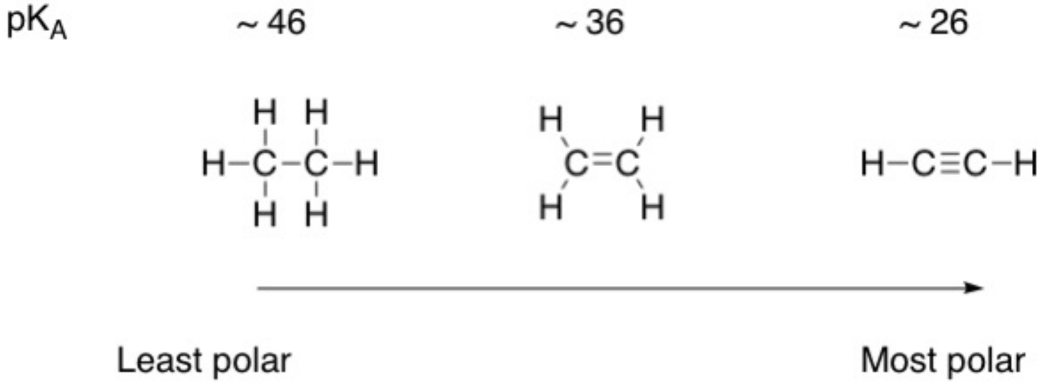
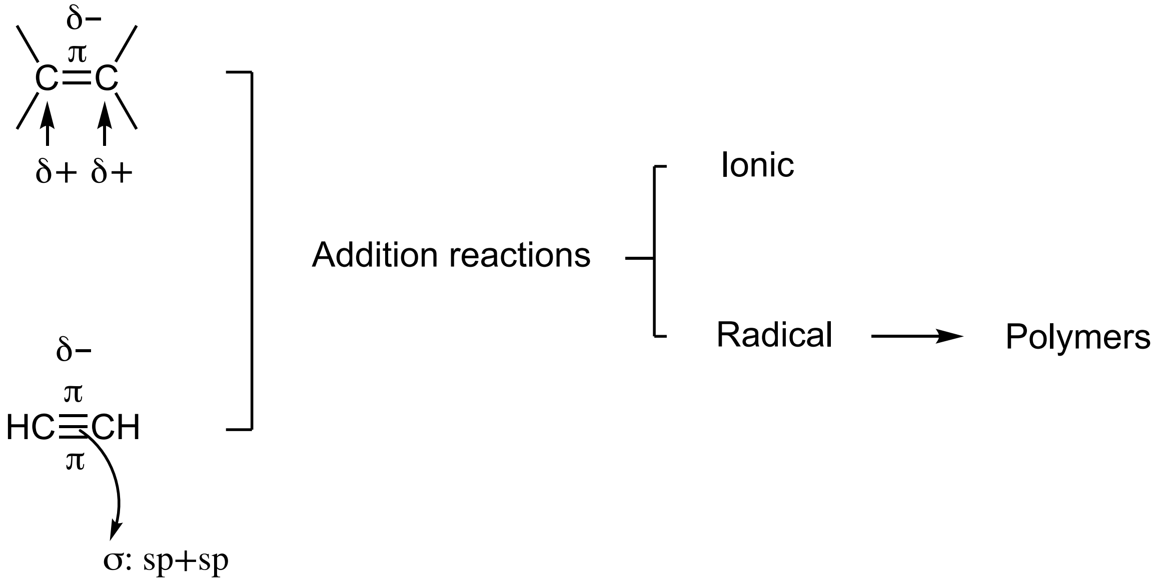
Characteristics of Alkanes, alkenes, and alkynes (density ρ = ~0.7, not miscible with water)

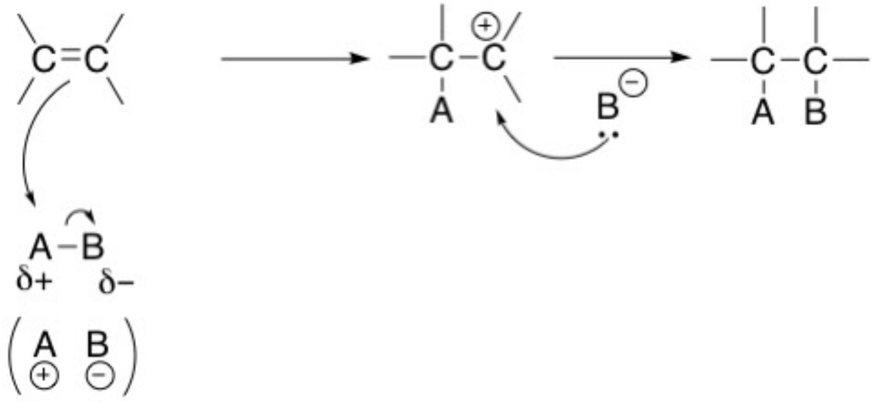


Alkynes have higher boiling point, melting point, and density

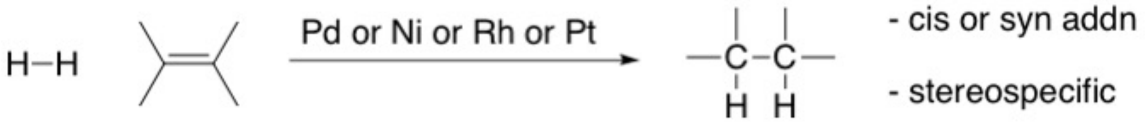


Addition Reaction:

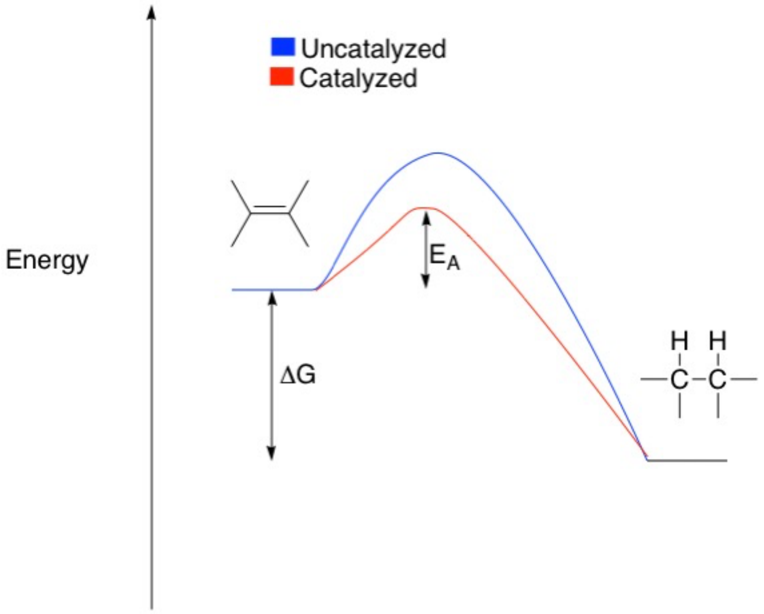
General Mechanism



Hydrogenation Addition of H_2

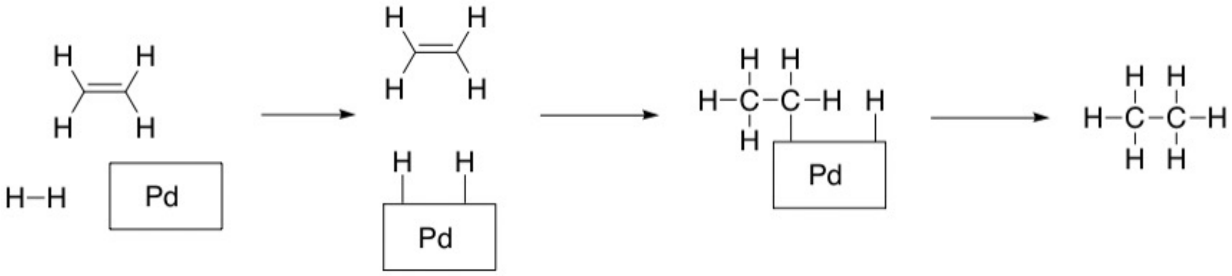


This reaction is **stereospecific**, meaning that the stereochemistry of the starting material determines the stereochemistry of the product (in this reaction, cis). The metals palladium (Pd), nickel (Ni), rhodium (Rh), and platinum (Pt) act as catalysts to facilitate this reaction.



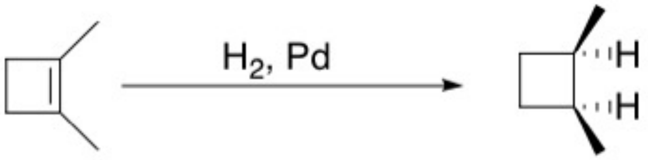
Catalysts accelerate the reaction rate by providing a lower energy pathway (red curve above). In general, they are not permanently converted to other products

Mechanism of hydrogenation



Hydrogenation examples

Example 1: 1,2-dimethylcyclobutene

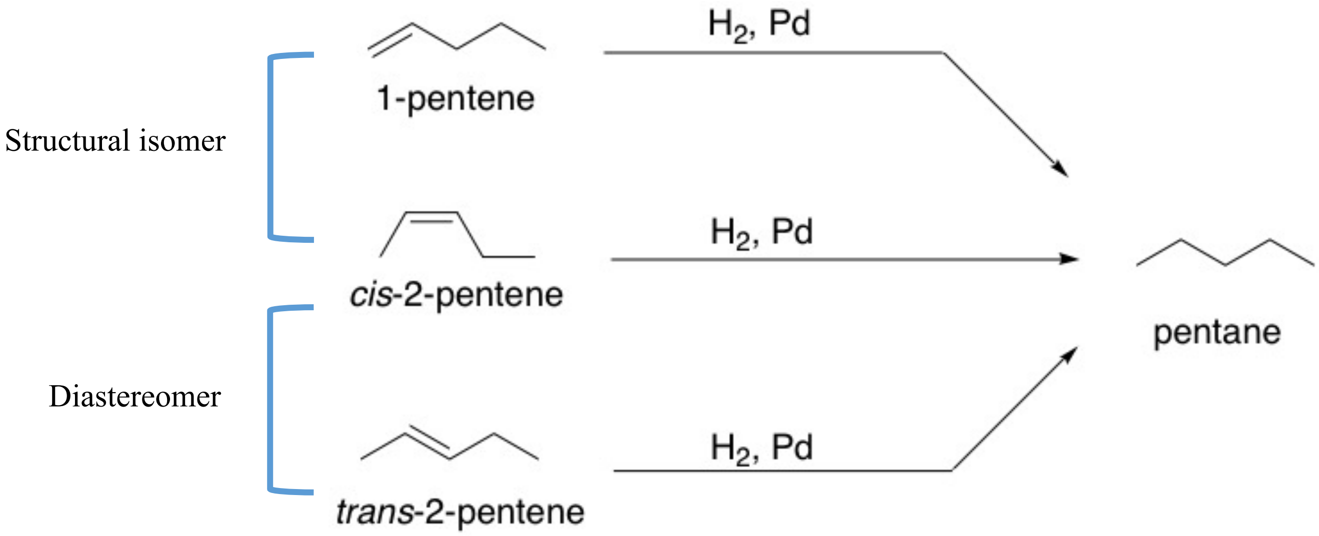


Achiral
(meso)

1,2-dimethylcyclobutene *cis*-1,2-dimethylcyclobutane

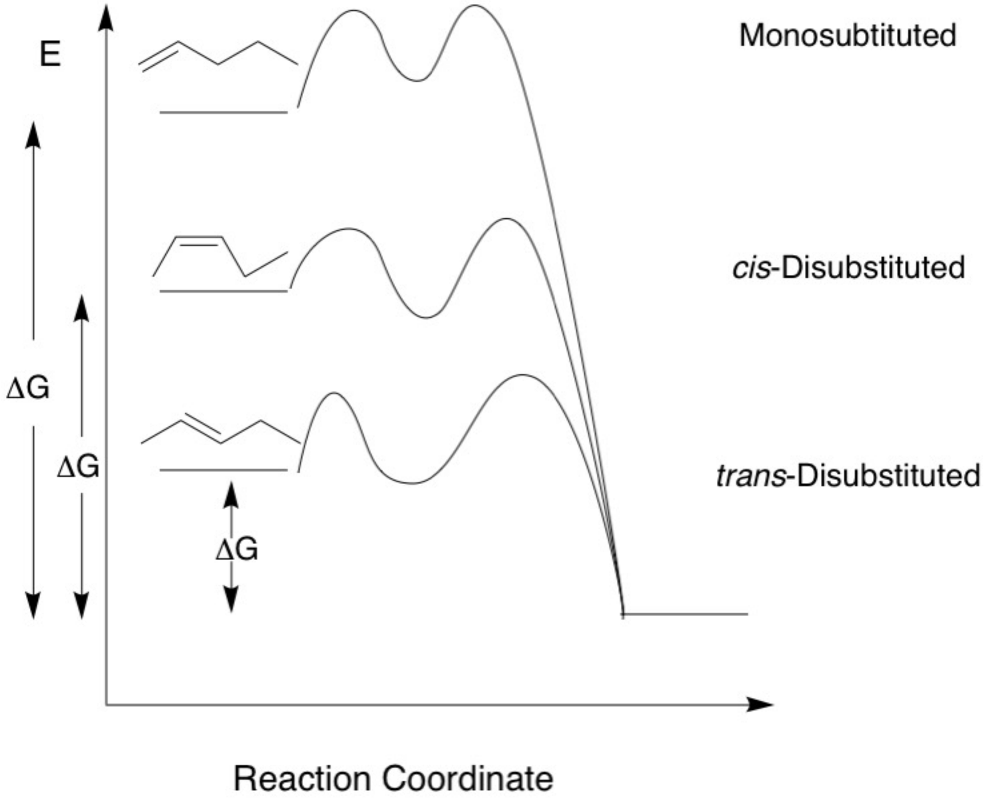
The hydrogenation can occur from the top or the bottom, which in this case produces the same product (cis isomer of 1,2-dimethylcyclobutane).

Example 2: Pentene



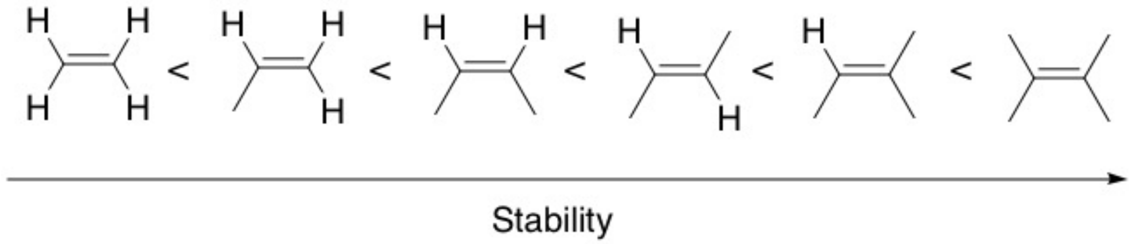
Energy is released in each of these reactions, the energy released implies stabilization caused from transforming the starting material into the product.

Energy diagram



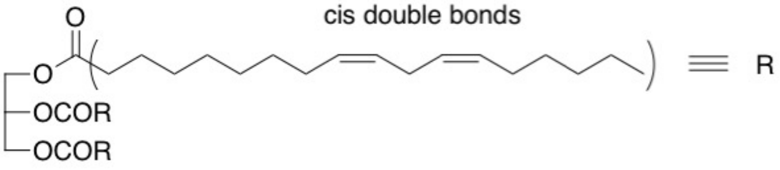
ΔG *trans*-isomer < ΔG *cis*-isomer < ΔG 1-pentene isomer

Alkenes with more substituents are more stable. Carbons in a double bond have a δ+, this is stabilized by the electron donating effects of alkyl groups. Hydrogens are less electron donating and so less substituted alkenes are less stable. Cis alkenes are less stable than trans alkenes as they have methyl groups facing the same direction which causes unfavorable steric interactions.

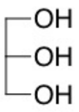


Example 3: Fats

Fat

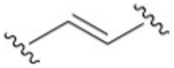


A triglyceride

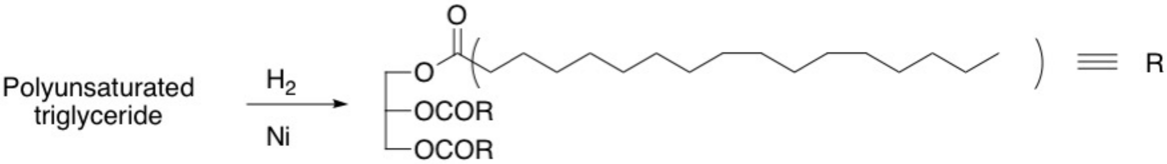


Glycerol

trans double bond

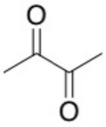


The triglyceride is a triester of glycerol
It is a polyunsaturated (>1 double bond) fats (e.g. canola oil)- unsaturation refers to the double bonds.
Trans double bonds can also be generated in fats, which are then called trans fats.
Hydrogenation give saturated fats (unsaturation remobed)



Major component of margerine

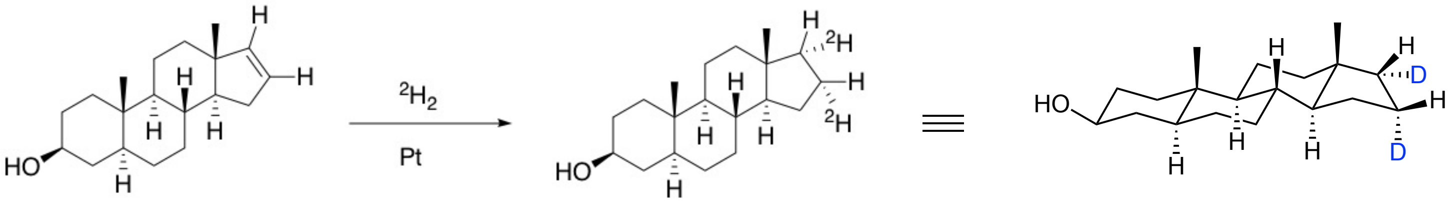
A solid saturated fat (margarine)
This molecule has greater London dispersion forces, cause it to exist as a solid



Diacetyl

Butter flavoring that adds a yellow color

Example 4: Steroid

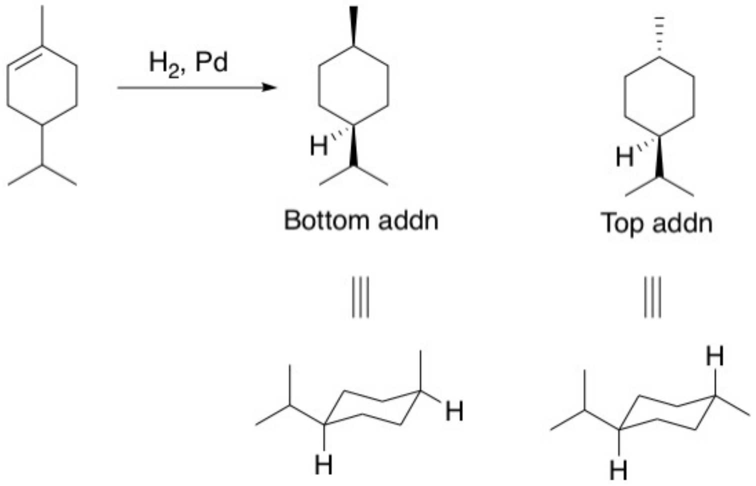


The deuteriums add to the back because of the steric hindrance of the nearby methyl group.

$^2H = D =$ deuterium

Example 5: Limonene

Limonene



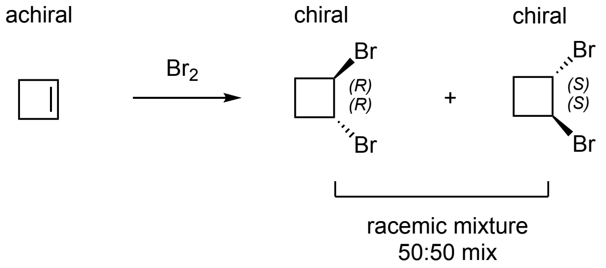
The two possible products are diastereomers.

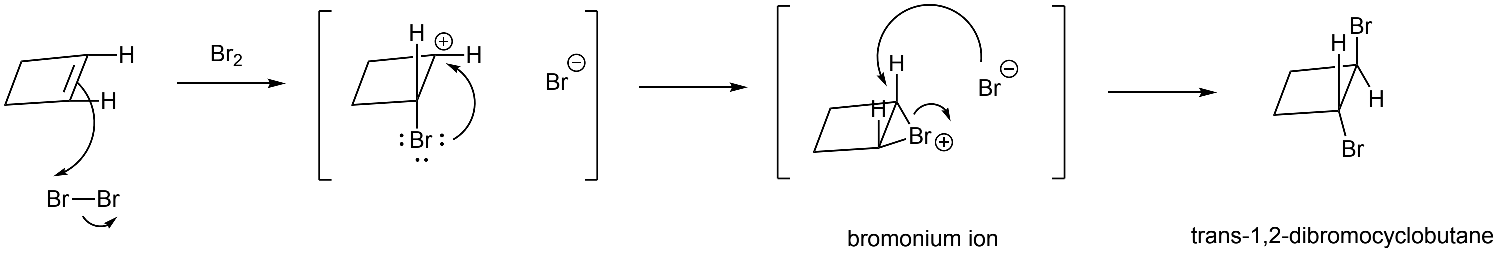
Halogenation: Addition of halogens across a double bond

Anti Addition
Trans Addition

X = F, Cl, Br, (I)

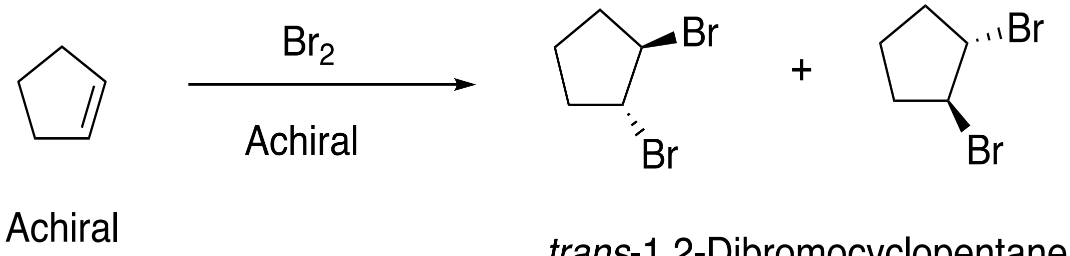
Didn't work for X = I





Note: Iodine can form the iodonium ion, however, instead of attacking on the carbon, iodine will attack the positively charged iodine and form the starting material alkene.

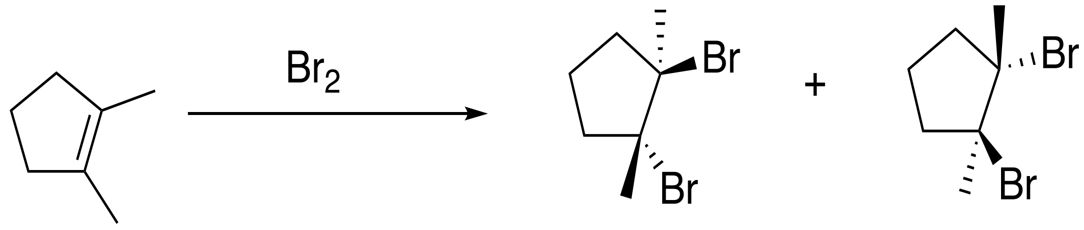
Ex #1) Cyclopentene **Stereospecific Reaction**



trans-1,2-Dibromocyclopentane

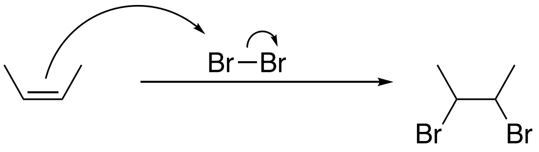
Both enantiomers formed (1:1 racemate)

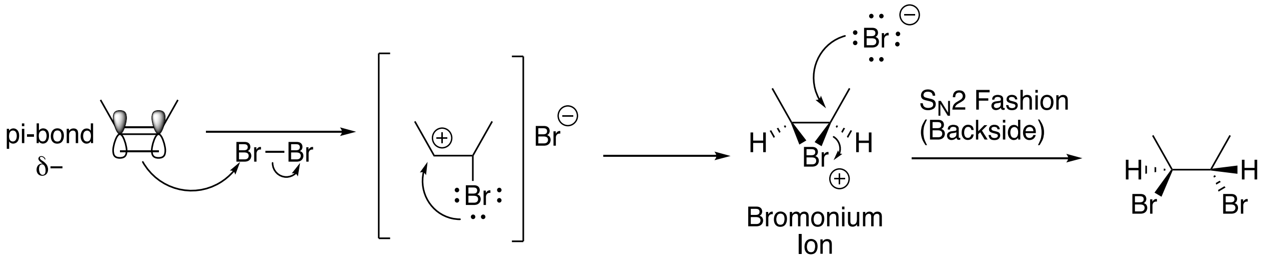
Ex #2) 1,2-dimethylcyclopentene



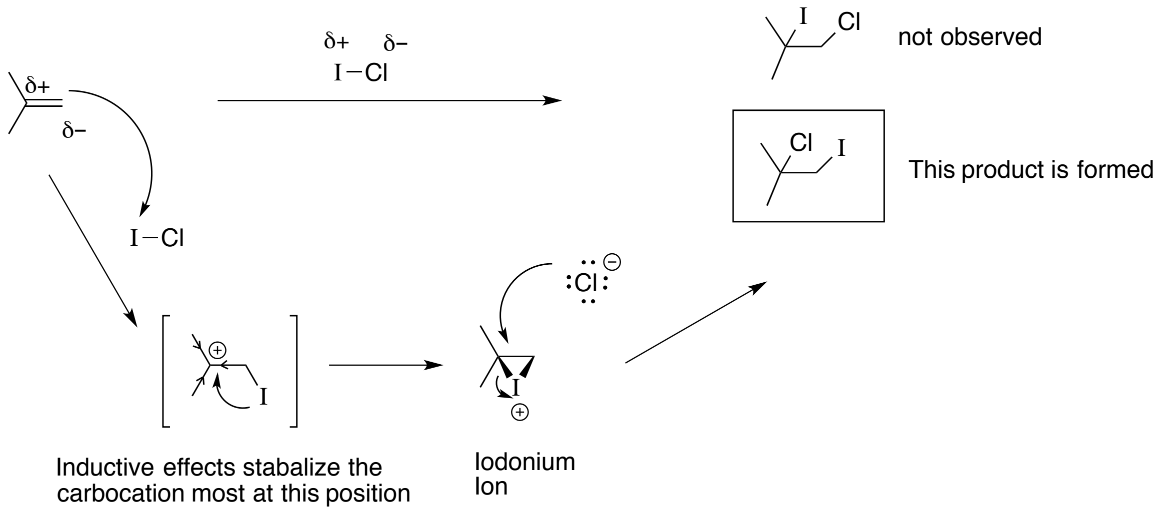
trans-1,2-Dibromo-1,2-dimethylcyclopentane

Mechanism:





Ex #3) 2-Methylpropene



Markovnikov's Rule: In an addition reaction, the positive end of an A–B system (e.g. I–Cl) adds to the least substituted end of the double bond to make the more stable carbocation.