04 Methods of Identification & Analysis

Content Area: **Science**
Course(s): **Organic Chemistry H**
Time Period: **Semester 1**
Length: **3 weeks**
Status: **Published**

Standards

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.
PS1.A	Structure and Properties of Matter
PS2.B	Types of Interactions
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.
PS1.B	Chemical Reactions
	Patterns
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.
	Planning and Carrying Out Investigations
	Stability and Change
HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
	Structure and Function
	Developing and Using Models
	Constructing Explanations and Designing Solutions
	Energy and Matter
	Scale, Proportion, and Quantity

Enduring Understandings

1. Determining the structure of compounds is central to the science of organic chemistry.
2. Understanding the structure and bonding of organic molecules is fundamental to being able to understand their properties and reactions.
3. Organic molecules can be categorized by the presence of functional groups.
4. Spectroscopy is an instrumental method for determining the structure of organic compounds by measuring and interpreting their interaction with electromagnetic radiation.
5. Spectroscopy is possible because molecules absorb certain wavelengths of energy based on their structural features.
6. Organic chemists employ a variety of laboratory techniques to separate desired products and determine their purity.

Essential Questions

1. What is spectroscopy and how is it used to determine the structure of organic compounds?
2. How does structure influence function?
3. How do spectroscopic techniques differ from chemical methods of analysis?
4. What are common laboratory techniques organic chemists employ?

Knowledge and Skills

Knowledge: Students will...

1. Know what spectroscopy is and understand the types of spectroscopy that are useful in the determination of organic structures.
2. Be familiar with the electromagnetic spectrum and have a sense of the relative energies of different types of electromagnetic energy.
3. Understand that molecules are very selective with respect to the frequency of electromagnetic radiation (energy) they absorb; the energy absorbed must equal the difference in energy (DE) between two quantized energy states of a molecule (vibrational states for IR, electronic states for UV, and spin states for NMR).
4. Understand that the absorption of e.m. radiation by a molecule may be measured by a spectrometer, and that the relationship between frequency and absorption is plotted as a spectrum (appears as a series of "peaks" at characteristic frequencies).
5. Understand that mass spectrometry (MS) measures what happens to a molecule when it is bombarded with a beam of high energy electrons… a molecular ion (an unstable radical cation species) is produced which fragments; positively charged fragments are deflected through a magnetic field, separated according to mass/charge and detected as a mass spectrum (m/z vs. relative abundance).
6. Understand that nuclear magnetic resonance (NMR) spectroscopy is a method for structure determination that is based on the effect of the molecular environment on the energy required to promote a given nucleus from a lower energy spin state to a higher energy spin state.

Skills: Students will be able to...

1. Identify (by wavelength, wavenumber, or both) the region of the electromagnetic spectrum which is used in infrared (IR) spectroscopy.
2. Interconvert between wavelength and wavenumber.
3. Discuss, in general terms, the effect that the absorption of infrared radiation can have on a molecule.

4. Describe how the “fingerprint region” of an infrared spectrum can assist in the identification of an unknown compound.
5. Identify the functional group or groups present in a compound, given a list of the most prominent absorptions in the infrared spectrum and a table of characteristic absorption frequencies.
6. Describe, briefly, how a mass spectrometer works.
7. Sketch a simple diagram to show the essential features of a mass spectrometer.
8. Identity peaks in simple mass spectra, and explain how they arise.
9. Perform a distillation to separate two liquids.
10. Use a melting point or boiling point test to determine the purity of a compound.

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit