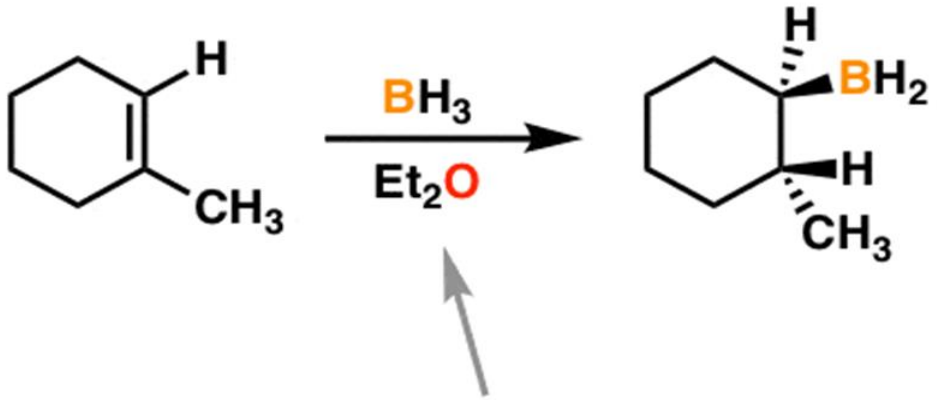
# Hydroboration and Birch Reduction

# TOPICS COVERED

- Hydroboration Reaction
- Mechanism of Hydroboration
- Hydroboration of alkene and alkyne and problems
- Birch Reduction and Mechanism
- Birch Reduction in Presence of Electron withdrawing and releasing group
- Problems

# Hydroboration Reaction of Alkene

**Hydroboration of alkenes**




**Regiochemistry**

**"anti-Markovnikov"**

*H adds to carbon with fewest attached hydrogens*

**Stereochemistry**

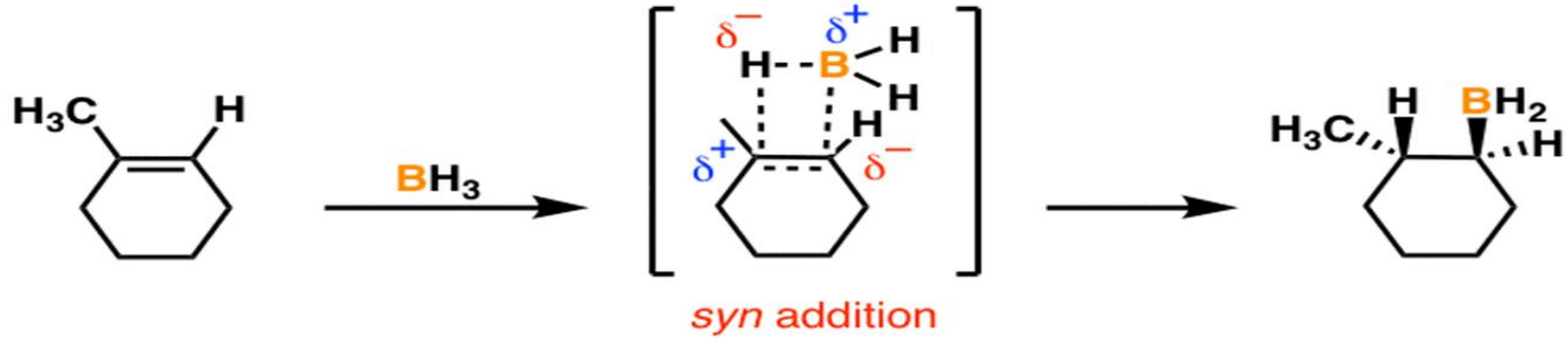
**"Syn"**

*H and B add to same face of alkene*

- No rearrangements observed
- Never observe incorporation of solvent

*Inconsistent with a free carbocation or with an intermediate 3-membered ring*

## The Hydroboration Mechanism




*syn* addition

- **Concerted transition state**

  C–H and C–B bonds are formed at approximately the same time

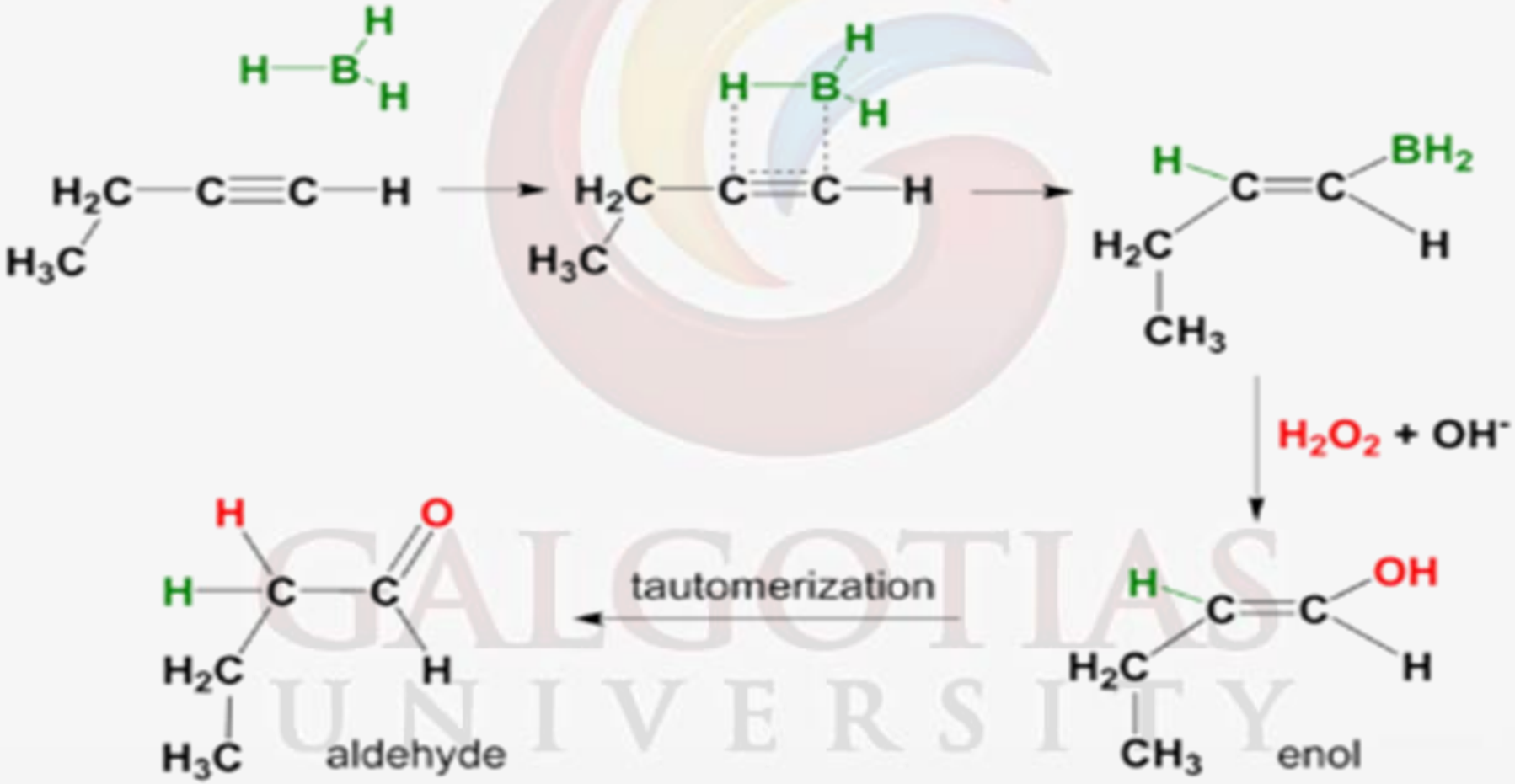
- **'Anti-Markovnikov' Regioselectivity**

  The most favored transition state allows the partially negative hydrogen atom to form a bond with the carbon atom best able to bear positive charge (the "most substituted" carbon of the alkene in most cases)

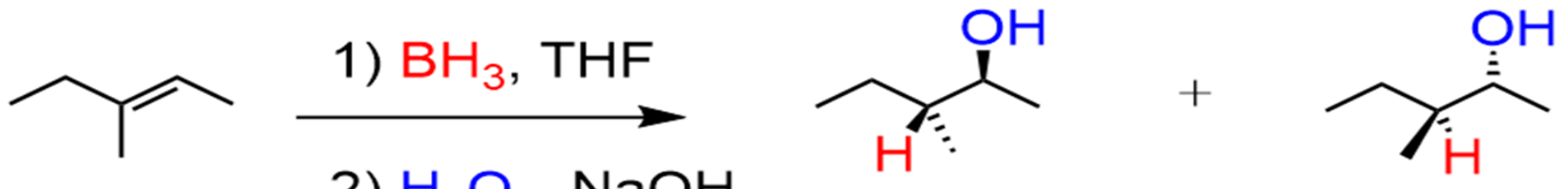
- **'Syn' Stereochemistry**

  In this concerted transition state, the C-H and C-B bonds are formed on the same side of the alkene (technical term: "suprafacial")

# Hydroboration Reaction of Alkyne

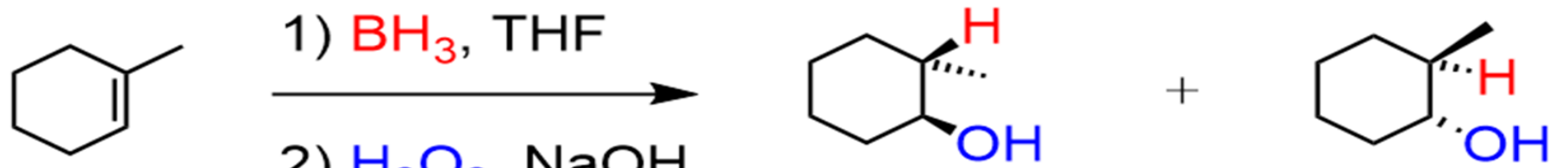


# Problems on Hydroboration




Enantiomers

**syn addition**




Enantiomers

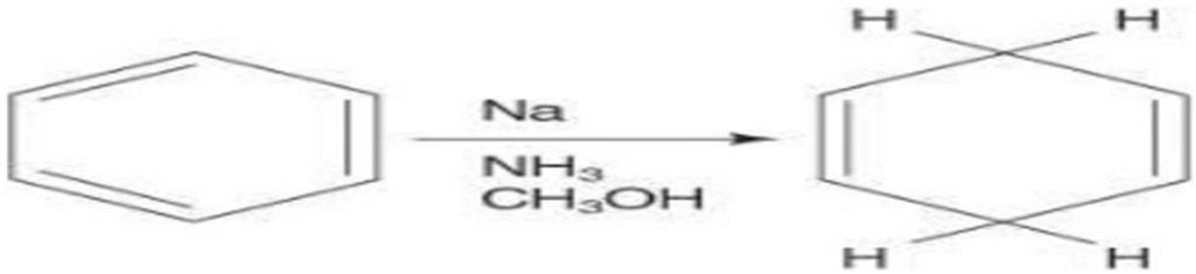
**syn addition**

# Birch reduction :-

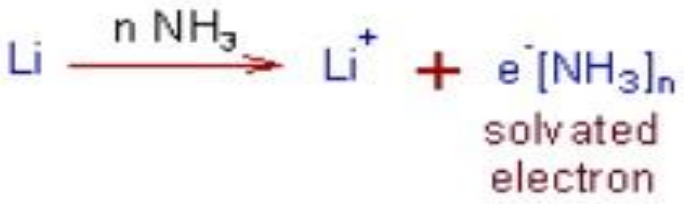
## Principle:-

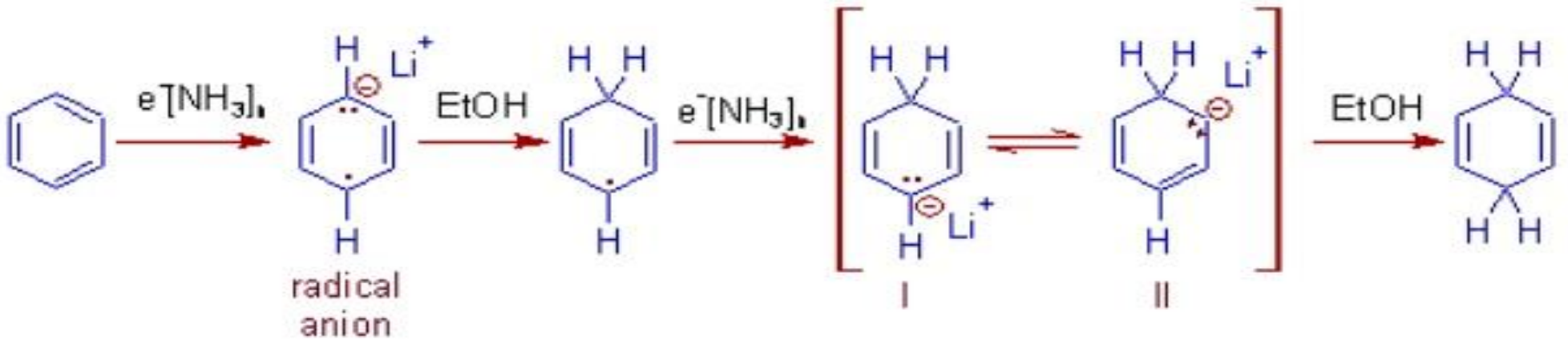
Reduction of aromatic rings by means of alkali metals (Li or Na ) in liquid ammonia or amines with ethanol as proton donar,to give mainaly unconjugated dihydroderivatives is known as birch reduction.

## General reaction:-

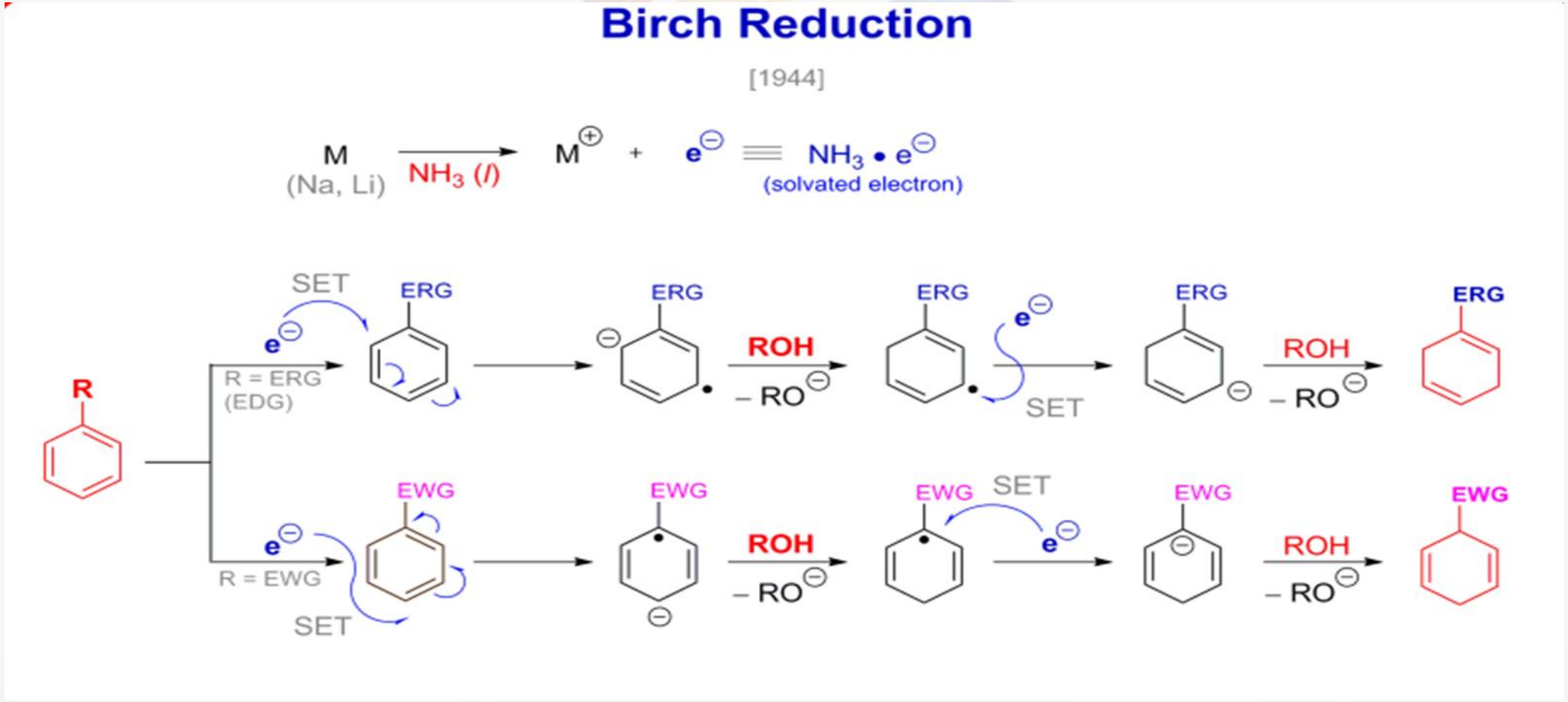


# Mechanism:-

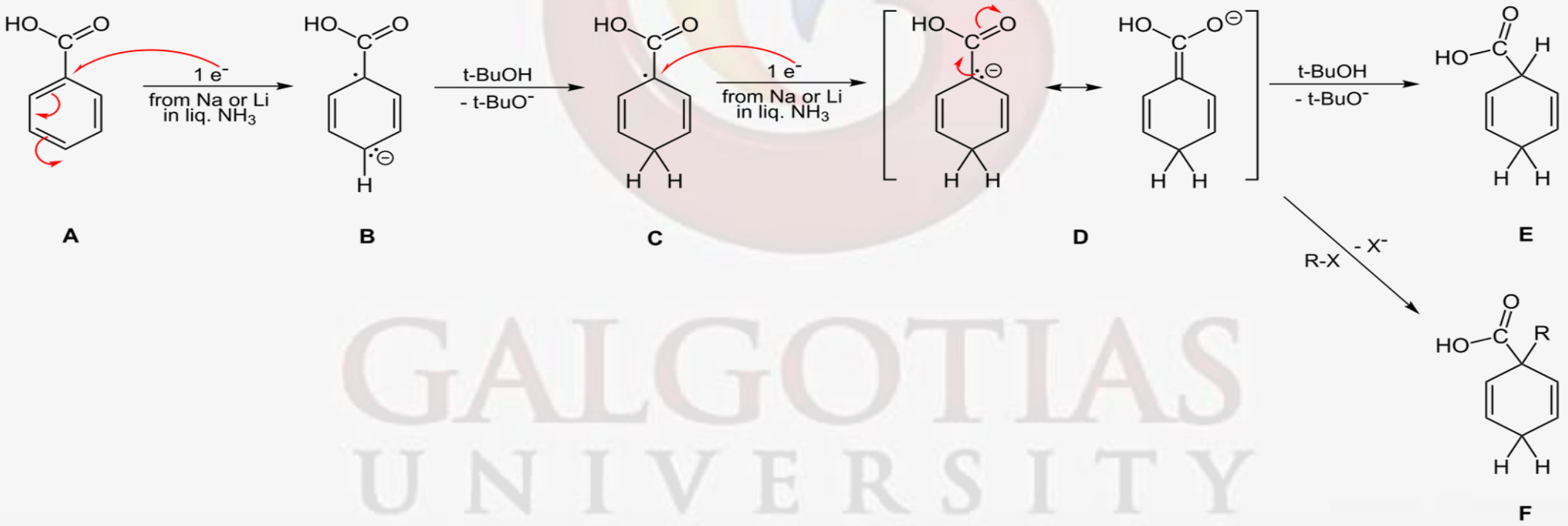

Li
n NH3
Li+
+
e-[NH3]n
solvated
electron


e-[NH3]n
H
Li+
radical
anion
EtOH
H H
H
e-[NH3]n
H H
Li+
H
I
H H
Li+
H
II
EtOH
H H
H H

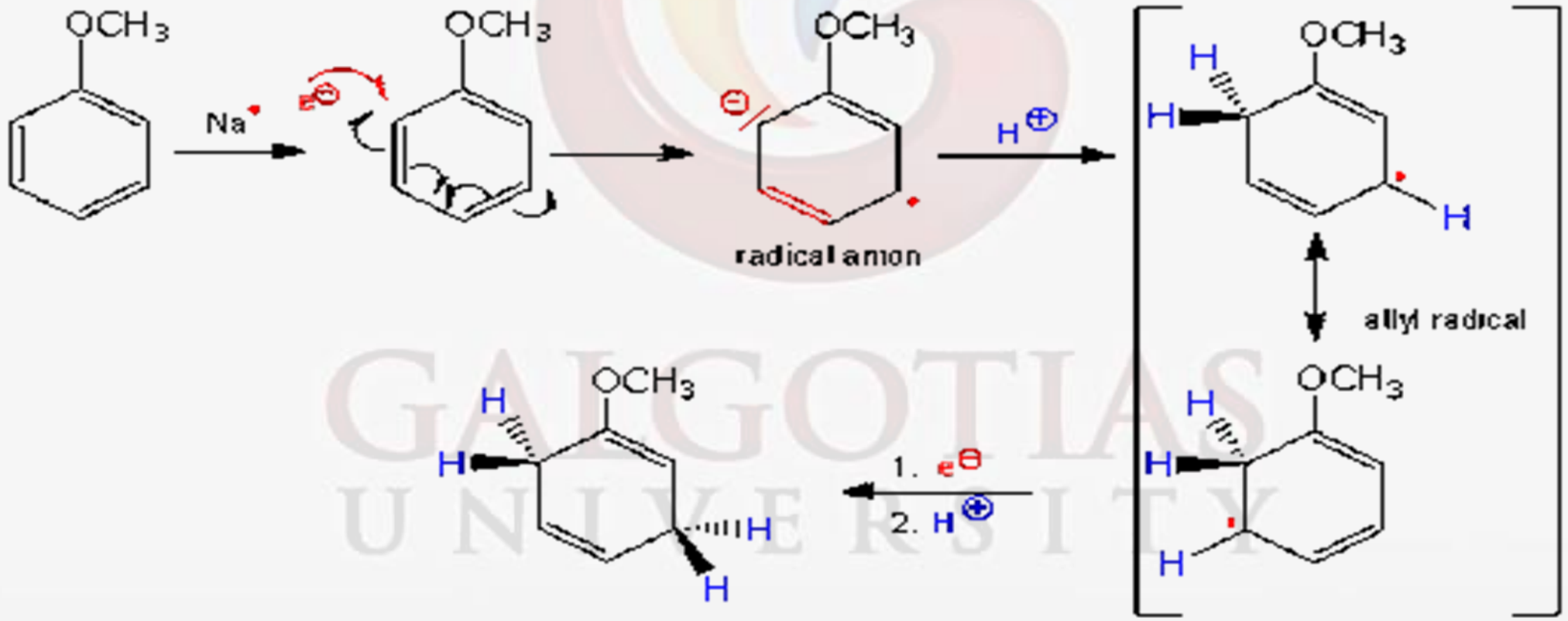
# Birch Reduction in Presence of Electron withdrawing Group (EWG) and Electron Releasing Group (ERG)



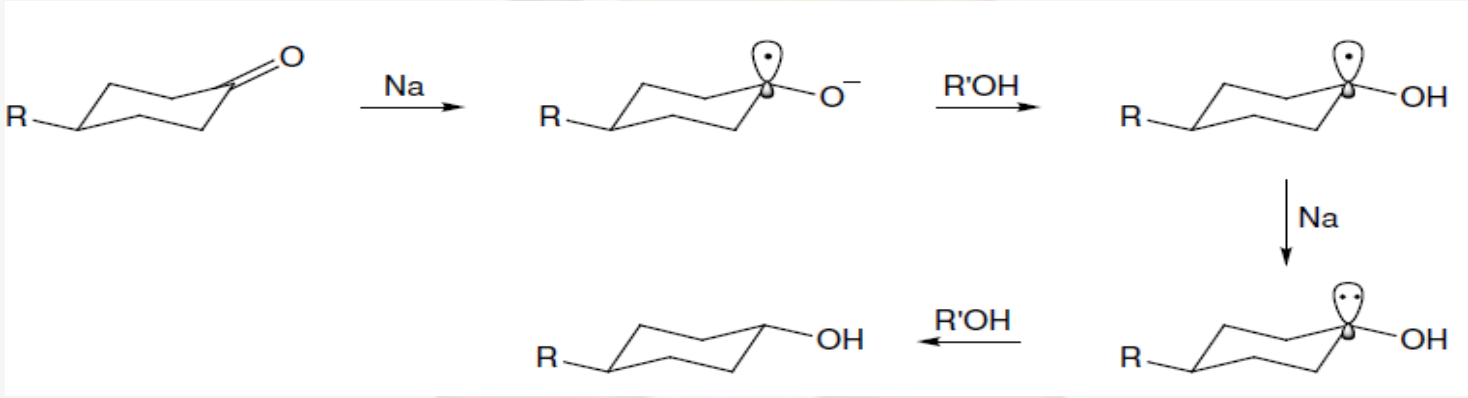
In Presence of EWG, ipso attack occurs, i.e, at the same position of EWG.



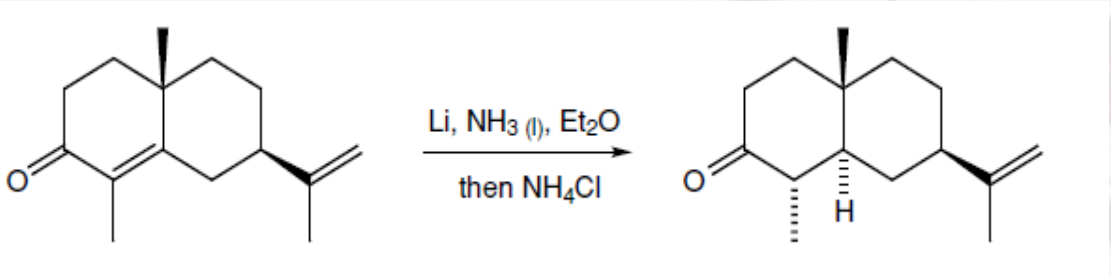
# Birch Reduction in presence of ERG, no ipso attack occurs



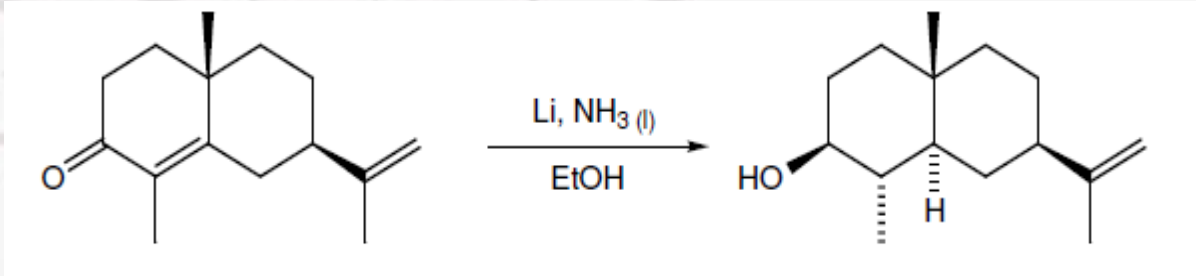
# More Examples of Birch Reduction




**Reduction of α, β unsaturated ketone gives saturated ketone and saturated alcohol depending upon the condition.**

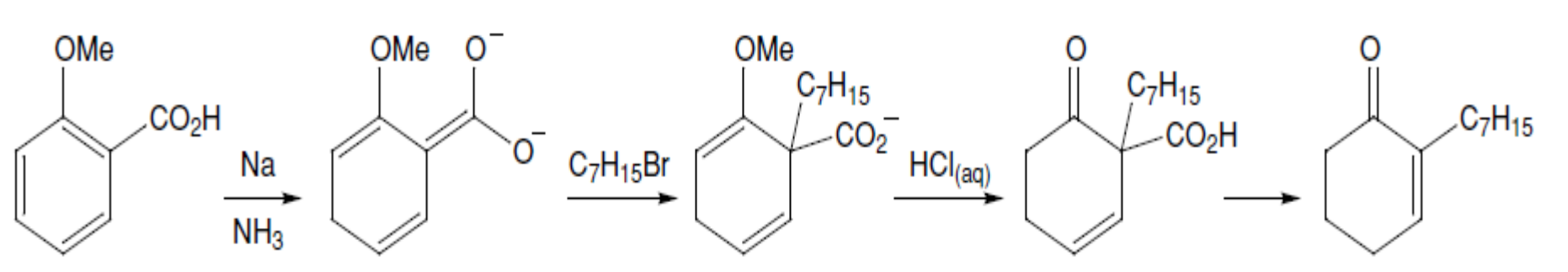


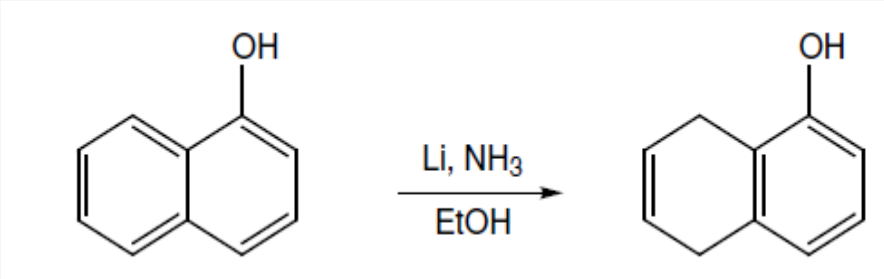

92%

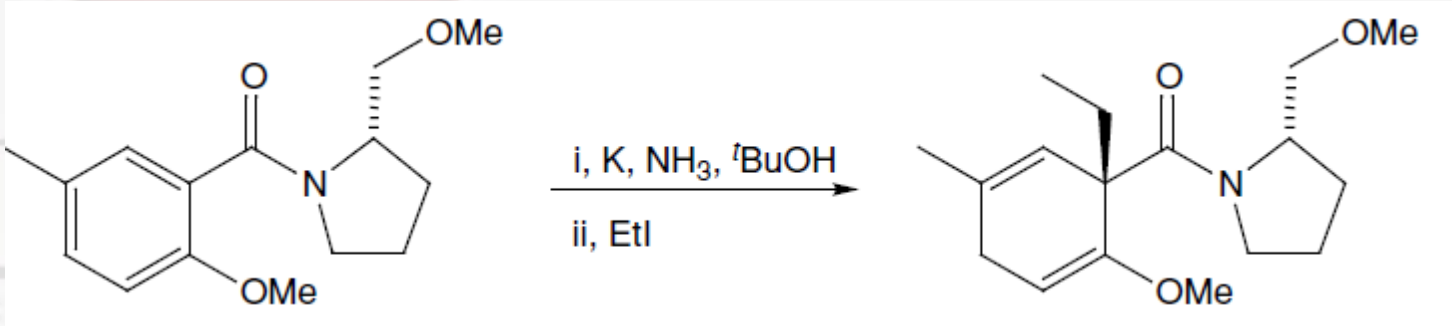



80%

# More Examples of Birch Reduction

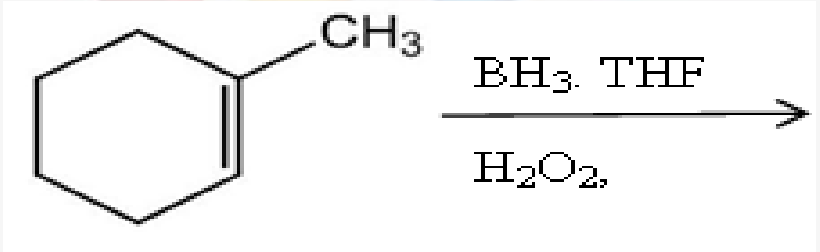


# Problems

Discuss the mechanism of Hydroboration Reaction? Identify the product and stereochemistry of following reaction.




Identify the reaction intermediate and reducing agent involved in Birch Reduction. Identify the products of the following two reactions. Determine the mechanism for each reaction.

# References


- W. Carruthers, Some Modern Methods of Organic Synthesis, 3rd edition, Cambridge University Press, New York, 1998.
- J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd edition, 2012.
- T.L. Gilchrist, Heterocyclic Chemistry, 3rd edition, Addison-Wesley Longman Ltd., England, 1997.
- https://www.google.com/search?q=oxidation+and+reduction+reactions+in+organic+chemistry+ppt&rlz=1C1CHBD_enIN920IN920&oq=Oxidation+and+Reduction+reaction+ppt&aqs=chrome.3.0l6.21843j0j15&sourceid=chrome&ie=UTF-8

# THANK YOU