

The Chemistry of Alkanes

Physical Properties of Alkanes

as molecular size increases so does the boiling point of the alkane

increased size increased dispersion forces

Alkanes

Boiling Point
°C

Methane	CH_4	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	-161.6
Ethane	C_2H_6	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	-88.6
Propane	C_3H_8	$\text{CH}_3 - (\text{CH}_2)_1 - \text{CH}_3$	-42.1
Butane	C_4H_{10}	$\text{CH}_3 - (\text{CH}_2)_2 - \text{CH}_3$	-0.5
Pentane	C_5H_{12}	$\text{CH}_3 - (\text{CH}_2)_3 - \text{CH}_3$	36.1
hexane	C_6H_{14}	$\text{CH}_3 - (\text{CH}_2)_4 - \text{CH}_3$	68.7

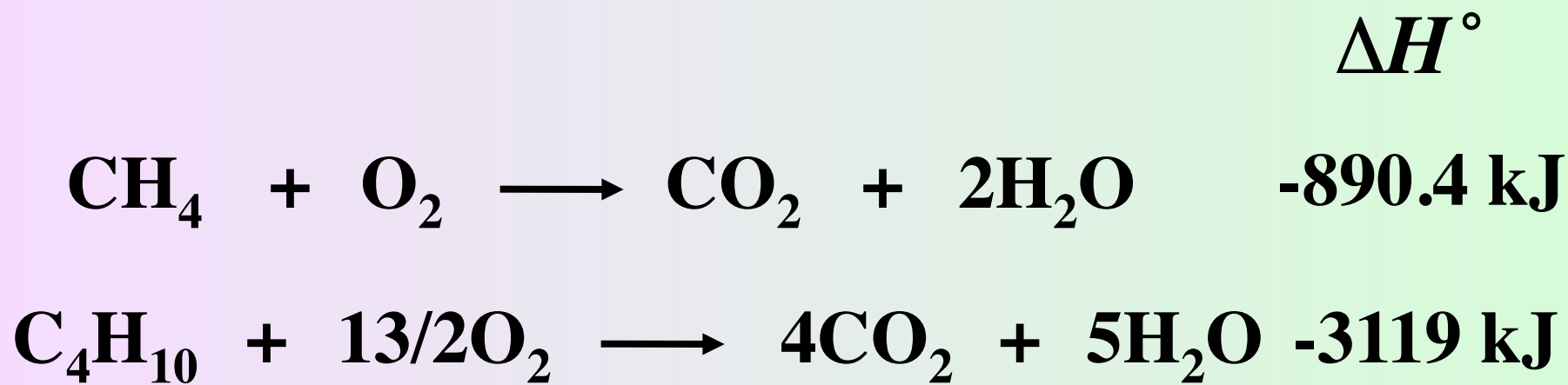
Chemical Reactions and Alkanes

because the C-C and C-H bonds are relatively strong , the alkanes are fairly unreactive

their inertness makes them valuable as lubricating materials and as backbone material in the construction of other hydrocarbons

Combustion of Alkanes

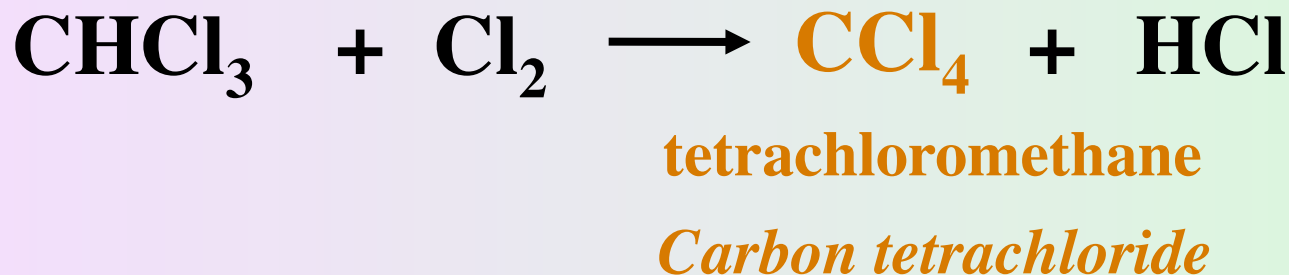
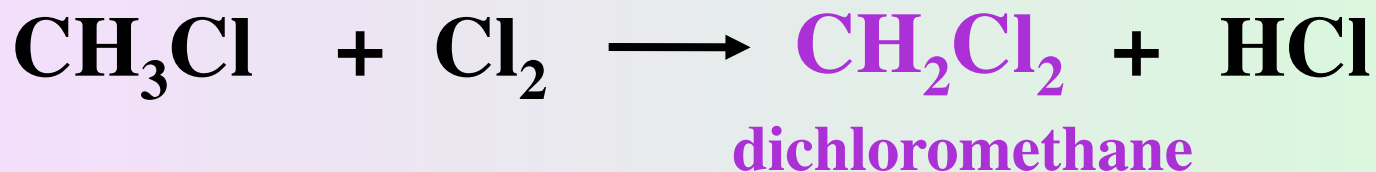
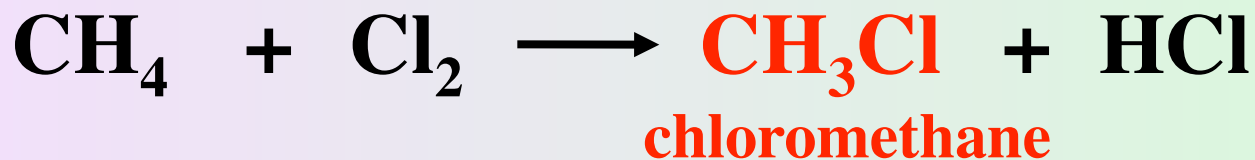
At high temperatures alkanes combust



these reactions are all highly exothermic

Halogenation of Alkanes

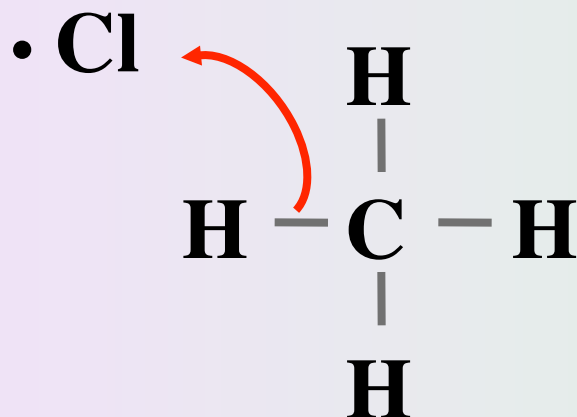
at temperatures
above 100 °C



Mechanism for Halogenation of Methane

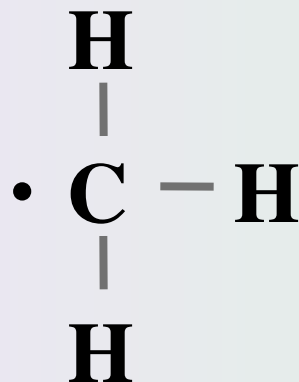


hν: energy required to break the Cl-Cl bond

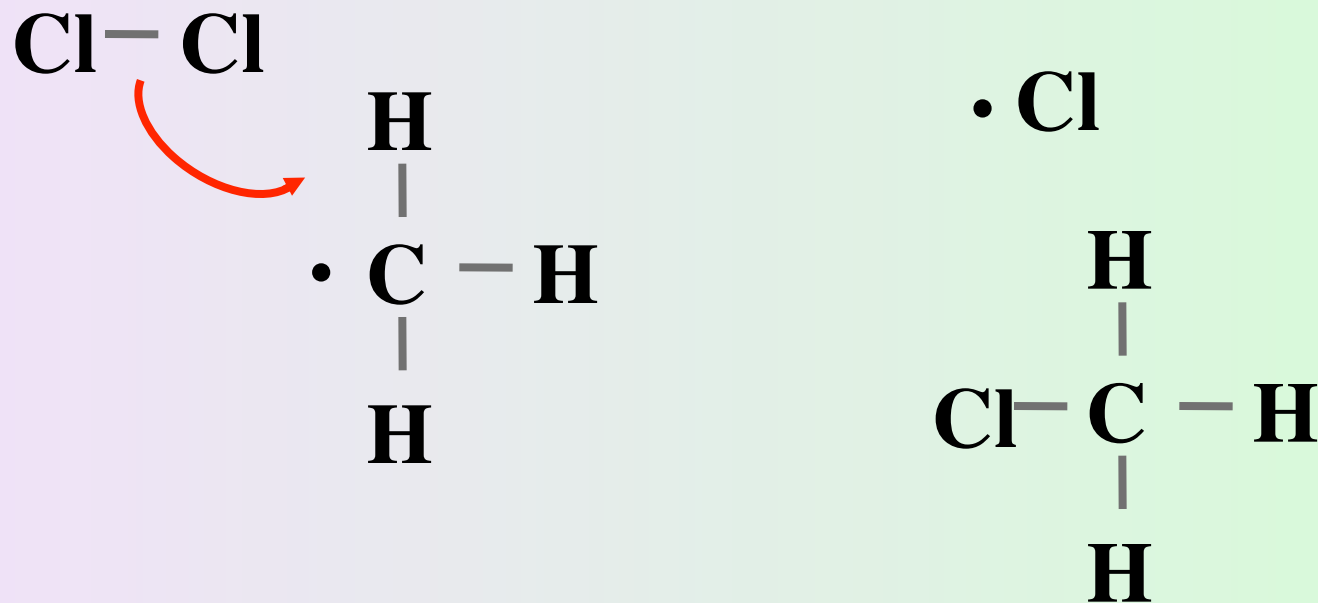


- **Cl** is very reactive and able to attack the C-H bond

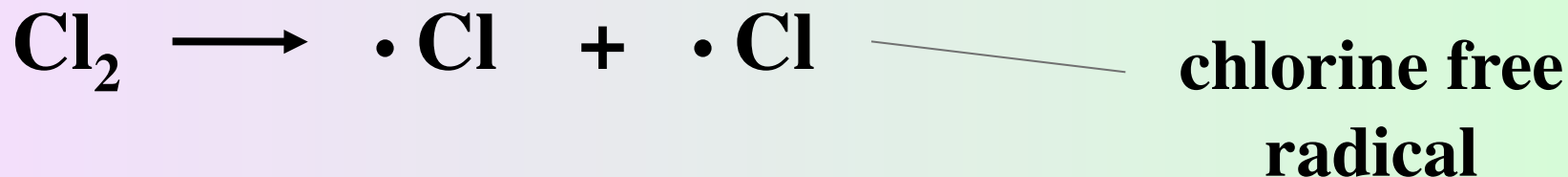
Mechanism for Halogenation of Methane



Mechanism for Halogenation of Methane



Mechanism for Halogenation of Methane

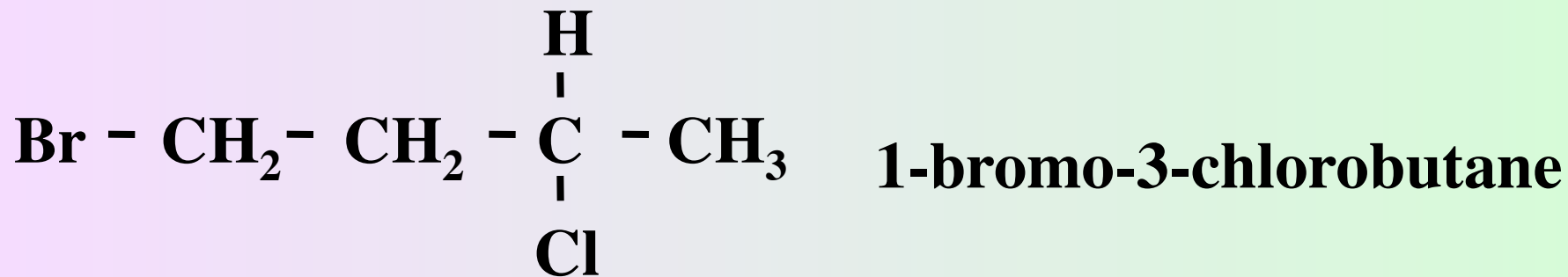
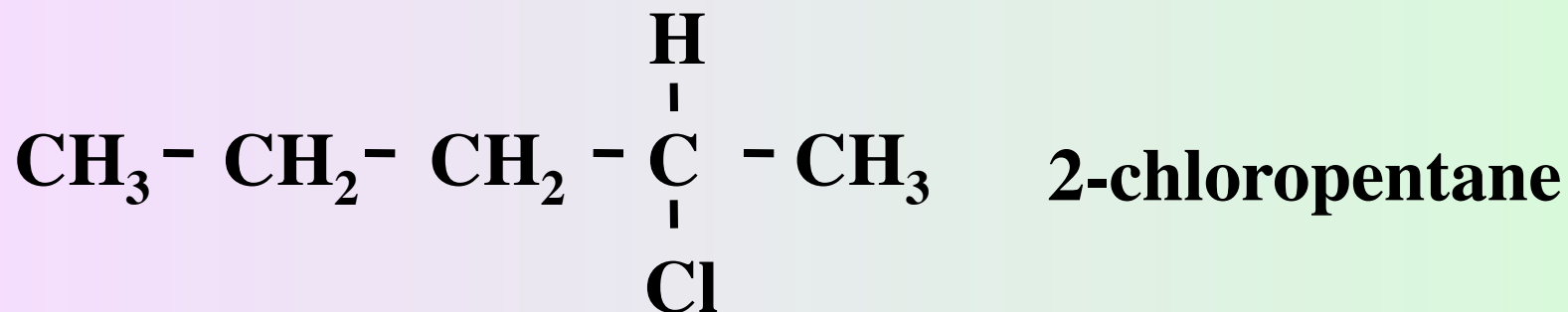


alkyl halide

**An alkane in which one or more hydrogens
have been replaced with halogens**



Example



A Functional Group

a group of atoms that are largely responsible for the chemical behavior of the parent molecule

some common
functional groups

NH_2 , F, Cl, Br, I, NO_2 ,, ,

Alkyl groups - derived from alkanes

Levels of Structure

Elemental Composition ✓

Empirical Formula ✓

Molecular Formula ✓

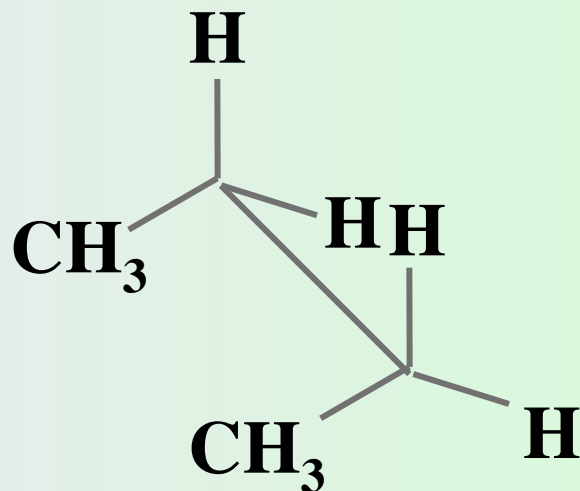
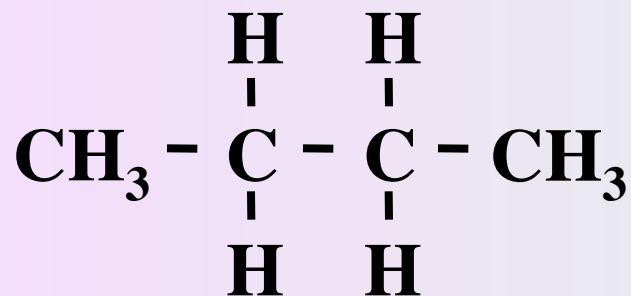
Constitution ✓

 **Conformation**

Configuration

Stereoisomers

isomers that have the same constitution but differ in the spatial arrangement of their atoms

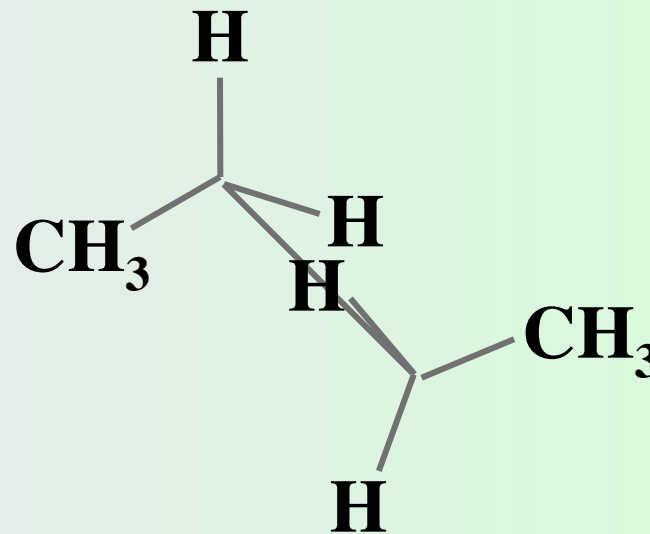
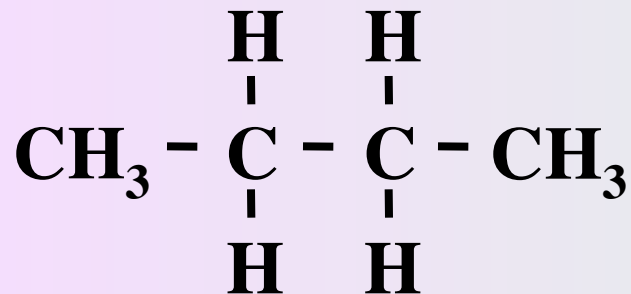


saw horse projection

Stereoisomers

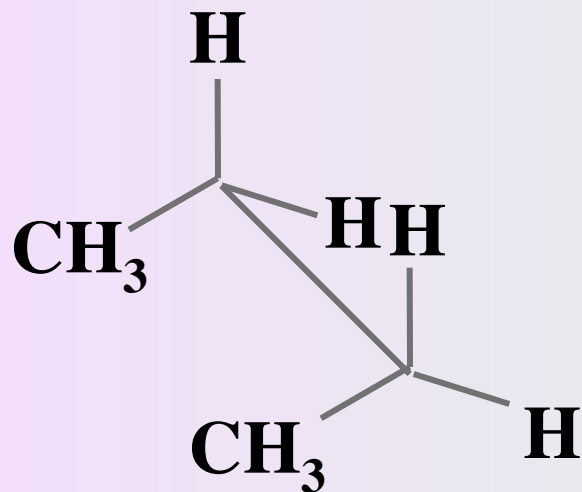
isomers that have the same constitution but differ in the spatial arrangement of their atoms

Conformations : different spatial arrangements of a molecule generated by rotation of atoms about single bonds

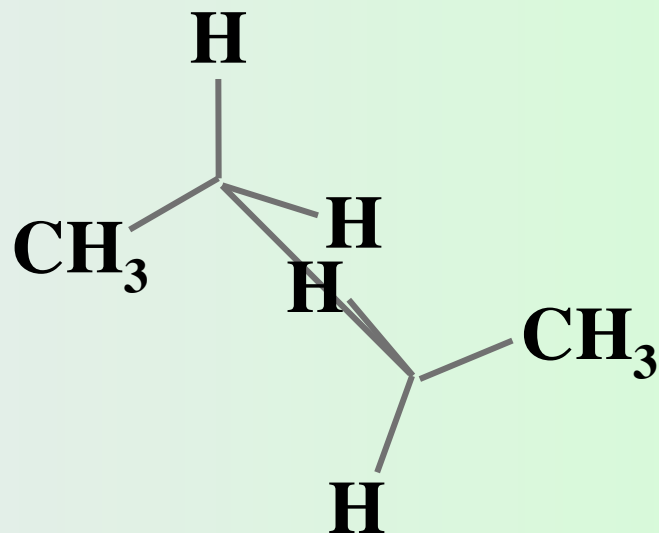


saw horse projection

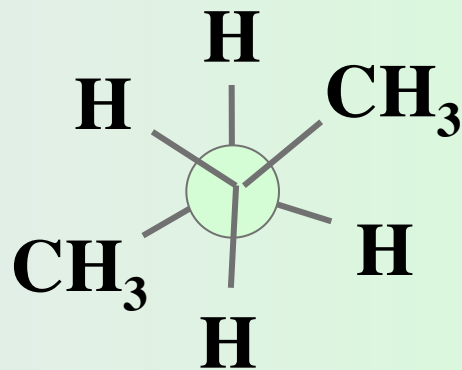
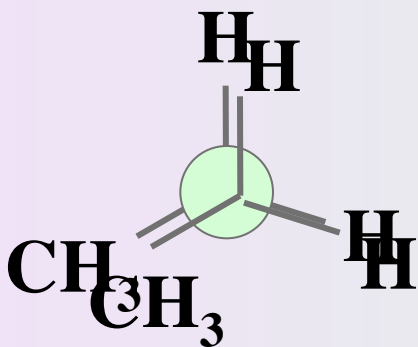
Stereoisomers



eclipsed conformation



staggered conformation



Newman projection

Van der Waals Strain / Steric Strain

a destabilization that results when two atoms or groups approach each other too closely

rotation of atoms about single bonds serves to reduce steric strain

Levels of Structure

Elemental Composition ✓

Empirical Formula ✓

Molecular Formula ✓

Constitution ✓

Conformation ✓



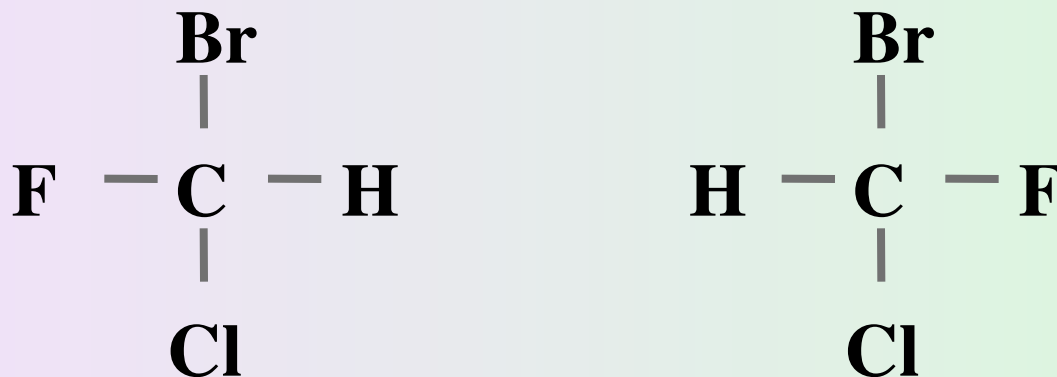
Configuration

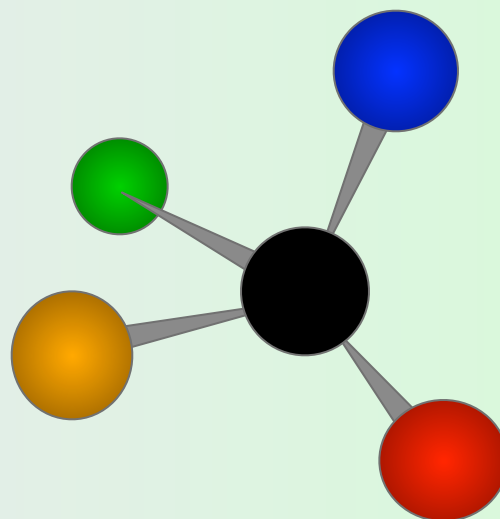
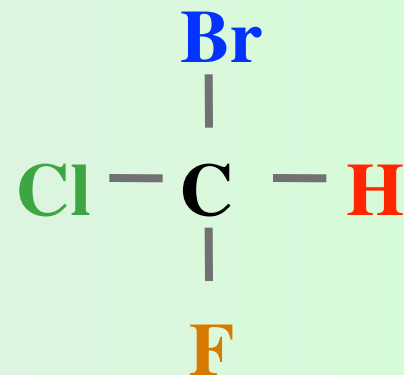
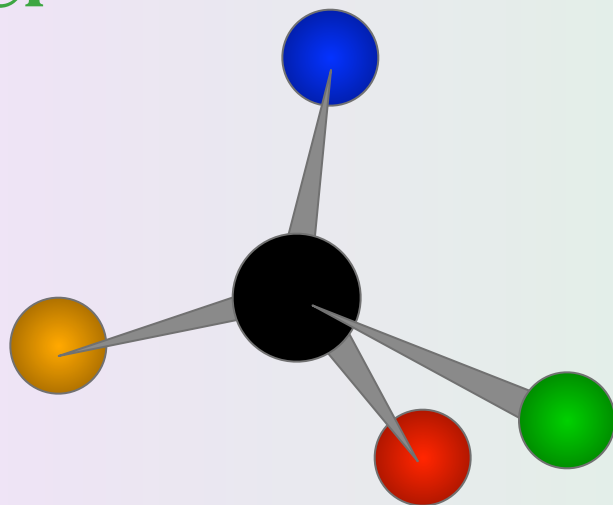
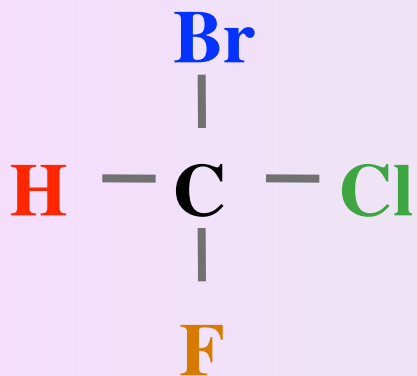
Enantiomers

Stereoisomers that are related as an object and its nonsuperimposable mirror image

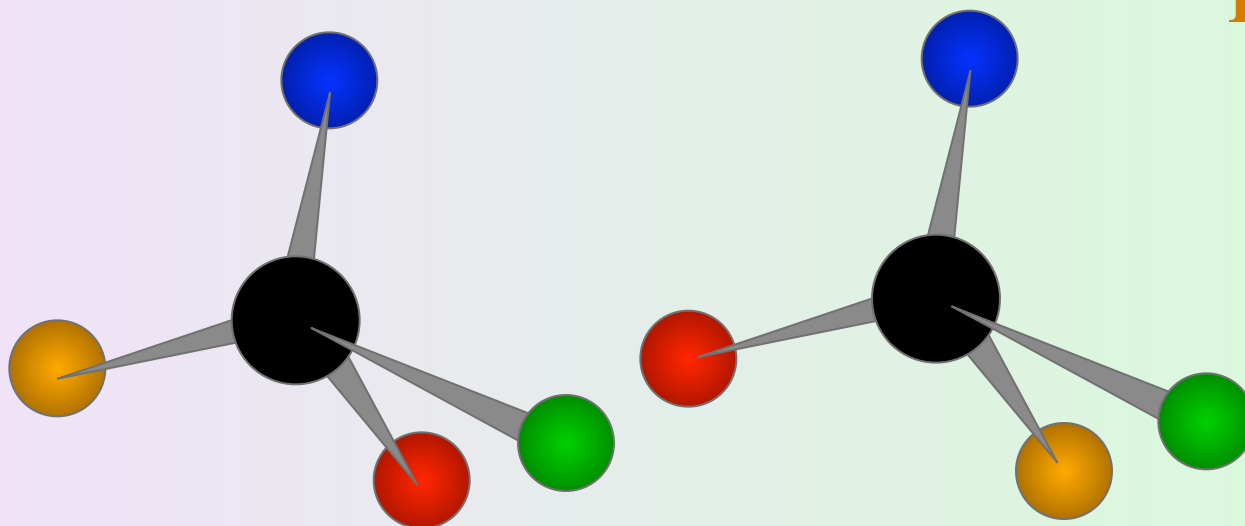
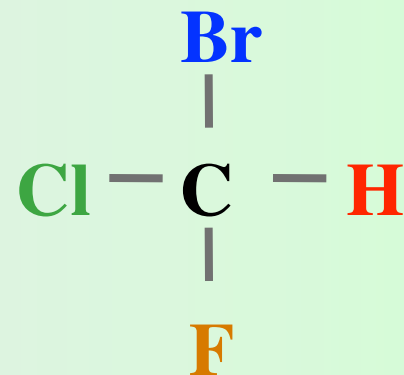
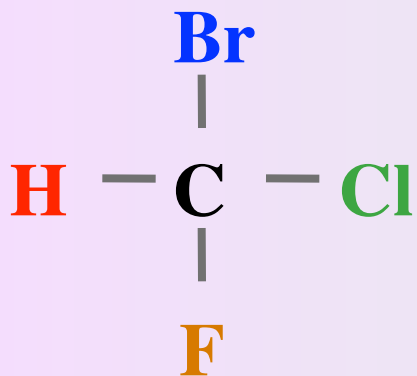
ie: being **chiral**

bromochlorofluoromethane





mirror images



nonsuperimposable

Cycloalkanes

Cycloalkanes

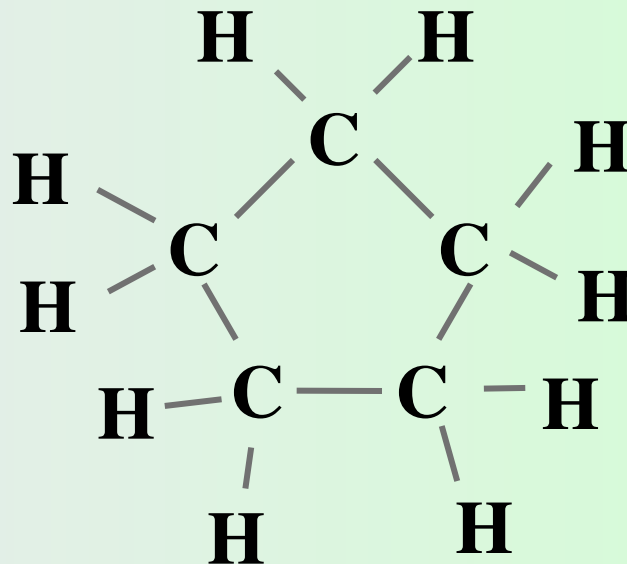
Alkanes whose carbon atoms are joined in rings



cyclopentane



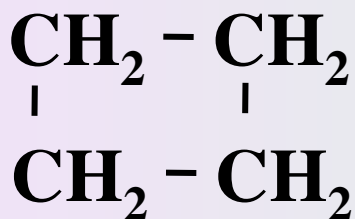
sp^3 hybridization



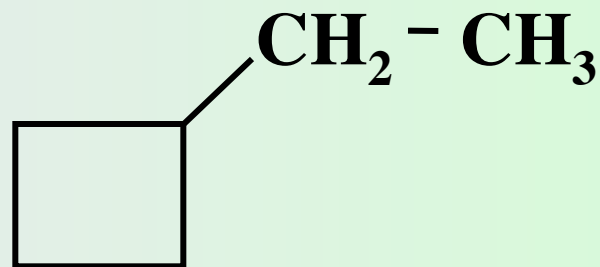
Alkane Nomenclature

follows the same rules as for naming other alkanes except that the root name is preceded by the prefix **cyclo-**

The ring is numbered to yield the smallest substituent number possible.

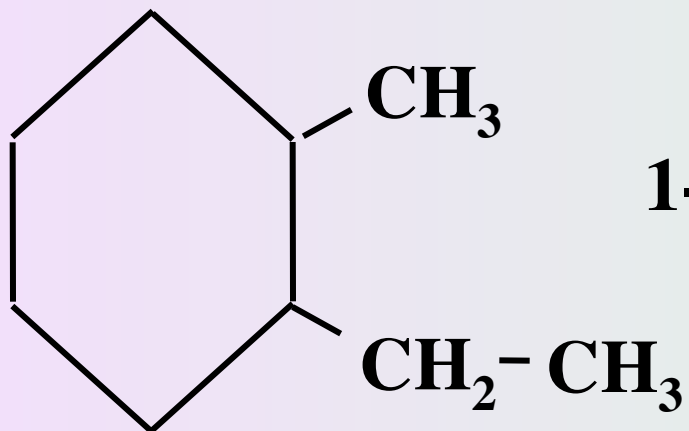


cyclobutane

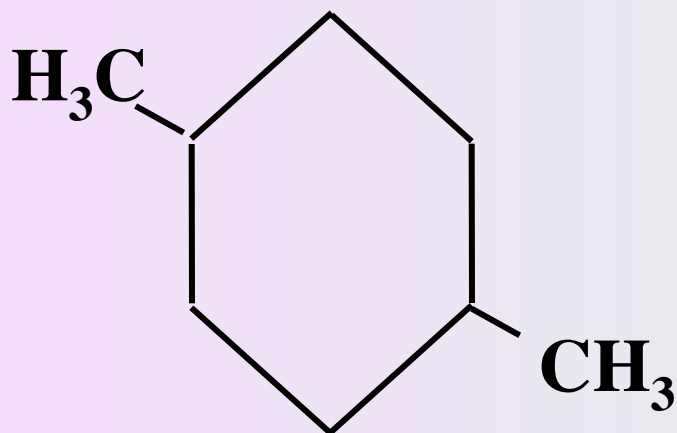


1-ethylcyclobutane

Example

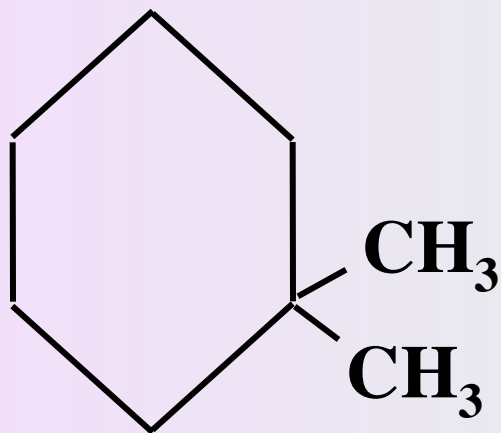


1-Ethyl-2-methylcyclohexane



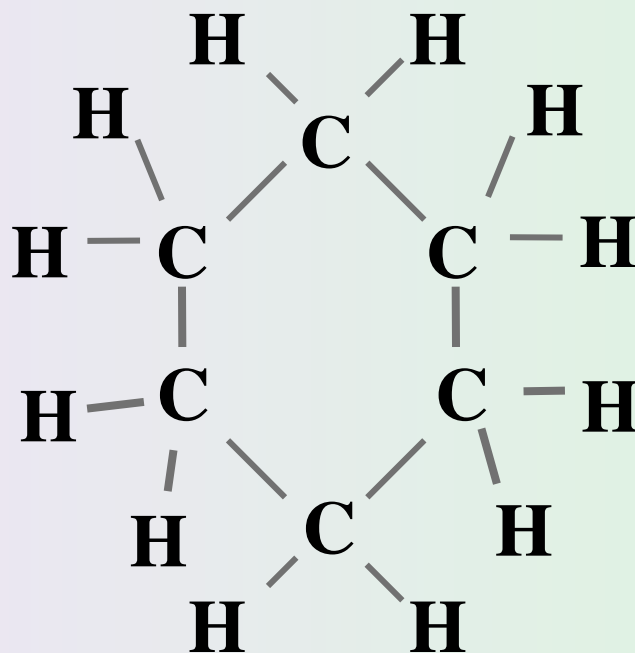
1,4-Dimethylcyclohexane

Example



1,1-Dimethylcyclohexane

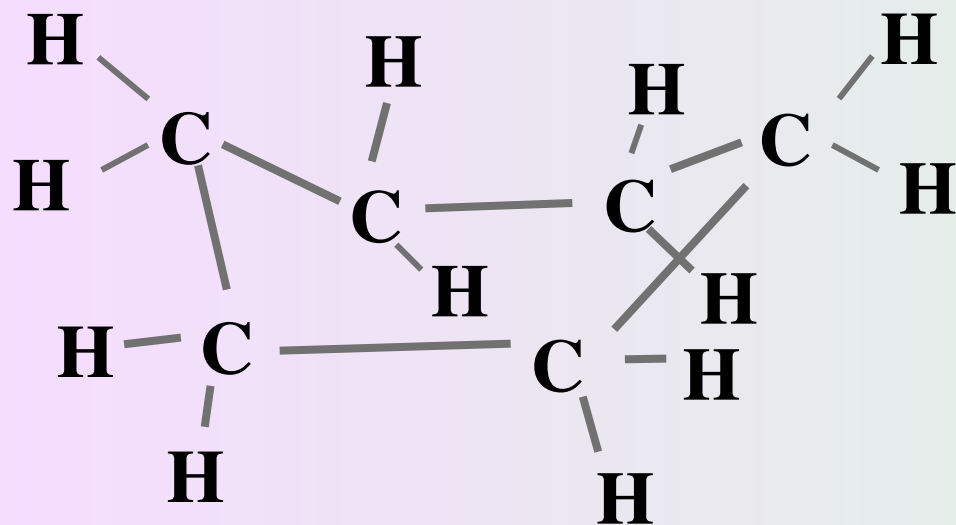
Cyclohexane



to attain tetrahedral bond angles the cyclohexane ring must “pucker”

Cyclohexane

Two stable conformations C_6H_{12}



Boat

Cyclohexane

Two stable conformations C_6H_{12}

Cyclohexane assumes
the chair conformation
99% of the time

