos:

Carboxlic Acid Introduction: Carboxlic Acid Introduction

Carboxylic Acid Naming: Carboxylic Acid Naming

Add carboxylic acids to your "Functional Groups" table.

Answer the following questions in your study notebook:

- Which group has the priority when naming: carboxyl, hydroxyl, amino, or carbonyl?
- What do the hydroxyl, amino, and oxo prefixes mean?
- How is the longest root chain determined for a carboxylic acid?

Carboxylic Acids Physical Properties

Read the following section in *Introduction to Organic Chemistry*:

- section 14.3 ("What are the Physical Properties of Carboxylic Acids?")

Review the following table:

- table 14.2

Answer the following questions in your study notebook:

- How does the carboxyl group behave with water?
- What do hydrophilic and hydrophobic mean?
- Why is the boiling point of carboxylic acids higher than the boiling point for other organic compounds?
- How does the molecular weight of carboxylic acids affect their solubility?

Update your "Functional Groups" table to include the physical properties of carboxylic acids, including the type of odor that they produce in liquid form and their acidity.

Carboxylic Acids Reactions

Read the following sections in *Introduction to Organic Chemistry*:

- section 14.4 ("What are the Acid-Base Properties of Carboxylic Acids?")
- section 14.5 ("How are Carboxyl Groups Reduced?")
- section 14.6 ("What is Fischer Esterification?")
- section 14.7 ("What are Acid Chlorides?")

Complete all of the practice problems within these sections.

Review the following videos on Fischer esterificiation and Acid chlorides:

Fisher Esterification: Fisher Esterification of Carboxylic Acids

Acid Chloride Formation: Acetic Acid to Acetyl Chloride mechanism. Can be generalized to forming any acid halide from a carboxylic acid

Make sure you know the common acids listed in section 14.4 and their relative acidities.

Answer the following questions in your study notebook:

- What causes increased acid strength?
- What reactants reduce a carboxyl group to a primary alcohol?

Read the following section in *Introduction to Organic Chemistry*:

- section 14.8 ("What is Decarboxylation?")

Complete the practice problems in this section.

Answer the following questions in your study notebook:

- What is lost in a decarboxylation reaction (think about the name of the reaction)?
- If two carboxyl groups are present, which one will be lost?

Review the following in *Introduction to Organic Chemistry*:

- the key reactions at the end of chapter 14

Add the key carboxylic acid reactions to your "Functional Groups" table.

Carboxylic Acids Applications

Read the following in *Introduction to Organic Chemistry*:

- Chemical Connections 14A "From Willow Bark to Aspirin and Beyond" in section 14.5
- section 21.2 ("What are Soaps and Detergents?")

Answer the following question in your study notebook:

- Which parts of soap are hydrophobic, and which parts are hydrophilic?

Write a description of how soap cleans in language that a high school chemistry student would be able to understand.

Check Your Understanding of Chapter 14 Concepts

Complete the chapter 14 practice problems, as listed in the assignment section of WileyPLUS. From the multiple choice answers, choose your selection and then use the "Submit Answer"

button to check your answer.

Derivatives of Carboxylic Acids

Complete the activities within this topic to gain an understanding of the structure and nomenclature of derivatives of carboxylic acids. Pay particular attention to esters and acid anhydrides. Esters often have a sweet or fruity smell and are responsible for the odor of bananas and oranges.

This topic addresses the following competencies:

- Competency 208.1.13: Carboxylic Acids and Their Derivatives
  The graduate can draw chemical structures of carboxylic acids and their derivatives, name, solve problems involving carboxylic acids, and use tests to distinguish acids.

Derivatives of Carboxylic Acids Structure and Nomenclature

Read the following section in *Introduction to Organic Chemistry*:

- section 15.1 ("What are Some Derivatives of Carboxylic Acids, and How are They Named?")

Complete the practice problems in this section.

Watch the following video:

Amides, Anhydrides, Esters and Acyl Chlorides: Carboxylic Acid Derivatives - Amides, Anhydrides, Esters and Acyl Chlorides

Add esters to your "Functional Groups" table.

Answer the following questions in your study notebook:

- What is an ester?
- What is an acyl group?
- What is the naming convention for anhydrides?

Organic Chemistry Nomenclature Performance Task

Now that you have studied the various organic compounds throughout this course, you are ready to complete the nomenclature performance task.

Review your notes and contact the course instructor if you have any questions as you work on the task.

This topic addresses the following competencies:

- Competency 208.1.13: Carboxylic Acids and Their Derivatives
  The graduate can draw chemical structures of carboxylic acids and their derivatives,

name, solve problems involving carboxylic acids, and use tests to distinguish acids.

Performance Task

Complete the following in TaskStream:

- Organic Chemistry Task 2.

For details about this performance assessment, see the "Assessment" tab in this course.

Before submitting, check that you have covered all the requirements in the rubric. If you need help, contact the course instructor.

Nature of Organic Chemistry

Now that you have a thorough understanding of the concepts and mechanisms of organic chemistry, you need to prepare yourself to present these concepts to your students. In this subject, you will review the history of organic chemistry and careers available to organic chemists.

Nature of Organic Chemistry

Complete the activities within this topic to gain an understanding of the nature of organic chemistry. Think about what it means to be an organic chemist. Think about how organic chemistry and the study of organic chemistry compares to chemistry and science in general.

This topic addresses the following competencies:

- Competency 208.1.1: Introduction to Organic Chemistry
  The graduate constructs standards-based lessons on the history and nature of organic chemistry, demonstrates how organic chemistry relates to the world, and introduces students to careers in organic chemistry.

Jobs in Organic Chemistry

What does someone with a degree in organic chemistry do for a career?

Access the following website for general information about chemists in the marketplace:

- **U.S. Bureau of Labor Statistics website**

Access the **Careers Page at the American Chemical Society website**. Here you can learn about jobs in several areas of chemistry, such as organic chemistry, medicinal chemistry, colloid and surface chemistry, polymer chemistry, and agricultural chemistry.

You can also try searching the Internet for the term *organic chemistry jobs*.

Post a job description of your favorite job in the message board.

Evolution of Theories

Organic chemistry is a constantly evolving field. To learn about how a theory has evolved, look at the following websites:

- Organic Chemistry
- Timeline of Biology and Organic Chemistry

Designing Lessons for an Organic Chemistry course

Read the following chapters of *Science for All Americans*:

- **chapter 1 ("The Nature of Science")**
- **chapter 13 ("Effective Learning and Teaching")**

Answer the following questions:

- How can inquiry be used in classroom instruction?
- What are some effective learning and teaching strategies?

Use the following website to better understand the National Science Education Standards:

- **National Science Education Standards**

Watch this video on identifying NSTA standards within TaskStream:

Note: To download this video, right-click the following link and choose "Save as...": download video.

List some National Science Education Standards that can be covered within an organic chemistry lab.

Nature of Organic Chemistry Performance Task

You are now ready to complete the performance task.

Review your notes and contact the course instructor if you have any questions as you work on the task.

Complete Summative Performance Assessment Task 1

Complete the following in TaskStream:

- Task 1

You are required to describe the evolution of major theories in organic chemistry for this task. Some possible theories are:

- Bonding theories and resonance
- Isomers and Nomenclature

- A chosen functional group and the reactions that can occur
- Aromatics
- Machinery (IR and NMR) and how they changed compound recognition
- Reactants that have improved yield or cost of reactions (catalysts or other molecules, like the different molecules that cause a reduction reaction)

You are required to describe an activity in which students investigate a phenomenon in organic chemistry. There is a very wide range of organic molecules that can be used in this activity including:

- Vitamins
- Holistic medicines
- Toxins
- Perfumes or other odorous compounds
- Pheromones
- Hormones

You are required to describe an inquiry lab in which students investigate concepts in organic chemistry. An inquiry lab will allow students to come to a conclusion about the material instead of the teacher telling the students what to conclude about the lab. For example, instead of telling students that ? is the relationship between circumference and radius of a circle, students would measure the circumference and radius of several circles, graph the data, and determine the slope is ?! This lab was inquiry-based because the students were able to come to a conclusion by their own interpretation of the data. Possible labs in organic chemistry could be:

- How a specified physical property is related to length of carbon chain
- How a specified physical property is related to functional groups
- Determining compounds found in different pain killers (Tylenol, Advil, Excedrin, etc)
- Investigating physical properties (i.e. melting or boiling points, color, solubility, Rf value) for a set of known compounds and then using the data to determine an unknown

For details about this performance assessment, see the "Assessment" tab in this course.

Before submitting, check that you have covered all the requirements in the rubric. If you need help, contact the course instructor.

Final Steps

Congratulations on completing the activities in this course! This course has prepared you to complete the assessments associated with this course. If you have not already been directed to complete the assessments, schedule and complete your assessments now.

The WGU Library

The WGU Library is available online to WGU students 24 hours a day.

For more information about using the WGU Library, view the following videos on The WGU

Channel:

- WGU: Accessing the Library
- WGU Library: Finding Articles, Books, & E-Reserves

Center for Writing Excellence: The WGU Writing Center

If you need help with any part of the writing or revision process, contact the Center for Writing Excellence (CWE). Whatever your needs—writing anxiety, grammar, general college writing concerns, or even ESL language-related writing issues—the CWE is available to help you. The CWE offers personalized individual sessions and weekly group webinars. For an appointment, please e-mail writingcenter@wgu.edu.

Feedback

WGU values your input! If you have comments, concerns, or suggestions for improvement of this course, please submit your feedback using the following form:

- Course Feedback