Randolph Township Schools
Randolph High School

Organic and Analytical Chemistry I Honors

It's a wild dance floor there at the molecular level.
Roald Hoffmann

STEM Department
Anthony Emmons

Curriculum Committee:
Theresa Wertheimer
Andrew Piascik

Curriculum Developed:
August, 2018

Date of Board Approval:
February 19, 2019

Randolph Township Schools
STEM Department
Organic and Analytical Chemistry I

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Randolph Township Schools

Mission Statement

We commit to inspiring and empowering all students in Randolph schools to reach their full potential as unique, responsible and educated members of a global society.

Randolph Township Schools
Affirmative Action Statement

Equality and Equity in Curriculum

The Randolph Township School district ensures that the district's curriculum and instruction are aligned to the state's standards. The curriculum provides equity in instruction, educational programs and provides all students the opportunity to interact positively with others regardless of race, creed, color, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, religion, disability or socioeconomic status.

N.J.A.C. 6A:7-1.7(b): Section 504, Rehabilitation Act of 1973; N.J.S.A. 10:5; Title IX, Education Amendments of 1972

RANDOLPH TOWNSHIP BOARD OF EDUCATION
EDUCATIONAL GOALS
VALUES IN EDUCATION

The statements represent the beliefs and values regarding our educational system. Education is the key to self-actualization, which is realized through achievement and self-respect. We believe our entire system must not only represent these values, but also demonstrate them in all that we do as a school system.

We believe:

- The needs of the child come first
- Mutual respect and trust are the cornerstones of a learning community
- The learning community consists of students, educators, parents, administrators, educational support personnel, the community and Board of Education members
- A successful learning community communicates honestly and openly in a non-threatening environment
- Members of our learning community have different needs at different times. There is openness to the challenge of meeting those needs in professional and supportive ways
- Assessment of professionals (i.e., educators, administrators and educational support personnel) is a dynamic process that requires review and revision based on evolving research, practices and experiences
- Development of desired capabilities comes in stages and is achieved through hard work, reflection and ongoing growth

Randolph Township Schools
STEM Department
Organic and Analytical Chemistry I

Course Introduction

This is a semester elective course designed for high school students interested in studying chemistry beyond the first year requirement. Organic Chemistry studies carbon and the resulting function of natural and man-made carbon based products. Analytical Chemistry studies the separation, identification, and quantification of both natural and man-made products. In order for students to develop an understanding of structure/function relationships, these disciplines of Chemistry are taught simultaneously. Interdisciplinary connections are also made so that students begin to appreciate the many facets of our world on a molecular level.

The Organic and Analytical Chemistry I curriculum has been rewritten to incorporate the newly adopted New Jersey Student Learning Standards for Science, also known as the Next Generation Science Standards. Within these standards there is a much higher placement of inquiry-based learning which is the method where we as educators supply the students with educational tools but allow them to build their own design. This approach cultivates something that is core to mathematical and scientific thinking which is the application and analysis of data to observed phenomena.

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
Curriculum Pacing Chart

SUGGESTED TIME ALLOTMENT	UNIT NUMBER	CONTENT - UNIT OF STUDY
3 weeks	I	Organic Structure and Bonding
1.5 weeks	II	Resonance and Electron Pushing
1.5 weeks	III	Acid Base Chemistry
3 weeks	IV	Organic Nomenclature
4 weeks	V	Stereochemistry- Molecular Handedness
4 weeks	VI	Reactions of Alkenes
1weeks	VII	E1 Mechanism

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
UNIT I: Organic Structure and Bonding

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="6">HS-PS1-1:
Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-7:
Use mathematical representation to support the claim that atoms, and therefore mass, is conserved during a chemical reaction.

HS-PS2-6:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

.</td><td>Chemical and physical properties of materials can be explained by the structure and arrangement of atoms, ions, or molecules and the forces between them.</td><td>• How does structure affect the behavior and properties of organic molecules?</td></tr>
<tr><td>Molecules with the same molecular formula may have different structures and exhibit different properties.</td><td>• How do we recognize and predict structural isomerism?</td></tr>
<tr><td>The reactivity of molecules is determined by the electron distribution with polarity/electronegativity being major factors.</td><td>• How does bond polarity affect the reactivity of the different functional groups?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:

Valence Shell Electron Pair Repulsion theory describes the repulsion of electron pairs through columbic forces.

According to Molecular Orbital Theory, orbitals can hybridize and form different overlaps of electron regions, resulting in sigma and pi bonds.

Isomers are molecules with the same chemical composition but differ in arrangement or shape. These can include structural, geometric and constitutional isomers.</td><td>Students will be able to:

Draw Lewis structures and predict the shapes of molecules.

Determine hybridization of an element within a given molecule.

Recognize and predict the existence of structural isomerism.</td></tr>
</table>

	Shapes and bond angles of molecules can be determined based on electron arrangements and the elements involved in bonding. Shapes and electron arrangements determine the chemical and physical properties of a molecule. Structural isomerism includes chain, positional and functional group isomerism. Theoretical knowledge can be applied to practical in the laboratory. Formal charge is important to describe molecules and intermediates. Resonance is the determining factor for the stability of aromatic compounds. **KEY TERMS:** electron configuration, polar covalent bond, resonance, formal charge, Lewis structure, hybridization, Valence Shell Electron Pair Repulsion Theory	Determine the geometry of a given molecule and determine bond angles of the bonded groups. Predict the general, physical properties of molecules based on their shapes. Create and use representations and models to analyze natural phenomena to solve problems. Describe and draw examples of structural isomerism. Explain how basic laboratory equipment can be used in organic chemical applications. Calculate formal charge on all atoms in a molecule. Draw all possible resonance structures of a compound.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Gathering information and citing evidence to support claim during guided inquiry exercises.
- Reflecting on laboratory data and experimental design.
- Conducting partner reviews and completing self-assessments.

KEY LEARNING EVENTS AND INSTRUCTION:

- Models of Organic Compounds Lab: Guided inquiry assignment associated with bonding, building molecular models and isomerism.
- Melting Point Determination: Become familiar with procedures to measure melting points and to understand the value of using melting point as a tool for characterizing organic compounds.

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
UNIT I: Organic Structure and Bonding

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
3 Weeks	**Unit I** - Organic Structure and Bonding • Covalent Bonds • Polar vs. Non-Polar Bonds • Molecular Polarity • Formal Charge • Isomers and Isomerism	Essential Organic Chemistry Paula Yurkanis Bruice (Pages 3-37) Organic Chemistry as a Second Language, 4th Edition David R. Klein Foundations of Organic Chemistry Ron B Davis Jr. AP Free Response questions 2005 question 6 Vial Organic I and II Lab Manual Lab: Models of Organic Compounds Lab: Melting Point Determination

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
UNIT II: Resonance and Electron Pushing

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="5">HS-PS1-2:
Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-4:
Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total energy.

HS-PS2-6:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.</td><td>Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.</td><td>• What is the role of carbon in the molecular diversity of life?</td></tr>
<tr><td>Several mechanisms may be postulated for most reactions, and experimentally determining the dominant pathway of such reactions is a central activity of chemistry.</td><td>• How is organic chemistry used and applied in the larger world?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:

The localized electron bonding model describes and predicts molecular geometry using Lewis diagrams and the VSEPR model.

Classes of chemical reactions include synthesis, decomposition, acid-base and oxidation reactions.

In cases where more than one equivalent Lewis structure can be constructed, resonance must be included to provide refinement to the molecular structure.

KEY TERMS: lone pair, resonance, pi bond, sigma bond resonance hybrid, curved arrow formalism, dipole moment</td><td>Students will be able to:

Draw Lewis structures and justify the best structure using formal charge.

Write an acid base reaction and track the role of the proton in the reaction.

Draw resonance structures of organic molecules when needed.</td></tr>
</table>

ASSESSMENT EVIDENCE: Students will show their learning by:

- Gathering information and citing evidence to support claim during guided inquiry exercises.
- Reflecting on laboratory data and experimental design.
- Conducting partner reviews and completing self-assessments.

KEY LEARNING EVENTS AND INSTRUCTION:

- Sample Resonance Problems: Complete sample resonance problems to practice moving electrons within a molecule.
- Resonance Structures and Hybridization: View the screencast by Khan Academy and self-assess by completing the closure quiz. https://www.khanacademy.org/science/organic-chemistry/organic-structures/formal-charge-resonance/v/resonance-localized-delocalized

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
Unit II: Resonance and Electron Pushing

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
1.5 Weeks	**Unit II** – Resonance and Electron Pushing • Lewis Diagrams • Electron Pushing • VSEPR Model • Classes of Chemical Reactions • Resonance	Essential Organic Chemistry Paula Yurkanis Bruice (Pages 73-111) Organic Chemistry as a Second Language, 4th Edition David R. Klein Foundations of Organic Chemistry Ron B Davis Jr. Vial Organic I and II Lab Manual Lab: Sample resonance problems Lab: Resonance Structures and hybridization Simulations for electron pushing Khan Academy Resonance Tutorial

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
UNIT III: Acid Base Chemistry

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="6">HS-PS1-2:
Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-5:
Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-6:
Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.</td><td>The Arrhenius definition of acids and bases states that in an aqueous solution, an acid produces hydrogen ions and a base produces hydroxide ions.</td><td>• Weak acids and bases are often used to initiate reactions by protonating and deprotonating just a small fraction of a starting material at equilibrium. Often, this can lead to a complete conversion to products. How is this possible?</td></tr>
<tr><td>In a solution, a strong acid completely ionizes in water, but a weak acid only partially ionizes.</td><td>• Why is the strength of an acid determined by the stability of its conjugate base?</td></tr>
<tr><td>The extent of dissociation of a weak acid is quantified by the acid dissociation constant, Ka, which is the equilibrium constant for the ionization of the weak acid.</td><td>• Does any given acid or base have only one associated pKa value, or can conditions like temperature and solvent influence the acidity or basicity of a compound?</td></tr>
<tr><td>Because Ka values can be extremely large or small, we often report these vales as pKa, or the negative log of the Ka value.</td><td>• The pH scale is theoretically infinite. Why is it that we often see a scale of 0 to 14 used when discussing aqueous solutions?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:

The proton-transfer reaction is an equilibrium- a state of dynamic interconversion between or among products and reactants. The extent to which this</td><td>Students will be able to:

Explain the relationship between the strengths of acids and bases and the values of their ionizations constants.</td></tr>
</table>

	equilibrium lies in favor of products or reactants is dependent on the strength of the acids in the reaction. The ion product constant for water, Kw, equals the product of the hydrogen ion concentration and the hydroxide ion concentration. **KEY TERMS:** acids and bases, conjugate acid base pairs, hydrophilic, hydrophobic, pH, van der Waals forces, Lewis acid, Lewis base	Compare the strength of a weak acid with the strength of its conjugate base. Relate pH and pOH to the ion product constant for water.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Gathering information and citing evidence to support claim during guided inquiry exercises.
- Reflecting on laboratory data and experimental design.
- Conducting partner reviews and completing self-assessments.

KEY LEARNING EVENTS AND INSTRUCTION:

- Determining the Ka of a weak acid: use inquiry skills to determine the Ka of several unknown weak acids.
- Titration of Benzoic Acid: use inquiry skills to investigate the fundamental technique of chemistry called titration.

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
Unit III: Acid Base Chemistry

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
1.5 Weeks	**Unit III –** Acid Base Chemistry • Acids and Bases • The Acid Dissociation Constant, Ka. • Proton-Transfer Reaction • The Ion Product Constant for Water, Kw	Essential Organic Chemistry Paula Yurkanis Bruice (Pages 40-63) Organic Chemistry as a Second Language, 4th Edition David R. Klein Foundations of Organic Chemistry Ron B Davis Jr. Vial Organic I and II Lab Manual Lab: Determine the Ka of a weak acid Lab: Titration of Benzoic Acid Acid base animations from the University of Arizona

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
UNIT IV: Organic Nomenclature

<table>
<tr><td rowspan="8">STANDARDS / GOALS:

HS-PS1-3:
Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS2-6:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td>The rules of systematic IUPAC nomenclature enable us to name a compound given a structure, and conversely, draw a structure given the systematic name.</td><td>• How does the IUPAC system of nomenclature allow us to determine the structure of a molecule?</td></tr>
<tr><td>The reactivity of molecules is determined by the electron distribution with polarity/electronegativity being major factors.</td><td>• Why is a consistent system of nomenclature important in organic chemistry?</td></tr>
<tr><td>The structures of organic molecules can be understood as deriving from simple hydrocarbons.</td><td>• Why does bond polarity affect the reactivity of the different functional groups?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:

Carbon is unique in forming multiple bonds with other carbon atoms and other elements. This bond forming ability is the reason for the enormous diversity of organic molecules.

The IUPAC system predicts the type of organic compound, given either the name or the structure.</td><td>Students will be able to:

Sketch a line bond drawing of a given molecule.

Given the IUPAC name, draw the structure of the molecule.

Given the structure, give the formal IUPAC name for a compound.

Recognize the common names of typical organic molecules.</td></tr>
</table>

	KEY TERMS: Alkanes, Alkenes, Alkynes, Cycloalkanes, IUPAC Nomenclature, Geometric Isomerism	

ASSESSMENT EVIDENCE: Students will show their learning by:

- Gathering information and citing evidence to support claims during guided inquiry exercises.
- Reflecting on laboratory data and experimental design.
- Conducting partner reviews and completing self-assessments.

KEY LEARNING EVENTS AND INSTRUCTION:

- Naming Organic Compounds: investigate the IUPAC system of organic nomenclature that is used worldwide.
- Organic Nomenclature: Complete a virtual assignment to practice using the IUPAC naming rules. http://www.chembio.uoguelph.ca/educmat/chm19104/nomenclature/quizes.html

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
Unit IV: Organic Nomenclature

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
3 Weeks	**Unit IV** – Organic Nomenclature • Carbon Bonds • IUPAC Nomenclature of Alkanes • Cycloalkane Nomenclature • Conformations of Cycloalkanes	Essential Organic Chemistry Paula Yurkanis Bruice (Pages 220-224) Organic Chemistry as a Second Language, 4th Edition David R. Klein Foundations of Organic Chemistry Ron B Davis Jr. Vial Organic I and II Lab Manual Lab: Naming Organic Compounds Lab: Organic Nomenclature

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
UNIT V: Stereochemistry – Molecular Handedness

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="6">HS-PS1-2:
Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-3:
Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

.</td><td>Stereoisomerism is responsible for significant differences in biological activity.</td><td>• How does the three dimensional arrangement of atoms in a molecule determine its stereochemistry?</td></tr>
<tr><td>Biology is affected by the natural predominance of certain stereoisomers and, therefore, nature is chiral.</td><td>• How does stereochemistry affect the biological activity of molecules such as carbohydrates, amino acids and nucleic acids?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:

The concept of chirality and stereo genic centers.

The difference between configuration and conformations.

The Kahn-Ingold-Prelog (R/S) convention and absolute configuration.

Stereoisomers have the same connectivity between atoms but different spatial arrangement.</td><td>Students will be able to:

Given a chiral molecule, determine the stereo genic center.

Distinguish between enantiomers and diastereomers.

Assign R and S configurations to stereoisomers and draw compounds with these configurations.

Comprehend that interconversion of configurational isomers requires breaking and remaking covalent bonds.</td></tr>
</table>

	Conformational isomers can be interconverted by simple rotation around single bonds. Stereoisomerism results from the tetrahedral geometry of the sp^3 hybridized carbon atom. Stereoisomerism is responsible for significant differences in chemical reactivity and biological activity. Nature is profoundly chiral. Particular stereoisomers predominate naturally in certain classes of biomolecules (carbohydrates and amino acids and nucleic acids). The chemistry of life is affected by the natural predominance of particular stereoisomers in biological molecules. The interaction of small drug molecules and proteins (enzymes) is often deeply rooted in chiral recognition. **KEY TERMS:** Absolute configuration, achiral, asymmetric carbon, Cahn-Ingold-Prelog convention, optical purity, racemic mixture, cis-trans isomers, superimposable	Categorize optical activity. Identify the properties of enantiomers. Determine the effectiveness and side effects of a drug based on the stereoisomers used. Describe plane-polarized light, a polarimeter, and specific rotation. Define enantiomers and racemic mixtures and recognize compounds capable of exhibiting these structures. Discuss the terms used to describe optical isomers. Draw pairs of enantiomers with one chiral carbon, using wedges/dashes and Fisher projections. Draw both the R and S enantiomer of Thalidomide and report on the difference in biological activity.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Gathering information and citing evidence to support claim during guided inquiry exercises.
- Reflecting on laboratory data and experimental design.
- Conducting partner reviews and completing self assessments

KEY LEARNING EVENTS AND INSTRUCTION:

- NBC Learn Carvone: Draw the two enantiomers and compare physical properties of each. https://www.nbclearn.com/portal/site/learn/freeresources/chemistry-now/cuecard/51988
- Drug Study: compare and contrast enantiomers in biological systems.

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
Unit V: Stereochemistry – Molecular Handedness

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
4 Weeks	**Unit V-** Stereochemistry – Molecular Handedness • Chirality • Kahn-Ingold-Prelog (R/S) Convention • Stereochemistry and Stereoisomers • Classes of Biomolecules • Chemistry of Life	Essential Organic Chemistry Paula Yurkanis Bruice (Pages 116-144) Organic Chemistry as a Second Language, 4th Edition David R. Klein Foundations of Organic Chemistry Ron B Davis Jr. Vial Organic I and II Lab Manual NBC Learn- Carvone Video and Worksheet New York Times – Thalidomide Research Project

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
UNIT VI: Reactions of Alkenes

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="5">HS-PS1-2:
Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-4:
Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy.</td><td>Though drawn in rigid, static form, molecules are constantly bending, twisting, and vibrating.</td><td>• In what ways can using rigid models to predict the behavior of dynamic molecules be problematic?</td></tr>
<tr><td>The type of bond between carbon atoms determines the reactivity of the hydrocarbon.</td><td>• How do alkenes and alkynes compare in terms of free energy to alkanes of similar size?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:

The presence of weaker and therefore more reactive pi bonds gives alkenes and alkynes the classification of ‘functional group’ when it comes to nomenclature.

The functional group(s) determines the chemical and physical properties of an organic molecule.

Reactions happen in a repeatable and predictable pattern based on inter and intra-molecular forces.

Markovnikov’s rule for predicting orientation of addition of unsymmetrical reagents to asymmetrical alkenes.</td><td>Students will be able to:

Describe the molecular orbitals, hybridization, and geometry of the carbon-carbon double and triple bonds.

Devise basic synthesis for different alkene molecules and discuss the advantages or disadvantages of the proposed synthetic reactions.

Predict the major product(s) of a reaction, given the reagents and reaction conditions.

Predict the products of the addition of hydrogen halides and water to asymmetrical alkenes.</td></tr>
</table>

	Alkanes, alkenes, and alkynes differ in terms of reactivity and bond type. **KEY TERMS:** elimination, nucleophile, electrophile, alkene, alkane, cycloalkane, bridge carbon	Identify sigma, pi, double, and triple bonds. Differentiate between alkanes, alkenes, and alkynes. Analyze bond types in a given organic compound.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Gathering information and citing evidence to support claims during guided inquiry exercises.
- Reflecting on laboratory data and experimental design.
- Conducting partner reviews and completing self-assessments.

KEY LEARNING EVENTS AND INSTRUCTION:

- Synthesis challenge: Synthesize target molecules on pare using a list of reaction types and reagents.
- Molecule of the Week: Investigate an organic molecule of choice, find a recent article concerning the molecule and share information regarding its structure, synthesis, history and purpose with the class.

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
Unit VI: Reactions of Alkenes

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
4 Weeks	**Unit VI** - Reactions of Alkenes • Functional Groups • Reactions and Reagents • Inter- and Intra-Molecular Forces • Markovnikov's Rule	Essential Organic Chemistry Paula Yurkanis Bruice (Pages 182-210) Organic Chemistry as a Second Language, 4th Edition David R. Klein Foundations of Organic Chemistry Ron B Davis Jr. Vial Organic I and II Lab Manual Kahn Academy – Markovnikov's Rule

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
UNIT VII: E1 Mechanism

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="5">HS-PS1-7:
Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS1-4:
Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy.</td><td>A number of mechanisms may be postulated for most reactions, and determining the dominant pathway of such reactions is a central activity of chemistry.</td><td>• Why is it that the first bond between atoms is always a sigma bond, while the second and third bonds are always pi bonds?</td></tr>
<tr><td>Many reactions proceed through a series of elementary steps referred to as the reaction mechanism.</td><td>• If chemical bonding lowers the enthalpy of a system, what induces chemical bonds to break when reactions are taking place?</td></tr>
<tr><td>Catalysts function by lowering the activation energy of an elementary step in a reaction mechanism and by providing a new and faster mechanism.</td><td>• What is the role a catalyst plays in increasing the reaction rate?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:

Tertiary carbocations are the most stable form.

The reaction mechanism, electrophilic addition, involves two basic steps. First, the electrophile attacks the pi bond of a double bond, extracts the pi electrons, and uses them to form a bond to one carbon: a carbocation results. In the</td><td>Students will be able to:

Identify examples of a primary, secondary and tertiary carbocations.

Determine the relative stabilities of carbocations.

Write general and specific examples illustrating the mechanism of electrophilic addition of hydrogen halides, halogens, and water to alkenes.</td></tr>
</table>

	second step, the carbocation is neutralized by the nucleophilic species of the adding reagent. In an E1 reaction, the rate determining step is the loss of the leaving group to form the intermediate carbocation. **KEY TERMS:** rate law, E1 Mechanism, synthesis, carbocation, cyclohexanol, alcohol, nomenclature, stability	Identify catalysts involved in electrophilic addition. Analyze the role catalysts play in electrophilic addition. Know the rate law. Interpret the rate law and its implications for E1 reactions. Calculate the rate for a given E1 reaction.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Gathering information and citing evidence to support claims during guided inquiry exercises.
- Reflecting on laboratory data and experimental design.
- Conducting partner reviews and completing self-assessments.

KEY LEARNING EVENTS AND INSTRUCTION:

- Formation of an alkene: convert cyclohexanol to cyclohexene and investigate the E1 mechanism that describes the reaction.
- Master Organic Chemistry: Complete the interactive activity and develop test-like problems regarding the E1 mechanism. https://www.masterorganicchemistry.com/2012/09/19/the-e1-reaction/

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I
Unit VII: E1 Mechanism

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
1 Week	**Unit VII-** E1 Mechanism • Types of Carobocations • Electrophilic Addition • E1 Mechanism	Essential Organic Chemistry Paula Yurkanis Bruice (Pages 283-289) Organic Chemistry as a Second Language, 4th Edition David R. Klein Foundations of Organic Chemistry Ron B Davis Jr. Vial Organic I and II Lab Manual Lab: Formation of an alkene Kahn-Academy- E1 mechanism

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I

APPENDIX A

RESOURCES:

Textbook:

Essential Organic Chemistry
Authors: Paula Yurkkanis Bruice
ISBN-13 978-321-93771-1
Copyright 2016 Pearson Education, Inc.

Technology:

- Software capable of gathering data such as Logger Pro
- Spreadsheet software such as Excel
- Word processor software such as Word
- Presentation software such as PowerPoint

Web Addresses:

- **http://www.organic-chemistry.org/namedreactions/**
- **http://www2.chemistry.msu.edu:80/faculty/reusch/VirtTxtJml/nomen1.htm**
- **http://www.ncbi.nlm.nih.gov/pubmed**
- **http://www.chemhelper.com/**
- **http://www.khanacademy.org/**
- **http://www.mhhe.com/physsci/chemistry/atkins**
- **http://epa.gov**
- **http://chemistry.boisestate.edu/people/richardbanks/organic/organicchem.html**
- **http://cdc.gov**
- **http://epa.gov/sustainability/basicinfo.htm**
- **http://epa.gov/climatechange**

Software Names:

- Vernier Probes and Logger Pro
- E-Chem

APPENDIX B

Opportunities exist for interdisciplinary units with courses such as Animal Behavior, Marine Biology and other science electives.

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Organic and Analytical Chemistry I

APPENDIX C

It is assumed that the student has successfully completed Honors Chemistry or received an A average in Chemistry A.