Unit 2: Reactions of Alkanes and Radicals

Content Area: **Science**
Course(s):
Time Period: **Marking Period 1**
Length: **3 Weeks**
Status: **Published**

Brief Summary of Unit

Although alkanes are the simplest organic molecules, they do not undergo simple chemical reactions due in part to their stability. It is possible, with extreme conditions, to get these compounds to react and typically it is quite literally, and figuratively, radical. This extreme reaction can then be linked to one of the greatest environmental disasters in modern human history and its effects on the environment and climate change.

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Standards

P.3	Consider the environmental, social and economic impacts of decisions.
MA.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
P.4	Demonstrate creativity and innovation.
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.
P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
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.
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.
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.
TECH.K-12.1.3.b	evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.
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.
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.

MA.A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.
TECH.K-12.1.6.a	choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
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.11-12.8	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.
HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are 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.
HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

Essential Questions / Enduring Understandings

Essential Questions

What conditions are required for stable alkanes to undergo chemical reactions?

What factors affect product formation in alkane reactions?

Enduring Understandings

Product formation in organic reactions is linked to the stability of intermediate(s) formed during a reaction process.

Reactions are more likely to occur in a compound with weak bonds or in an area with a significant charge compared to the rest of the molecule.

Objectives

Students will know the initiation, propagation, and termination steps for a radical reaction of an alkane.

Students will know the factors that determine production distribution in chlorination and bromination.

Students will be skilled at using the reactivity-selectivity principle (RSP) to predict product formation.

Students will know the limitations of the RSP for reactions beyond the alkanes.

Students will be skilled at identifying the hydrogen which, when removed, results in the most stable alkyl

radical.

Students will know the different between primary, secondary, and tertiary radicals.

Students will know that more reactive species are less selective about where they bond to an alkane.

Students will know that resonance can contribute to the stability of a radical.

Students will know how radical reactions play a role in biological or natural processes (i.e. ozone depletion & climate change).

Students will know that organic reactions can produce compounds with the same formula but different structure (enantiomers/diastereomers).

Learning Plan

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

Model the stability of the alkanes and why it makes alkanes less reactive than other organic molecules.

Introduce halogenation reactions of alkanes (chlorination and bromination) and investigate why similar reactions do not take place with fluorine and iodine.

Demonstrate the "curved arrow" notation that is used to explain organic mechanisms.

Calculate product formation using the reactivity-selectivity principle (RSP) with the understanding that it is essentially limited to this use.

Extend the RSP to model how delocalized electrons can affect product formation.

Model stereochemistry of simple alkanes and how formulas can be identical while the structure is not.

Conduct the "Simple and Safe Halogenation" Experiment (https://www.researchgate.net/publication/231264748_A_Safe_Simple_Halogenation_Experiment; can be a 'paper' lab)

Research the depletion of ozone and why a chlorine-based compound was so effective at destroying it.

Unit Quizzes (at teacher discretion)

Unit Test

Assessment

Formative Assessment

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

Apply curved-arrow notation in the development of organic mechanisms for chlorination and fluorination.

Predict major product of chlorination and bromination reactions.

Determine results of reactions when delocalized electrons are part of the structure of the reactant or intermediate.

Report writing for the “Simple and Safe Halogenation” experiment.

Benchmark Assessment

Calculate product distribution for chlorination and bromination reactions.

Compare and contrast (or identify) stereoisomers.

MidTerm Exam

Alternative Assessment

Propose a mechanism for the depletion of ozone and compare the proposal with literature on the subject.

Summative Assessment

Unit Quizzes

Unit Tests

Materials

Guided notes or teacher handouts

Organic Chemistry (Bruice, 2007) – electronic textbook

Activity/Lab Handouts (Includes materials specific to each activity: Simple and Safe Halogenation [https://www.researchgate.net/publication/231264748_A_Safe_Simple_Halogenation_Experiment])

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