



# Alkanes

# **PREPARATION OF ALKANES (PART-I)**

# **ALKANES**

## **Preparation of alkanes**

**1. From unsaturated hydrocarbons**

**2. From alkyl halides**

**3. From salts of carboxylic acids**

# ALKANES

## 1. From unsaturated hydrocarbons

➤ When  
w

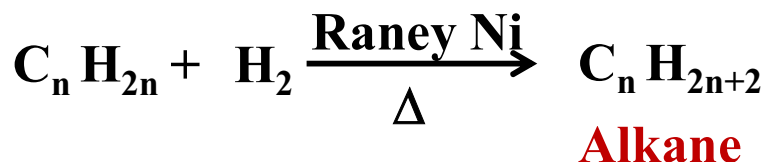
Reaction of alkenes or alkynes with  
Hydrogen in presence of Raney Ni at  $300^{\circ}\text{C}$  is  
called sabatier –sendren's reaction.

Crude oil and natural gas  
are the main sources of  
alkanes.

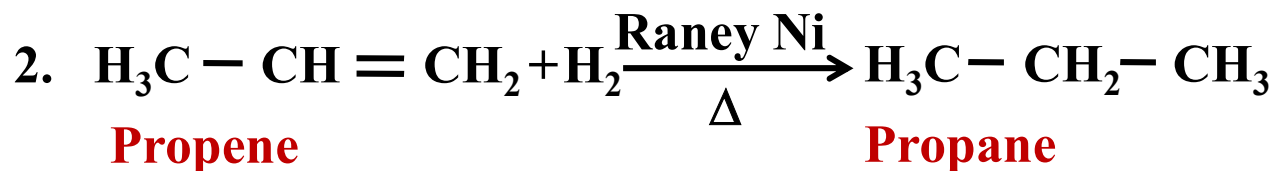
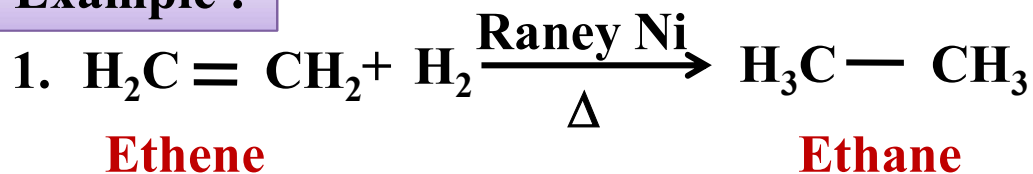
## ALKANES

### 1. From unsaturated hydrocarbons

#### a. Alkene



#### Example :

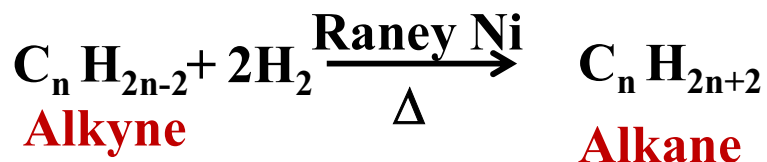


Widely used industrially with hydrogen gas

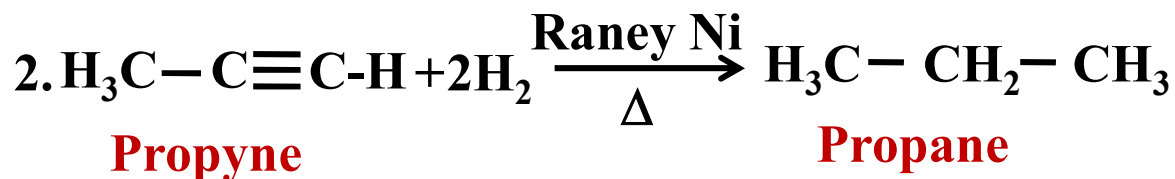
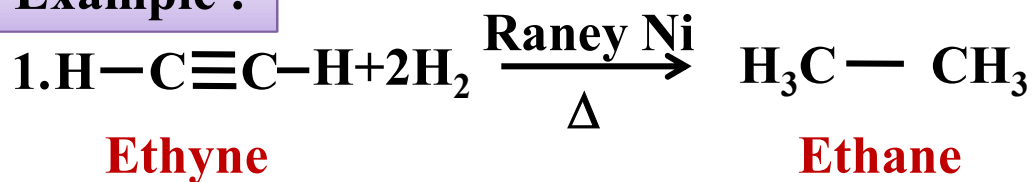
# ALKANES

## 1. From unsaturated hydrocarbons

### b. Alkyne



Example :



When Alkyne reacts with hydrogen gas

## ALKANES

*MCQs*

1. Reaction of Ethylene with Hydrogen gas in the presence of Raney nickel gives ?

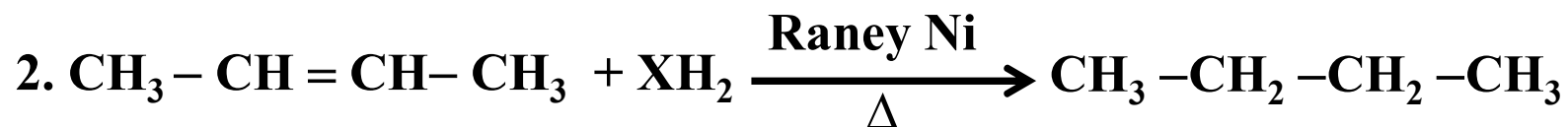
a) Methane

b) Ethene

 c) Ethane

d) Butane

## ALKANES



identify X ?

a) 3 moles

b) 2 moles

 c) 1 mole

d) 10 moles



## ALKANES

# PREPARATION OF ALKANES (PART-II)

# ALKANES

## 2. From alkyl halides

### (a) By reduction

Reduction of alkyl halides (Except fluorides) with zinc and dilute hydro chloric acid gives Alkanes



EX:

Reduction of methyl chloride with zinc and dilute Hydro chloric acid [provides  $\text{H}^+$ ] forms methane



## ALKANES

In the same way



For same type of reduction instead of Zn+HCl, we can use reducing agents like Zn + CH<sub>3</sub>COOH, Zn-NaOH, Zn-Cu/C<sub>2</sub>H<sub>5</sub>OH Na+C<sub>2</sub>H<sub>5</sub>OH or HI/Red P.



1- Chloro propane



Propane

# ALKANES

## 2. From alkyl halides

### (b) By wurtz reaction

- When alkyl halides react with sodium metal in presence of dry ether, alkanes are formed.

Because, by this reaction, a mixture of alkanes are obtained which have less difference in B.Pts so it becomes difficult to separate

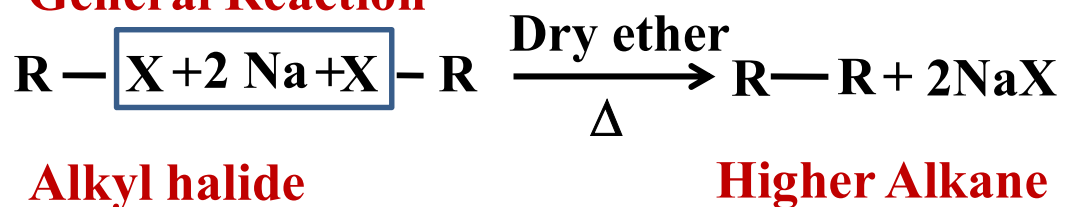
- This reaction is called *Wurtz reaction*.
- This method is used to prepare higher alkanes of even number of carbon atoms.

# ALKANES

## 2. From alkyl halides

### (b) By wurtz reaction

#### General Reaction



In the presence of dry  
ether as a solvent  
Higher alkane is formed

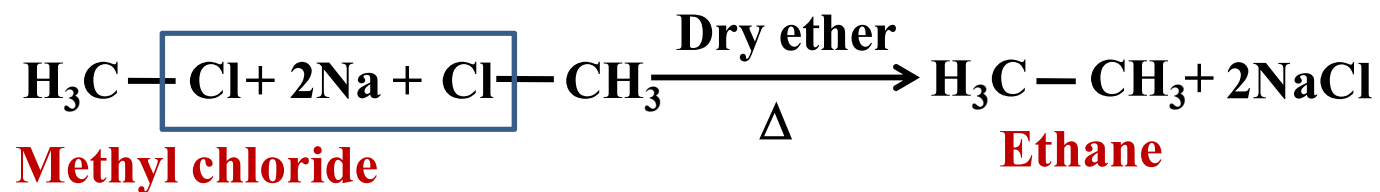
# ALKANES

## 2. From alkyl halides

### (b) By Wurtz reaction

- When different alkyl halides are taken, mixture of hydrocarbons will be formed.

e.g: 1

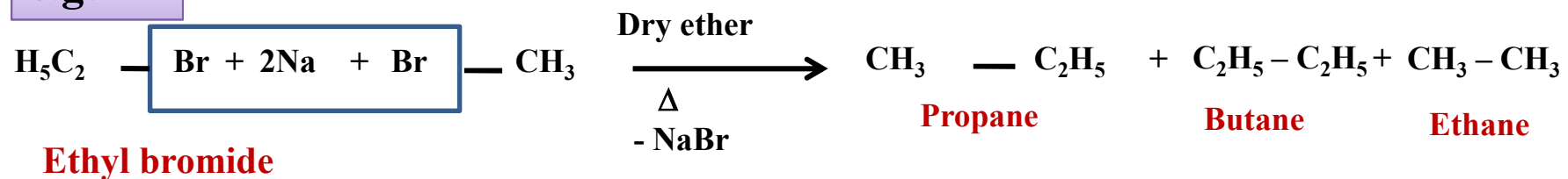


# ALKANES

## 2. From alkyl halides

### (b) By Wurtz reaction


e.g:



## ALKANES

MCQs

1.  $\text{C}_2\text{H}_5\text{Cl}$ , in Wurtz reaction gives \_\_\_\_\_?

- a) ethane
- b) propane
-  c) butane
- d) hexane



## ALKANES

2. Propyne under hydrogenation, gives \_\_\_\_\_?

a) ethane

 b) propane

c) methane

d) none of the above

# **PREPARATION OF ALKANES (PART-III)**

## ALKANES

### 3.From salts carboxylic acids

#### a) By decarboxylation of **Sodium** salt of fatty acids

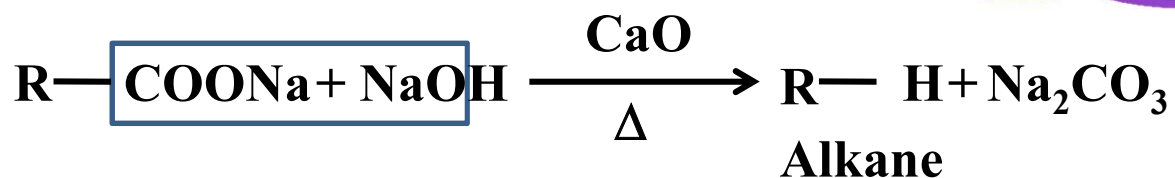
- When sodium salts of carboxylic acids are heating with soda lime[NaOH + CaO] give alkanes, containing one carbon less than carboxylic acid.
- This reaction is called as **decarboxylation**.

## ALKANES

### 3. From salts carboxylic acids

#### a) By decarboxylation of **Sodium** salt of fatty acid

##### General Reaction



When RCOONa is heated

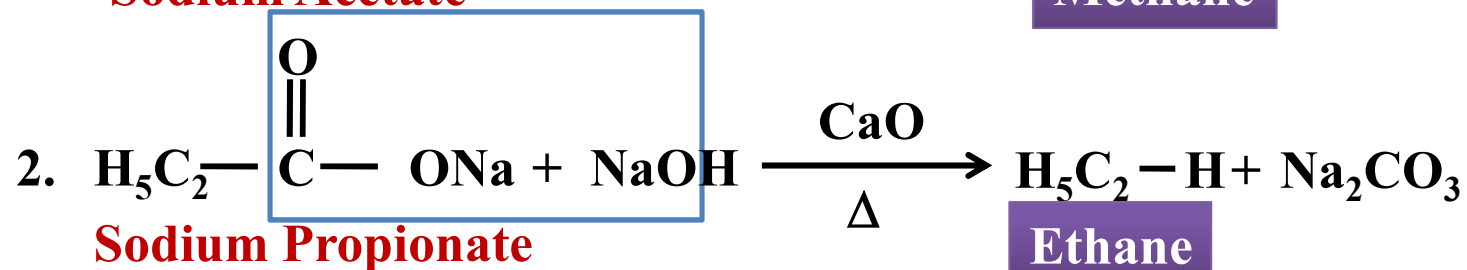
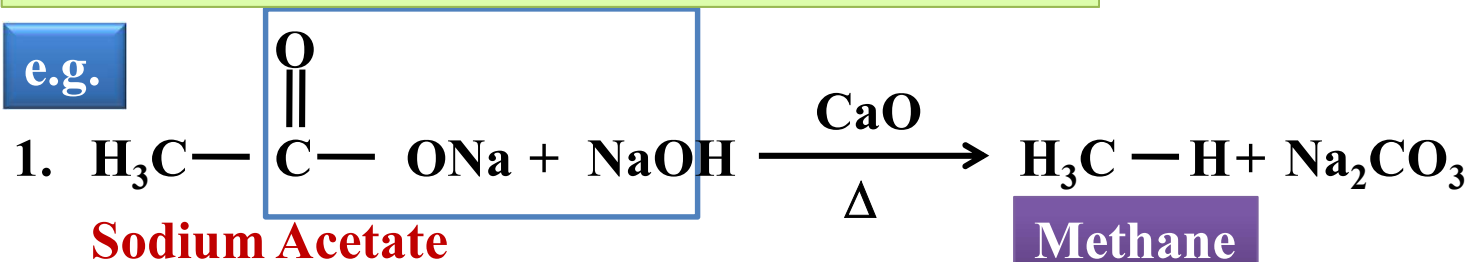


## ALKANES

### 3. From salts carboxylic acids

#### a) By decarboxylation of Na salt of fatty acid

e.g.

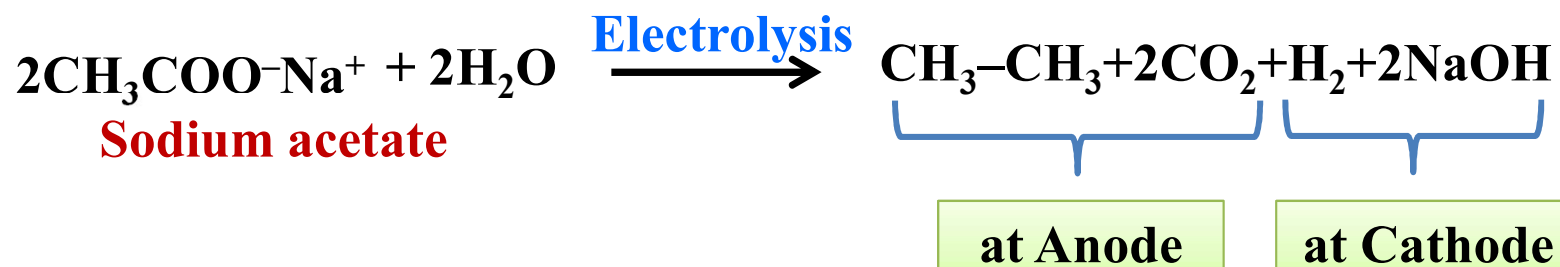


## ALKANES

### 3. From carboxylic acids

#### (b) Kolbe's electrolysis

- When an aqueous solution of sodium or potassium salt of a carboxylic acid is subjected to electrolysis gives alkane, containing even number of carbon atoms.

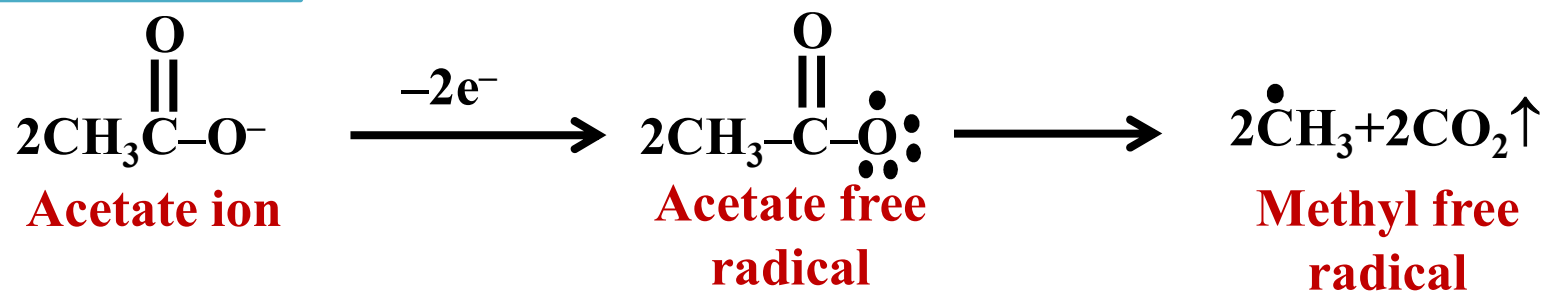


## ALKANES

### Mechanism



ii) At anode

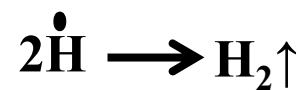
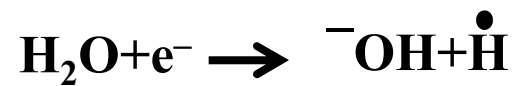


## ALKANES

### Mechanism



iv) At cathode

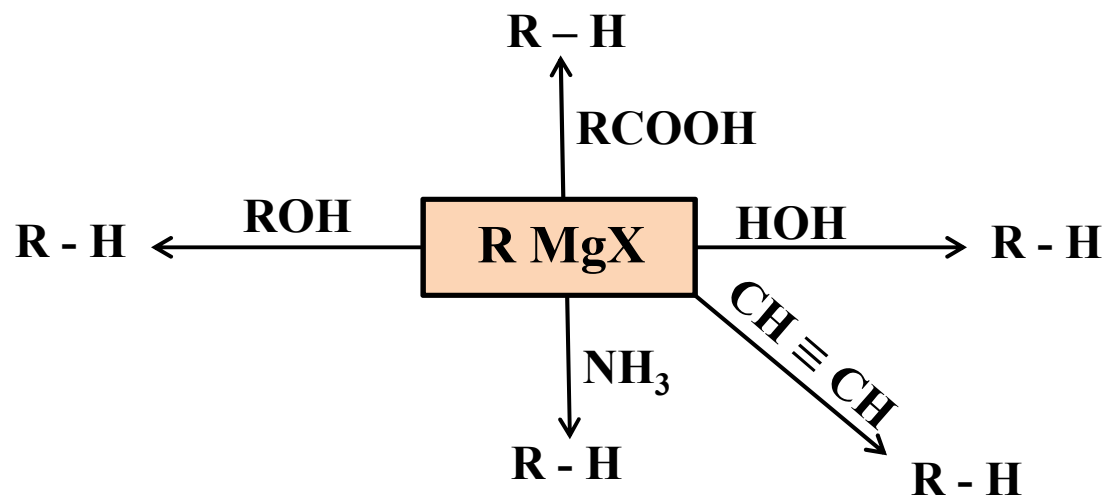




## ALKANES

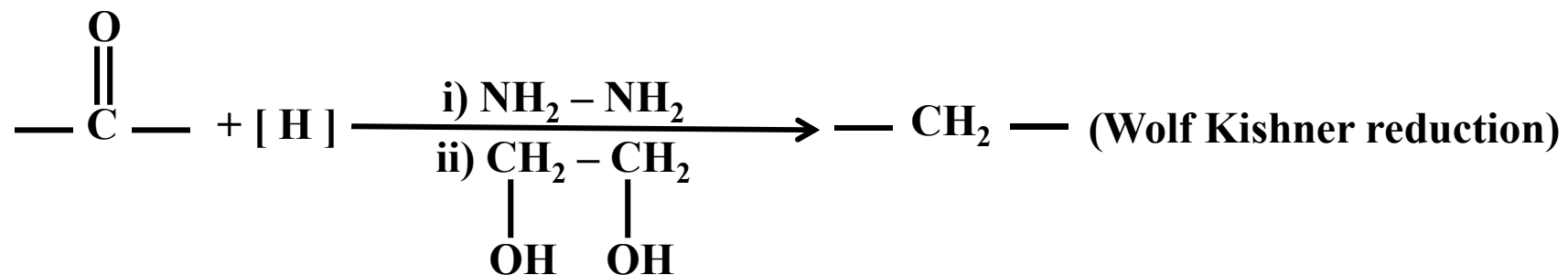
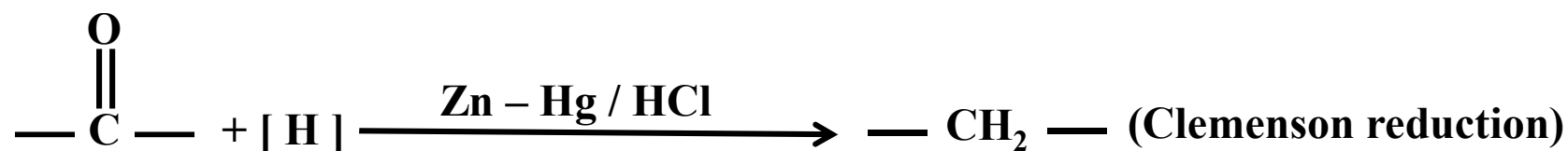
### ADDITIONAL INFORMATION

#### i) Preparation of alkanes ( From Grignard reagent)



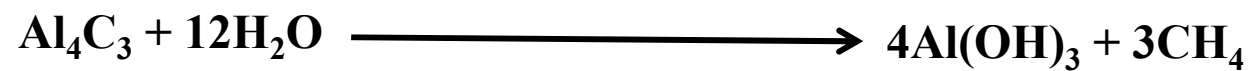
## ALKANES

ii) From carbonyl compounds :



## ALKANES

### iii) Preparation of methane



## ALKANES

## MCQs

1. Which of the following compound can not be prepared by Kolbe's electrolysis?



## ALKANES

2. The products formed at anode in kolbes electrolysis of sodium acetate ?

a)  $\text{CH}_3\text{-CH}_3$

b)  $\text{CH}_3\text{-CH}_3, \text{H}_2$

 c)  $\text{CH}_3\text{-CH}_3, \text{CO}_2$

d)  $\text{CO}_2, \text{NaOH}$

## ALKANES

3. Sodium acetate heated with soda lime gives \_\_\_\_\_?

a) ethane

b) propane

 c) methane

d) none of the above

## ALKANES

# Physical properties of Alkanes

## ALKANES

### Physical properties of alkanes

- Alkanes are non-polar because of covalent nature of C-C and C-H bonds.
- Molecules possess only weak **vander Waal's** force of attractions.
- As the molecular weight increases, force of attractions also will increase.



## ALKANES

### Physical properties of alkanes

- The first four members of alkanes ( $C_1$  to  $C_4$ ) are gases.
- Next, ( $C_5$  to  $C_{17}$ ) are liquids & remaining alkanes are solids.

## **ALKANES**

### **Physical properties of alkanes**

### **Boiling point**

- **As the molecular weight increases, boiling point also increases.**
- **In case of chain isomers, the isomer with more branches has less boiling points.**
- **This is due to less surface area.**

## ALKANES

### Physical properties of alkanes

### Boiling point

- This results in smaller area of contact and weaker inter molecular forces.

e.g

In case of chain isomers of pentane, the order of boiling point is

**n-pentane > Isopentane > Neopentane**

# ALKANES

## Physical properties of alkanes

### Melting point

- Alkanes with even number of C atoms have more melting point than their preceding and succeeding odd 'C' alkanes.
- This is due to, alkanes with even number of carbon atoms pull closely and have greater intermolecular attractions.

# ALKANES

## Physical properties of alkanes

## Solubility

Like dissolves like

- **Polar compounds** are soluble in **polar solvents**.
- **Non polar compounds** are soluble in **non polar solvents**.
- Alkanes are **insoluble** in water and hydrophobic in nature.
- Alkanes are **soluble** in organic solvents.

## ALKANES

### Physical properties of alkanes

### Solubility

- As the molecular weight increases, solubility decreases.

e.g:

**Grease, a mixture of higher hydrocarbons is soluble in petrol.**

- **Petrol and lower fractions of petroleum are used for dry cleaning.**



## ALKANES

MCQs

1. Which of the following has the least melting point?

a) ethane


✓ b) propane

c) butane

d) pentane

## ALKANES

2. Which one of the following alkane has high boiling point ?

- a)  n- pentane
- b) Iso pentane
- c) Neo pentane
- d) Propane



**CHEMICAL  
PROPERTIES OF ALKANES  
(PART-I)**

# ALKANES

## Chemical Properties of alkanes

### 1. Substitution reactions

- One or more hydrogen atoms of alkanes can be replaced by halogens, nitro group and sulphonic acid group at high temperature (or) in the presence of light, these reactions are called **substitution reactions**.

# ALKANES

## Chemical Properties of alkanes

### 1. Substitution reactions

### Halogenation

- **Halogenation of alkanes takes place at high temperature (573 - 773 K) or in presence of the diffused sunlight.**

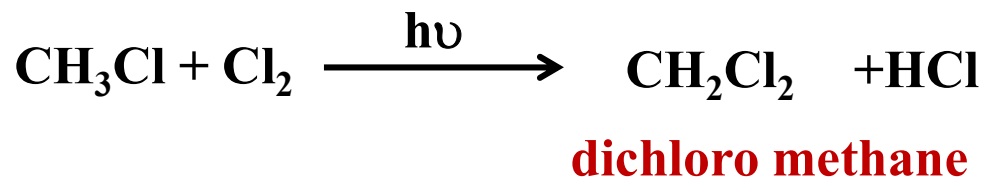
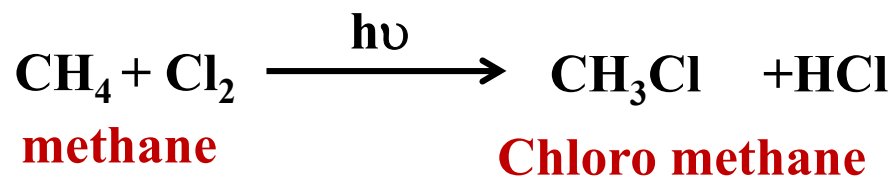
# ALKANES

## Chemical Properties of alkanes

### 1. Substitution reactions

### Halogenation

Example:



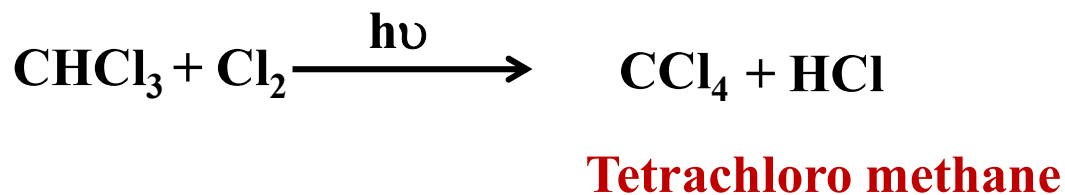
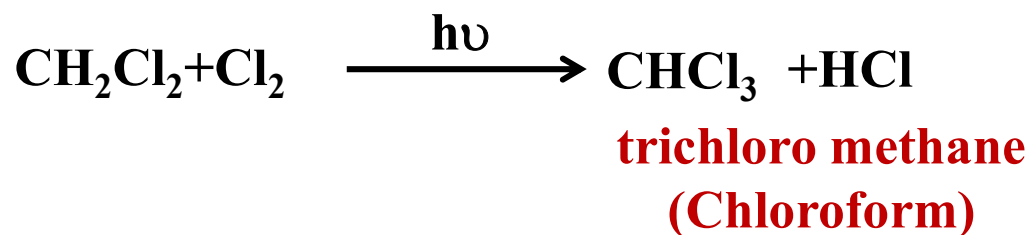
# ALKANES

## Chemical Properties of alkanes

### 1. Substitution reactions

### Halogenation

### Example:



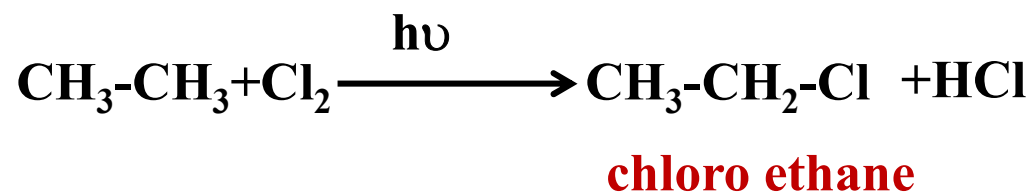
# ALKANES

## Chemical Properties of alkanes

### 1. Substitution reactions

### Halogenation

Example:



# ALKANES

## Mechanism

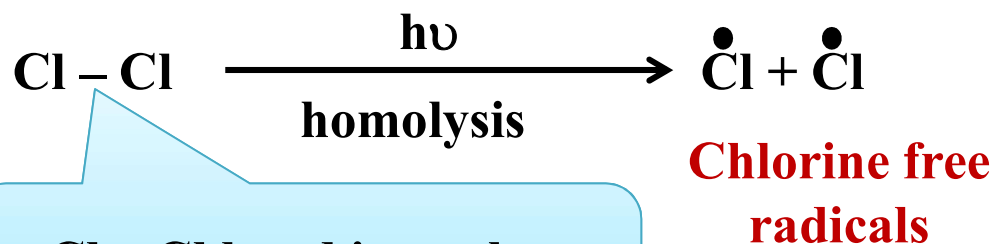
- Halogenation of alkanes is free radical substitution reaction.
- This mechanism involves 3 steps namely
  - i) Initiation
  - ii) Propagation
  - iii) Termination.

## ALKANES

### Mechanism

#### i) Initiation

- The reaction is initiated by homolysis of chlorine molecule in the presence of light or heat.



Cl – Cl bond is weaker than C-C and C–H bond



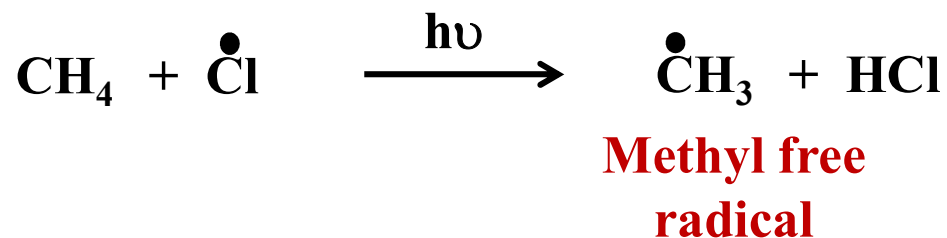
## ALKANES

### Mechanism

### ii) Propagation

- (a) When chlorine free radical attacks methane, it breaks the C-H bond to form methyl free radical and hydrogen chloride.

The reaction between a molecule and free radical is known as chain propagation reaction.

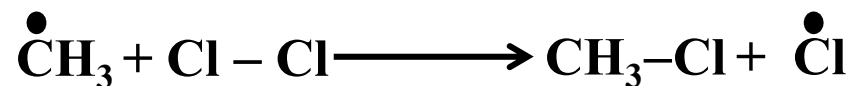


## ALKANES

### Mechanism

### ii) Propagation

(b) The methyl free radical attacks the 2<sup>nd</sup> molecule of chlorine to form CH<sub>3</sub>Cl & chlorine free radical.



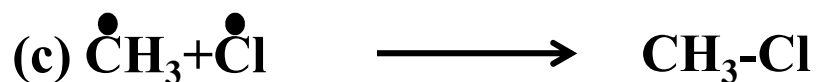
Both a & b steps repeat many number of times before obtaining the main products.

## ALKANES

### Mechanism

### iii) Termination

➤ The possible chain termination steps



The reaction between any two free radicals is known as chain termination reaction.

## ALKANES

### Make a note:

- Rate of the replacement of hydrogens of alkanes is



- Rate of the reaction of alkanes with halogens is



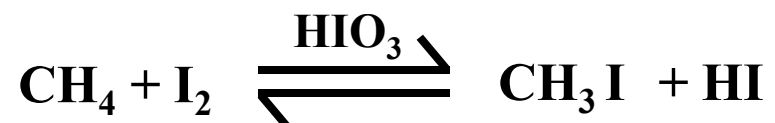
- Fluorination is too violent to be controlled.
- Iodination is very slow and a reversible reaction.

## ALKANES

**Make a note:**

- Iodination can be carried out in the presence of oxidising agents like  $\text{HIO}_3$  or  $\text{HNO}_3$

**Example:**



## ALKANES

## MCQs

1. Formation of chloro methane takes place from methane with chlorine in presence of sunlight is proceed through ?

- ✓ a) Free radical Mechanism
- b) Cationic Mechanism
- c) Anionic Mechanism
- d) Takes in single step (directly)

## ALKANES

2. The steps involve in halogenation of Ethane are...

a) initiation

b) Propagation

c) termination

 d) All of these

**CHEMICAL  
PROPERTIES OF ALKANES  
(PART-II)**



# ALKANES

## Chemical Properties of alkanes:

### 2. Combustion

- When alkanes are heated in the presence of oxygen, they oxidise to carbon dioxide and water.
- This is highly exothermic reaction.
- Hence used as fuels.

The reaction in which energy released is called exothermic reaction

## ALKANES

### Chemical Properties of alkanes:

### 2. Combustion:

Example:

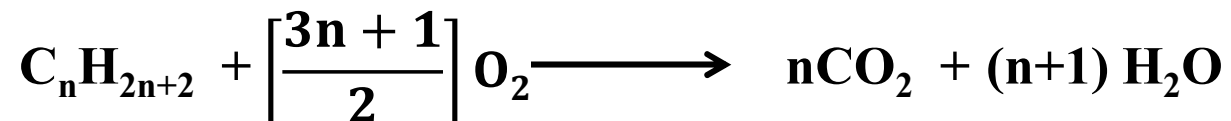


## ALKANES

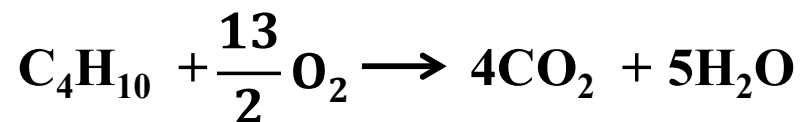
### Chemical Properties of alkanes:

### 2. Combustion:

- General combustion equation for any alkane is



- If  $n = 4$  then

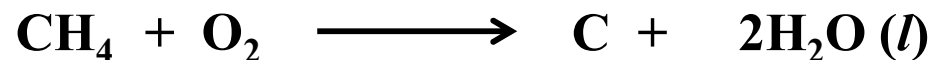


## ALKANES

### Chemical Properties of alkanes:

### 2. Combustion:

#### Incomplete combustion:



- Incomplete combustion of methane, carbon black is formed which is used in ink, black pigments and filters.

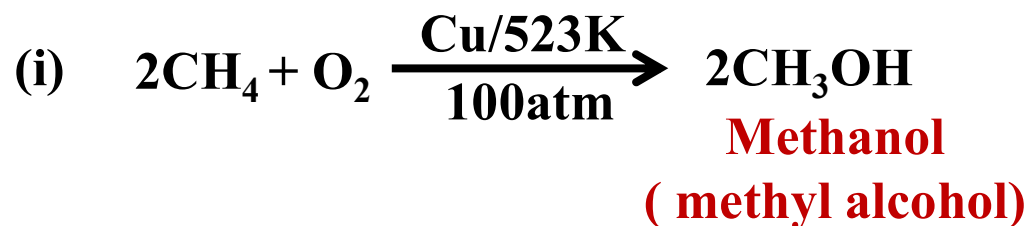
## ALKANES

### Chemical Properties of alkanes:

### 3. Controlled oxidation

- Alkanes on heating with limited supply of O<sub>2</sub> or air at high pressure and in the presence of catalyst give different products.

#### Example:

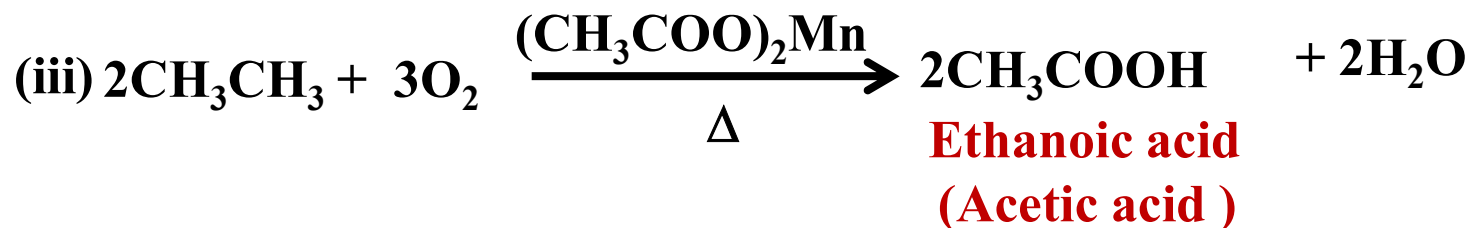
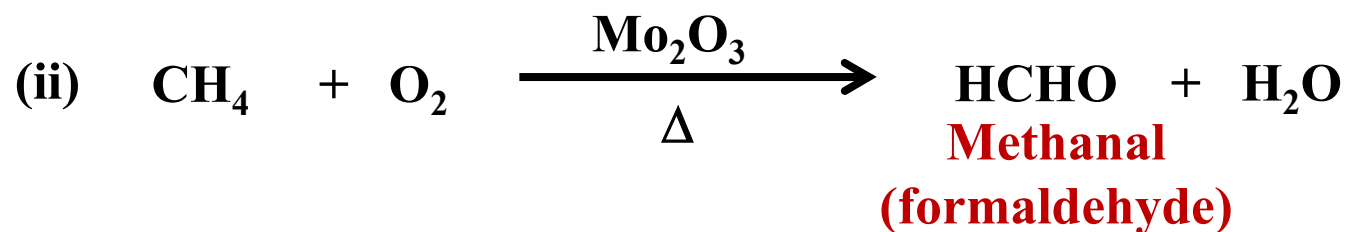


## ALKANES

### Chemical Properties of alkanes:

### 3. Controlled oxidation

Example:

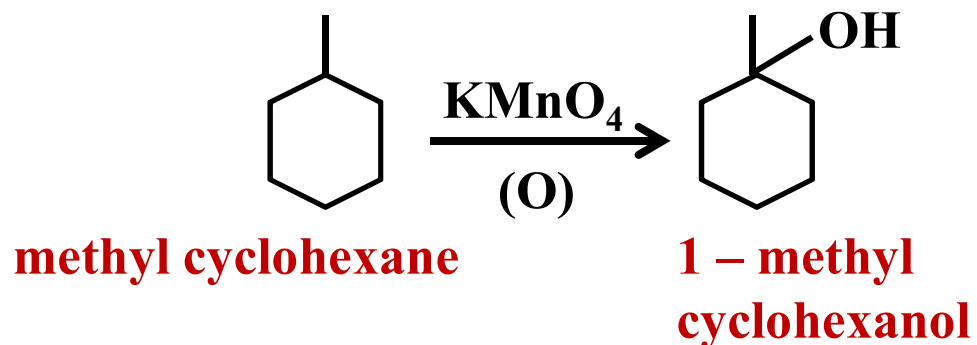
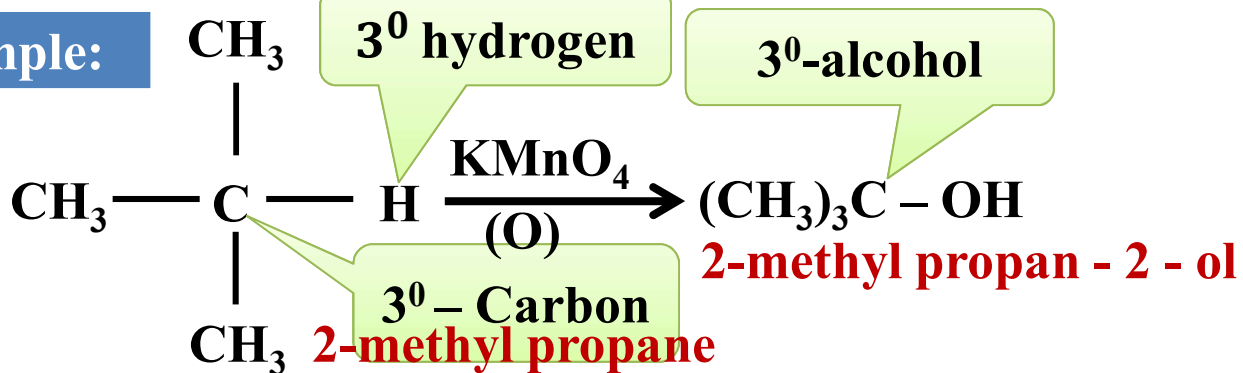


## ALKANES

### Chemical Properties of alkanes:

### 3. Controlled oxidation

Example:



## ALKANES

## MCQs

1. On controlled oxidation of ethane in presence of manganese acetate produces?

a) Methanal

 b) Acetic acid

c) Methanol

d) Carbon black



## ALKANES

2. No. of moles of oxygen require to complete combination of  $\text{C}_4\text{H}_{10}$ ?

a) 13

 b)  $\frac{13}{2}$

c) 7

d) 8

**CHEMICAL  
PROPERTIES OF ALKANES  
(PART-III)**

## ALKANES

### Chemical Properties of alkanes:

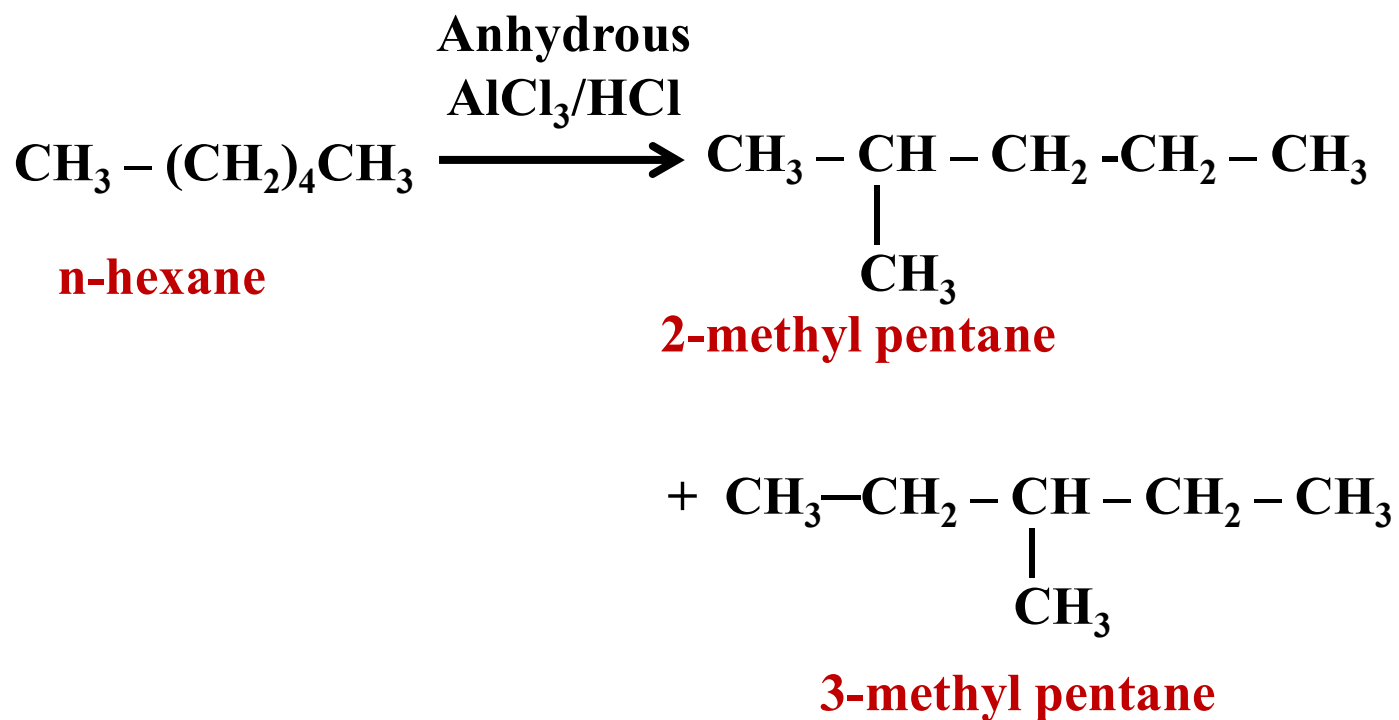
#### 4. Isomerization

- **n-alkanes on heating in the presence of anhydrous  $\text{AlCl}_3$  and HCl gas, isomerises to branched chain alkanes, this reaction is called isomerisation.**

## ALKANES

### Chemical Properties of alkanes:

### 4. Isomerization



## ALKANES

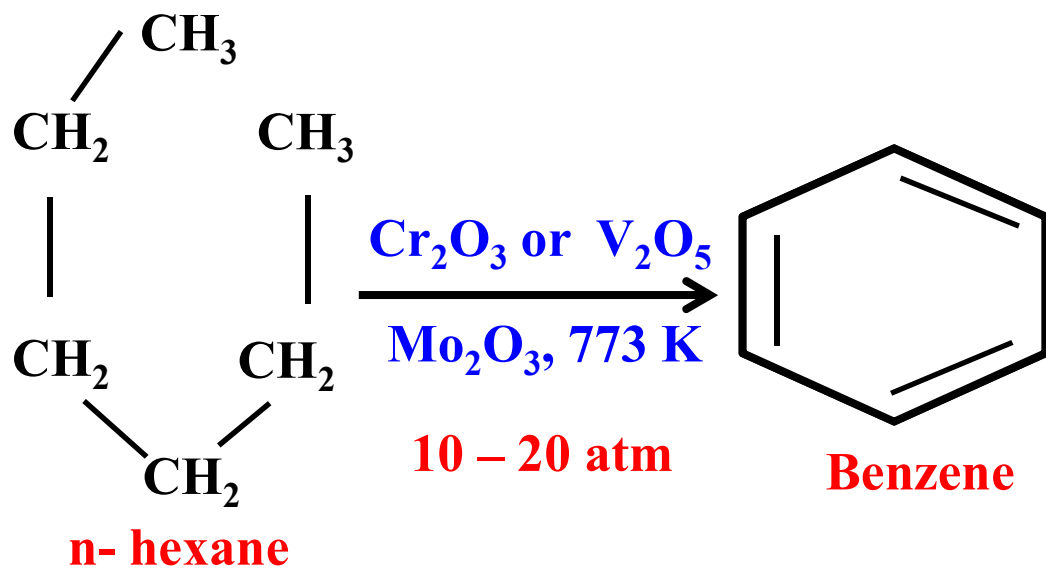
### Chemical Properties of alkanes: 5. Aromatization

- **n- alkanes having six or more carbon atoms on heating to 773 K at 10 – 20 atm pressure in the presence of  $V_2O_5$  or  $Cr_2O_3$  or  $Mo_2O_3$  over alumina, produce benzene or its homologues.**
- **This reaction is called **aromatization or reforming**.**

## ALKANES

### Chemical Properties of alkanes:

### 5. Aromatization



## ALKANES

MCQs

1. When n-heptane is subjected to aromatization, the product is?

- a) Benzene
- b) Toluene
- c) Methyl benzene
- d)  Both (b) & (c)

## ALKANES

2. 2-methyl pentane & 3 – Methyl pentane are...

a) Chain isomers



b) Position isomers

c) Chain & Position isomers

d) Metamers



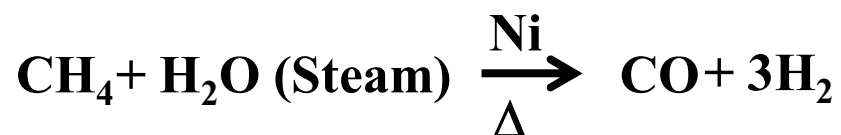
**CHEMICAL PROPERTIES OF  
ALKANES  
(PART-IV)**

## ALKANES

### Chemical Properties of alkanes:

#### 6. Reaction with steam

- Methane reacts with steam at 1273 K in the presence of nickel catalyst gives **carbon monoxide & H<sub>2</sub>**.
- This method is used to prepare **hydrogen gas** in industries.



## ALKANES

### Chemical Properties of alkanes:

### 7. Pyrolysis or cracking

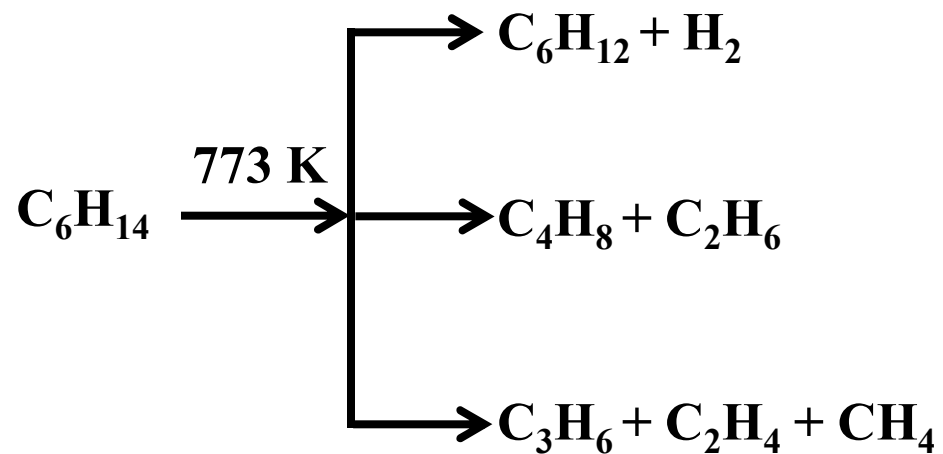
- Higher alkanes on heating to high temperature decompose into lower alkanes, alkenes etc.
- This reaction is called pyrolysis or cracking.
- This reaction takes place through the **free radical mechanism**.

The decomposition of higher alkanes to smaller fragments is called **pyrolysis**.

## ALKANES

### Chemical Properties of alkanes:

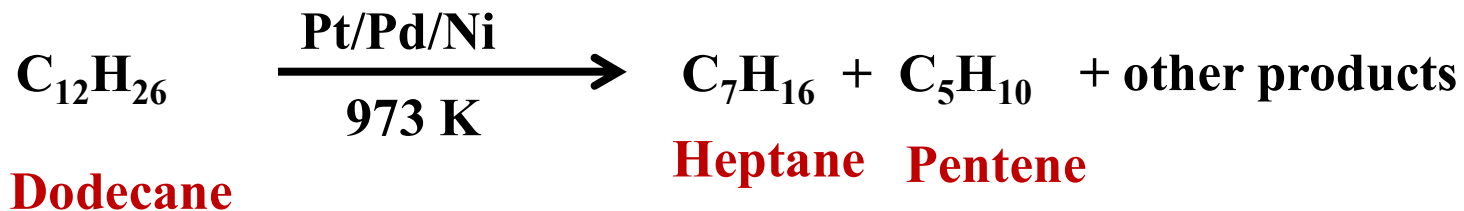
### 7. Pyrolysis or cracking



## ALKANES

## Chemical Properties of alkanes:

## 7. Pyrolysis or cracking

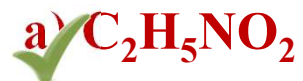


- **Pyrolysis is used to prepare petrol or kerosine from gasoline.**

## ALKANES


*MCQs*

1. Ethane under nitration gives...



## ALKANES

2. Propane under combustion gives...

- a) methane and water
- b)  $O_2$  , water and heat
-  c)  $CO_2$ , water and heat
- d) none of the above

## ALKANES


3. Halogenation is...

- a) carbocation reaction
- b) carbanion reaction
- ✓ c) free radical reaction
- d) alkyl halide reaction



## ALKANES

4. Pyrolysis involves...

- a) dehydrogenation
- b) cracking
-  c) both
- d) none of the above

## ALKANES

5. Ethane under dehydrogenation gives...

 a) ethene

b) propene

c) methane

d) none of the above

## ALKANES

# OBJECTIVE QUESTIONS PCQS

## ALKANES

1) C- H and C- C bond lengths (in pm) in ethane are ( Medical – 2014)

1) 133, 154

2) 110, 136

3)  112, 154

4) 100, 152

## ALKANES

**2) What are the shapes of ethyne and methane ? ( Engg – 2014)**

**1) Tetrahedral & trigonal planar**

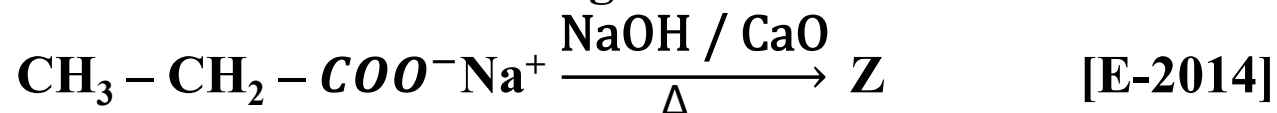
 **2) Linear & tetrahedral**

**3) Trigonal planar & linear**

**4) Square planar & linear**

## ALKANES

3) What is Z in the following reactions?



1) n - butane    2)  ethane    3) ethyne    4) propane

**Solution :**



De carboxylation in presence of sodalime

## ALKANES

4)  $\text{C}_2\text{H}_6 \xrightarrow{450^\circ\text{C}} \text{C}_2\text{H}_4 + \text{H}_2$  above reaction is Called as

[E-2013]

1) Combustion


2) Rearrangement

3)  Pyrolysis

4) cleavage

## ALKANES

5) The Wurtz – fitting reaction involves condensation of:  
[J.M.O.L-2013]

- 1)  One molecule of each of aryl – halide and alkyl - halide
- 2) Two molecules of aryl alkyl - halides
- 3) One molecule of each aryl – halide and phenol
- 4) Two molecules of aryl halides

**Solution :**

Wurtz – Fitting reaction involves alkyl and aryl halides with Na metal





## ALKANES

6) 6 litres of an alkene require 27 litres of Oxygen at constant temperature and pressure for complete combustion. The alkene is:  
[J.M.O.L-2013]

1) Ethene

 2) Propene

3) 1 - Butene

4) 2 - Butene

## ALKANES

**Solution :**



1.0L..... $\frac{9}{2}$  L of  $\text{O}_2$

6.0 L.....?  $6 \times \frac{9}{2} = 27$  L

## ALKANES

7) Which branched chain isomer of the hydrocarbon with molecular mass 72U gives only one isomer of mono substituted alkyl halide?

(AIEEE- 2012)

1) Isohexane

2) Neohexane

3) Tertiary butyl chloride

4)  Neopentane

## ALKANES

8) The chlorination of ethane is an example for which type of the following reactions? (EAMCET- 2012)

1) Nucleophilic substitution

2) Electrophilic substitution

3)  Free radical substitution

4) Rearrangement

## ALKANES

9) The compounds formed at anode in the electrolysis of an aqueous solution of potassium acetate are (2005 M)

✓ 1)  $\text{C}_2\text{H}_6$  and  $\text{CO}_2$

2)  $\text{C}_2\text{H}_4$  and  $\text{CO}_2$

3)  $\text{CH}_4$  and  $\text{H}_2$

4)  $\text{CH}_4$  and  $\text{CO}_2$

## ALKANES

10) Wurtz reaction of methyl iodide yields an organic compound X. which one of the following reactions also yields X? (2003 M)



**Solution :**



## ALKANES

- 11) What is the minimum quantity of methyl iodide required for preparing one mole of ethane by wurtz reaction  
(At. wt. of iodine= 127) (E 2002)

1) 142 gram   2) 568 gram   3) 326 gram    4) 284 gram

**Solution :**



2×142gm.....1 mole

## ALKANES

12) Which of the following reacts with water to give ethane? (2000 E)

1)  $\text{CH}_4$

✓ 2)  $\text{C}_2\text{H}_5\text{MgBr}$

3)  $\text{C}_2\text{H}_4\text{OH}$

4)  $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$

**Solution :**





## ALKANES

13) The gas evolved on heating  $\text{CH}_3\text{MgBr}$  in methanol is  
(J.M.O.L -2016)

✓ 1) Methane

2) Ethane

3) Propane

4)  $\text{HBr}$

## ALKANES

