

Hydrocarbons — 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

Alkanes — Structure and Preparation

1. Write any two methods for the preparation of alkanes.
2. Explain why alkanes are chemically less reactive.
3. Explain the structure of alkanes (sp^3 hybridisation, tetrahedral carbon).

Reactions of Alkanes

1. Explain the free radical mechanism of the chlorination of methane.
2. Write the products of the complete and incomplete combustion of methane.
3. Write the order of reactivity of halogens with alkanes.

Alkenes — Unsaturation and Preparation

1. Write any two methods for the preparation of alkenes.
2. Explain the structure of the $C=C$ double bond in ethene.
3. Why are alkenes called unsaturated hydrocarbons?

Addition Reactions of Alkenes

1. State Markovnikov's rule and apply it to the addition of HBr to propene.
2. Write the reactions of an alkene with H_2 , Br_2 and H_2O .
3. Explain Markovnikov's rule using the stability of carbocation intermediates.

Alkynes

1. Describe the structure of the $C\equiv C$ triple bond in ethyne.
2. Write any two methods for the preparation of alkynes.
3. Why are terminal alkynes acidic in nature?

Aromatic Hydrocarbons — Benzene

1. Explain the aromaticity of benzene using Hückel's rule.
2. Write the reactions of benzene for nitration and halogenation.
3. State Hückel's rule for aromaticity.

Part B — Integrated problems (multi-topic)

1. Write the chemical equation for the preparation of ethane by the reduction of ethyl bromide.
2. Explain the free radical mechanism of the chlorination of methane with the initiation, propagation and termination steps.
3. State Markovnikov's rule and predict the product of the addition of HBr to propene.
4. Why is the $\text{C}\equiv\text{C}-\text{H}$ bond of a terminal alkyne acidic? Write one reaction that demonstrates it.
5. Explain why benzene undergoes electrophilic substitution rather than addition, using Hückel's rule.

Answer Key**Alkanes — Structure and Preparation**

General formula $\text{C}_n\text{H}_{2n+2}$; sp^3 hybridised tetrahedral carbon. Prepared by the reduction of alkyl halides or the hydrogenation of alkenes. Alkanes are less reactive because the C–C and C–H bonds are strong and non-polar.

Reactions of Alkanes

Main reaction: free radical substitution with halogens (initiation, propagation, termination). Complete combustion gives $\text{CO}_2 + \text{H}_2\text{O}$. Reactivity of halogens: $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$.

Alkenes — Unsaturation and Preparation

General formula C_nH_{2n} ; doubly bonded carbon is sp^2 . Prepared by the dehydration of alcohols. The C=C bond has one sigma and one pi bond; the pi bond makes alkenes reactive.

Addition Reactions of Alkenes

Hydrogenation (H_2/Ni), halogenation (Br_2), hydrohalogenation (HBr) and hydration ($\text{H}_2\text{O}/\text{H}^+$). Markovnikov's rule: the negative part adds to the carbon with fewer hydrogens, favoured by the more stable carbocation.

Alkynes

General formula $\text{C}_n\text{H}_{2n-2}$; triply bonded carbon is sp . The $\text{C}\equiv\text{C}$ bond has one sigma and two pi bonds. Terminal alkynes are acidic because the sp carbon holds the C–H electrons tightly (sodium acetylide formation).

Aromatic Hydrocarbons — Benzene

C_6H_6 , planar cyclic, delocalised 6 pi electrons ($4n + 2$, $n = 1$) → aromatic. Undergoes electrophilic substitution (nitration, halogenation) to preserve aromaticity.

Integrated problems

1: $\text{CH}_3\text{CH}_2\text{Br} + \text{H}_2 (\text{Zn}/\text{H}^+) \rightarrow \text{CH}_3\text{CH}_3$. 2: Initiation $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$; propagation $\text{CH}_4 + \text{Cl}\cdot \rightarrow \text{CH}_3\cdot + \text{HCl}$, $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$; termination combination of radicals. 3: $\text{CH}_3-\text{CH}=\text{CH}_2 + \text{HBr} \rightarrow \text{CH}_3-\text{CHBr}-\text{CH}_3$ (2-bromopropane). 4: sp carbon, acidic H; $2\text{HC}\equiv\text{CH} + 2\text{Na} \rightarrow 2\text{HC}\equiv\text{CNa} + \text{H}_2$. 5: Delocalisation gives aromatic stability; addition would destroy it.