

Unit 1: What Do Chemists See When They Look At Chemicals?

Stage 1 – Desired Results

Established Goals:

- The bonding characteristics of carbon lead to many different molecules with varied sizes, shapes, and chemical properties, providing the biochemical basis of life.
(Source: California State Chemistry Standard 10. Organic and Biochemistry)
- Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content the other four strands, students should develop their own questions and perform investigations.
(Source: California State Investigation and Experimentation Standard 1)

Understandings:

Students will understand that...

- There are three worlds in chemistry: Macroscopic (the world you can see), Microscopic (the world you think about), and Symbolic (the way chemists communicate ideas).
- Chemists see the world in terms of atoms and molecules and that the identity, shape and arrangement of these atoms give molecules their specific properties.
- The two-dimensional symbols we use for three-dimensional molecules sometimes leads to false ideas.

Essential Questions:

- What do chemists see when they look at chemicals?
- What kind of chemicals do you have in your home?
- How do chemists communicate with each other about chemicals?

Students will know...

- the bond angle of H-C-H bond.
- the bonding capacity of C, H, O, Cl, Br, and I.
- the names and symbols of the elements used.
- that the parent chain can be bent.
- that hydrocarbons are good fuels.
- the names of side groups: methyl –CH₃ ethyl –C₂H₅ bromo –Br iodo –I chloro –Cl
- to start numbering carbons of a parent chain where there are more side groups.
- that “n” means “normal” (straight chain.) For example, n-pentane.
- that tetramethyl means 4 methyl groups, trimethyl means 3 groups, dimethyl means 2 groups.
- that hydrocarbons with:

all single bonds are called alkanes	end with “-ane”	follow the formula C _n H _{2n+2}
one double bond are called alkenes	end with “-ene”	follow the formula C _n H _{2n}
one triple bond are called alkynes	end with “-yne”	follow the formula C _n H _{2n-2}

Students will be able to...

- give examples of hydrocarbons.
- give examples of molecular formulas and structural formulas.
- list prefixes 1 – 10 (meth-, eth-, prop-, but-, etc.)
- build models of molecules.
- state the # of atoms and # of elements in a molecule.
- draw isomers of molecules and recognize isomers.
- write the formula of a hydrocarbon, given its name and vice versa.
- give household examples of hydrocarbons (methane, ethane, propane, butane, octane).
- identify the “parent chain” looking at a structural formula
- give examples of substituted hydrocarbons.
- draw and name isomers of substituted hydrocarbons.
- build a model of a double bond using two carbon atoms connected by two springs.
- demonstrate that double bonds cannot rotate like a single bond.
- demonstrate cis- and trans- isomerism using dichloroethene, C₂H₂Cl₂.
- recognize whether the molecule is an alkane, alkene, or alkyne given the formula.
- name a molecule, given the structural formula.
- write the correct structural formula, given the name.
- build a model of a triple bond using two carbon atoms connected by three springs.
- draw and build cyclopentane.

- that "cyclo-" means the molecule contains a ring.
- that "saturated" means "saturated with hydrogens" and describes alkanes.
- that alkenes, alkynes, and cyclic hydrocarbons are all "unsaturated."
- that unsaturated fats are better for you (the double bond makes them easier to digest and less likely to coat the inside of your arteries.)
- that various types of compounds (alcohols, ethers, etc.) have atoms in common (called functional groups).
- that "R" stands for the "Rest of the molecule" (methyl, ethyl, etc.) [Officially, "R" = "Residue".]
- examples of these molecules in daily life. (methyl alcohol, ethyl alcohol, denatured alcohol, rubbing alcohol, formaldehyde, acetone, diethylether, acetic acid, citric acid, salicylic acid, methylsalicylate, vitamins)
- Acid + Alcohol → Ester + H₂O
- Amino Acid + Amino Acid → Protein + H₂O
- that one way molecules can join, a reaction where H₂O is formed, is called a "condensation reaction."
- that a polymer ("poly" means many, "mer" means parts) consists of many repeating parts.
- a second way molecules can join, in which a double bond opens to form two new bonds, is called an "addition reaction."

- circle the atoms that make up the functional group, given the structural formula of a molecule.

alcohol $R - OH$	aldehyde $R - \overset{O}{\parallel} - H$	ketone $R - \overset{O}{\parallel} - R$	ether (bunny) $R - O - R$
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carboxylic acid $R - \overset{O}{\parallel} - OH$	ester $R - \overset{O}{\parallel} - O - R$	amine $R - NH_2$	amide $R - \overset{O}{\parallel} - NH_2$
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- state natural examples of polymers such as proteins (many amino acids), carbohydrates (many sugar units), and DNA (many nucleotide bases).
- state man-made polymers like polyester (many ester linkages), and polyethylene, polystyrene, and Teflon.
- draw the "repeat unit" with the double bond open and copy the repeat unit to draw the polymer, given a monomer (like ethane, aka. ethylene),
- give examples of common substances made from addition polymers.

Stage 2 - Assessment Evidence

Performance Tasks:

- Choose a household chemical and present it to the class orally and in poster form. Demonstrate how chemists see this household chemical.

Other Evidence:

- Quizzes on each skill
- Homework and class work assignments.

CALIFORNIA STATE STANDARDS IN UNIT 1

Organic and Biochemistry

10. The bonding characteristics of carbon lead to many different molecules with varied sizes, shapes, and chemical properties, providing the biochemical basis of life. As a basis for understanding this concept, students know:

- large molecules (polymers) such as proteins, nucleic acids, and starch are formed by repetitive combinations of simple sub-units.
- the bonding characteristics of carbon lead to a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.
- amino acids are the building blocks of proteins.
- * the system for naming the ten simplest linear hydrocarbons and isomers containing single bonds, simple hydrocarbons with double and triple bonds, and simple molecules containing a benzene ring.*
- * how to identify the functional groups which form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.*
- * the R-group structure of amino acids and how they combine to form the polypeptide backbone structure of proteins.*

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content the other four strands, students should develop their own questions and perform investigations. Students will:

- select and use appropriate tools and technology (such as computer-linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
- identify and communicate sources of unavoidable experimental error.
- identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- formulate explanations using logic and evidence.
- solve scientific problems using quadratic equations, and simple trigonometric, exponential, and logarithmic functions.
- distinguish between hypothesis and theory as science terms.
- recognize the use and limitations of models and theories as scientific representations of reality.
- recognize the issues of statistical variability and the need for controlled tests.
- recognize the cumulative nature of scientific evidence.
- analyze situations and solve problems that require combining and applying concepts from more than one area of science.
- investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.
- know that when an observation does not agree with an accepted scientific theory, sometimes the observation is mistaken or fraudulent (e.g., Piltdown Man fossil or unidentified flying objects), and sometimes the theory is wrong (e.g., Ptolemaic model of the movement of the sun, moon and planets).