

Organic Chemistry: Some Basic Principles and Techniques — Assignment 2

Class 11 Chemistry · Higher-difficulty challenge set + integrated problems · Answer key included · Narayan Gurukul Academy

Instructions: (1) Attempt all questions; start with the topic-wise challenge set, then attempt the integrated (multi-topic) problems.
(2) Give all answers with correct SI units. $g = 10 \text{ m/s}^2$ unless stated.
(3) A final answer key is provided at the end — try the full set before checking it.

Part A — Topic-wise challenge questions

Why Carbon — Tetravalency and Catenation

1. Explain tetravalency and catenation of carbon with examples.
2. Why are organic compounds covalent in nature? Explain briefly.
3. Why does carbon form a very large number of compounds?

IUPAC Nomenclature — The Rules

1. Write the IUPAC rules for naming organic compounds.
2. Write the IUPAC names of $\text{CH}_3\text{CH}_2\text{CHO}$ and CH_3COCH_3 .
3. Write the IUPAC name of a branched chain compound such as 2-methylbutane.

Functional Groups

1. Define a functional group and list any four functional groups with their formulae.
2. Identify the functional groups in CH_3CHO , CH_3COOH and CH_3NH_2 .
3. Name the functional group present in CH_3COCH_3 .

Isomerism

1. Define structural isomerism and explain chain and position isomerism with one example each.
2. Distinguish between functional group isomerism and stereoisomerism with examples.
3. How many structural isomers does butane have? Draw them.

Hybridisation and Bonding in Organic Molecules

1. Explain the hybridisation of carbon in ethane, ethene and ethyne.
2. Distinguish between a sigma and a pi bond.
3. State the hybridisation and bond angle in a molecule with sp^2 hybridisation.

Electron Displacement Effects

1. Explain the inductive effect with one example and distinguish between the +I and -I effects.
2. Explain the resonance (mesomeric) effect with one example.
3. What is hyperconjugation? Give an example.

Reactive Intermediates and Types of Reactions

1. Explain the nature of carbocations and carbanions with one example each.
2. Distinguish between substitution and addition reactions with one example each.
3. Explain the stability of free radicals.

Part B — Integrated problems (multi-topic)

1. Write the IUPAC name of $(\text{CH}_3)_3\text{C}-\text{CH}_2-\text{CH}_3$.
2. Identify the functional groups and the class of compound in CH_3CHO and CH_3COOH .
3. Draw and name the two structural isomers of C_4H_{10} .
4. State the hybridisation of each carbon atom in propene ($\text{CH}_3-\text{CH}=\text{CH}_2$).
5. Arrange the carbocations $(\text{CH}_3)_3\text{C}^+$, $(\text{CH}_3)_2\text{CH}^+$ and CH_3CH_2^+ in order of decreasing stability, giving a reason.

Answer Key

Why Carbon — Tetravalency and Catenation

Carbon is tetravalent and shows catenation (forms chains and rings with strong C–C bonds). Organic compounds are covalent, so they are generally poor conductors. This gives an enormous variety of compounds.

IUPAC Nomenclature — The Rules

Select the longest chain, number to give the lowest locants to substituents/functional groups, name substituents and add the suffix for the functional group. $\text{CH}_3\text{CH}_2\text{CHO}$ = propanal; CH_3COCH_3 = propanone.

Functional Groups

A functional group is the atom or group that defines the chemical behaviour of a compound. $-\text{CHO}$ = aldehyde, $-\text{COOH}$ = carboxylic acid, $-\text{NH}_2$ = amine, $-\text{OH}$ = alcohol.

Isomerism

Isomers have the same molecular formula but different structures. Butane has 2 structural isomers (n-butane and isobutane). Structural isomerism includes chain, position and functional group isomerism; stereoisomerism includes geometric and optical isomerism.

Hybridisation and Bonding in Organic Molecules

sp^3 (ethane, 109.5°), sp^2 (ethene, 120°), sp (ethyne, 180°). A sigma bond is formed by head-on overlap; a pi bond by sideways overlap. A $\text{C}=\text{C}$ consists of one sigma and one pi bond.

Electron Displacement Effects

Inductive effect: permanent polarisation of a sigma bond through the chain (+I/–I). Resonance effect: delocalisation of pi electrons. Hyperconjugation: interaction of sigma C–H electrons with an empty p orbital or pi system. These affect the stability of carbocations and reaction rates.

Reactive Intermediates and Types of Reactions

Carbocation (+ve carbon), carbanion (–ve carbon) and free radical (unpaired electron). Reactions are classified as substitution, addition, elimination and rearrangement. Stability of carbocations: $3^\circ > 2^\circ > 1^\circ$.

Integrated problems

1: 2,2-dimethylbutane. 2: CH_3CHO — aldehyde; CH_3COOH — carboxylic acid. 3: n-butane and 2-methylpropane. 4: C1 sp^3 , C2 sp^2 , C3 sp^2 . 5: $(\text{CH}_3)_3\text{C}^+ > (\text{CH}_3)_2\text{CH}^+ > \text{CH}_3\text{CH}_2^+$ (more alkyl groups give greater +I and hyperconjugative stabilisation).