School of Chemistry

Aims and Objectives: Session 2023-2024

Module CH1601: Organic and Biological Chemistry I

Course Title: Organic Chemistry 1

Duration: 27 hours

Lecturer: Dr N. S. Keddie and Professor A. D. Smith

Aims: To introduce students to the fundamentals of organic chemistry, emphasising the importance of stereochemistry and reaction mechanisms in terms of electron flow. The course will be framed in terms of the properties and behaviour of the various hybridization states carbon atoms adopt in organic compounds.

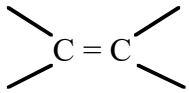
Objectives:

1. Appreciate the uniqueness of carbon in its ability to bond to other carbon atoms.

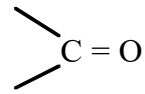
2. Understand hybridisation in bonding of carbon.

3. Use IUPAC nomenclature for alkanes and define constitutional isomerism and homologous series.

4. Understand the concept of a functional group, list common groups,



, –C ≡ C–, Cl–, Br–, I–, HO–, –O–, HS–, –S–, H_2N–,

R_2N–,  *etc*. and use IUPAC rules to name simple examples.

5. Understand the conformations of ethane and of butane and relate these to conformations of cyclohexane and substituted cycloalkanes. Be aware of the extension of these ideas to polycyclic molecules.

6. Appreciate the strain in, and therefore the reactivity of, cyclopropane.

7. Define the terms, chirality, stereogenic centre, and enantiomer and designate simple tetrahedral stereogenic centres as *R* or *S*.

8. Understand the consequences of having multiple stereogenic centres in a molecule and understand and define the term diastereoisomer.

9. Understand how trends in acidity and basicity relate to those in nucleophilicity and electrophilicity.

10. Appreciate the relative acidities of a range of organic molecules and how structural features, including resonance, inductive effects and bond lengths, can affect the acid / base strength of organic molecules.

11. Understand the mechanisms of nucleophilic substitution of haloalkanes, S_N1, S_N2.

12. Understand that β-elimination and substitution reactions can compete when nucleophiles react with haloalkanes. Understand the mechanisms of β-elimination reactions and the stereochemical consequences of substitution (S_N1 and S_N2) and of elimination reactions (E1 and E2).

13. Understand the influence of the structure of the alkyl group, the nature of the leaving group, the reagent and the solvent on substitution and elimination reactions.

14. Understand the structure, bonding and isomerism of alkenes.

15. Appreciate the relative stabilities of alkenes.

16. Understand the stereoisomerism in but-2-ene and designate the stereoisomers of alkenes as *E* and *Z* using the Cahn-Ingold-Prelog rules.

17. Understand the reactivity of alkenes, especially the addition of electrophiles, and use of the "curved arrow" notation to show the movement of electrons in reactions.

18. Appreciate the relative stabilities of carbocations and so understand the orientation of addition of electrophiles such as HCl to propene and to other unsymmetrical alkenes.

19. Understand carbocation rearrangements and their role in Wagner-Meerwein and pinacol rearrangements.

20. Understand that addition of bromine to alkenes is *trans* whereas catalytic hydrogenation is a *cis* addition.

21. Understand that, under different reaction conditions, addition of HBr to propene can result in the formation of either 2-bromopropane or 1-bromopropane.

22. Appreciate the reactions of alcohols – substitution, elimination, esterification, and oxidation – and know how formation of derivatives can modify their reactivity in substitution and elimination reactions.

23. Know reactions for the formation of ethers, including epoxides and other cyclic ethers, and appreciate the relative unreactivity of diethyl ether and the reactivity of ethylene oxide.

24. Understand the bonding in 1,3-dienes and their reactions in electrophilic addition reactions.

25. Appreciate that the hydrogen on C-1 of alk-1-ynes is acidic, hence appreciate their application in synthesis.

26. Appreciate that organometallic reagents are formed when metals such as Li or Mg react with haloalkanes and that these reagents are excellent nucleophiles.

27. Identify the result of addition of electrophiles to, and the catalytic hydrogenation of, alkynes.

28. Understand that amines are basic and react as nucleophiles and how primary, secondary and tertiary amines are formed.

29. Understand the use of spectroscopy in structure determination and of ^{1}H and ^{13}C NMR to distinguish constitutional isomers.

30. Understand the structure and bonding present in a carbonyl group.

31. Identify various carbonyl-containing functional groups, *e.g.* ester, aldehyde, ketone, *etc.*

32. Appreciate the role of a carbonyl group in nucleophilic addition reactions.

33. Understand the relative reactivities of carbonyl-containing functional groups toward nucleophiles.

34. Identify and understand common reactions of carbonyl-containing functional groups, *e.g.* ester hydrolysis.

35. Understand the role of the carbonyl group in affecting the acidity of adjacent protons.