DOUGLAS COLLEGE

COURSE INFORMATION

DEPARTMENT SCIENCES & MATHEMATICS DATE June 1980

CHEMISTRY CHE-321	ORGANIC CHEMISTRY I H	5
NAME & NUMBER OF COURSE	DESCRIPTIVE TITLE	SEMESTER HOURS CREDIT

CATALOGUE DESCRIPTION: This course deals with the fundamental principles of modern organic chemistry and includes the structure properties and reactions, of all common functional groups. Emphasis would be placed on reaction mechanisms and the physical aspect of the science. The course is designed for prospective Honors and Majors students in science. Credit will not be given for both Chemistry 320 and Chemistry 321.

COURSE PREREQUISITES: CHE - 210

COURSE COREQUISITES:

HOURS PER WEEK FOR EACH STUDENT.

LECTURE	4 HRS.	FIELD EXPERIENCE	
LABORATORY	3 HRS.	STUDENT DIRECTED LEARNING	1
SEMINAR	HRS.	OTHER (SPECIFY)	

TOTAL 8

COLLEGE CREDIT TRANSFER [x] COLLEGE CREDIT NON-TRANSFER [ ] NON-CREDIT [ ]

TRANSFER INFORMATION

EQUIVALENT COURSES

UBC
SFU
OTHER

Applied for

UNASSIGNED CREDIT
(specify if unassigned within a discipline or a faculty)

Hendrick H Persad
COURSE DESIGNER

DEAN OF CURRICULUM AND INSTRUCTION

Desmond Wilson
DEPARTMENT HEAD

PRINCIPAL

Form C-1(Revised April'72) Use blank paper for additional pages

COURSES FOR WHICH THIS IS A PREREQUISITE:

CHE - 421

RELATED COURSES:

TEXTBOOKS, REFERENCES, MATERIALS (LIST READING RESOURCES ELSEWHERE)

Morrison, R.T and Boyd, R.N., Organic Chemistry 3rd ed. (Allyn and Bacon) ($30.95). This text is also used in CHE 421
Reference: Solomons, T.W.G. Organic Chemistry, Revised edition (John Wiley and Sons, 1978).

COURSE OBJECTIVES, CONTENT, METHOD, EVALUATION:

OBJECTIVES

The student will be able to:

1. describe and illustrate s, p and d orbitals
2. write electronic configurations of atoms
3. describe the process of covalent bonding using atomic orbitals
4. define sp, sp^2 and sp^3 hybridization and compare this to the molecular orbital and VSERP approach
5. predict the direction of dipole moments
6. define with appropriate examples Lewis and Lowry-Bronsted acids and bases
7. classify the hydrocarbons into aliphatic and aromatic groupings and to further divide these into the various families
8. describe and illustrate in detail the structure of methane and compare this structure with other saturated hydrocarbons
9. write equations for the oxidation and halogenation of methane
10. write equations showing the free radical mechanism of halogenation and to describe each step and its relationship to activation energy
11. illustrate the progress of a chemical reaction with the use of a potential energy diagram
12. discuss theoretically the rate of reaction using the collision theory and to compare this with the transition state theory
13. given ΔH discuss the relative reactivities of the halogens towards methane
14. given percentage compositions calculate empirical formulas and given formulas; calculate percentage composition
15. do conformational analysis of ethane propane and butane including energy considerations
16. define homologous series and draw isomeric structures for the series up to C_7
17. name all hydrocarbons up to C_{10} using the common and I.U.P.A.C. systems

18. do problems on synthesis using hydrogenation reduction by metals and coupling reactions
19. write equations for halogenation, combustion and pyrolysis reactions of hydrocarbons
20. explain the order $3^{o} > 2^{o} > 1^{o}$ for hydrogen abstraction in light of the stability of free radicals
21. discuss the transition state for halogenation and rationalize why rearrangements of free radicals do not occur
22. define stereochemistry and stereoismers, plane polarized light and optical activity
23. do problems involving specific rotation
24. define evantiomers and diastereomers with appropriate examples
25. discuss the chiral center and its relationship to chirality
26. define and discuss the racemic modification and do concentration calculations based on partial rotation
27. specify configurations by the Cahn-Ingolf-Prelog convention
28. recognize and draw evantiomers and meso structures for compounds with two chiral centers
29. deduce the shape, structure, bonding orbitals, type of bonds and the distinguishing feature of the carbon double bond in alkene structures
30. with appropriate examples explain what geometric isomers are
31. name the alkenes using common names and the I.U.P.A.C. system
32. write equations for the preparation of alkenes by dehydrohalogenation, dehydration, dehalogenation and reduction
33. give reasonable mechanisms for the above (32) reactions
34. discuss the carbonium ion its structure and stability including rearrangement considerations
35. write equations for the reactions of alkenes with halogens, hydrogen, hydrogen halides water, halohydrins
36. write equations to indicate an understanding of dimerization, alkylation, oxymercuration and hydroboration as they apply to alkenes
37. use the mechanism of hydrogen halide addition to demonstrate Markovnikov's rule
38. demonstrate an understanding of the peroxide effect
39. show with the aid of a detailed mechanism an understanding of orientation and reactivity in electrophilic addition to alkenes
40. demonstrate an understanding of carbonium ion rearrangements
41. distinguish between Markovinkov and anti-Markovnikov orientation and give reasons for the difference
42. show an understanding of resonance using benzene and the allyl radical as an example
43. demonstrate an understanding of hyperconjugation
44. do problems on synthesis based on the reactions studied under alkenes

45. convert an achiral compound into a chiral compound using appropriate examples
46. explain the process and results when reactions with a chiral molecule do not involve the bonds at the chiral centre and vice versa.
47. give a simple reaction pathway to the synthesis of optically active compounds
48. demonstrate the use of optically active compounds in mechanistic studies
49. define with examples stereoselective and stereospecific reactions and relate these to the mechanism of bromination of alkenes
50. discuss and illustrate the structure, bonding orbitals and shape of the carbon carbon triple bond
51. name the alkynes up to C_{10} using the common and IUPAC systems
52. write equations for the preparation of alkynes by dehydrohalogenation, dehalogenation and by reactions of sodium acetylides
53. demonstrate a knowledge of the reaction of alkynes with , hydrogen, halogens, hydrogen halides and water
54. show an understanding of the formation of heavy metal acetylides and alkali metal acetylides
55. demonstrate a knowledge of keto-enol tautomerism using appropriate examples
56. do problems of synthesis using the reactions relating to alkynes
57. discuss and illustrate the structure, bonding orbitals and shape of conjugated systems
58. name the dienes up to C_{10}
59. discuss the industrial processes used in the manufacture of 1,4-butadiene and its importance in the rubber industry
60. explain the stability of dienes and other conjugated systems using the orbital picture, resonance and hyperconjugation
61. account for the products of 1,2-and 1,4-addition in light of the mechanism of the addition reactions of dienes
62. explain the difference observed in product distribution attributable to the rate of addition and that attributable to equilibration at high temperature
63. explain using a mechanistic approach and the stability of free radicals the importance of orientation and reactivity in free radical addition to dienes
64. name the alycyclic hydrocarbons including bicyclo[2.2.1] heptane, bicyclo[2.2.2] octa-2-ene and nortricyelene given the structure
65. relate the similarity in reactivity of the cyclic hydrocarbons to their straight chain counterpart
66. draw the boat and chair conformations of cyclohexane and predict the most stable conformer with the aid of Newman drawings
67. with the use of conformational analysis predict relative stabilities of substituted cyclohexanes
68. give the reactions for the production of carbenes and distinguish between the singlet and triplet states
69. use the carbene reaction to synthesise simple compounds

70. discuss in some detail the structure, stability orbital picture and aromatic characteristics of benzene and other aromatic compounds
71. name all the common benzene derivatives
72. write equations for the nitration, sulfonation, halogenation, alkylation, acylation and protonation of benzene and its derivatives including substituent effect
73. detail the mechanisms of the above reactions and with the aid of these mechanisms theorize on the directional influences of the various substituents
74. write equations for the oxidation and side chain halogenation of alkyl benzenes
75. discuss the resonance stabilization of the benzyl and triphenylmethyl free radical
76. discuss the electromagnetic spectrum and the use of the infrared and ultraviolet spectrophotometer in the identification of organic compounds
77. know the structure and nomenclature of all the alkyl halides up to C_{10} and how they are prepared
78. define rate constant and first and second order reactions and relate these to the mechanisms of reactions
79. thoroughly understand SN2, SN1, E_2 and E_1 reactions under the headings of mechanism, kinetics, stereochemistry, reactivity order, rate determining factors, rearrangement, transition states and limitations
80. classify and name alcohols by the common, carbinol and IUPAC systems
81. write equations to show the preparation of alcohols by oxymercurations, hydroboration, Grignard reaction and hydrolysis of alkyl halides
82. give mechanisms of the above reactions (82)
83. explain why hydroboration is ant-Markovnikov addition of water to the double bond
84. write equations for the reactions of alcohols with hydrogen halides, phosphorous trihalides mineral acids, active metals, organic acids, acid chlorides, and potassium dichromate
85. outline mechanisms for the above reactions
86. perform synthesis of more complicated alcohols
87. perform synthesis using alcohols as the major starting materials
88. chemically analyse alcohols and classify them as primary, secondary or tertiary
89. draw the structures and name ethers and epoxides
90. write equations for the preparation of ethers by Williamson's synthesis and alkoxymercuration
91. write the equation and detail the mechanism of the cleavage of ethers by acids
92. write the equations for the preparation of epoxides from halohydrins and olefins
93. write equations for the reactions of epoxides with acids bases and Grignard reagents accompanied by the mechanisms of these reactions
94. rationalize the orientation of cleavage of epoxides
95. name the carboxylic acids using the common names and the IUPAC system
96. outline the reactions for the preparation of carboxylic acids from alcohols alkylbenzenes, Grignard reagents, and nitrites

97. write equations for the reaction of acids, to give, salts, acid chlorides esters, amides, alcohols and alpha halogens
98. discuss the effects of various substituents on acidity and the role of resonance and inductive effects on acidity
99. draw structures for oxalic, malonic, succinic, nucleic, fumaric and the pathalic acids
100. recognize the distinct absorption patterns in the infrared spectra of acids
101. name the common derivatives of carboxylic acids e.g. acid chlorides, anhydrides, amides and esters.
102. write equations for the reactions of these derivatives with water, ammonia and alcohols
103. outline the Friedel-crafts acylation of acid chlorides and anhydrides
104. write equations for the reactions of esters with Grignard reagents, Lithium aluminum hydride and hydrogen
105. give the details of the mechanism of the acid and base hydrolysis of esters under the headings of kinetics, stereochemistry, tracer studies and isotopic exchange
106. name aldehydes and ketones by their common and IUPAC names
107. write equations for the preparation of aldehydes from alcohols, methylbenzenes and acid chlorides
108. write equations for the preparation of ketones by the oxidation of alcohols Friedel-crafts acylation and reactions of acid chlorides
109. outline the results of the reactions of aldehydes and ketones with the common oxidizing and reducing agents $Ag(NH_3)_2$, $KMnO_4$, $K_2Cr_2O_7$, H_2, $LiAlH_4$, ZnHg/HCl, NH_2NH_2)
110. write the equations for the reactions of aldehydes and ketones with Grignard reagents, cyanide, bisulfite, hydroxylamine, hydrazine, phenylhydrazine, semi-carbazide and alcohols
111. outline the Cannizzaro reaction and the halogenation of ketones
112. recognize the distinct absorption patterns in the infrared and ultra-violet spectra of aldehydes and ketones

COURSE OUTLINES

I. STRUCTURE AND PROPERTIES:

Covalent bond, Hybrid orbitals, bond dissociation energy, polarity, acids and bases, spatial arrangements, isomerism.

II. METHANE

Classification, structure, reactions, mechanism of halogenation, activation energy, rate of reaction, transition states, elemental analysis.

III. HIGHER ALKANES

Structure, Conformations, Homologous series, Nomenclature, Properties, Reactivity and orientation, Selectivity and Analysis.

IV. STEREOCHEMISTRY - I

Stereoisomers, Isomer numbers, Optical activity, Enantiomerism, Chirality, Configurations, Sequence rules, Diastereomers, Meso-structures, Conformations.

V. ALKENES

Structure, Geometric Isomerism Nomenclature, Preparation, Mechanism of dehydration, Rearrangements, Electrophilic and Free Radical additions, Heats of Hydrogenation, Halogen additions, Hydrogen halide addition, Markovnikov's rule, Peroxide effect, Mechanisms of addition, Rearrangements, Halohydrins, Alkylation, Allylic hydrogen, Resonance, Hyperconjugation, Ozonolysis, Analysis of alkenes.

VI. STEREOCHEMISTRY II

Synthesis, Bond breaking, Reactions, Optical purity, Resolution, Mechanisms, Stereoselective and stereospecific reactions.

VII. ALKYNES AND DIENES

Structure, Nomenclature, Preparation Reactions, Tautomerism, Conjugated dienes Stability, Resonance, Hyperconjugation, 1,4-addition, Delocalization, Rate vs Equilibrium, Free radical addition, Orientation and Reactivity, Polymerization, Analysis.

VIII. ALICYLIC HYDROCARBONS

Nomenclature, Reactions, Strain, Heats of combustion, Orbital picture, Conformations, Cyclohexane equitorial and axial bonds, Stereoisomerism, Conformational analysis, Carbenes, Elimination, Analysis.

IX. BENZENE

Structure, History, Kekule Structure, Stability, Reactions, Heat of hydrogenation, Resonance, Orbital picture, Huckel rule, Other aromatics, Aromatic character, Nomenclature.

X. AROMATIC SUBSTITUTION

Reactions, Effect of substituents, Orientation, Relative reactivity, Substituent classification, Disubstituted benzenes, Mechanisms, Activation energy, Reactivity and Orientation, Theory of Orientation, Resonance, Halogen effect.

XI. ARENES

Structure and nomenclature, Properties, Preparation, Friedel-Crafts mechanism, Reactions, Ring and Sidechain halogenation, Benzyl radical.

XII. SPECTROSCOPY AND STRUCTURE I

Infrared and Ultra Violet spectroscopy, as analytical tools, Gas Liquid Chromatography.

XIII. ALKYL HALIDES

Structure and Nomenclature, Properties, Preparation, Reactions, First and second-order Kinetics, SN1 and SN2 reactions, Inversion and Retention of Configuration, Reactivity and Orientation, Rearrangements, Solvolysis, E_1 and E_2 reaction mechanisms, Stereochemistry.

XIV. ALCOHOLS

Preparation and Physical Properties, Nomenclature Grignard synthesis, Hydroboration, Reactions and mechanisms, Synthesis and Analysis.

XV. ETHERS AND EPOXIDES

Structure, Nomenclature, Preparation, Electrophilic substitution, Cyclic ethers, clearage reactions, Ethylene oxide, Analysis.

XVI. CARBOXYLIC ACIDS

Structure, nomenclature, preparation, reactions,derivatives of carboxylic acids, substituent effects, spectroscopic analysis.

XVII. ALDEHYDES AND KETONES

Structure, nomenclature, preparation reactions, spectroscopic analysis.

METHOD

The course will be presented using lectures, assigned readings, problem sessions, class discussions and student directed learning. Films and other audio-visual aids, handouts and programmed material will be used where appropriate. The laboratory course will be used to illustrate the practical aspects of the course material. Close co-ordination will be maintained between laboratory and classroom work whenever possible.

EVALUATION	PERCENTAGES
1. Class Tests (a minimum of three) and Assignments	45%
2. Final Examination	30%
3. Laboratory	25%