

THE COLLEGE OF THE BAHAMAS
SCHOOL OF NATURAL SCIENCES & ENVIRONMENTAL STUDIES
CHEMISTRY DEPARTMENT

CHEM 230 – ORGANIC CHEMISTRY

COURSE OUTLINE

1. INTRODUCTION

Revision of definition and scope of organic chemistry and representation of bonding and structure in organic molecules. The use of molecular, abbreviated and full structural formulae. Functional groups, homologous series. IUPAC prefixes and suffixes. Occurrence and nomenclature of constitutional (structural) isomers of alkanes.

2. BONDING

Revision of wave description of the electron. The energy levels and shapes of s, p, d and f orbitals. Empirical rule suggesting number of covalent bonds (i.e. number of half filled atomic orbitals) and anomalous behaviour of carbon. Ground state and bonding state of carbon and how hybridisation explains experimental bond lengths/angles of CH₄. sp³, sp² and sp hybridisation (with examples). Special properties of π-bond as a reactive functional group (exposed and mobile electrons) and rigidity it confers on molecules that possess it. Stereoisomerism. *Cis-trans* (geometrical) isomers resulting from π-bonding. Nomenclature of alkenes. Delocalisation versus bond isolation in 1,3-butadiene and benzene. Stability gained by such delocalisation. Bond polarity, +1 and -1 effects. Unstable intermediates (C⁺ and CH₃) and bonding in these.

3. ALKANES AND CYCLOALKANES

Physical properties: Van der Waals' forces, lack of polarity. Effect of alkyl chain length and branching on solubility, boiling point and density.

Chemical properties: Inertness; no functional groups, neither oxidising nor reducing agents, neither acids nor bases.

Principle reactions: (1) Free radical reactions and mechanisms with Cl₂ and Br₂ (photochemical initiation).

(2) Combustion (ΔH for CH₂ group).

Compare ΔH_f of cyclohexane and benzene. Explain resonance stabilisation energy.

Cycloalkanes: isomers to alkenes, reactivity compared to straight chain alkanes (ring strain versus preferred hybrid angle). Stereoisomerism of substituted rings.

4. ALKENES

Physical properties: Similarity to alkanes.

Chemical properties:

(1) Mechanism of addition of HX with (i) ethene;

(ii) propene

to illustrate (a) transition state theory;

(b) carbocation formation;

(c) definitions of electrophiles, nucleophiles and primary/secondary/tertiary carbon atoms;

(d) Markovnikov's rule.

(2) Addition of H₂SO₄/H₂O

(3) Addition of halogens

(4) Mixed addition with Br₂/Cl₂ and Br₂/H₂O

(5) Catalytic hydrogenation

(6) Stability of alkenes versus stability of benzene

(7) Oxidation of KMnO₄ and O₃ with and without cleavage of π-bond, emphasising mixed products

(8) Introduction to polymerisation.

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5. ALKYL HALIDES (HALOALKANES)

Nomenclature. Revise structural- and stereo-isomerism. Position isomerism as different type of structural isomerism. Optical isomerism as different type of stereoisomerism. Asymmetric (chiral) centres. Plane polarised light, optical activity, laevo- and dextro-rotatory, enantiomers, racemic mixtures, diastereoisomers.

Physical properties: dipoles, lack of hydrogen bonding. Effect on boiling point, solubility. Classification and nomenclature.

Chemical properties: introduction to S_N1 , S_N2 , E1 and E2 reaction mechanisms. Steric hindrance. Stereochemistry of reactions. Differences between nucleophiles and Lewis bases. S_N2 reactions of alkyl halides with NH_3 , CH_3COOAg , CN^- , NO_2^- , OH^- . Polyhalides. Haloalkenes.

6. ALCOHOLS

Classification and nomenclature.

Physical properties: hydrogen bonding: effect on boiling point and solubility.

Chemical properties: -OH as poor leaving group. Susceptibility to S_N1 , S_N2 , E1 and E2 reactions. Similarity of reactions to those of haloalkanes.

Reactions: as acids, combustion, esterification, oxidation (1° , 2° and 3° dependent).

7. ETHERS

Nomenclature.

Physical properties.

Chemical properties

Compare bonding to that in alcohol and water. Relative inertness. Reaction with hot HI (substitution reaction). Williamson synthesis.

8. AROMATIC CHEMISTRY (BENZENE AND SUBSTITUTED BENZENES)

Stereochemistry: cyclic, planar, p-orbitals directed perpendicular to the plane. Simple nomenclature (*o*-, *m*-, *p*- and numerical).

Reaction mechanisms: electrophilic aromatic substitution. 1^{st} substitution including halogenation with $FeBr_3$, nitration with conc. HNO_3 and conc. H_2SO_4 . Friedel-Craft reaction including alkylation and acylation using $AlCl_3$ as catalyst. Sulphonation with fuming H_2SO_4 . 2^{nd} and 3^{rd} substitution with an explanation of ring activation and deactivation, 2, 4-directing and 3-directing, mechanism of 2^{nd} substitution including resonance stabilisation of intermediates. Comparison with aliphatic compounds: aryl and alkyl halides, phenols and alcohols. Benzenediazonium salts (brief).

9. ALDEHYDES AND KETONES

Nomenclature.

Physical properties: hydrogen bonding.

Chemical properties: mechanism of reactions. Nucleophilic as opposed to electrophilic addition. Comparison of reactivities of aldehydes and ketones. Addition reactions with alcohols, HCN, NH_3 and $R-NH_2$. Reaction with hydrazine and related compounds. Reduction of aldehydes and ketones to alcohols. Oxidation. Tollen's reagent. Iodoform test. Aldol condensation. Cannizzaro's reaction.

10. CARBOXYLIC ACIDS, ACID CHLORIDES, ANHYDRIDES, ESTERS & AMIDES

Nomenclature.

Physical properties: general physical properties

Chemical properties: the carboxyl group: the effect of both carbonyl and hydroxyl groups on the same carbon. Acidity: relationship of structure to acid strength. Resonance stabilisation of anion. Comparison with aryl acids. Reactions including esterification and reduction. Polyfunctional carboxylic acids (brief). Reactivity of carboxylic acid derivatives. Esters, fats, soaps. Polyesters, polyamides and their uses (nylon, proteins).

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11. NITRILES

Nomenclature. Bonding. Preparation. Reactions including hydrolysis to carboxylic acids and reduction to amides.

12. AMINES

Classification and nomenclature.

Physical properties: different hydrogen bonding characteristics.

Chemical properties: basicity of amines and salt formation. Reaction of amines with nitrous acid to form aryl diazonium compounds, nitrosamines or tertiary amines.

13. AMINO ACIDS & PROTEINS (brief)

Properties of compounds with more than one functional group in the molecule. Zwitterions.

ASSESSMENT

Tests and assignments	15%
Laboratory work	20%
Mid-term examination	15%
Final examination	50%

TEXTBOOK

Brown, W.H. , *Organic Chemistry* Latest international edition. Saunders College Publishing.
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