

Course Title: Honors Organic Chemistry

Board Approval Date: May 21, 2020

Credit / Hours: 1.0

Course Description:

This course would be beneficial for a student who is going into any science-related field in college, including biology, chemistry, physics, and any of the medical fields. This course will focus on the study of carbon compounds and their relation to living organisms, the naming of structures and their reactions of organic compounds: alkanes, alkenes, alcohols, benzene, amines, aldehydes, ketones, and carboxylic acids. Simple reaction mechanisms and their relation to living organisms will be studied.

Learning Activities / Modes of Assessment:

Large Group Instruction	Computer Simulations
Tests and Quizzes	Lab Journals / Write-ups
Teacher Observation	Various Websites
Student Response Systems	Laboratory Experiments
Small Group Projects w/ Rubrics	Audio/Visual Media
	Laboratory Reports

Instructional Resources:

Various Websites
Laboratory Experiments

Curriculum: Dover Area School District
 Course: Honors Chemistry
 TOPIC: Introduction to Organic Chemistry,

10 days

Know:

Understand:

Do:

<p>Organic chemistry is the study of the structure, properties, composition, reactions, and preparation of carbon-containing compounds, which include not only hydrocarbons but compounds with any number of other elements, including hydrogen, nitrogen, oxygen, halogens, phosphorus, silicon, and sulfur.</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p> <p>VOCAB: Organic chemistry</p>	<p>The structure and function of organic compounds affects our everyday life.</p> <p>Organic chemistry is the study of compounds containing carbon.</p> <p>Chemists obtain organic compounds either by isolation from plant and animal sources or by synthesis in the laboratory.</p> <p>Carbon normally forms four bonds and has no unshared pairs of electrons. Nitrogen normally forms three bonds and has one unshared pair of electrons.</p> <p>Oxygen normally forms two bonds and has two unshared pairs of electrons.</p> <p>A functional group is a site of chemical reactivity; a particular functional group, in whatever compound it is found, always undergoes the same types of chemical reactions.</p> <p>Functional groups are characteristic structural units by which we both classify and name organic compounds.</p> <p>Important functional groups include the hydroxyl group, the amino group, the carboxyl group, and the ester group.</p>	<p>Support why organic chemistry is a separate branch of chemistry.</p> <p>Provide examples of organic compounds that are isolated from nature.</p> <p>Provide examples of organic compounds that are synthesized in the laboratory.</p> <p>Compare and contrast molecular formulas and structural formulas.</p> <p>Draw structural formulas from given molecular formulas using the HONC1234 rule.</p> <p>Identify functional groups in structural formulas. Identify alcohols and amines as primary, 1, secondary, 2, or tertiary, 3. Determine the boiling point and melting point of a given substance.</p> <p>Determine the identity of an unknown substance using the boiling and melting points.</p>
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Hydrocarbons Molecular formulas Structural formulas Skeletal structures Functional groups Hydroxyl group Amino group Carboxyl group Ester group primary, 1° secondary, 2° tertiary, 3°		
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Curriculum: Dover Area School District

Course: Honors Organic Chemistry

TOPIC: Alkanes

10 days

Know:

Understand:

Do:

<p>Organic chemistry is the study of the structure, properties, composition, reactions, and preparation of carbon-containing compounds, which include not only hydrocarbons but compounds with any number of other elements, including hydrogen, nitrogen, oxygen, halogens, phosphorus, silicon, and sulfur.</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p> <p>VOCAB: Alkane Constitutional isomers</p>	<p>Hydrocarbon contains only carbon and hydrogen.</p> <p>Saturated hydrocarbon contains only single bonds.</p> <p>An alkane is a saturated hydrocarbon whose carbon atoms are arranged in an open chain.</p> <p>Constitutional isomers have the same molecular formula but different connectivity of their atoms.</p> <p>Alkanes are named according to a set of rules developed by the International Union of Pure and Applied Chemistry (IUPAC).</p> <p>The IUPAC name of an alkane consists of two parts: a prefix that tells the number of carbon atoms in the parent chain, and the ending -ane.</p> <p>Substituents derived from alkanes by removal of a hydrogen atom are called alkyl groups and denoted by the symbol R—.</p> <p>Natural gas consists of 90-95% methane with lesser amounts of ethane and other lower molecular weight hydrocarbons.</p> <p>Petroleum is a liquid mixture of thousands of different hydrocarbons.</p>	<p>Draw constitutional isomers for a given molecular formula.</p> <p>Name alkanes using the IUPAC system as well as some common names.</p> <p>Draw alkanes from provided IUPAC and common names.</p> <p>Describe the fractional distillation of petroleum.</p> <p>Name cycloalkanes using the IUPAC system as well as some common names.</p> <p>Draw cycloalkanes provided IUPAC and common names.</p> <p>Draw cyclopentane in the envelope conformation.</p> <p>Draw cyclohexane in the chair conformation.</p> <p>Determine the lowest energy conformation of a group of substituted cyclohexanes.</p> <p>Name cis-trans isomers of cycloalkanes using IUPAC nomenclature rules.</p> <p>Draw cis-trans isomers of cycloalkanes provided IUPAC and common nomenclature rules.</p> <p>Predict the state of matter for an alkane provided the</p>
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<p>IUPAC Substituents alkyl groups Cycloalkane cis -trans isomers oxidation halogenation</p>	<p>A cycloalkane is an alkane that contains carbon atoms bonded to form a ring.</p> <p>To name a cycloalkane, prefix the name of the open-chain alkane with a cyclo — .</p> <p>A conformation is any three - dimensional arrangement of the atoms of a molecule that results from rotation about a single bond.</p> <p>The lowest energy -conformation of cyclopentane is an envelope conformation.</p> <p>The lowest energy -conformation of cyclohexane is a chair conformation.</p> <p>In a chair conformation, six C—H bonds are axial and six C —H bonds are equatorial.</p> <p>A substituent on a six -membered ring is more stable when it is equatorial than when it is axial.</p> <p>Cis -trans isomers of cycloalkanes have (1) the same molecular formula and (2) the same connectivity of their atoms, but (3) a different orientation of their atoms in space because of the restricted rotation around the C —C bonds of the ring.</p> <p>For cis -trans isomers of cycloalkanes, cis means that substituents are on the same side of the ring; trans means that substituents are on the opposite sides of the ring.</p>	<p>molecular formula.</p> <p>Predict the boiling points of alkanes provided the structural formula.</p> <p>Predict the products and balance oxidation of alkane reactions.</p>
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Alkanes are nonpolar compounds, and the only forces of attraction between their molecules are London dispersion forces.

At room temperature, low -molecular - weight alkanes are gases, higher - molecular -weight alkanes are liquids, and very -high -molecular -weight alkanes are waxy solids.

For any group of alkane constitutional isomers, the least branched isomer generally has the lowest boiling point.

Alkanes are insoluble in water but soluble in each other and in other nonpolar organic solvents such as toluene.

All liquid and solid alkanes are less dense than water.

The oxidation of alkanes to carbon dioxide and water, an exothermic reaction, is the basis for our use of them as sources of heat and power.

The halogenation of alkanes is the reaction of an alkane with chlorine or bromine.

This reaction results in the substitution of a halogen atom for a hydrogen atom.

Curriculum: Dover Area School District

Course: Honors Organic Chemistry

TOPIC: Alkenes and Alkynes

9 days

Know:	Understand:	Do:
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trienes
isoprene units

Substituents are numbered and named in alphabetical order.

The presence of a carbon—carbon triple bond is indicated by the prefix that shows the number of carbons in the parent chain and the ending *-yne*.

The carbon atoms of the double bond of a cycloalkene are numbered 1 and 2 in the direction that gives the smaller number to the first substituent.

Compounds containing two double bonds are called dienes, those with three double bonds are called trienes, and those containing four or more double bonds are called polyenes.

Because alkenes and alkynes are nonpolar compounds and the only interactions between their molecules are London dispersion forces, their physical properties are similar to those of alkanes with similar carbon skeletons.

The characteristic structural feature of a terpene is a carbon skeleton that can be divided into two or more isoprene units.

The most common pattern is the head of one unit bonded to the tail of the next unit. A characteristic reaction of alkenes is addition to the double bond.

Curriculum: Dover Area School District

Course: Honors Organic Chemistry

TOPIC: Alcohols, Ethers, and Thiols

10 days

Know:

Understand:

Do:

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ether
glycols
cyclic ether
thiol
sulfhydryl

Alcohols are polar compounds in which oxygen bears a partial negative charge and both the carbon and the hydrogen bonded to it bear partial positive charges.

Alcohols associate in the liquid state by hydrogen bonding.

As a consequence, their boiling points are higher than those of hydrocarbons of similar molecular weight.

Because of increased London dispersion forces, the boiling points of alcohols increase with their increasing molecular weight.

Alcohols interact with water by hydrogen bonding and are more soluble in water than are hydrocarbons of similar molecular weight.

Alcohols have about the same pKa values as pure water.

For this reason, aqueous solutions of alcohols have the same pH as that of pure water.

Common names for ethers are derived by naming the two groups bonded to oxygen followed by the word "ether".

A cyclic ether, oxygen is one of the atoms of the ring.

Ethers are weakly polar

	<p>compounds.</p> <p>Their boiling points are close to that of hydrocarbons of similar molecular weight.</p> <p>Because ethers form hydrogen bonds with water, they are more soluble in water than hydrocarbons of similar molecular weight. A thiol contains an –SH (sulfhydryl) group.</p> <p>Thiols are named in the same manner as alcohols, but the suffix of the parent alkane is retained and –thiol is added.</p> <p>Common names for thiols are derived by naming the alkyl group bonded to the –SH group and adding the work mercaptan.</p> <p>The S—H bond is nonpolar and the physical properties of thiols resemble those of hydrocarbons of similar molecular weight.</p>	
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Curriculum: Dover Area School District
 Course: Honors Organic Chemistry
 TOPIC: Chirality-The Hardness of Molecules

8 days

Know:	Understand:	Do:
<p>Organic chemistry is the study of the structure, properties, composition, reactions, and preparation of carbon-containing compounds, which include not only hydrocarbons but compounds with any number of other elements, including hydrogen, nitrogen, oxygen, halogens, phosphorus, silicon, and sulfur.</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p> <p>VOCAB : mirror image enantiomers</p>	<p>Structural diversity allows for functional diversity underlying the processes and variety of life.</p> <p>A mirror image is the reflection of an object in a mirror.</p> <p>Enantiomers are a pair of stereoisomers that are nonsuperposable mirror images.</p> <p>A racemic mixture contains equal amounts of two enantiomers and does not rotate the plane of polarized light.</p> <p>Diastereomers are stereoisomers that are not mirror images.</p> <p>An object that is not superposable on its mirror image is said to be chiral; it has handedness.</p> <p>An achiral object lacks chirality (handedness); that is, it has a superposable mirror image.</p> <p>The most common cause of chirality in organic molecules is the presence of a tetrahedral carbon atom with four different groups bonded to it.</p> <p>Such a carbon is called a stereocenter.</p>	<p>Identify molecules as mirror images to each other.</p> <p>Compare and contrast enantiomers and diastereomers. Identify carbon atoms as stereocenters.</p> <p>Describe the common cause of chirality in molecules.</p> <p>Use the R,S system to specify the configuration of a stereocenter.</p> <p>Identify a molecule as dextrorotatory or levorotatory.</p>

<p>racemic diastereomers polarimeter dextrorotatory levorotatory</p>	<p>We use the R,S system to specify the configuration of a stereocenter.</p> <p>For a molecule with n stereocenters, the maximum number of stereoisomers possible is 2^n.</p> <p>Light with waves that vibrate in only parallel lines is said to be plane polarized.</p> <p>We use a polarimeter to measure optical activity.</p> <p>A compound is said to be optically active if it rotates the plane of polarized light.</p> <p>If a compound rotates the plane clockwise, it is dextrorotatory; if it rotates the plane counterclockwise, it is levorotatory.</p> <p>Each member of a pair of enantiomers rotates the plane of polarized light an equal number of degrees, but in opposite directions.</p> <p>An enzyme catalyzes biological reactions of molecules by first positioning them at binding sites on its surface.</p> <p>An enzyme with binding sites specific for three of the four groups on a stereocenter can distinguish between a molecule and its enantiomer or one of its diastereomers.</p>	
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Curriculum: Dover Area School District

Course: Honors Organic Chemistry

TOPIC: Amines

8 days

Know:

Understand:

Do:

<p>Organic chemistry is the study of the structure, properties, composition, reactions, and preparation of carbon-containing compounds, which include not only hydrocarbons but compounds with any number of other elements, including hydrogen, nitrogen, oxygen, halogens, phosphorus, silicon, and sulfur.</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p> <p>VOCAB: amine</p>	<p>Structural diversity allows for functional diversity underlying the processes and variety of life.</p> <p>Amines are classified as primary, secondary, or tertiary, depending on the number of carbon atoms bonded to the nitrogen.</p> <p>In an aliphatic amine, all carbon atoms bonded to nitrogen are derived from alkyl groups.</p> <p>In an aromatic amine, one or more of the groups bonded to nitrogen are aryl groups.</p> <p>In a heterocyclic amine, the nitrogen atom is part of a ring.</p> <p>In IUPAC nomenclature, aliphatic amines are named by changing the final -e of the parent alkane to -amine and using a number to locate the amino group on the parent chain.</p> <p>In the common system of nomenclature, aliphatic amines are named by listing the carbon groups bonded to nitrogen in alphabetical order in one word ending in the suffix -amine.</p> <p>Amines are polar compounds, and primary and secondary amines associate</p>	<p>Categorize amines as primary, secondary, or tertiary.</p> <p>Distinguish between aliphatic, aromatic and heterocyclic amines.</p> <p>Construct names for amines using IUPAC and common names.</p> <p>Interpret information about amines based on physical properties.</p> <p>Compare the basicity of aliphatic and aromatic amines.</p> <p>Predict the products of reactions of amines.</p>
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<p>aliphatic amine aromatic amine heterocyclic amine</p>	<p>by intermolecular hydrogen bonding.</p> <p>All classes of amines form hydrogen bonds with water and are more soluble in water than are hydrocarbons of comparable molecular weight.</p> <p>Amines are weak bases, and aqueous solutions of amines are basic.</p> <p>The base ionization constant for amine in water is denoted by the symbol K_b.</p> <p>Aliphatic amines are stronger bases than aromatic amines.</p> <p>All amines, whether soluble or insoluble in water react with strong acids to form water-soluble salts.</p> <p>We can use this property to separate water-insoluble amines from water soluble nonbasic compounds.</p>	
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Curriculum: Dover Area School District

Course: Honors Organic Chemistry

TOPIC: Aldehydes and Ketones

10 days

Know:

Understand:

Do:

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<p>Ketone Tollen's Reagent hemiacetal acetal tautomers</p>	<p>Aldehydes can be reduced to primary alcohols and ketones to secondary alcohols.</p> <p>Addition of a molecule of alcohol to an aldehyde or ketone produces a hemiacetal.</p> <p>A hemiacetal can react with another molecule of alcohol to produce an acetal.</p> <p>A molecule containing an –OH group bonded to a carbon of a carbon-carbon double bond is called an enol.</p> <p>Constitutional isomers that differ in the location of a hydrogen atom and a double bond are called tautomers.</p>	
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Know:

Understand:

Do:

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<p>triglyceride micelle decarboxylation</p>	<p>hydrophilic parts are on the surface.</p> <p>Carboxylic acids are weak acids, which react with strong bases to form water soluble salts.</p> <p>Treatment of a carboxylic acid with an alcohol in the presence of an acid catalyst gives an ester.</p> <p>When exposed to a very high temperature, carboxylic acids can undergo decarboxylation.</p>	
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Know:	Understand:	Do:
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<p>step-growth polymerization anhydride phosphohryl group</p>	<p>reaction is the reverse of Fischer Esterification.</p> <p>Base is a reactant and are required in stoichiometric amounts.</p> <p>Phosphoric anhydrides consist of two phosphohryl groups (P=O) bonded to the same oxygen atom.</p> <p>Step-growth polymerization involves the stepwise reaction of difunctional monomers.</p> <p>Important commercial polymers synthesized through step-growth processes include polyamides, polyesters, and polycarbonates.</p>	
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Know:	Understand:	Do:
<p>Organic chemistry is the study of the structure, properties, composition, reactions, and preparation of carbon-containing compounds, which include not only hydrocarbons but compounds with any number of other elements, including hydrogen, nitrogen, oxygen, halogens, phosphorus, silicon, and sulfur.</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p> <p>VOCAB: monosaccharides D-monosaccharide L-monosaccharide</p>	<p>Structural diversity allows for functional diversity underlying the processes and variety of life.</p> <p>Monosaccharides are polyhydroxyaldehydes or polyhydroxyketones.</p> <p>The most common monosaccharides have the general formula $C_nH_{2n}O_n$, where n varies from 3 to 8.</p> <p>Names that contain the suffix –ose, and the prefixes tri-, tet-, and so on indicate the number of carbon atoms in the chain.</p> <p>The prefix aldo- indicates an aldehyde, and the prefix keto- indicates a ketone.</p> <p>In a Fischer Projection of a monosaccharide, we write the carbon chain vertically with the most highly oxidized carbon toward the top.</p> <p>Horizontal lines represent groups projecting above the plane of the page; vertical lines represent groups projecting behind the plane of the page.</p> <p>The penultimate carbon of a monosaccharide is the next-to-last carbon of a fischer projection. A monosaccharide that has</p>	<p>Classify, formulate, predict, identify, categorize Identify monosaccharides.</p> <p>Analyze the names of monosaccharides to determine the number of carbons and functional group present.</p> <p>Predict the structures of fischer projections based on the names of monosaccharides.</p> <p>Predict the names of monosaccharides based on the fischer projections.</p> <p>Differentiate between D- and L-monosaccharides.</p> <p>Identify monosaccharides as D- and L-.</p> <p>Draw and identify pyranose and furanose monosaccharides.</p> <p>Identify the anomeric carbon in hemiacetal monosaccharides.</p> <p>Identify hemiacetal monosaccharides as α or β.</p> <p>Draw Haworth Projections for furanoses and pyranoses.</p> <p>Draw chair conformations for pyranoses.</p>

<p>L-glyceraldehyde pyranose furanose</p>	<p>the same configuration at the penultimate carbon as D-glyceraldehyde is called Dmonosaccharide; one that has the same configuration at the penultimate carbon as L-glyceraldehyde is called an L-glyceraldehyde.</p> <p>Monosaccharides exist primarily as cyclic hemiacetals.</p> <p>A six-membered cyclic hemiacetal is a pyranose; a five-membered cyclic hemiacetal is a furanose.</p>	
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Honors Organic Chemistry Pacing Guide

Course: Honors Organic Chemistry

Course Unit (Topic Periods)	Length of Instruction (Class Periods)
1. Introduction to Organic Chemistry	10 days
2. Alkanes	10 days
3. Alkenes and Alkynes	9 days
4. Alcohols, Esters, and Thiols	10 days
5. Chirality-The Hardness of Molecules	8 days
6. Amines	8 days
7. Aldehydes and Ketones	10 days
8. Carboxylic Acids	7 days
9. Carboxylic Anhydrides, Esters, and Amides	9 days
10. Carbohydrates	9 days

Total Days: 90 days