Unit 5: Alkynes Properties and Reactions

Content Area:	**Science**
Course(s):	
Time Period:	**Marking Period 2**
Length:	**3 Weeks**
Status:	**Published**

Brief Summary of Unit

After alkanes and alkenes are the last of the simple hydrocarbons: alkynes. The nomenclature and chemistry of these molecules will be covered. The naming is similar to that of the alkenes and the reactions have plenty of similarities; however, in some cases it is almost like performing an alkene reaction twice. In the prior unit, the groundwork for designing multistep synthesis was introduced and students will have the opportunity to start on their own.

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Standards

LA.W.11-12.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
LA.W.11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
LA.W.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (MLA or APA Style Manuals).
LA.W.11-12.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
LA.RI.11-12.7	Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
MA.A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.
MA.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
MA.A-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

SCI.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.
SCI.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 bond energy.
SCI.HS-PS3-5	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
SCI.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.
SCI.HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
SCI.HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
SCI.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.
SCI.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.
WRK.K-12.P.3	Consider the environmental, social and economic impacts of decisions.
WRK.K-12.P.4	Demonstrate creativity and innovation.
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
TECH.K-12.1.1.c	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
TECH.K-12.1.3.b	evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.
TECH.K-12.1.6.a	choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.

Essential Questions

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How does the addition of another pi bond affect the reactivity and reaction mechanisms of the alkynes?

How do alkynes compare with alkenes in terms of structure and other physical properties?

Enduring Understandings

A change in structure, no matter how “small”, can have a significant effect on the properties of the molecule.

Organic reactions involving similar structures (alkene v alkyne) tend to proceed along similar pathways and this realization reduces the need for memorization.

Retrosynthesis can be used to develop a pathway from product to reactant(s) for any organic reaction.

Objectives

Students will know that nomenclature of alkynes is analogous to that of alkanes and alkenes.

Students will know how the structure around the triple bond affects the molecule's physical properties.

Students will be skilled at identifying alkyne reactions with alkyl halides that produce mono- and di-halide products.

Students will know the acid-catalyzed hydration as well as hydroboration-oxidation of an alkyne follows the same mechanism of that of an alkene.

Students will be skilled at interconverting the hydration product (enol) into a ketone (tautomerization).

Students will know terminal alkynes are more stable than internal alkynes and may require special reaction conditions.

Students will be skilled at modeling the mercuric-ion catalyzed hydration of terminal alkynes.

Students will know that terminal enols (produced via mercuric-ion or hydroboration-oxidation mechanisms) interconvert to aldehydes.

Students will know radicals and halogen pathways are similar to that of alkenes.

Students will know hydrogenation of an alkyne produces an alkane unless a special catalyst is used.

Students will be skilled at identifying the mechanism required to produce a specific alkene from hydrogenation of an alkyne.

Students will know how the hybridization of a carbon affects the electronegativity and therefore acidity of the molecule.

Students will know that time, cost, and yield are important factors when designing a synthesis.

Students will know that alkylation reactions can increase the length of carbon chains in a synthesis.

Students will be skilled at developing retrosynthetic analysis to determine how a molecule was created from given starting materials.

Learning Plan

Preview essential questions and connect them to the concepts we will cover in the unit.

Compare the naming system of the alkynes to that of alkanes and alkenes.

Model the structure of alkynes and how the physical properties compare to alkanes and alkenes.

Complete the Alkyne Nomenclature and Models Activity [can be combined with the Alkyne Structure and Properties Activity].

Preview how alkynes react and the formation of ions that cannot be created with an alkene.

Present the mechanism for the addition of hydrogen halides and halogens to alkynes.

Differentiate the addition of water to an alkyne to that of an alkene [including enol-keto tautomerization].

Model hydroboration-oxidation and how it differs from the acid/mercuric-ion catalyzed versions.

Demonstrate the range of similarities between alkene and alkyne reactions with the Alkene v Alkyne Reactions activity.

Discuss the hydrogenation of alkynes and how different catalysts can affect the result (also contrast with alkenes).

Investigate the Reaction of Ethyne with Chlorine. (http://www.nuffieldfoundation.org/practical-chemistry/reaction-ethyne-chlorine; can be a ‘paper’ lab and include experimental differences between this and the halogenation of an alkane experiment.)

Present alkylation reactions as the introduction to designing synthesis.

Model the design of a simple, multi-step synthesis including retrosynthetic analysis.

Assessment

Formative Assessment

Completion of practice problems assigned by teacher (textbook or otherwise).

Develop appropriate alkyne names using IUPAC nomenclature.

Determine the structure of an alkyne given its name.

Determine the outcome of basic alkyne reactions.

Identify reaction type when given a mechanism.

Predict the results of the Ethyne and Chlorine experiment.

Correctly develop a mechanism through retrosynthetic analysis (given product and reactant(s)).

Benchmark Assessment

Correctly build structures from names and names from structures (modeling activity).

Write detailed mechanisms of all reaction types.

Midterm Exam

Alternative Assessment

Design a mechanism (only given product) with presentation (poster/PP/etc.) detailing each step.

Experimental report on Ethyne and Chlorine (teacher discretion).

Summative Assessment

Unit Quizzes

Unit Test

Materials

Guided notes or teacher handouts

Organic Chemistry (Bruice, 2007) – electronic textbook

Activity/Lab Handouts (Includes materials specific to each activity: Ethyne and Chlorine [http://www.nuffieldfoundation.org/practical-chemistry/reaction-ethyne-chlorine])

Molecular Modeling Kits (teacher provided)

Molecular Modeling Websites (an example: https:\\molview.org)

Safety Supplies (specifics to when they are required included in lab handouts)

Integrated Accommodations and Modifications Spec Ed., ELL, At-Risk, G&T, Career Education, 504s

https://docs.google.com/spreadsheets/d/1WPR9w7-UpEeDhl7-1U_EjbNwTuqMkUj8KIJdNwAS0Es/edit?usp=sharing