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Give Short Answers of the Following Questions

1. Define the following:

- i) Cycloalkanes ii) Isomerism iii) Conjugated dienes iv) Industrial effect

Ans. (i) Cycloalkanes: Cycloalkanes are saturated hydrocarbons with carbon atoms arranged in a ring structure, containing only single bonds.

General formula: $C_n H_{2n}$

ii) Isomerism

Two or more compounds having the same molecular formula but different structural formulas and properties are said to be isomers and the phenomenon is called isomerism.

iii) Conjugated dienes

Conjugated dienes are organic compounds that contain two double bonds separated by a single bond. The double bonds are alternating (i.e., conjugated) in the carbon chain.

iv) Inductive effect

The inductive effect refers to the transmission of charge through a chain of atoms in a molecule by the polarization of sigma bonds. It occurs when an atom or group of atoms in a molecule either donates electron density (electron-donating) or withdraws electron density (electron-withdrawing) through the sigma bonds.

2. Differentiate between:

- i) Aliphatic and Aromatic hydrocarbons ii) Homolytic and Heterolytic fission
iii) Electrophile and Nucleophile

Ans. i) Aliphatic and Aromatic hydrocarbons

Property	Aliphatic Hydrocarbons	Aromatic Hydrocarbons
Structure	Open chain (straight or branched) or non-aromatic rings	Contain one or more benzene rings (aromatic rings)
Bonding	May have single, double, or triple bonds.	Contain delocalized π -electrons in a ring structure
Stability	Less stable than aromatics	Highly stable due to resonance
Types	Alkanes, alkenes, alkynes, and cycloalkanes	Benzene, toluene, naphthalene, etc.
Reactivity	Generally more reactive	Less reactive toward addition reactions
Example	Ethane (C_2H_6), propene (C_3H_6). Butyne (C_4H_6).	Benzene (C_6H_6), Toluene (C_7H_8)

ii) Homolytic and Heterolytic fission

Feature	Homolytic Fission	Heterolytic Fission
Bond breaking	Bond breaks evenly	Bond breaks unevenly
Electron distribution	Each atom gets one electron	One atom gets bonding electrons
Produces	Free radicals	Ions (cation and anion)

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Occurs in	Non-polar solvents or under high energy (e.g. UV light)	Polar solvents or in presence of electrophiles/nucleophiles
Example	$\text{Cl-Cl} \rightarrow \text{Cl}^\bullet + \text{Cl}^\bullet$	$\text{H-Cl} \rightarrow \text{H}^+ + \text{Cl}^-$

iii) Electrophile and Nucleophile

Property	Electrophile	Nucleophile
Definition	Electron-deficient species	Electron-rich species
Electron behavior	Accepts electron pairs	Donates electron pairs
Charge	Often positively charged or neutral	Often negatively charged or neutral
Affinity	Attracted to electron-rich centers	Attracted to electron-deficient centers
Role in reactions	Acts as a Lewis acid	Acts as a Lewis base
Example	H^+ , NO_2^+ , AlCl_3 , BF_3	OH^- , NH_3 , Cl^- , CN^-

3. Explain why alkanes do not undergo addition reactions.

Ans. Alkanes do not undergo addition reactions because:

- They are saturated hydrocarbons, meaning all carbon-carbon bonds are single (σ) bonds.
 - These σ -bonds are strong and stable, and there are no regions of high electron density like double or triple bonds for an electrophile to attack.
 - Addition reactions typically occur with unsaturated compounds (like alkenes or alkynes), which have π -bonds that are more reactive.
- In short, Alkanes lack π -bonds, making them chemically inert toward addition reactions and more likely to undergo substitution reactions instead.

4. How elimination reaction is considered the opposite of an addition reaction.

Ans. An elimination reaction is considered the opposite of an addition reaction because:

- In an addition reaction, atoms or groups are added to a molecule, typically converting a double or triple bond into a single bond.
- In an elimination reaction, atoms or groups are removed from a molecule, typically forming a double or triple bond from a single bond.

Alkanes do not undergo elimination reactions under normal conditions because:

- Elimination reactions require a molecule to have a leaving group (like -OH, -Br, -Cl) on one carbon and a B-hydrogen (on an adjacent carbon).
- Alkanes consist of only C-C and C-H single bonds and do not have good leaving groups naturally.
- They are also non-polar and chemically stable, making it hard to break bonds without strong reagents or high energy.

In short, Alkanes lack both the leaving groups and reactive centres needed for elimination, so they

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do not undergo elimination reactions unless first converted to more reactive derivatives (like alkyl halides).

5. Compare the carbocation stability in propene and 2-butene.

Ans. (i) Propene ($\text{CH}_3\text{-CH=CH}_2$)

- If a proton is removed from the double bond, the most likely carbocation formed is the allyl carbocation ($\text{CH}_2 = \text{CH} - \text{CH}_2^+$).
- This allylic carbocation is resonance-stabilized, meaning the positive charge is delocalized over two carbon atoms.
- **Stability:** Relatively stable due to resonance.

(ii) 2-Butene ($\text{CH}_3\text{-CH=CH-CH}_3$)

- Ionization typically leads to a secondary carbocation ($\text{CH}_3\text{-C}^+\text{H-CH=CH}_3$).
- There is no resonance stabilization unless rearrangement occurs.
- **Stability:** Less stable than the allylic carbocation of propene.

6. Give the molecular formula C_5H_{10} , list all possible structural isomers that are alkenes.

Ans. C_5H_{10} Alkene Isomers:

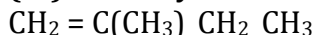
(i) Pent-1-ene



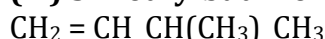
(ii) Pent-2-ene



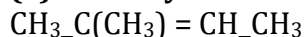
(iii) 2-Methylbut-1-ene



(iv) 3-Methylbut-1-ene



(v) 2-Methylbut-2-ene



7. When propene (C_3H_6) undergoes electrophilic addition with HBr, it forms 2-bromopropane as the major product. Explain why 2-bromopropane is favored over 1-bromopropane using the concept carbocation stability.

Ans. When propene ($\text{CH}_3\text{-CH=CH}_2$) reacts with HBr, the reaction proceeds via an electrophilic addition mechanism. The major product is 2-bromopropane, and this can be explained using carbocation stability:

Explanation:

1. Electrophilic attack:

The π electrons of the double bond attack the H^+ from HBr.

This can lead to two possible carbocations:

- Path A (less stable): H^+ adds to the CH_2 end, forming a primary carbocation ($\text{CH}_3\text{-CH-CH}_2^+$)
- Path B (more stable): H^+ adds to the CH end, forming a secondary carbocation ($\text{CH}_3\text{-C}^+\text{H-CH}_3$)

2. Carbocation stability:

- Primary carbocations are less stable
- Secondary carbocations are more stable due to hyperconjugation and inductive effects from surrounding alkyl groups

3. Nucleophilic attack:

- Br^- then attacks the more stable secondary carbocation, leading to 2-bromopropane.

Conclusion:

2-bromopropane is the major product because its formation proceeds through a more stable secondary carbocation, following Markovnikov's rule.

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8. Explain why conjugated alkenes may show different reactivity compared to isolated alkenes.

Ans. As Conjugated alkenes show different reactivity compared to isolated alkenes due to delocalization of π electrons across alternating double and single bonds.

Aspect	Conjugated Alkenes	Isolated Alkenes
Structure	Alternating double and single bonds.	Double bonds separated by two or more single bonds.
Electron delocalization	π - electrons are delocalized across the system.	π - electrons are localized between two atoms.
Stability	More stable due to resonance.	Less stable.
Reactivity	Can undergo special reactions (e.g. 1, 4-addition).	React through normal electrophilic addition only.
UV/Visible absorption	Often absorb at longer wavelengths.	Less likely to absorb in the visible range.

9. Explain how inductive effects from alkyl groups stabilize carbocations in alkenes.

Ans. Inductive effects from alkyl groups help stabilize carbocations in alkenes by donating electron density through sigma (σ) bonds toward the positively charged carbon.

- Carbocations are electron-deficient species (positively charged carbon).
- Alkyl groups (like $-\text{CH}_3$ or $-\text{CH}_2\text{CH}_3$) have a slight electron-releasing character.
- Through the inductive effect, they push electron density toward the carbocation, reducing its positive charge and making it more stable.

Relative stability of carbocation due to inductive effects:

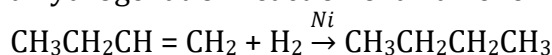
- **Tertiary carbocation** (3 alkyl groups) → Most stable
- **Secondary carbocation** (2 alkyl groups)
- **Primary carbocation** (1 alkyl group)
- **Methyl carbocation** (no alkyl groups) → Least stable

10. Write the equation for each reaction.

- $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ with H_2 (Ni catalyst)
- $\text{CH}_3\text{CH}=\text{CH}_2$ with Cl_2
- $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$ with H_2O (H_2SO_4 catalyst)

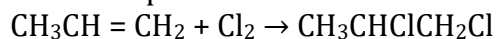
Ans. i. $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ with H_2 (Ni catalyst)

This is a hydrogenation reaction of an alkene.



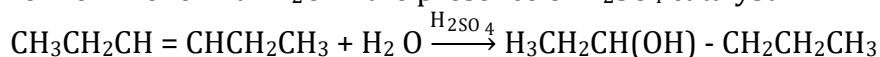
ii. $\text{CH}_3\text{CH}=\text{CH}_2$ with Cl_2

This is an electrophilic addition of chlorine to an alkene.



iii. $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$ with H_2O (H_2SO_4 catalyst)

It is Hydration of hex-2-ene with H_2O in the presence of H_2SO_4 catalyst



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10. Write structural formulas for each of the following compounds.

- (i) Isobutylene (ii) 2,3,4,4-Tetramethyl-2-pentene (iii) 2,5-Heptadiene
 (iv) 4,5-Dimethyl-2-hexene (v) Vinyl acetylene (vi) 1,3-pentadiene
 (vii) 1-Butyne (viii) 3-n-propyl-1,4-pentadiene (ix) Vinyl bromide
 (x) But-1-en-3-yne (xi) 4-Methyl-2-pentyne (xii) Isopentane

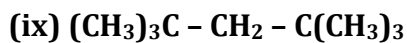
Ans. Structural Formula

i. Isobutylene $\text{CH}_3 - \text{C} = \text{CH}_2$ $\quad \quad $ $\quad \quad \text{CH}_3$ (IUPAC Name = 2-Methylpropene)	ii. 2,3,4,4-Tetramethyl-2-pentene $\quad \quad \quad \text{CH}_3$ $\quad \quad \quad $ ${}^5\text{CH}_3 - {}^4\text{C} - {}^3\text{C} = {}^2\text{C} - {}^1\text{CH}_3$ $\quad \quad \quad \quad \quad \quad $ $\quad \quad \text{CH}_3 \quad \text{CH}_3 \quad \text{CH}_3$
iii. 2,5-Heptadiene ${}^7\text{CH}_3 - {}^6\text{CH} = {}^5\text{CH} - {}^4\text{CH}_2 - {}^3\text{CH} = {}^2\text{CH} - {}^1\text{CH}_3$	iv. 4,5-Dimethyl-2-hexene ${}^6\text{CH}_3 - {}^5\text{CH} - {}^4\text{CH} - {}^3\text{CH} = {}^2\text{CH} - {}^1\text{CH}_3$ $\quad \quad \quad \quad $ $\quad \quad \text{CH}_3 \quad \text{CH}_3$
v. Vinyl acetylene $\text{H}_2\text{C} = \text{CH} - \text{C} \equiv \text{CH}$	vi. 1,3-Pentadiene ${}^5\text{CH}_3 - {}^4\text{CH} = {}^3\text{CH} - {}^2\text{CH} - {}^1\text{CH}_2$
vii. 1-Butyne ${}^4\text{CH}_3 - {}^3\text{CH}_2 - {}^2\text{C} \equiv {}^1\text{CH}$	viii. 3-n-Propyl-1,4-pentadiene ${}^5\text{CH}_2 = {}^4\text{CH} - {}^3\text{CH} - {}^2\text{CH} = {}^1\text{CH}_2$ $\quad \quad $ $\quad \quad \text{CH}_2 - \text{CH}_2 - \text{CH}_2$
ix. Vinyl bromide $\text{H}_2\text{C} = \text{CH} - \text{Br}$	x. But-1-en-3-yne ${}^1\text{CH}_2 - {}^2\text{CH} - {}^3\text{C} \equiv {}^4\text{CH}$
xi. 4-Methyl-2-pentyne ${}^5\text{CH}_3 - {}^4\text{C} - {}^3\text{C} = {}^2\text{C} - {}^1\text{CH}_3$ $\quad \quad $ $\quad \quad \text{CH}_3$	xii. Isobutylene ${}^4\text{CH}_3 - {}^3\text{CH}_2 - {}^2\text{CH} - {}^1\text{CH}_3$ $\quad \quad \quad $ $\quad \quad \quad \text{CH}_3$

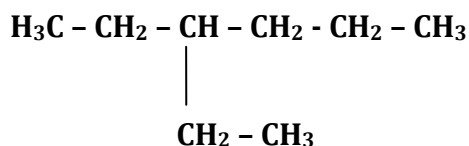
11. Write down names of the following compounds according to IUPAC - System.

- (i) $\text{H}_3\text{C} - \text{CH} = \text{CH}(\text{CH}_2)_2\text{CH}_3$ (ii) $(\text{CH}_3)_2\text{C} = \text{CH}_2$
 (iii) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{C} = \text{CH}_2$ (iv) $\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$
 $\quad \quad \quad |$
 $\quad \quad \quad \text{CH}(\text{CH}_3)_2$
 (v) $\text{CH}_2 = \text{C} - \text{CH}_2\text{CH}_2\text{CH}_3$ (vi) $(\text{CH}_3\text{CH}_2)_3\text{CH}$
 $\quad \quad |$
 $\quad \quad \text{C}_2\text{H}_5$
 (vii) $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}_3$ (viii) $\text{CH}_2 = \text{CH} - \text{C} \equiv \text{C} - \text{CH} + \text{CH}_2$

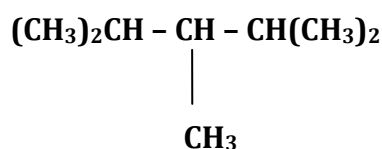
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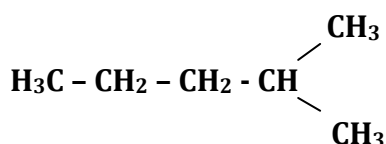
(a)



(b)



(c)



Ans. IUPAC Names

i. $\text{H}_3\text{C}^1 - ^2\text{CH} = ^3\text{CH} - ^4\text{CH}_2 - ^5\text{CH}_2 - ^6\text{CH}_3$ 2-Hexene	ii. $\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3 - \text{C} = \text{CH}_2 \end{array}$ 2-Methylpropene
iii. $^5\text{CH}_3 - ^4\text{CH}_2 - ^3\text{CH}_2 - ^2\text{C} = ^1\text{CH}_2$ $\quad \quad \quad $ $\quad \quad \quad \text{CH}_3 - \text{HC} - \text{CH}_3$ 2-Isopropyl-1-pentene	iv. $\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$ 1,3 - Butadiene
v. $^1\text{CH}_2 = ^2\text{C} - ^3\text{CH}_2^4\text{CH}_2^5\text{CH}_3$ $\quad \quad \quad $ $\quad \quad \quad \text{C}_2\text{H}_5$ 2-Ethyl-1-pentene	vi. $\begin{array}{c} ^1\text{CH}_3 \\ \\ ^2\text{CH}_2 \\ \\ \text{CH}_3 - \text{CH}_2 - ^3\text{CH} \\ \\ ^4\text{CH}_2 \\ \\ ^5\text{CH}_3 \end{array}$ 3-Ethylpentane
vii. $\begin{array}{c} \text{CH}_3 \\ \\ \text{H}_3^1\text{C} - ^2\text{CH}_2 - ^3\text{C} - ^4\text{CH} - \text{CH}_3 \\ \quad \\ \text{CH}_3 \quad ^5\text{CH}_2 \\ \\ ^6\text{CH}_3 \end{array}$ 3,3,4-Trimethylhexane	viii. $^1\text{CH}_2 = ^2\text{CH} - ^3\text{C} \equiv ^4\text{C} - ^5\text{CH} = ^6\text{CH}_2$ 1,5-Hexadien-3-yne

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ix. $ \begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \quad \\ \text{H}_3\text{C} - \text{C} - \text{CH}_2 - \text{C} - \text{CH}_3 \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array} $ 2,2,4,4 - tetramethylPentane	x. ${}^1\text{CH}_2 = {}^2\text{CH} - {}^3\text{C} \equiv {}^4\text{CH}$ 1-Buten-3-yne
xi. $ \begin{array}{c} \text{CH}_3 \\ \\ \text{H}_3\text{C} - \text{C} - \text{CH}_2 - \text{CH}_3 \\ \\ \text{CH}_3 \end{array} $ 2,2 - dimethylbutane	a) $ \text{H}_3 - {}^1\text{C} - {}^2\text{CH}_2 - {}^3\text{CH} - {}^4\text{CH}_2 - {}^5\text{CH}_2 - {}^6\text{CH}_3 $ $\text{CH}_2 - \text{CH}_3$ 3-ethylhexane
b) $ \begin{array}{c} {}^1\text{CH}_3 - {}^2\text{CH} - {}^3\text{CH} - {}^4\text{CH} - {}^5\text{CH}_3 \\ \quad \quad \\ \text{CH}_3 \quad \text{CH}_3 \quad \text{CH}_3 \end{array} $ 2,3,4- trimethylpentane	c) $ \text{H}_3 - {}^5\text{C} - {}^4\text{CH}_2 - {}^3\text{CH}_2 - {}^2\text{CH} - {}^1\text{CH}_3 $ CH_3 2-Methylpentane