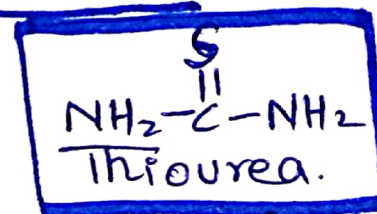
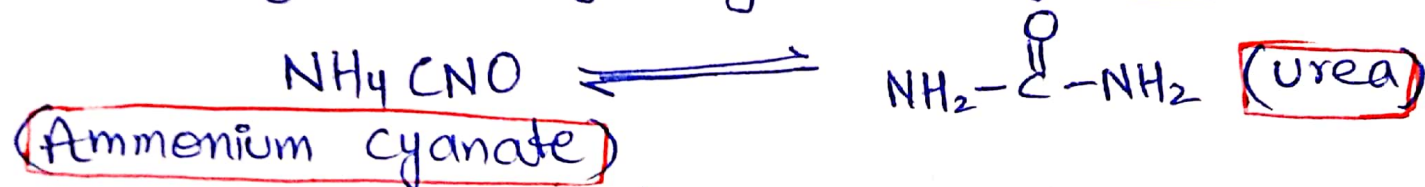


# INTRODUCTION TO ORGANIC CHEMISTRY

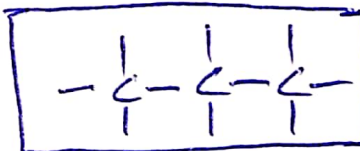
- Vital force theory rejected by Friedrich Wohler.



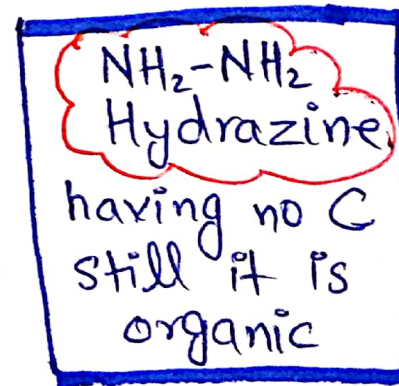
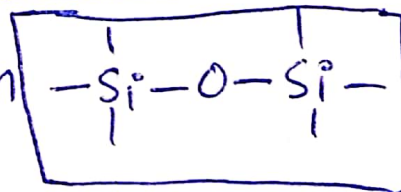
- **Organic Chemistry:** Study of compounds of H & C and their derivatives.

## General Properties:

1. **Catenation:** → Homocatenation



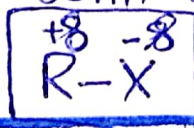
- Heterocatenation



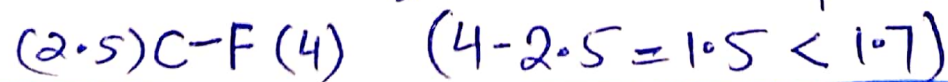
2. **Non-Ionic/Covalent:**

Non-crystalline, semi solids ( $C \geq 18$ )

Have polarity



no compound 100% ionic, E-N difference must be greater than 1.7 for ionic compound.



### 3. Rates of organic reactions:

slow, Molecular nature. (Bond breaking and forming involved)

### 4. Solubility:

Soluble in non-polar solvents

Some are soluble in Water due to H-bonding ( $C < 4$ )

Lyophilic, Lyophobic

### 5. Isomerism:

(Same molecular formula, Different structural formula)  
organic compounds show isomerism.

### Sources

Coal

Destructive distillation  
or  
Carbonization

(500-1000°C, absence of air)

Coal gas

Coal tar

Coke.

Total coal reserves in Pakistan = **184 billion tons**

Peat ——— 40-60 % C

Lignite ——— 60-70 % C

Bituminous. ——— 70-85 % C

Anthracite ——— 90-95 % C

inferior quality coal, used in furnace  
soft coal, used in thermal station.

common coal, used in homes.

superior quality, used in industries.



Coal contains more than 200 °C

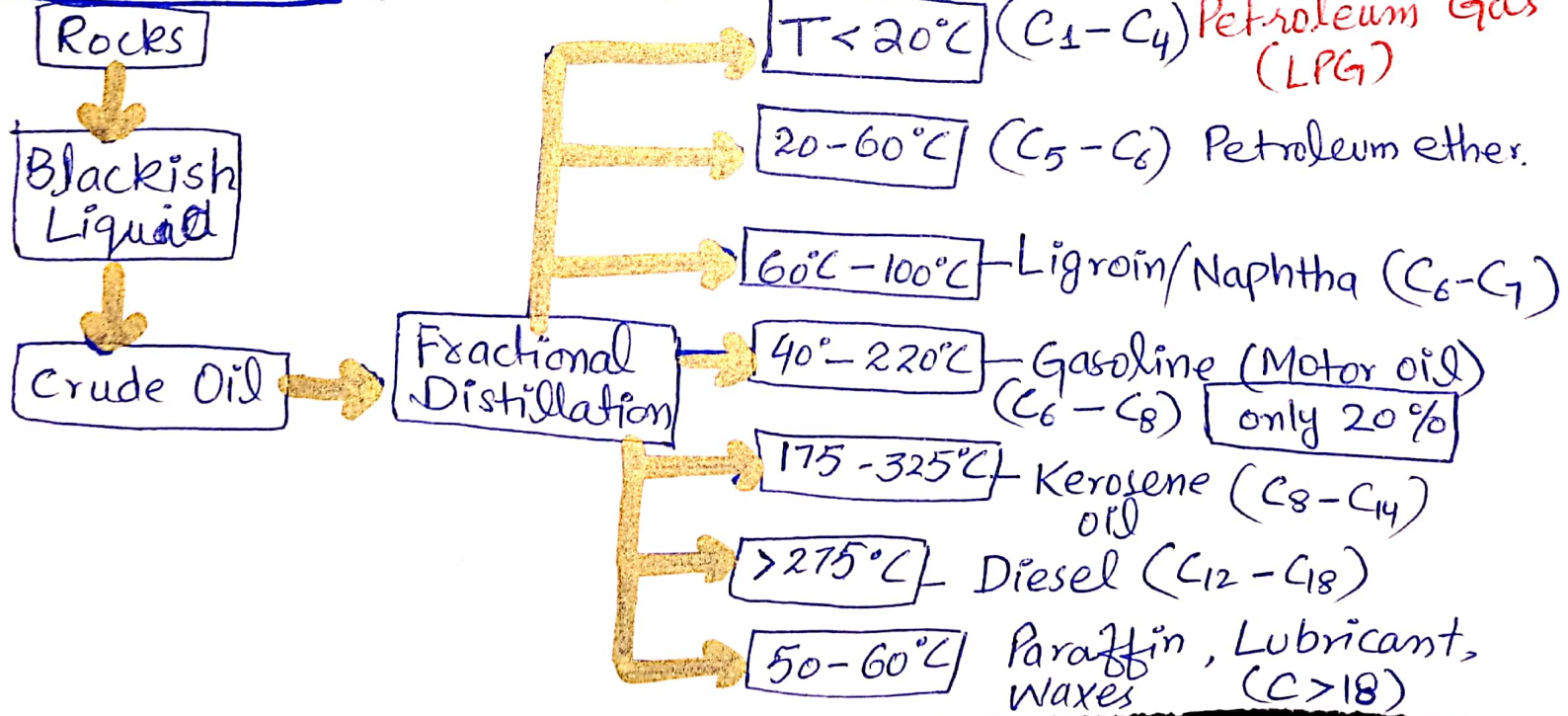
Cannel coal or Candle coal = Liptinite

Graphite is difficult to ignite — not used as fuel.

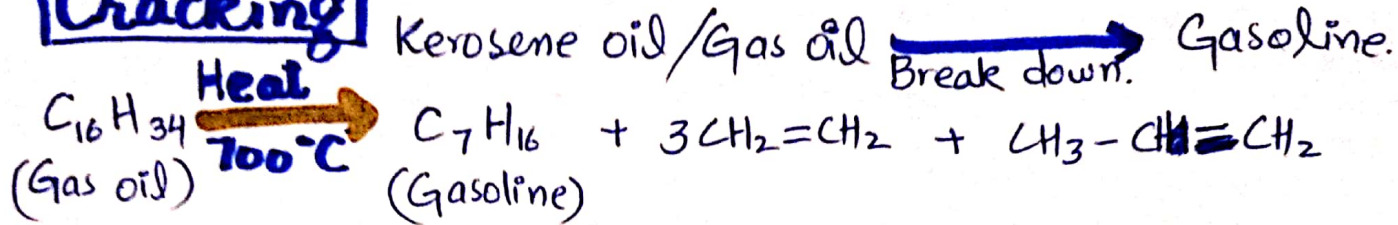
%age of S in coal = 1.8% can be removed by **CuO**

**Natural Gas** Mixture of low boiling hydrocarbons. Major portion = CH<sub>4</sub> **80-95%**

**Petroleum** (Black Gold)



# Cracking



## Thermal Cracking: (Pyrolysis)

- \* High T and P (150-900°C)
- \* Bulton Process (370-400°C = T)

## Catalytic Cracking:

- T = 500°C, P = 2 atm Catalyst =  $\text{SiO}_2 + \text{Al}_2\text{O}_3$
- \* Better quality gasoline with  $\uparrow$  octane no.

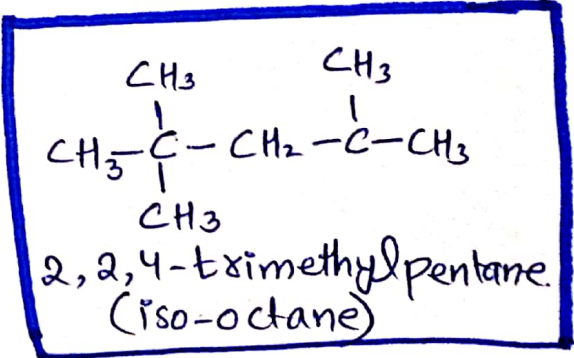
Cracking involves:  
→ Dehydrogenation  
→ Cyclization  
→ Isomerization.

## Steam Cracking

- T = 900°C with steam and cooled rapidly.
- \* produces lower unsaturated hydrocarbons.
  - \* Used for manufacturing drugs.

# Octane Number

- \* % age of iso-octane in fuel.
- \* Fuel having 80% iso-octane and 20% octane = 80-octane no.





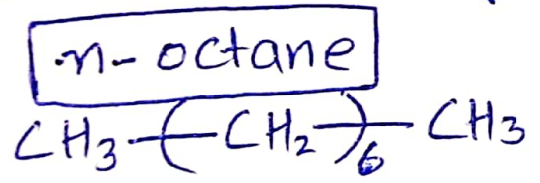
# Reforming

Fuel  $\rightarrow$  Pre-ignition  $\rightarrow$  sharp metallic sound  $\rightarrow$  Knocking

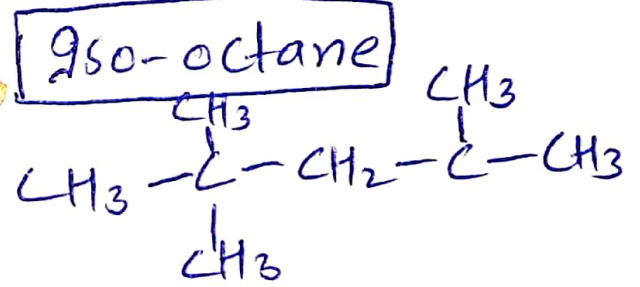
$\downarrow$   
Reduces efficiency of engine.

To reduce knocking

1. Reforming (Heating in absence of  $O_2$  and in presence of catalyst)

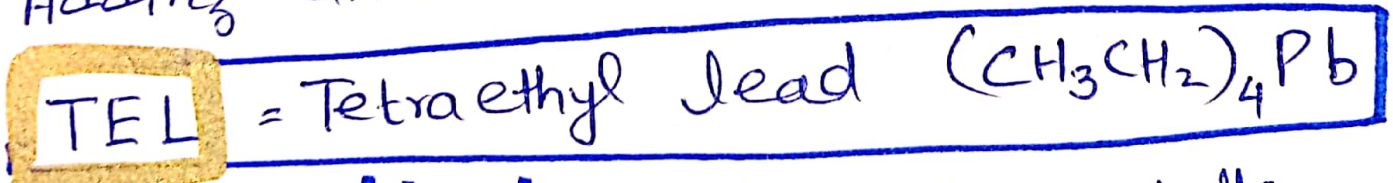


heat  
 $\rightarrow$   
catalyst



(increasing octane no.)

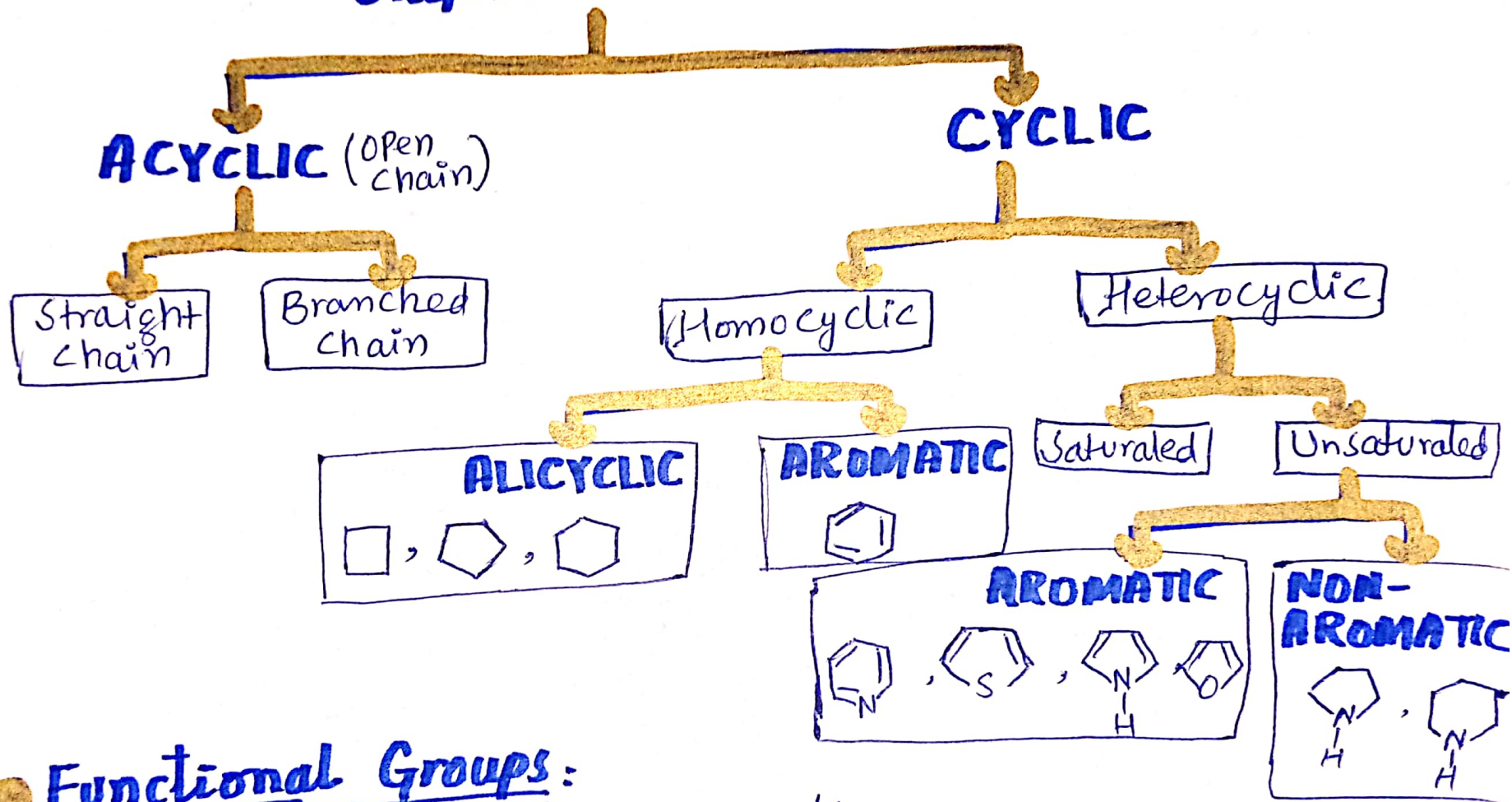
2. Adding anti knock agent to fuel. e.g. TEL



Adverse effect: Reduces to metallic Pb causes air pollution.

# Classification of Organic Compounds

## ORGANIC COMPOUNDS.



## ● Functional Groups:

Imparts properties to compounds.

-SH Mercapto group.

$\text{>C=NH}$  Imine group

$\text{-C}\equiv\text{N}$  Nitrile group

$\text{-N}\begin{matrix} \text{O} \\ \parallel \\ \text{O}^- \end{matrix}$  Nitro group.

$\text{-C=C-}$  Double bond.

$\text{-C-O-C-}$  Ether Linkage.



# SATURATED HYDROCARBONS

- LPG  $\rightarrow$  Propane + Butane.
- Methanogens  $\rightarrow$  Anaerobic Environment ( $\text{CO}_2 + \text{H}_2 \rightarrow \text{CH}_4$ )  
(organisms) Marsh Gas
- Residue obtained in fractional distillation of crude oil = **Asphaltic Bitumen ( $\text{C}_{30}$ )**

## Open chain (Aliphatic Compounds)

Alkane (Paraffin = Little Affinity)



● **Natural Sources:** Natural gas  
+  
Petroleum  
Other sources = Cracking \*

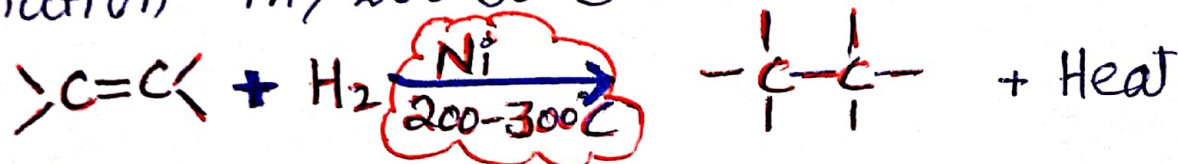
| Alkane  | No. of isomers |
|---------|----------------|
| Butane  | 2              |
| Pentane | 3              |
| Hexane  | 5              |
| Heptane | 9              |
| Octane  | 18             |
| Nonane  | 35             |
| Decane  | 75             |

# PREPARATION OF ALKANES.

1. Isolation from natural sources.
2. Preparation from other compounds.

## 1. From Alkene (Sabatier-Senderen's Reaction) :-

Hydrogenation  $\text{Ni}/200-300^\circ\text{C}$



Highly Exothermic

High energy of Activation

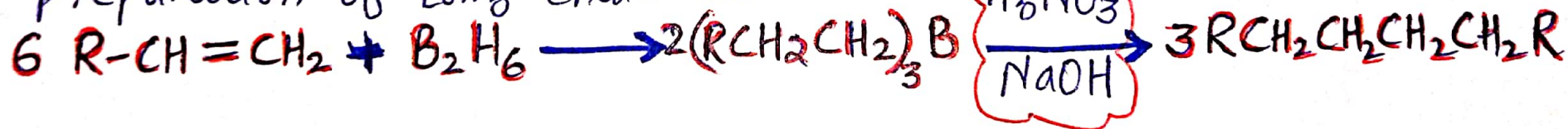
Imp

Production of vegetable ghee on Industrial scale.

Raney Ni = Ni-Al alloy  
 $\text{Ni-Al} + \text{NaOH} \xrightarrow{\text{Alcohol}} \text{Ni} + \text{NaAlO}_2$

## 2. Coupling of alkyl boranes :-

for preparation of long chain alkanes.



## 3. From Alkyl Halides :- (R-X)

### A. Reduction by dissolving metal :-

Zn in aq. acid like HCl or  $\text{CH}_3\text{COOH}$





## B. Reduction by $\text{LiAlH}_4$ :- ( $1^\circ$ and $2^\circ$ $\text{R-X} \rightarrow \text{R-H}$ )

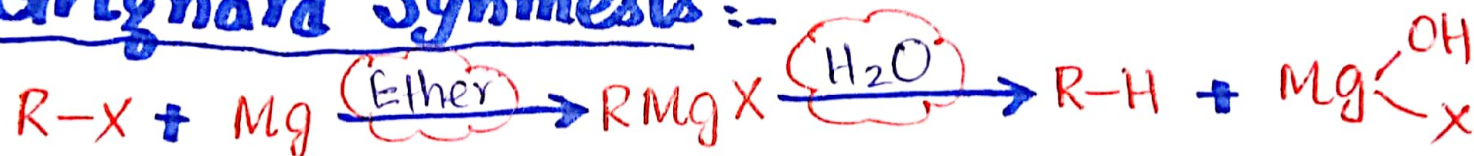


- $\text{NaBH}_4$  reduces  $2^\circ$  and  $3^\circ$   $\text{R-X}$  to Alkane.
- Triphenyl tin hydride  $\text{Ph}_3\text{SnH}$  reduces  $1^\circ$ ,  $2^\circ$  and  $3^\circ$   $\text{R-X}$  to alkanes.

## C. Catalytic Hydrogenolysis :-



## D. Grignard Synthesis :-



## E. Corey House Synthesis :- (Coupling with organometallic compound)



- Product (alkane) has higher no. of C atoms than starting  $\text{R-X}$ .

## F. Wurtz Synthesis :-

- Symmetrical alkanes with even no. of C atoms are produced.



- Not useful for  $3^\circ$   $\text{R-X}$ , elimination product formed.

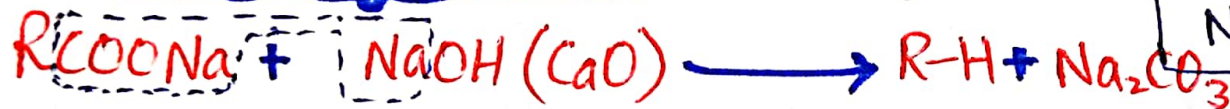
## 4. From salt of monocarboxylic acid :-

### A. Kolbe Reaction :-

- Concentrated solution of Na/K salt of carboxylic acid  $\rightarrow$  Electrolysis

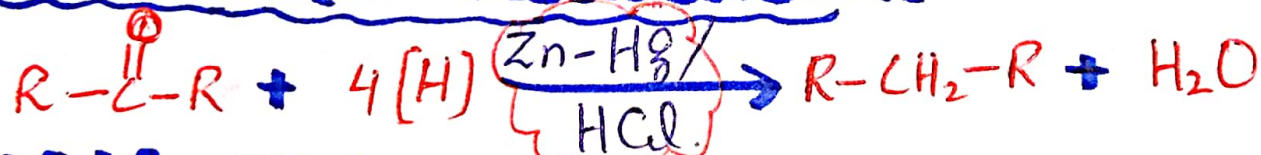


### B. Decarboxylation :- Mix of salt + Soda lime NaOH (CaO) $\rightarrow$ heated

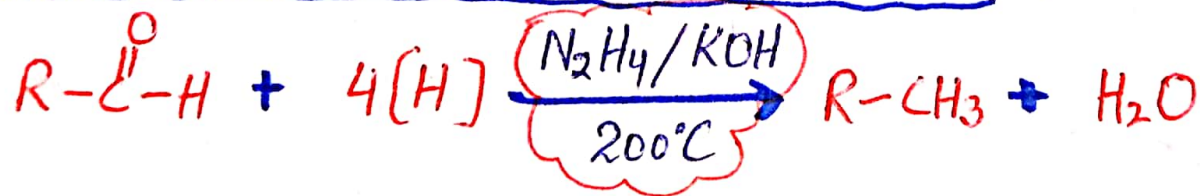


## 5. From Carbonyl Compounds :-

### A. Clemenson Reduction :-



### B. Wolf-Kishner Reduction :-





# Physical Properties :-

- Gas (upto C-4) , Liquid (C<sub>5</sub> - C<sub>17</sub>) , Solid (C<sub>18</sub> onward)
- Non-polar so, soluble in non-polar solvents.
- M.P°, B.P°, density etc increases with increase in C no.

★  $20-30^{\circ}\text{C}$  ↑se in B.P° for each CH<sub>2</sub> added.

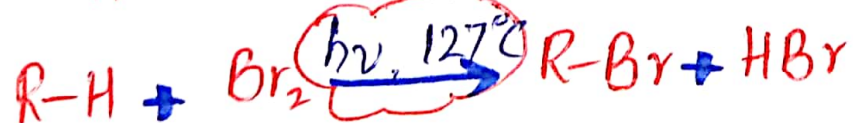
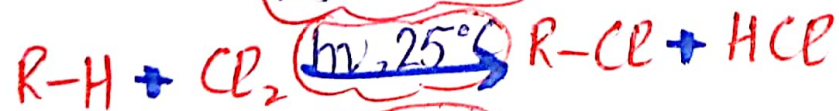
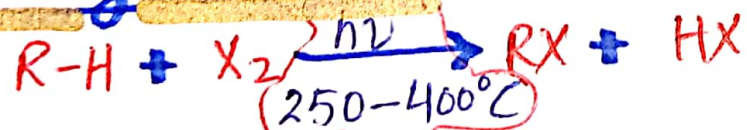
★ B.P° (Straight chain > Branched) for same C no.

● Alkanes are lighter than water so, floats on water.  
Max density of alkane =  $0.8\text{ g/cm}^3$

## Reactions of Alkanes

● Substitution reaction.

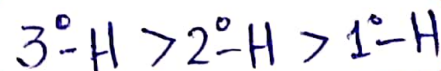
### 1. Halogenation :-



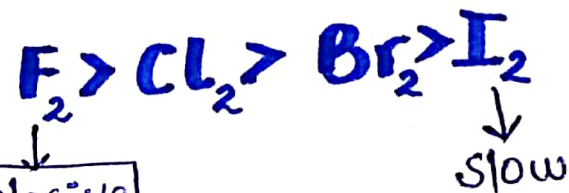
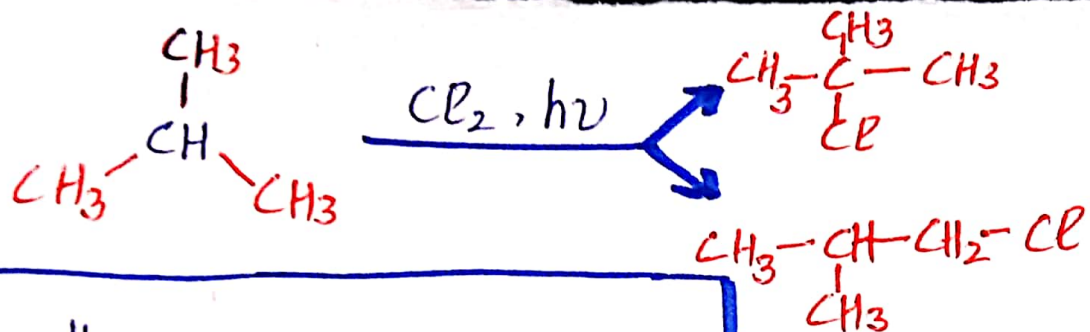
Free Radical Mechanism

Diff. products obtained

Rate



C-H bond energy =  $415\text{ kJmol}^{-1}$



Explosive.

• Dilute F<sub>2</sub> with inert gas used.

slow

|  |                                 |
|--|---------------------------------|
| $\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{H} \\   \\ \text{H} \end{array}$      | $\Delta H = 381 \text{ kJ/mol}$ |
| $\begin{array}{c} \text{H} \\ \diagdown \\ \text{C}-\text{H} \\ \diagup \\ \text{H} \end{array}$ | $\Delta H = 410 \text{ kJ/mol}$ |
| $\text{C}-\text{H}$  | $\Delta H = 435 \text{ kJ/mol}$ |

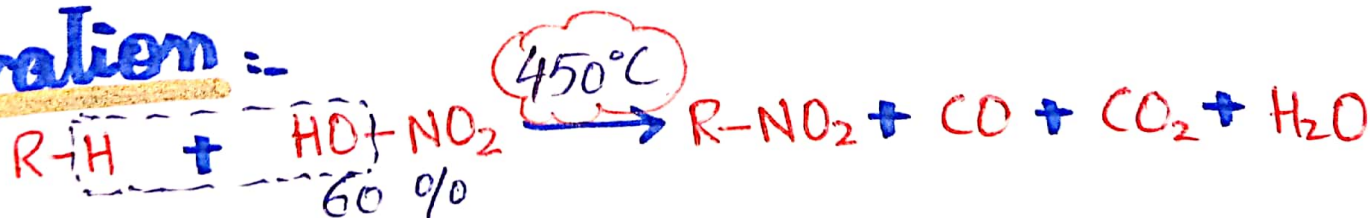
## • Direct chlorination:-

Sulfonyl chloride → more reactive.



- 3°-H replaced 5 times faster and 2°-H replaced 3-8 times faster than 1°-H.
- Temp ↑ses → collision ↑se → 1°-H gets more reactive

## 2. Nitration:-

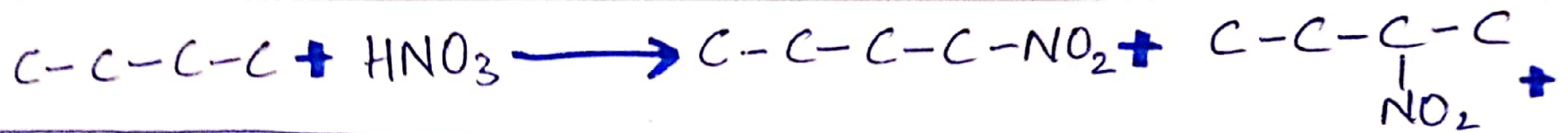


• Free-radical Mechanism

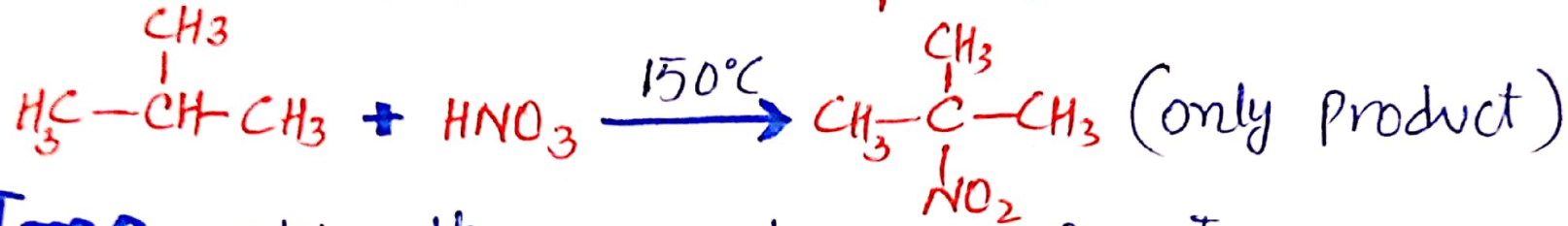
• Mixture obtained → Fractional distillation



Rule

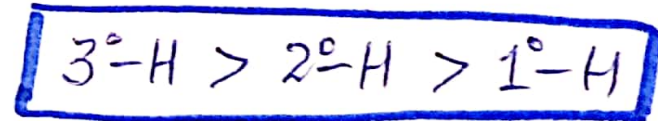
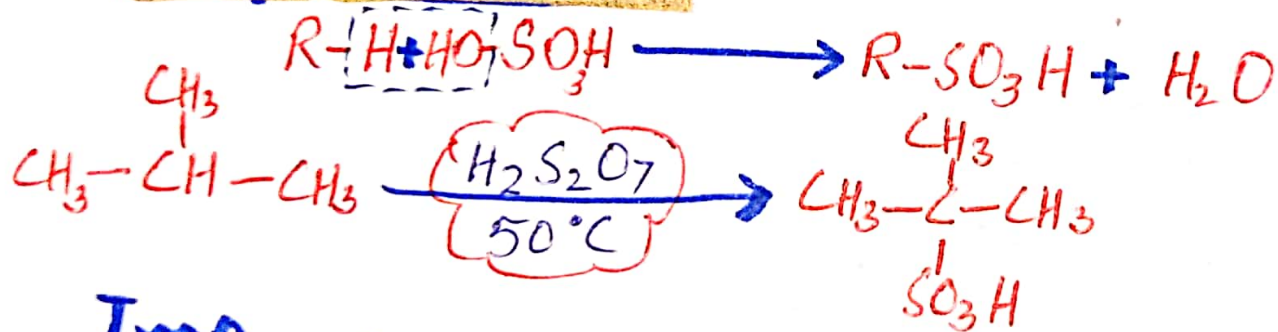


2-nitropropane is not possible.  $C-C-NO_2 + C-C-C-NO_2$



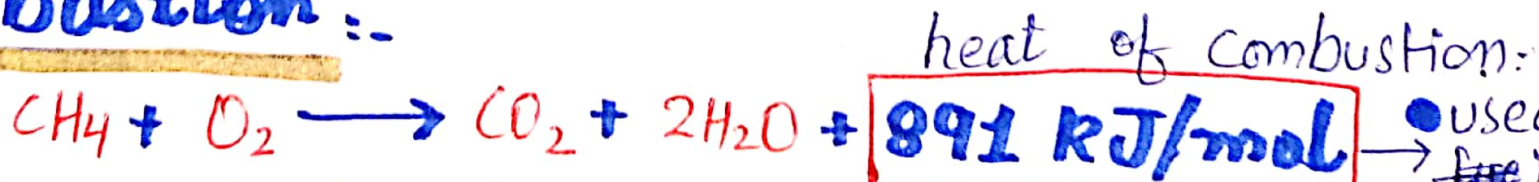
Imp: Nitroalkanes used as solvents.

### 3. Sulphonation:



Imp: Sulphonic group introduced in long chains to form detergents.

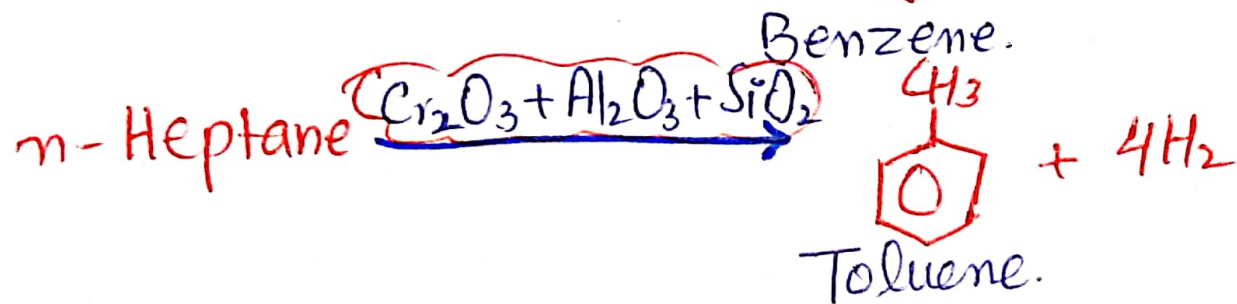
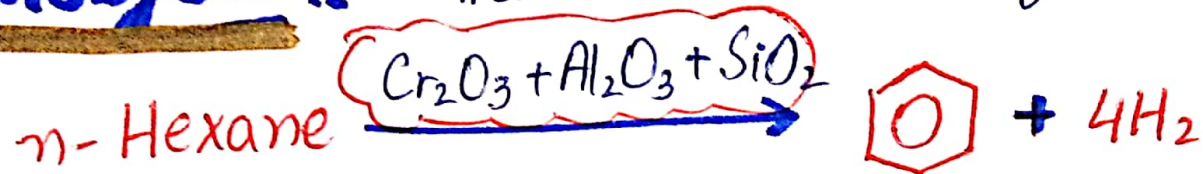
### 4. Combustion:



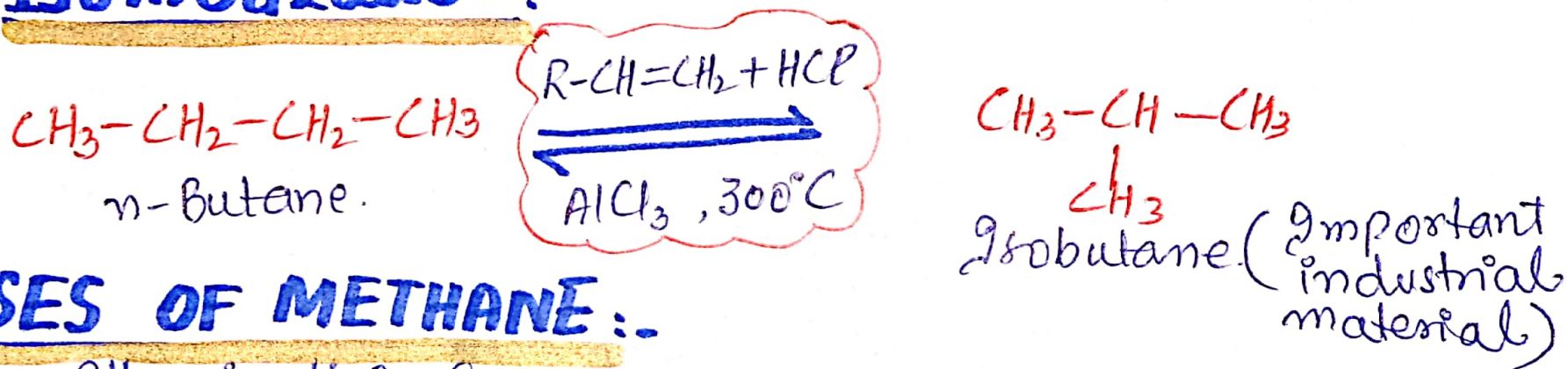
Imp: heat produced used in automobile engines.

used for estimation of individual bond strength

## 5. Pyrolysis :: Thermal cracking.



## 6. Isomerization:



## USES OF METHANE ::

- Illuminating gas.
- Preparation of  $\text{CH}_3\text{Cl}$ ,  $\text{CH}_2\text{Cl}_2$ ,  $\text{CHCl}_3$  and  $\text{CCl}_4$
- Industrial preparation of  $\text{CH}_3\text{OH}$ ,  $\text{HCHO}$  and  $\text{HCN}$
- **C black** used in paint, printing inks and automobile tyres.
- in manufacturing of **urea** fertilizer.