



Department of Chemistry

Sophomore Organic Chemistry for non-Chemistry Majors

CHEMISTRY 331 \diamond ORGANIC CHEMISTRY I

GENERAL INFORMATION

Chemistry 331, Chemistry 332 and Chemistry 337 constitute the course sequence for pre-professional students (medicine, dentistry, optometry, pharmacy and other health professions), chemical engineering students and other students, not majoring in chemistry, who require a year of organic chemistry.

PREREQUISITES

One year of freshman chemistry
CH 121, CH 122, CH 123; or
CH 221, CH 222, CH 223

ACID-BASE CHEMISTRY IN ORGANIC CHEMISTRY

Bronsted-Lowry acids and bases
 K_a values, pK_a values, equilibrium constants
Predicting the positions of acid-base equilibria
Predicting approximate pK_a values
Ranking acids in order of acid strength; ranking bases in order of base strength
Acids and bases in organic chemistry
Lewis acids and bases
Nucleophiles and electrophiles
Mechanism of an acid-base reaction
-two-electron processes; the use of curved arrow notation

ALKANES

Nomenclature, structure and bonding, physical properties
Stereochemistry
-structural isomerism, stereoisomerism, conformational isomerism
Conformations of acyclic alkanes, cyclic alkanes including cyclohexane, monosubstituted cyclohexanes and disubstituted cyclohexanes
-torsional strain, steric strain, angle strain, ring strain
Conformational equilibria
-equilibrium constants, composition at equilibrium

ALKENES

Nomenclature, structure, bonding, physical properties
Stereochemistry
-configurational isomerism, chirality, optical activity
Conversion to Markovnikov alkyl halides
-hydrohalogenation, protonation, carbocations, carbocation rearrangements, regiochemistry/stereochemistry, mechanistic aspects
Conversion to Markovnikov alcohols
-hydration via the aqueous acid pathway, protonation, carbocations, carbocation rearrangements, regiochemistry/stereochemistry, mechanistic aspects
-hydration via the oxymercuration-demercuration pathway, mercurinium ions, organomercurial alcohols, regiochemistry/stereochemistry, mechanistic aspects
Conversion to anti-Markovnikov alcohols

-hydration via the hydroboration-oxidation pathway, alkylboranes, regiochemistry/stereochemistry, mechanistic aspects

Conversion to vicinal-dihalides and halohydrins
-cyclic halonium ions, anti-addition, regiochemistry/stereochemistry, mechanistic aspects

Conversion to alkanes
-catalytic hydrogenation, syn-addition, stereochemistry, mechanistic aspects

Conversion to epoxides
-syn-addition, stereochemistry, mechanistic aspects

Conversion to vicinal-diols
-using osmium tetroxide, using permanganate, stereochemistry, mechanistic aspects

Conversion to aldehydes, ketones &/or carboxylic acids
-oxidative cleavage using permanganate, ozonolysis

ALKYL HALIDES

Nomenclature, structure, bonding, physical properties
 S_N1 and $E1$ reactions
-rate laws, substituent effects, leaving group effects, solvent effects, rearrangements, stereochemistry, mechanistic aspects, competition
-applications to synthesis
 S_N2 and $E2$ reactions
-rate laws, nucleophilicity, steric effects, solvent effects, leaving group effects, stereochemistry, mechanistic aspects, competition
-applications to synthesis

ALKYNES

Nomenclature, structure and bonding, physical properties
Preparations of alkynes
-via the double dehydrohalogenation of alkyl dihalides, mechanistic aspects
Conversion to Markovnikov vinyl halides, dihalides
-protonation, vinyl cations, regiochemistry/stereochemistry, mechanistic aspects
Conversion to ketones
-hydration via the mercuric ion catalyzed pathway, regiochemistry/stereochemistry, keto-enol tautomerism, mechanistic aspects
Conversion to alkanes and cis alkenes
-via catalytic hydrogenation, stereochemistry
Conversion to trans alkenes
-via metal-ammonia reduction to trans alkenes, stereochemistry, mechanistic aspects
Conversion to geminal dihalides, tetrahalides
-stereochemistry, mechanistic aspects
Chemistry acetylide ions
-preparations/properties, applications to synthesis



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CHEMISTRY 332 ◊ ORGANIC CHEMISTRY II

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One year of freshman chemistry
CH 121, CH 122, CH 123; or
CH 221, CH 222, CH 223
and CH 331

ALCOHOLS AND ETHERS

Nomenclature, structure, bonding, physical properties
Conversion to alkyl halides and sulfonate esters
-mechanistic aspects, applications to synthesis
Conversion to alkenes
-via the acid-catalyzed dehydration of alcohols, E1 and E2 pathways, mechanistic aspects
Conversion to aldehydes and ketones
-oxidizing agents (Jones reagent, PCC)
-oxidation of primary alcohols to aldehydes and carboxylic acids, mechanistic aspects
-oxidation of secondary alcohols to ketones, mechanistic aspects
Chemistry of ethers
-epoxide ring opening, mechanistic aspects
-Williamson ether synthesis, mechanistic aspects
-acid-catalyzed cleavage of ethers, mechanistic aspects

ALDEHYDES AND KETONES

Nomenclature, structure, bonding, physical properties
Relative reactivities of aldehydes and ketones
Conversion to alcohols
-via the addition of hydride and organometallic reagents (preparations/properties of sodium borohydride, lithium aluminum hydride, Grignard reagents, acetylide ions, organolithium compounds), mechanistic aspects
Conversion to hydrates, hemiacetals, acetals
-via the addition of water and alcohols, acetals as protecting groups in synthesis, mechanistic aspects
Conversion to imines
-via the addition of ammonia and its derivatives, mechanistic aspects

AROMATICITY AND CHEMISTRY OF BENZENE

Nomenclature, structure, bonding, physical properties
Aromaticity
Electrophilic aromatic substitutions
-halogenation, nitration, sulfonation, Friedel-Crafts alkylation, Friedel-Crafts acylation, mechanistic aspects
Clemmensen reduction
Wolff-Kishner reduction

CARBOHYDRATES

Nomenclature, structure, bonding, physical properties
Aldoses, ketoses
D sugars, L sugars
Furanoses, furanosides, pyranoses, pyranosides
Alpha and beta anomers
Oxidations
-conversion to aldaric acids
-conversion to aldonic acids
Reductions
-conversion to alditols
Reducing sugars, nonreducing sugars
Alpha-glycosidic linkages, beta-glycosidic linkage
the constituent sugar(s) of a disaccharide; a trisaccharide; a polysaccharide

CARBOXYLIC ACIDS AND ESTERS

Nomenclature, structure, bonding, physical properties
Chemistry of carboxylic acids
-esterification, metal hydride reduction, mechanistic aspects
Chemistry of esters
-acid-catalyzed hydrolysis, saponification, metal hydride reduction, conversion to alcohols, mechanistic aspects
Fatty acids
Waxes, triglycerides, fats, oils
Soaps

STRUCTURE DETERMINATION

Degrees of unsaturation
Energy, wavelength, frequency
Infrared spectroscopy
-typical vibrational modes
-predicting/interpreting spectral features
-compound identification
Proton NMR spectroscopy
-shielding, deshielding
-chemically equivalent protons, non-chemically equivalent protons
-splitting, pitchfork diagrams
-predicting/interpreting spectral features
-compound identification



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CHEMISTRY 337 ◊ ORGANIC CHEMISTRY LABORATORY

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CH 121, CH 122, CH 123; or
CH 221, CH 222, CH 223;

and

CH 331, CH 332 or
CH 334, CH 335, CH 336

ENOLATE CHEMISTRY

Alkylation
Aldol condensation
Claisen condensation

RADICAL CHEMISTRY

Conversion of alkanes to alkyl halides
-one-electron processes; chain reactions; reactive intermediates;
energy diagrams; mechanistic aspects
Addition of hydrogen halides to alkenes and alkynes
Radical polymerization

AMINES AND AMIDES

Nomenclature, structure and bonding, physical properties
Preparations and reactions

AMINO ACIDS

Classification, nomenclature
Acid-base properties of amino acids
Separation techniques
Electrophoresis and thin-layer chromatography

PROTEINS

Classification, structure
Peptide bonds; disulfide bonds
Peptide synthesis

LABORATORY TECHNIQUES

Melting point determination
Recrystallization
Extraction (solid-liquid; liquid-liquid)
Chromatography (TLC; GC)
Distillation (simple; fractional; steam)
Preparation/handling of moisture-sensitive reagents
Spectroscopy (IR; NMR)

LABORATORY EXPERIMENTS

- *Isolation/characterization of trimyristin from nutmeg*
Techniques Solid-liquid extraction, simple distillation, melting point determination
- *Synthesis of salicylic acid via saponification*
Chemistry Ester saponification
Techniques Heating under reflux, recrystallization, melting point determination, IR, NMR
- *Separation of a methanol/water mixture*
Techniques Simple distillation, fractional distillation
- *Isolation/characterization of essential oils from spices*
Techniques Steam distillation, liquid-liquid extraction, IR, NMR
- *Synthesis of dibenzalacetone via an aldol condensation*
Chemistry Aldol condensation
Techniques Recrystallization, melting point determination, IR, NMR
- *Synthesis of benzoic acid via a Grignard reaction*
Chemistry Grignard chemistry
Techniques Prep/handling of moisture-sensitive reagents, liquid-liquid extraction, recrystallization, melting point determination, IR, NMR
- *Isolation/characterization of lactose*
Chemistry Benedict's test
- *Isolation/characterization of green-leaf pigments from spinach*
Techniques Solid-liquid extraction, liquid-liquid extraction, column chromatography, TLC
- *Synthesis of 1-butene, cis-2-butene and trans-2-butene via E1 dehydration of 2-butanol*
Chemistry Dehydration alcohols
Techniques GC
- *Synthesis of 1-butene, cis-2-butene and trans-2-butene via E2 dehydrohalogenation of 2-bromobutane*
Chemistry Dehydrohalogenation of alkyl halides
Techniques GC