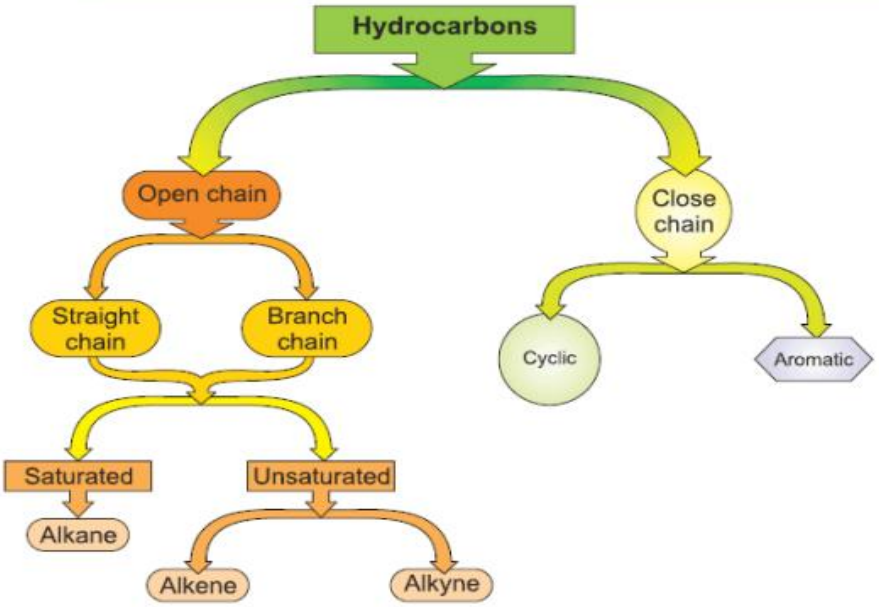
Hydrocarbons

Hydrocarbon: Compound composed of only carbon and hydrogen

Saturated Hydrocarbons: Compound with only single bonds

Unsaturated Hydrocarbons: Compounds with at least one doubl or triple bond.



Hydrocarbon Classifications

Compound Type	Functional Group	Example
alkanes	none (no double or triple bonds)	$CH_3—CH_2—CH_3$, propane
alkenes	$>C=C<$ double bond	$CH_2=CH—CH_3$, propene
alkynes	$—C\equiv C—$ triple bond	$H—C\equiv C—CH_3$, propyne
aromatics	benzene ring	CH_2CH_3 ethylbenzene

Alkanes

Alkanes are organic compounds that consist entirely of single-bonded carbon and hydrogen atoms and lack any other functional groups. Alkanes have the general formula C_nH_{2n+2} and can be subdivided into the following three groups: the linear straight-chainalkanes, branched alkanes, and cycloalkanes. Alkanes are also *saturated hydrocarbons*

Physical Properties of Alkanes:

- Alkanes are colourless.
- Alkanes are less dense than water (alkanes float on top of water).
- Alkanes are non-polar molecules so they are more soluble in non polar solvents than they are in polar solvents. Alkanes are insoluble in water.
- The melting and boiling points of the shorter chain alkanes is low, but the melting and boiling of alkanes increase as the number of carbon atoms in the carbon chain increases.

Molecular Name	Formula	Melting Point (°C)	Boiling Point (°C)	Density (20°C)*	Physical State (at 20°C)
methane	CH_4	–182	–164	0.668 g/L	gas
ethane	C_2H_6	–183	–89	1.265 g/L	gas
propane	C_3H_8	–190	–42	1.867 g/L	gas
butane	C_4H_{10}	–138	–1	2.493 g/L	gas
pentane	C_5H_{12}	–130	36	0.626 g/mL	liquid
hexane	C_6H_{14}	–95	69	0.659 g/mL	liquid
octane	C_8H_{18}	–57	125	0.703 g/mL	liquid
decane	$C_{10}H_{22}$	–30	174	0.730 g/mL	liquid

IUPAC Rules

♣ Rule 1:Find the longest continuous chain of carbon atoms, and use the name of this chain as the base name of the compound.

♣ Rule 2:Number the longest chain, beginning with the end of the chain nearest a substituent.

♣ Rule 3:Name the groups attached to the longest chain as alkyl groups. Give the location of each alkyl group by the number of the main-chain carbon atom to which it is attached.

♣ Write the alkyl groups in alphabetical order regardless of their position on the chain.

Sub-rules for IUPAC nomenclature

1. If there are two or more longest chains of equal length:

Choose the one having the largest number of substituents.

Choose the one having the simples substituents.

2. If both ends of the root chain have equidistant substituents.

Begin numbering at the end nearest a third substituent, if one is present.

Begin numbering at the end nearest the first cited group

NAMES OF ALKANES and ALKYL GROUPS

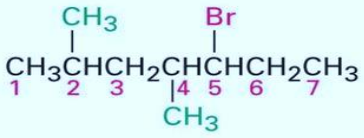
Alkane	Molecular Formula	Structural Formula	Alkyl	Molecular Formula
Methane	CH_4	CH_4	Methyl	CH_3
Ethane	C_2H_6	CH_3CH_3	Ethyl	C_2H_5
Propane	C_3H_8	$CH_3CH_2CH_3$	Propyl	C_3H_7
Butane	C_4H_{10}	$CH_3(CH_2)_2CH_3$	Butyl	C_4H_9
Pentane	C_5H_{12}	$CH_3(CH_2)_3CH_3$	Pentyl	C_5H_{11}
Hexane	C_6H_{14}	$CH_3(CH_2)_4CH_3$	Hexyl	C_6H_{13}
Heptane	C_7H_{16}	$CH_3(CH_2)_5CH_3$	Heptyl	C_7H_{15}
Oktane	C_8H_{18}	$CH_3(CH_2)_6CH_3$	Oktyl	C_8H_{17}
Nonane	C_9H_{20}	$CH_3(CH_2)_7CH_3$	Nonyl	C_9H_{19}
Dekane	$C_{10}H_{22}$	$CH_3(CH_2)_8CH_3$	Dekyl	$C_{10}H_{21}$
Undekane	$C_{11}H_{24}$	$CH_3(CH_2)_9CH_3$	Undekyl	$C_{11}H_{23}$
Dodekane	$C_{12}H_{26}$	$CH_3(CH_2)_{10}CH_3$	Dodekyl	$C_{12}H_{25}$

Common Nonalkyl Groups

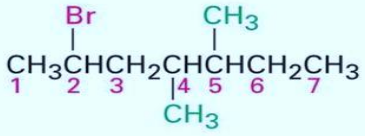
Group	Name
—F	fluoro
—Cl	chloro
—Br	bromo
—I	iodo
—NO_2	nitro
—NH_2	amino

For example :-

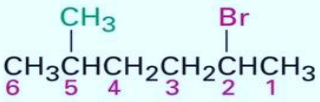
Nomenclature of Halogen Compounds



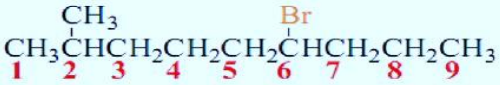
5-Bromo-2,4-dimethylheptane



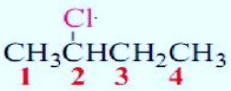
2-Bromo-4,5-dimethylheptane



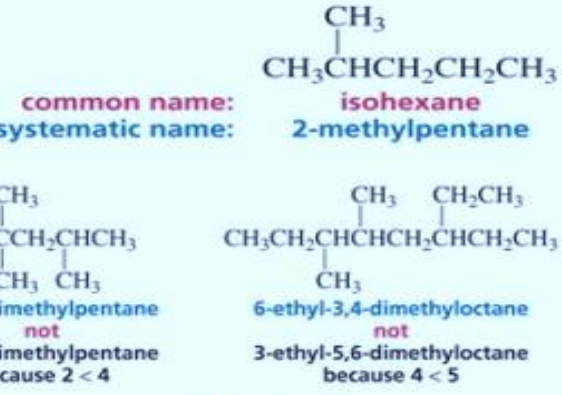
2-Bromo-5-methylhexane

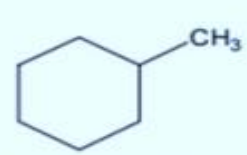


6-bromo-2-methylnonane

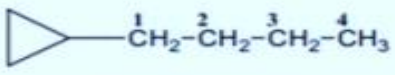


2-chlorobutane

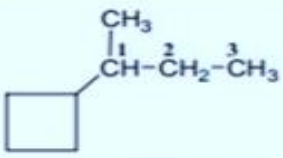




Methyl cyclohexane

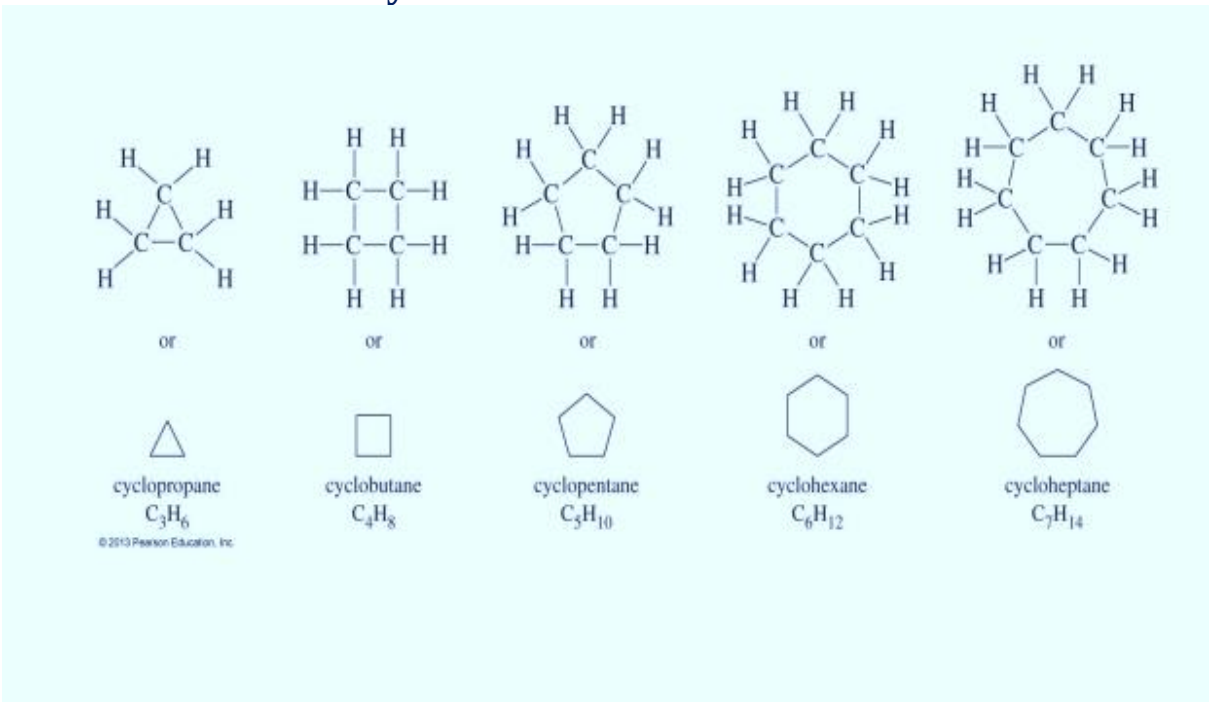


1-Cyclopropyl butane



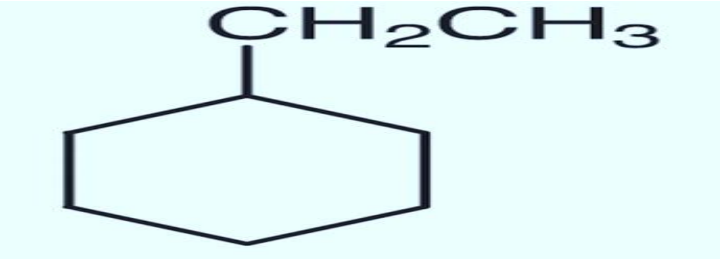
(1-Methyl propyl) cyclobutane
or, sec-Butyl cyclobutane

Cycloalkanes: CnH2n



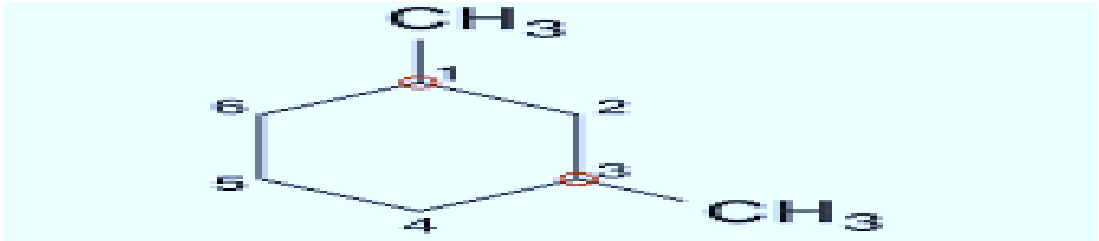
Cycloalkane Nomenclature

- Cycloalkane is the main chain: alkyl groups attached to the cycloalkane will be named as alkyl groups.
- If only one alkyl group is present, then no number is necessary

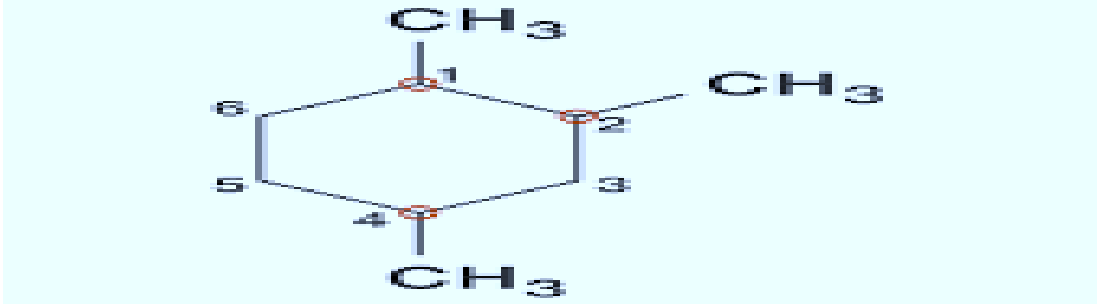


Ehyl cyclohexane

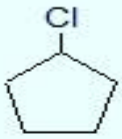
- If there are two or more substituents, number the main chain to give all substituents the lowest possible number.



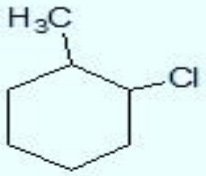
1,3-dimethylcyclohexane



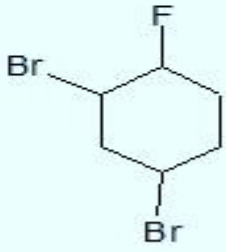
1,2,4-trimethylcyclohexane



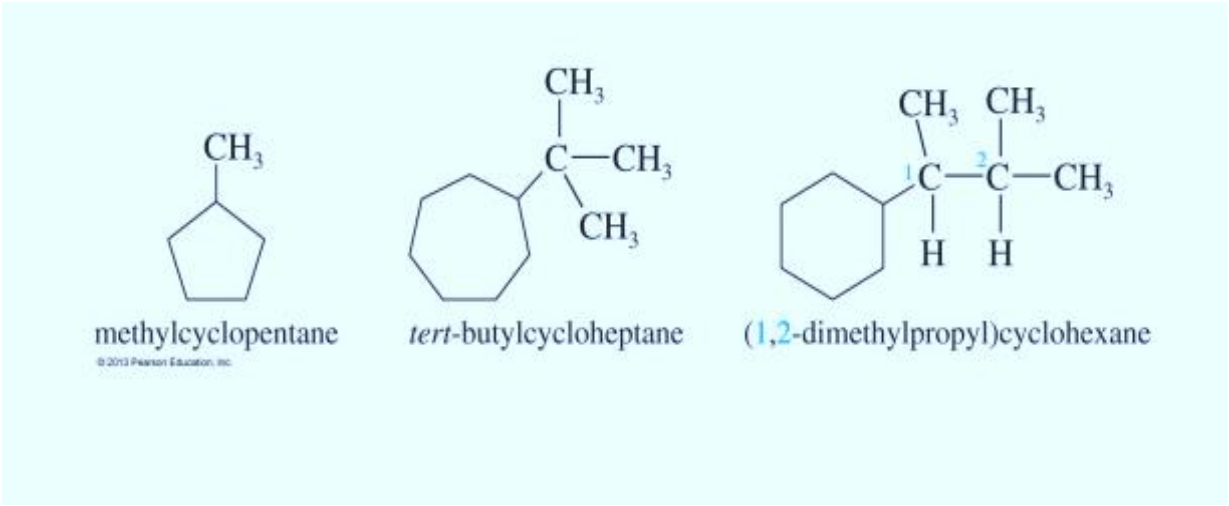
chlorocyclopentane



1-chloro-2-methylcyclohexane



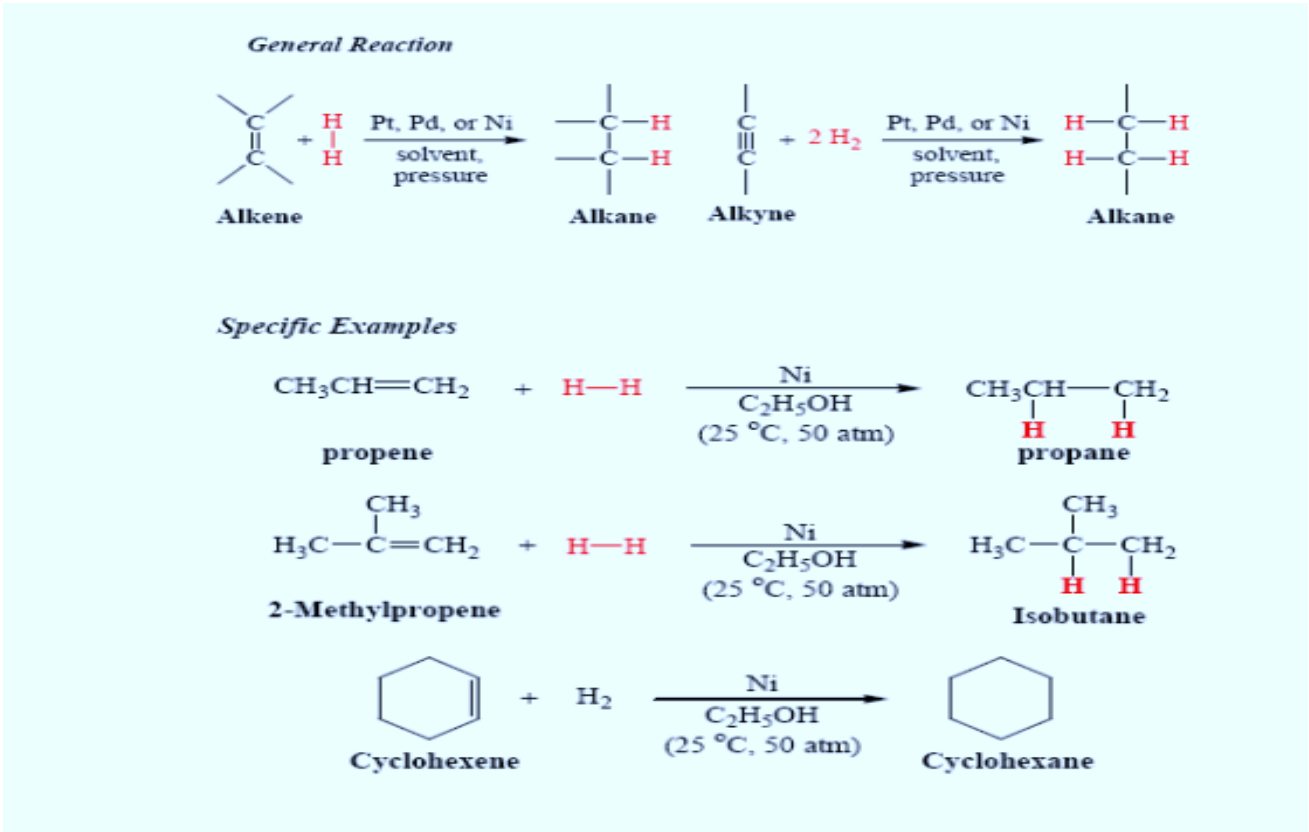
2,4-dibromo-1-fluorocyclohexane



Preparation of Alkanes

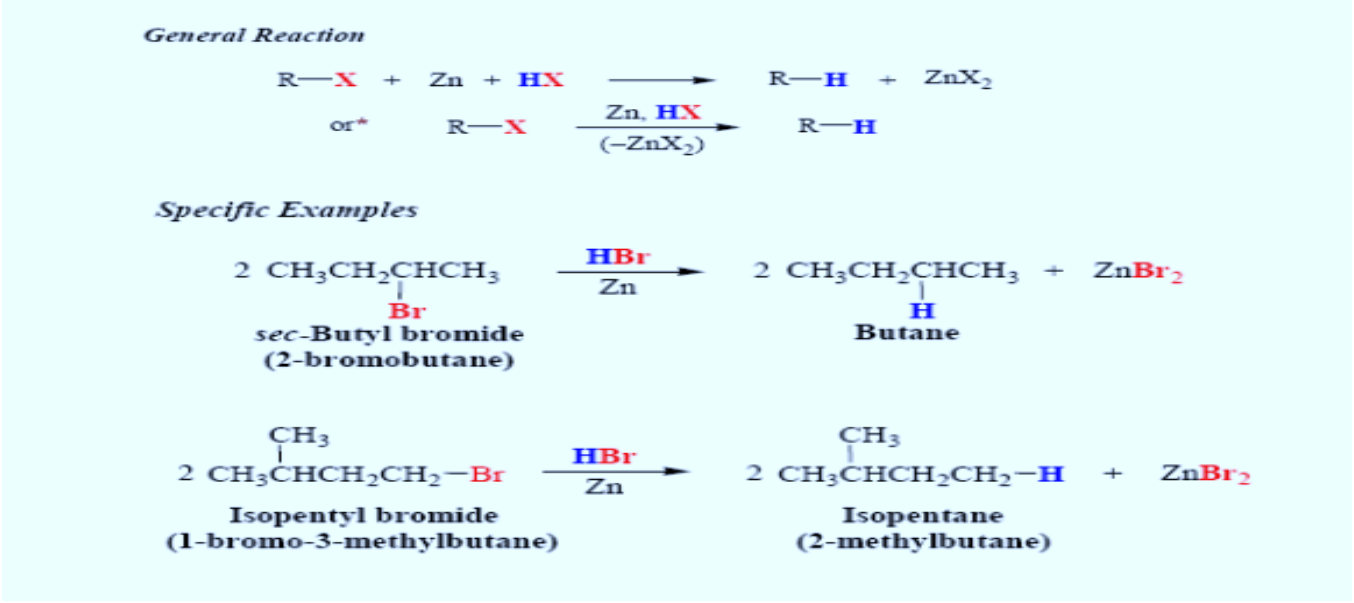
1. From Unsaturated Hydrocarbons (hydrogenation)

Unsaturated hydrocarbons (alkenes and alkynes) react with H_2 in the presence of finely divided catalysts such as platinum, palladium or nickel to form alkanes. This process is called hydrogenation.



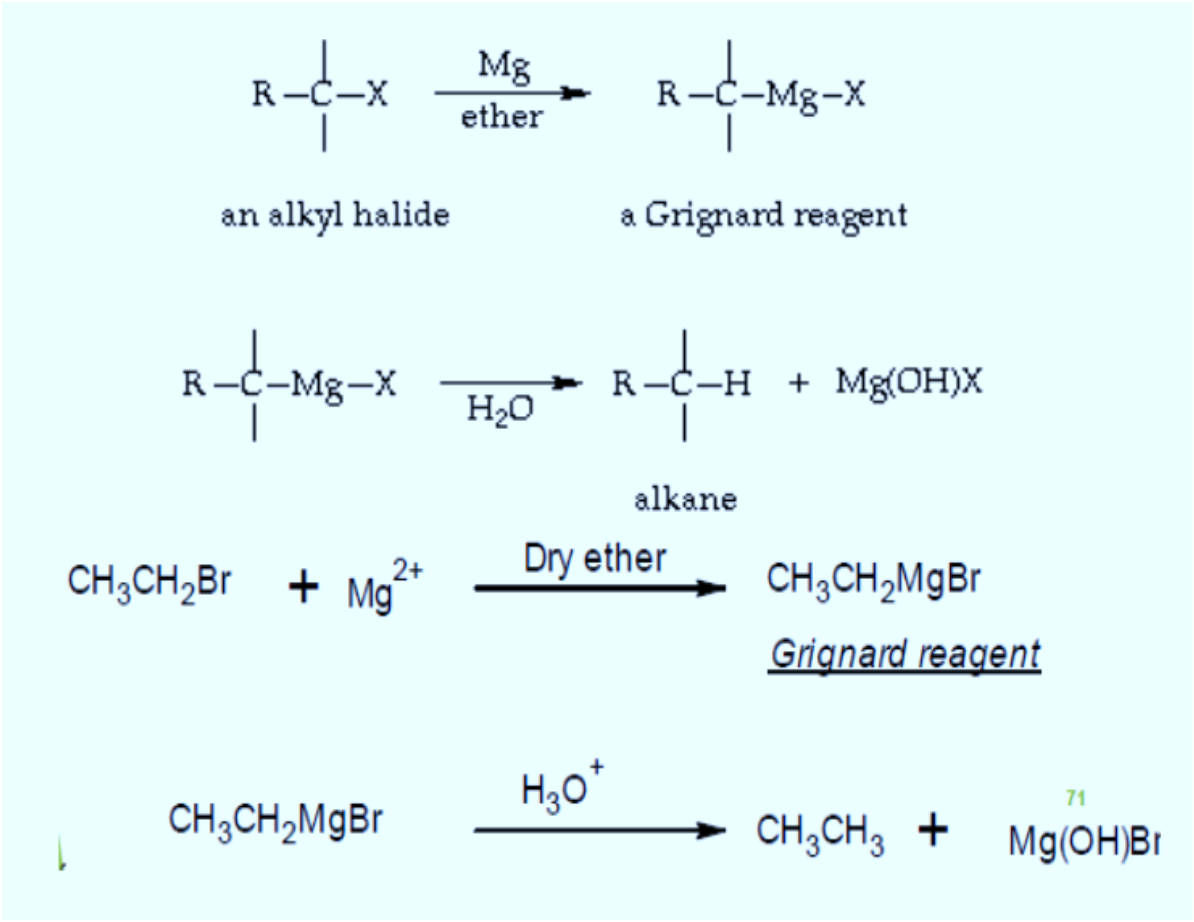
2. From alkyl Halides

A. Reduction of alkyl halides



B. Hydrolysis of Grignard Reagent

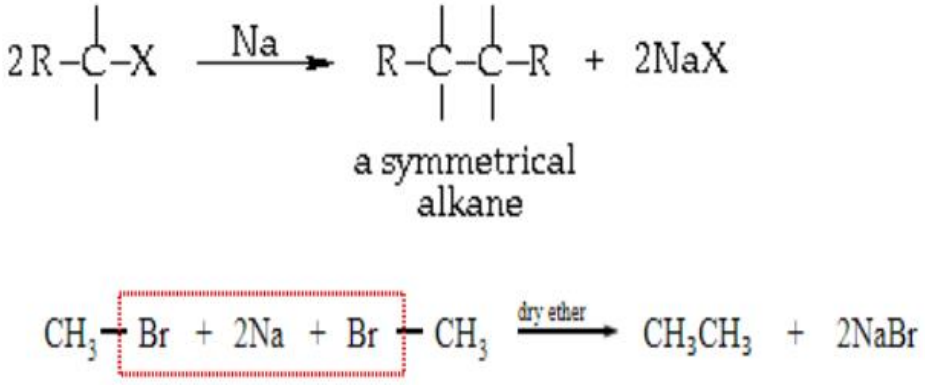
- Grignard reagent is an alkyl magnesium halide compound, R Mg-X
- The Grignard reagent is formed when a solution of an Alkyl Halide (R-X) is allowed to stand over a metallic magnesium in the presence of dry ether .
- Then Grignard reagent react with water or alcohol to form alkane.



C. Wurtz Reaction

This is the reaction of two alkyl halides (R-X) with metallic sodium to give symmetrical alkanes.

The wurtz reaction is a poor method for the preparation of unsymmetrical alkanes.

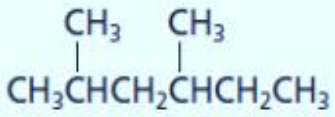


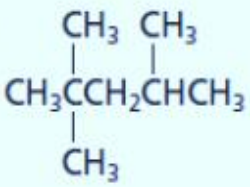
Problem

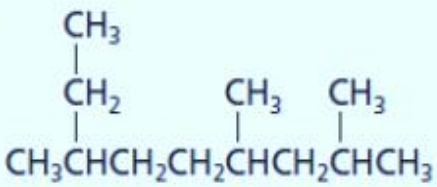
Give the structures of:

- 4-isopropyloctane
- 5-*t*-butyldecane
- 2,3-dimethyl-5-propyldecane
- 3,4,5triethyloctane

Use the IUPAC rules to name the following structures.

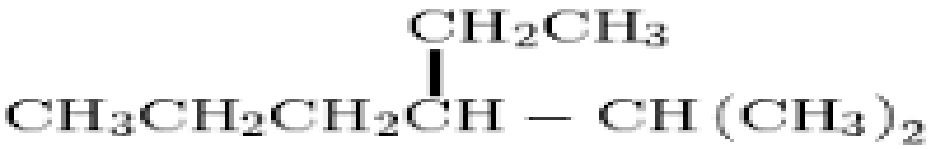
a. 

b. 

c. 

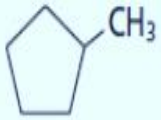
-Give a systematic (IUPAC) name for the following compound.

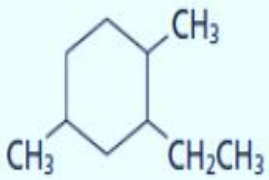
A. 

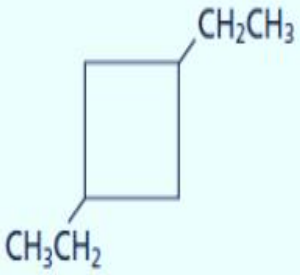
B. 

C. 

Use IUPAC rules to name the following structures.

a. 

b. 

c. 

Challenge Draw the structures of the following cycloalkanes.

a. 1-ethyl-3-propylcyclopentane

b. 1,2,2,4-tetramethylcyclohexane

Use the iupac rules to name the following structure