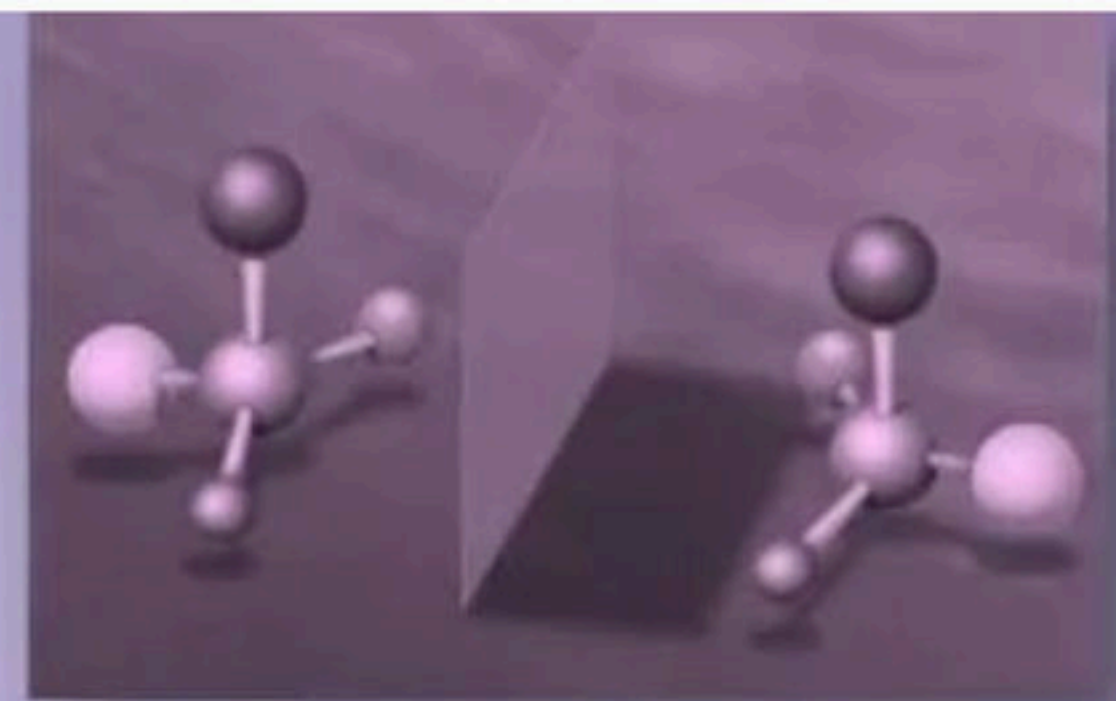




Stereochemistry -VI

Complete Course on Stereochemistry - CSIR NET - 2025



Stereochemistry

Part - VI

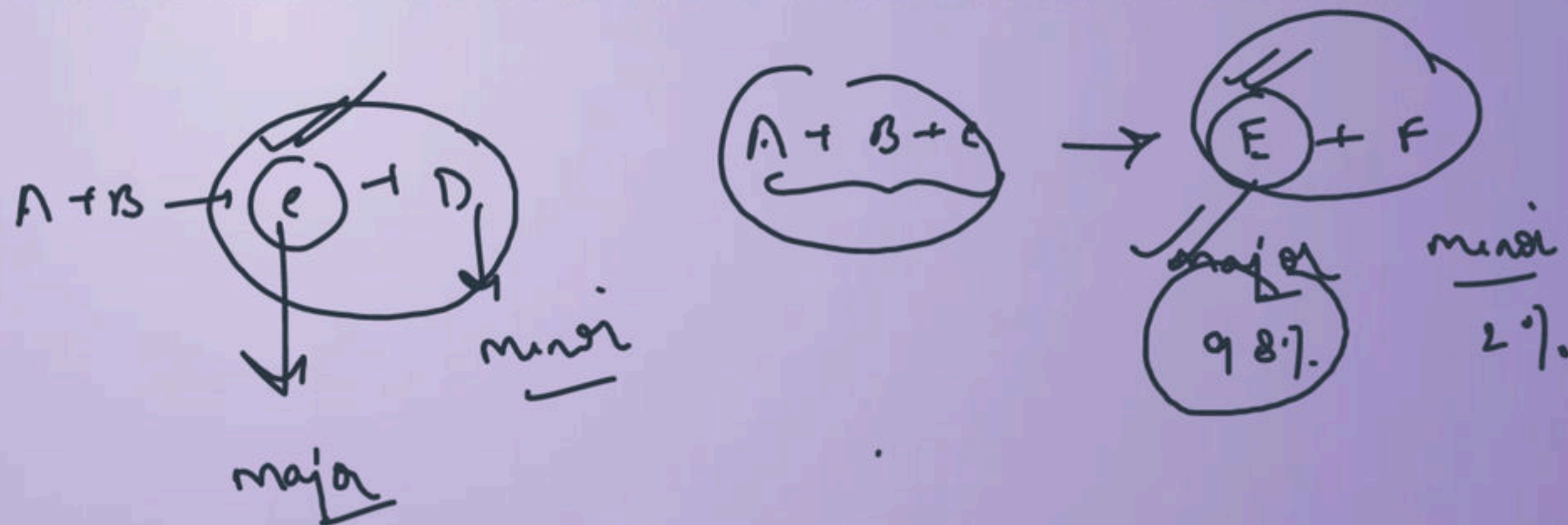
✓✓ Stereospecific & Stereoselective Reactions

CSIR NET – CHEMICAL SCIENCE
DR SEEMA CHAWLA

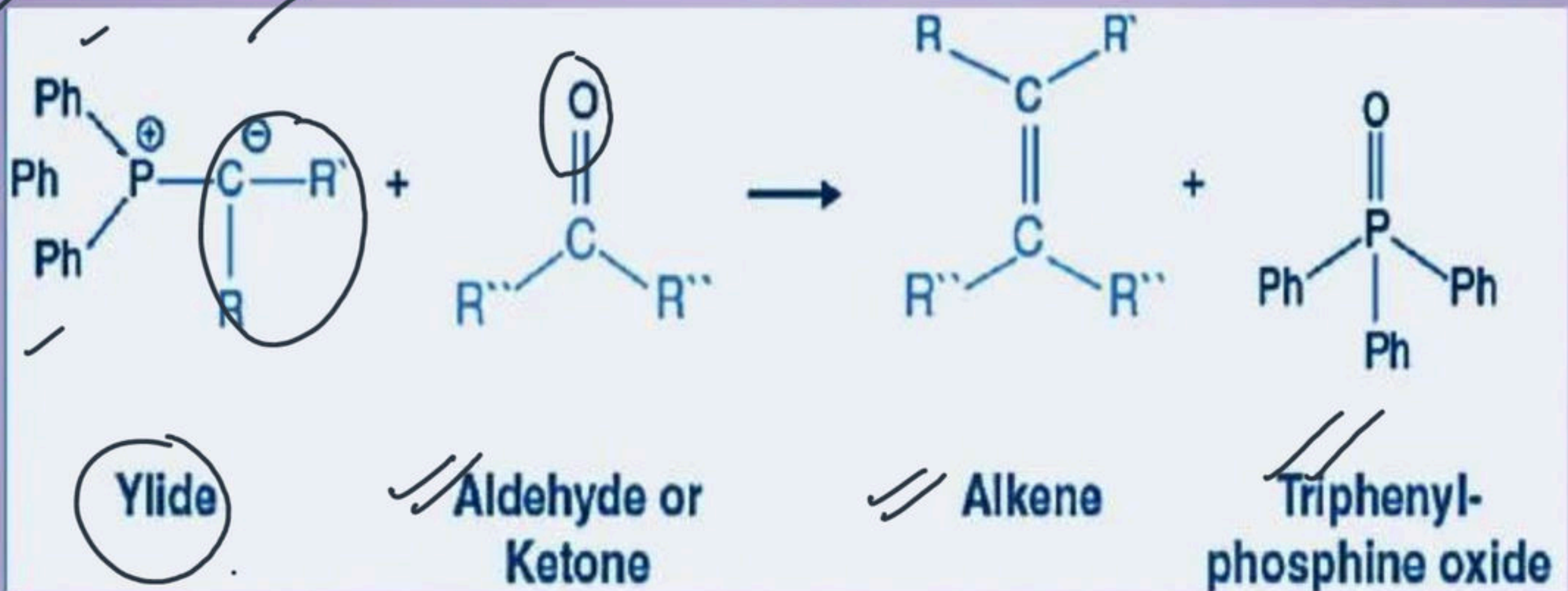
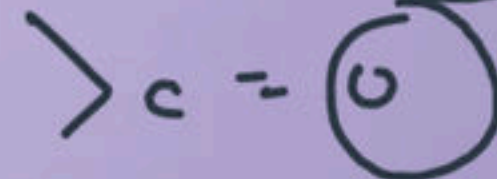
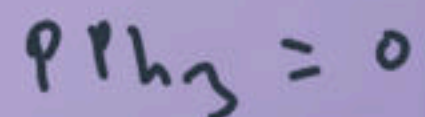
✓✓ Stereoselective Reaction

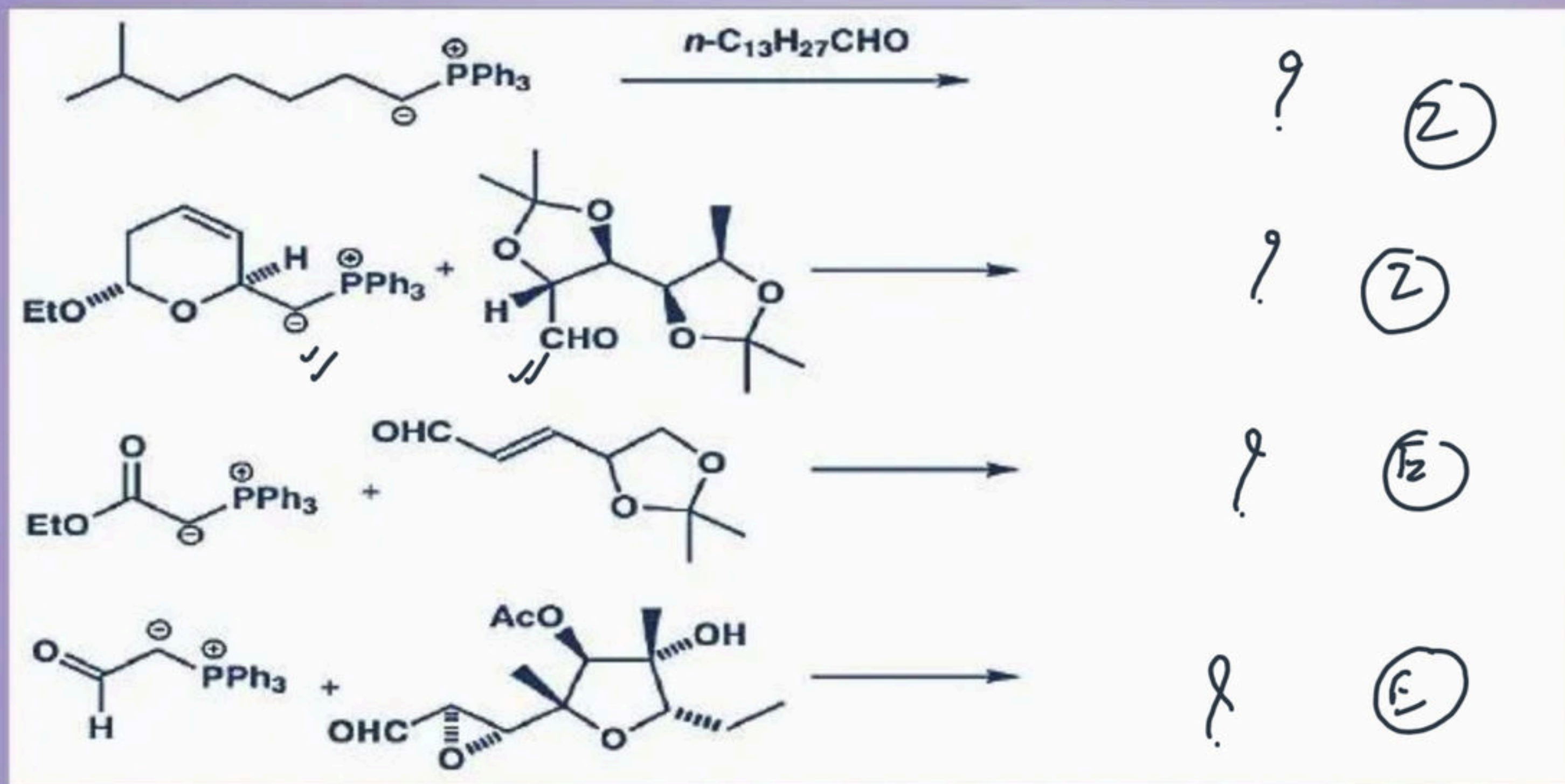
✓✓ A reaction in which one stereoisomer is formed ^{major} predominantly out of several stereoisomers is known as Stereoselective reaction and the property of reaction is called Stereoselectivity.

Stereoselectivity can be classified as Enantioselectivity and Diastereoselectivity.



Triphenyl phosphonium ylide





(Z/E)

(E)

glyde stabilise

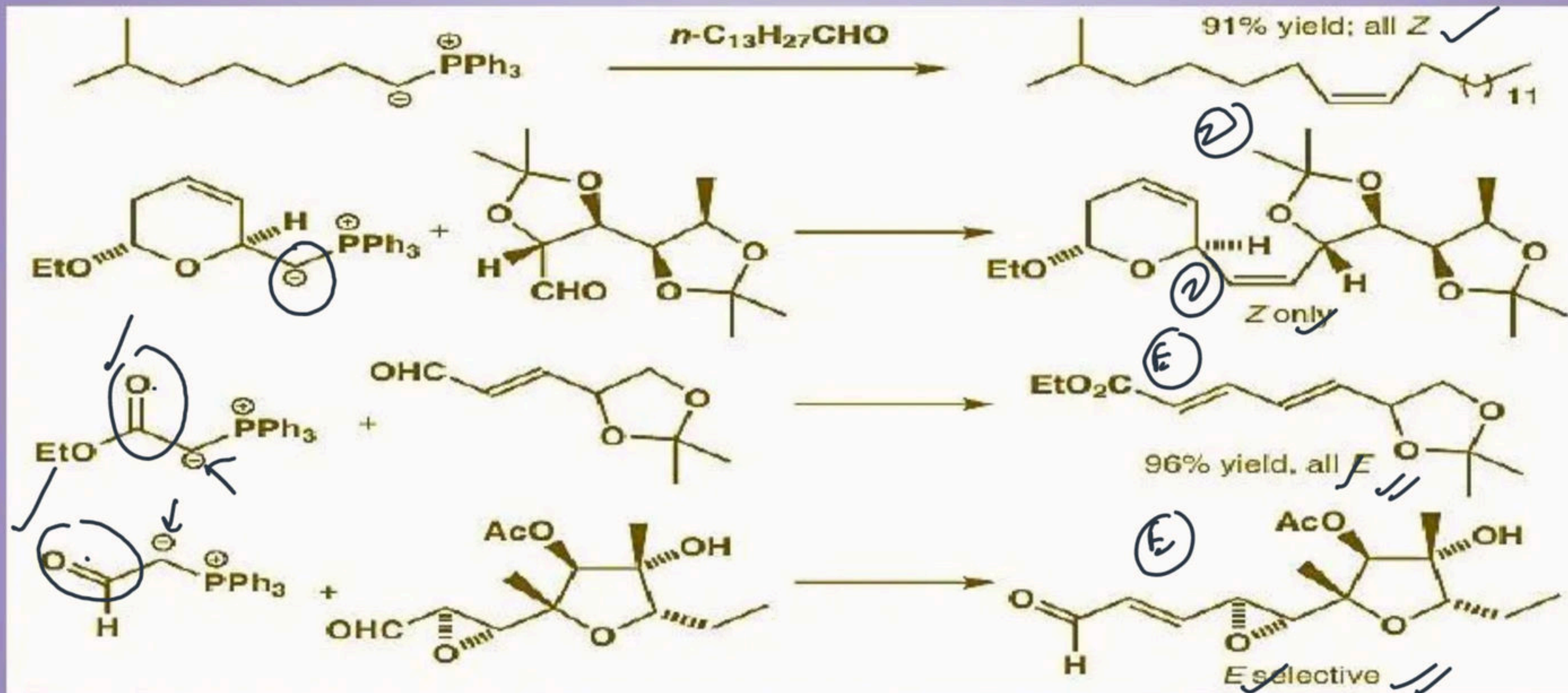
$>C=O$ near

glyde stabilise. X

(Z)

$$n\text{-C}_{13}\text{H}_{27}\text{CHO}$$

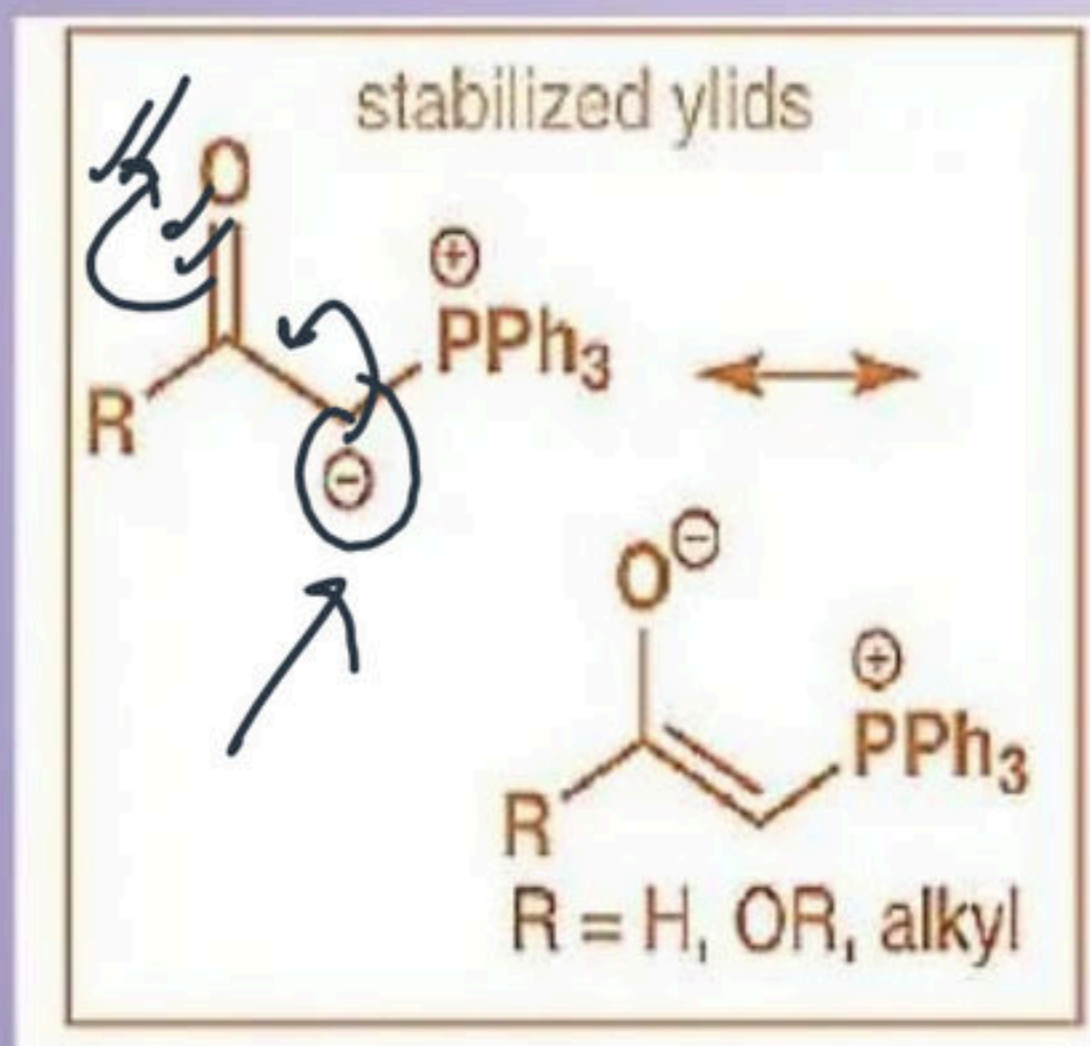
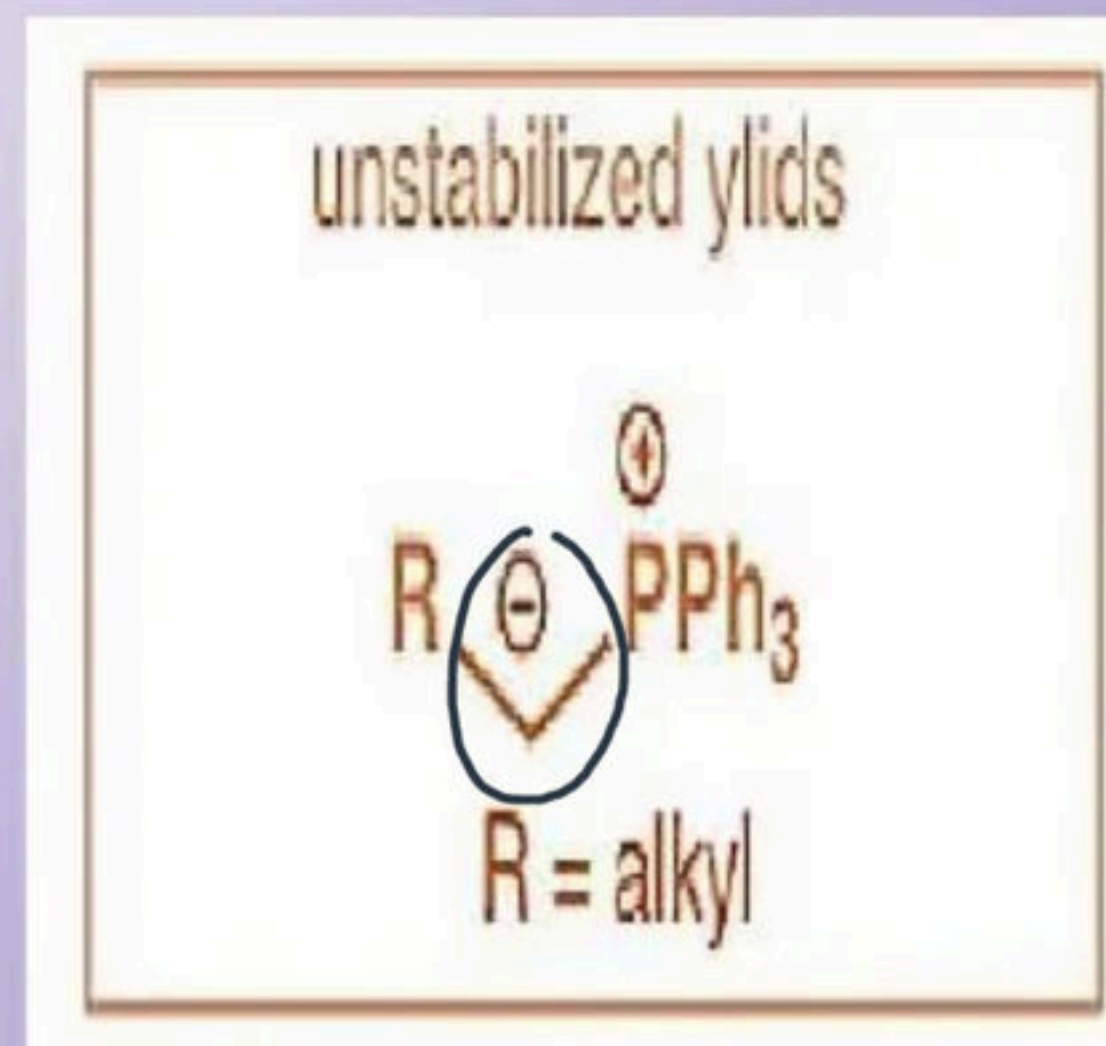
91% yield; all *Z* ✓

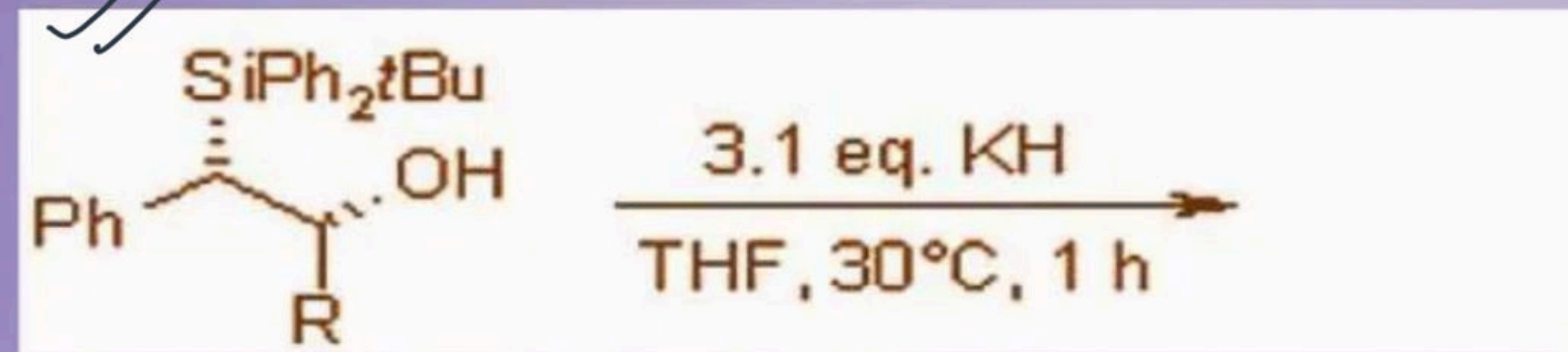
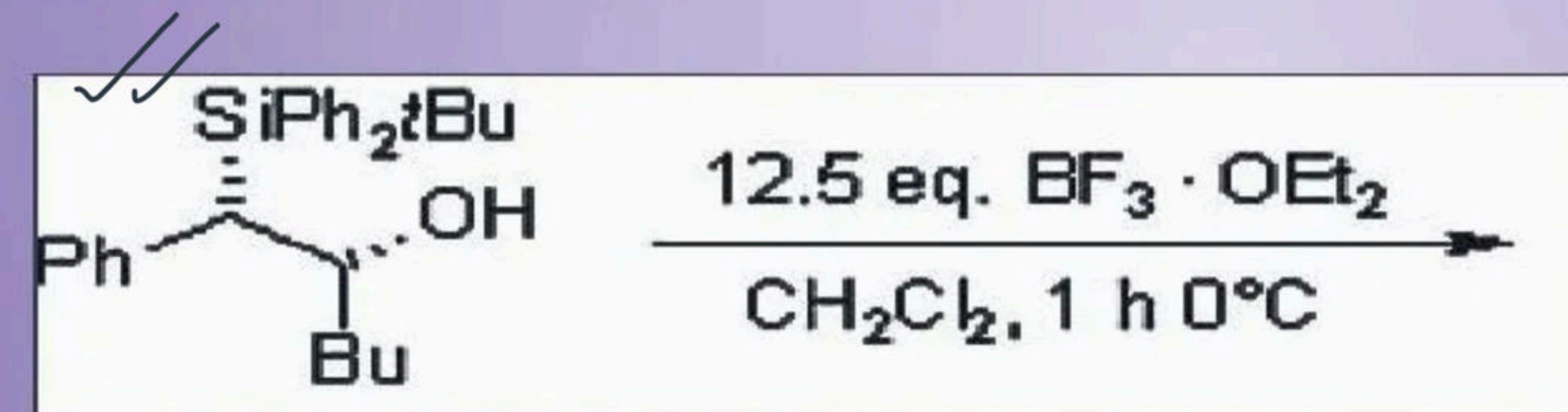


The general rule for stereochemistry of the Wittig reaction is:

- with stabilized ylids the Wittig reaction is E selective
- with unstabilized ylids the Wittig reaction is Z selective.

Wittig reaction is stereoselective





Peterson Defination

α-silyl carbanions
+ Ketone (Alk.)

↓
β-hydroxy silane

↓
Elimination

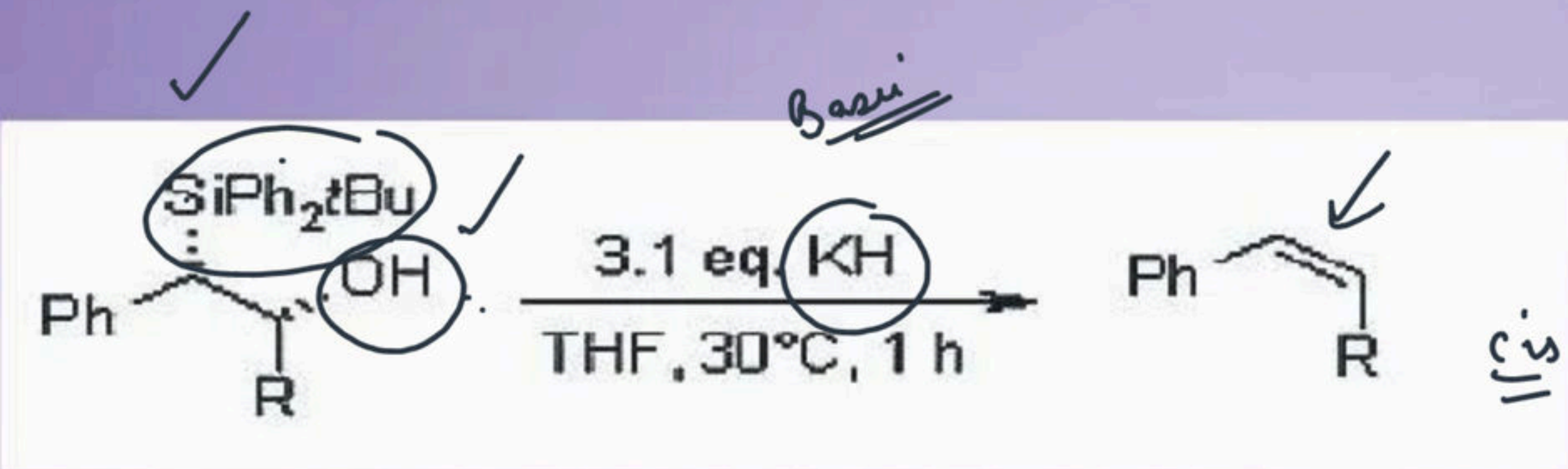
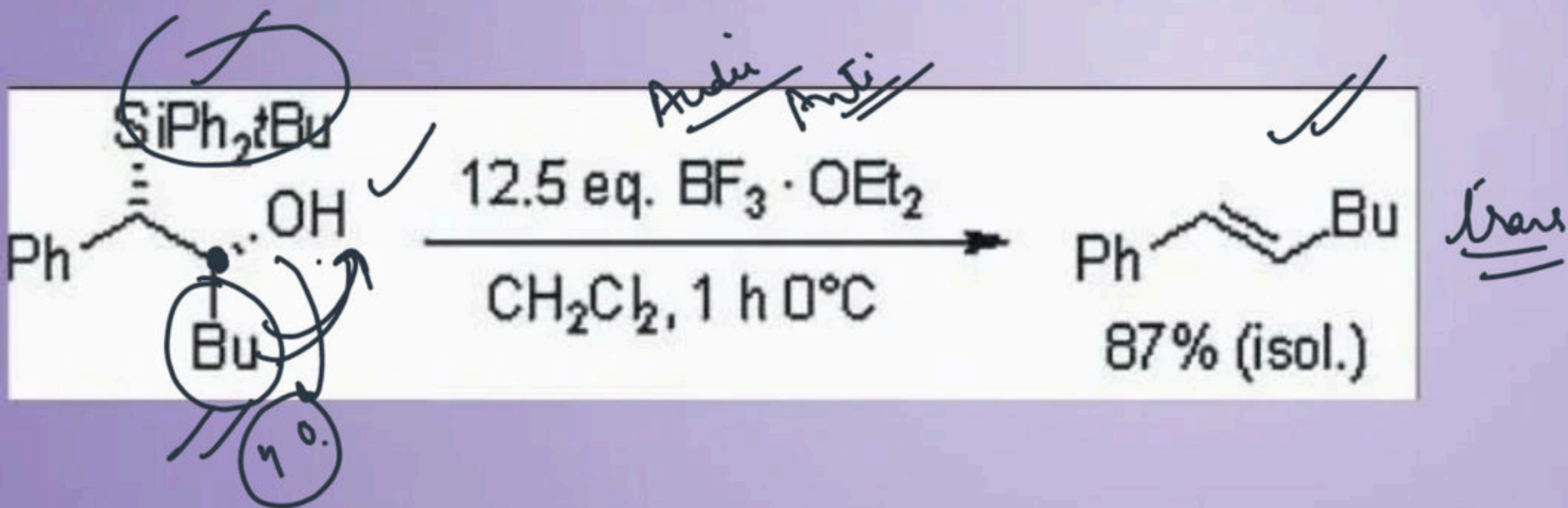
Alkene

Acidic

Anti

Basic

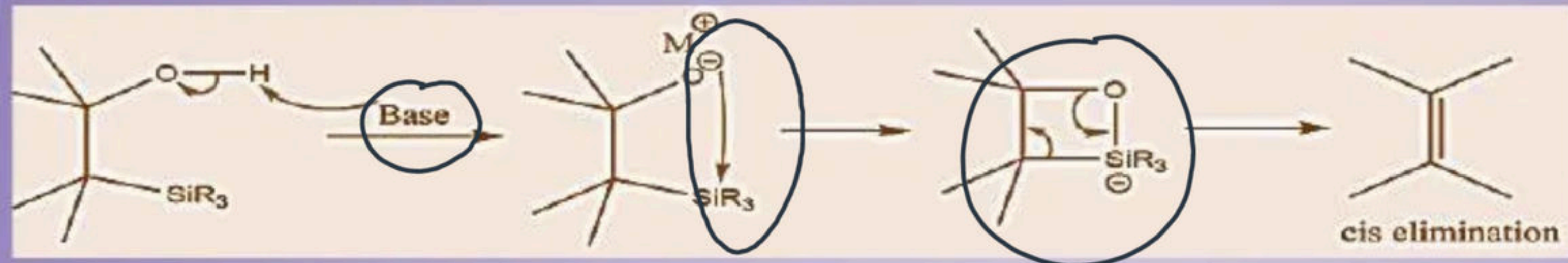
Syn



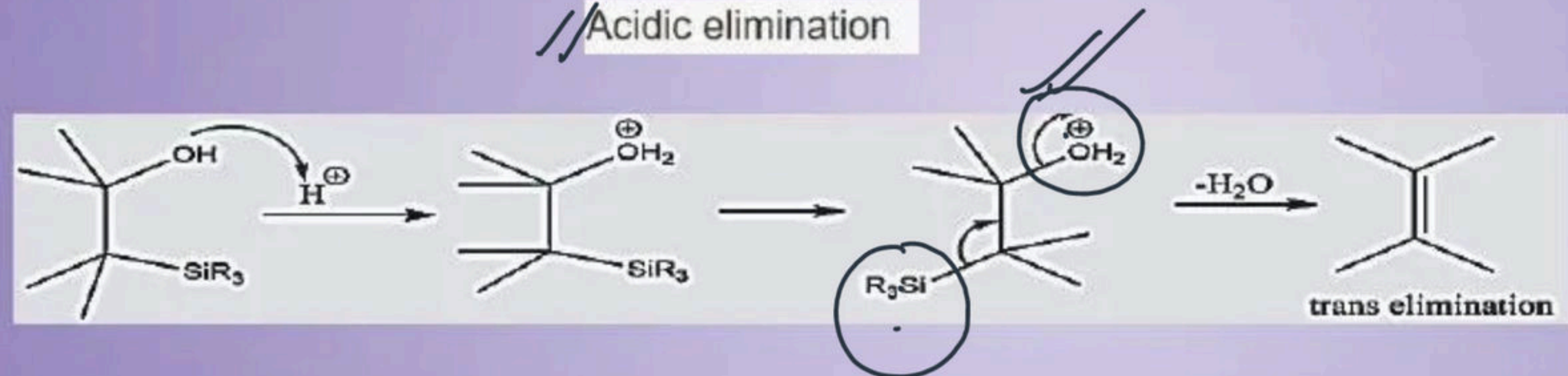
Anti $\rightarrow$ Anti



Basic elimination



Acidic elimination

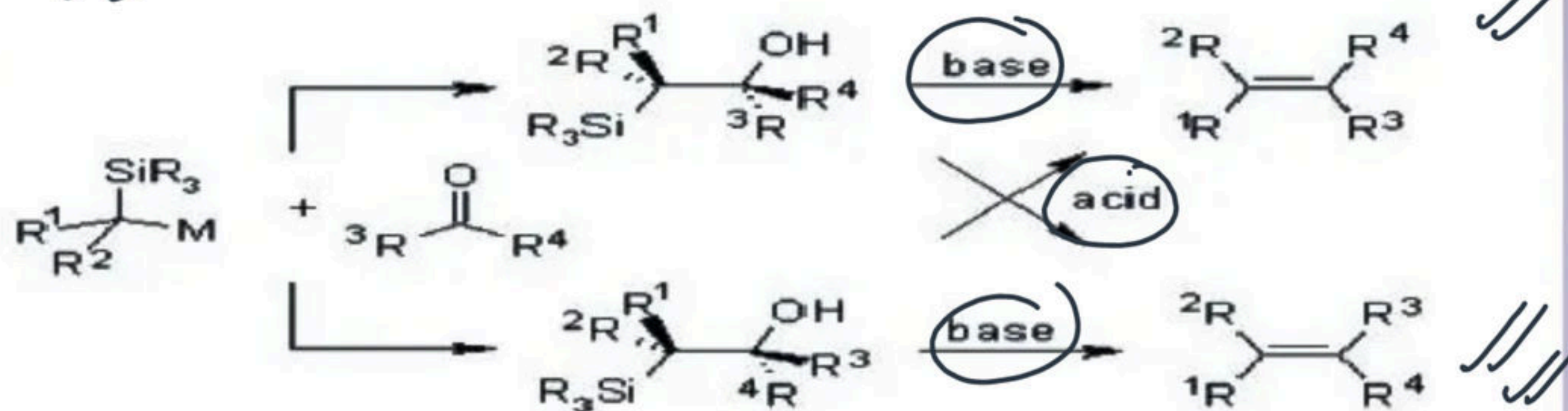


Choose the wrong statement :

- 1) Peterson reaction is known as sila Wittig reaction
- 2) In Peterson reaction, the stereochemistry of the product formed can be reversed when the catalyst is changed from acid to base
- 3) The Peterson olefination goes *via* four membered cyclic transition state
- 4) The Peterson olefination involves a free radical intermediate

Peterson Olefination

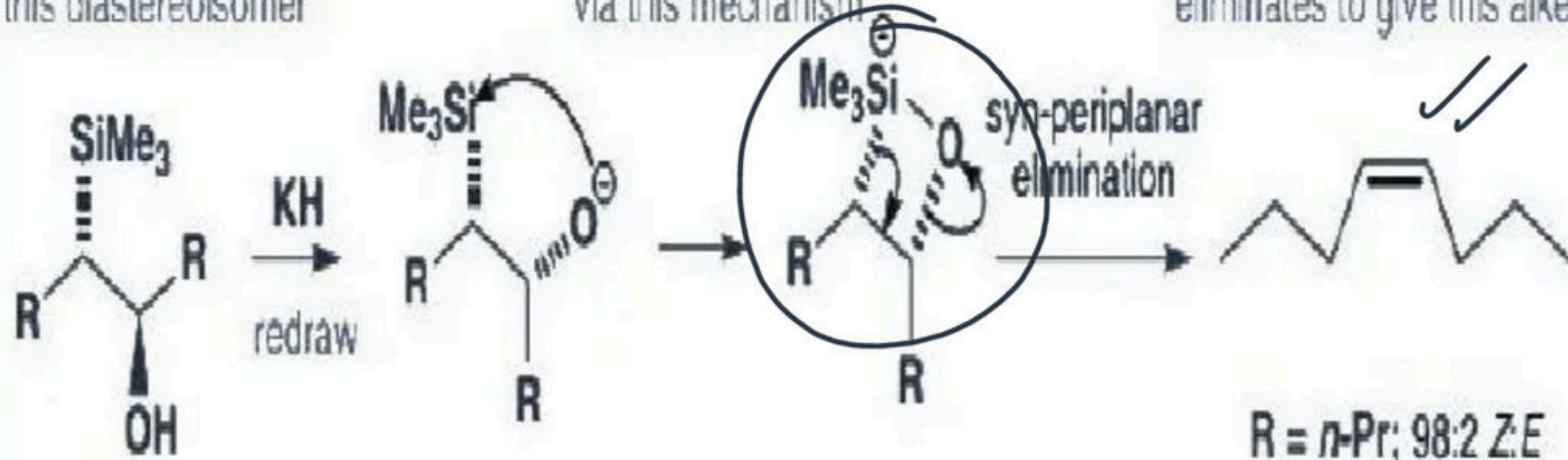
There is a silicon version of the Wittig reaction,



this diastereoisomer

via this mechanism

eliminates to give this alkene



X in following reaction is

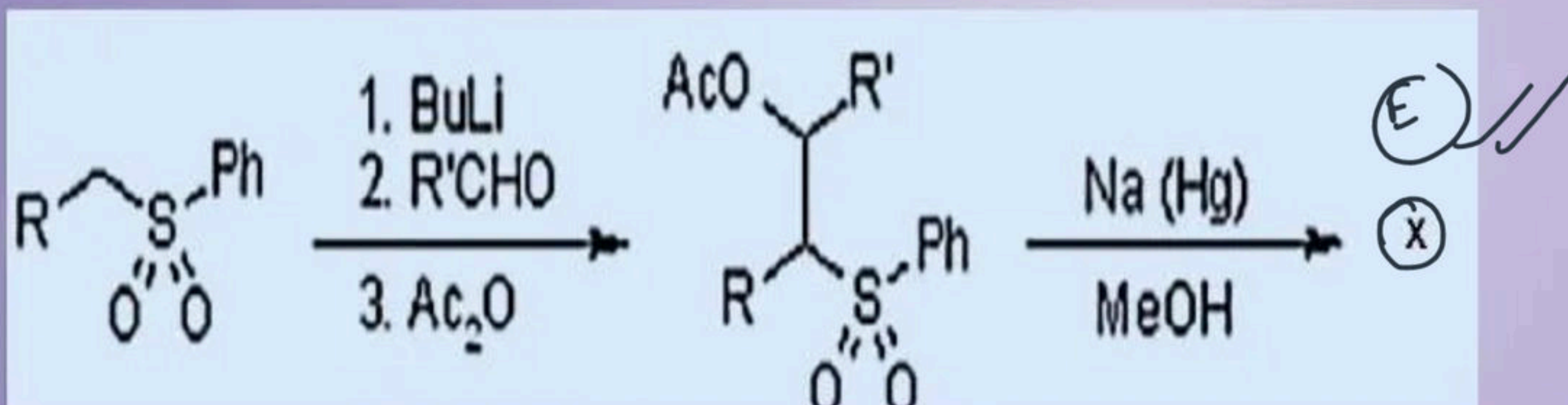
E-selective

Z-selective

both E and Z

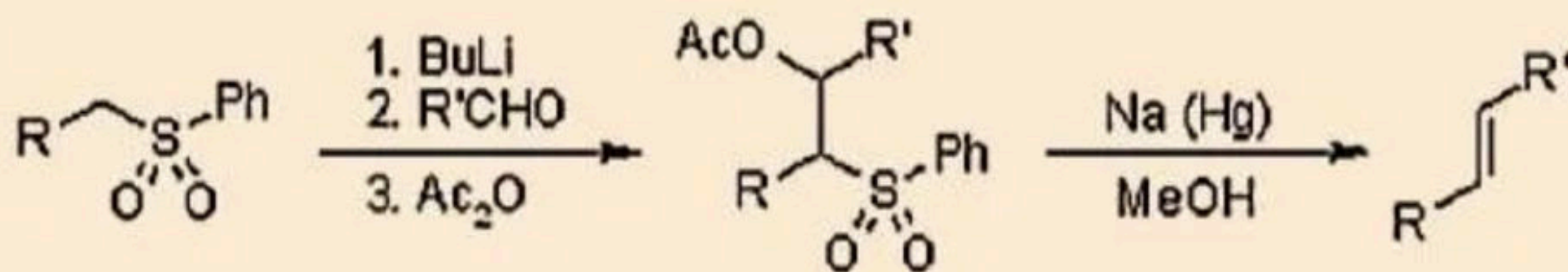
None

Tulia Oleyination

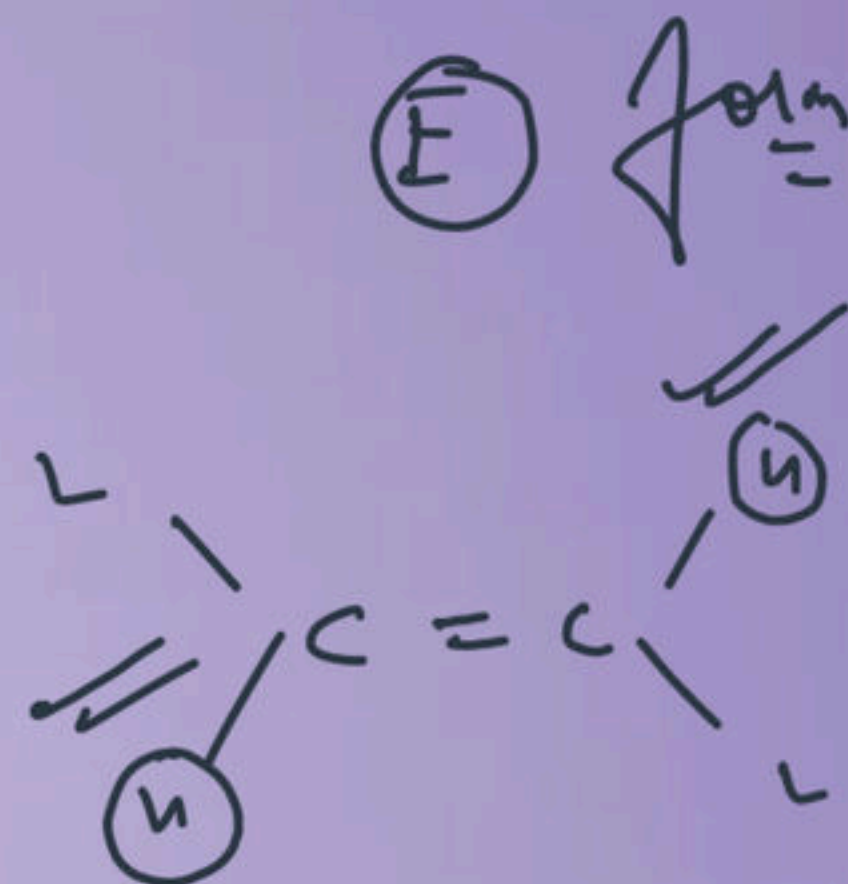


Julia olefination

sulfones can be used to prepare alkenes, ^(E)

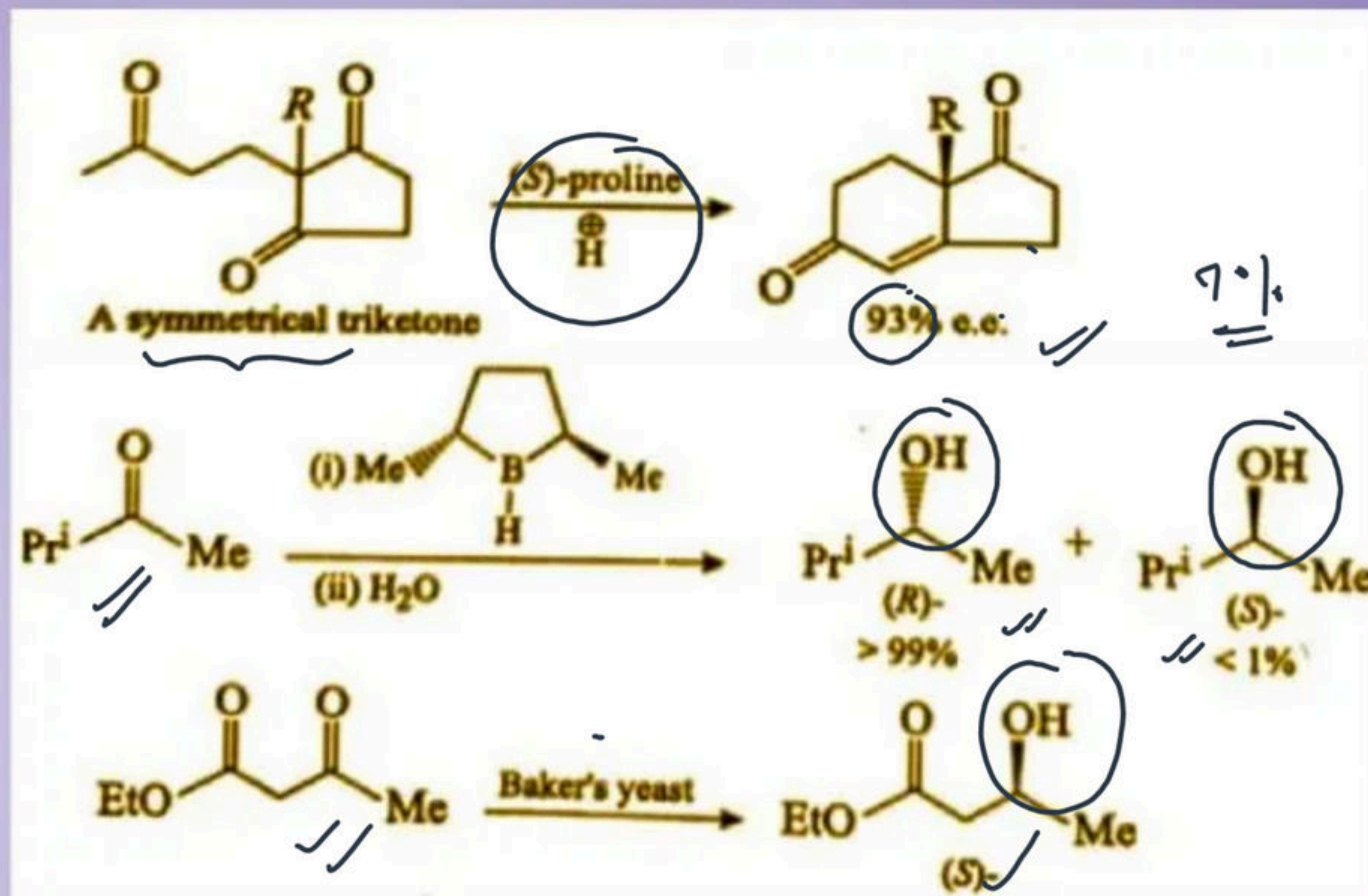


This multistep synthesis enables the preparation of (E)-alkenes.

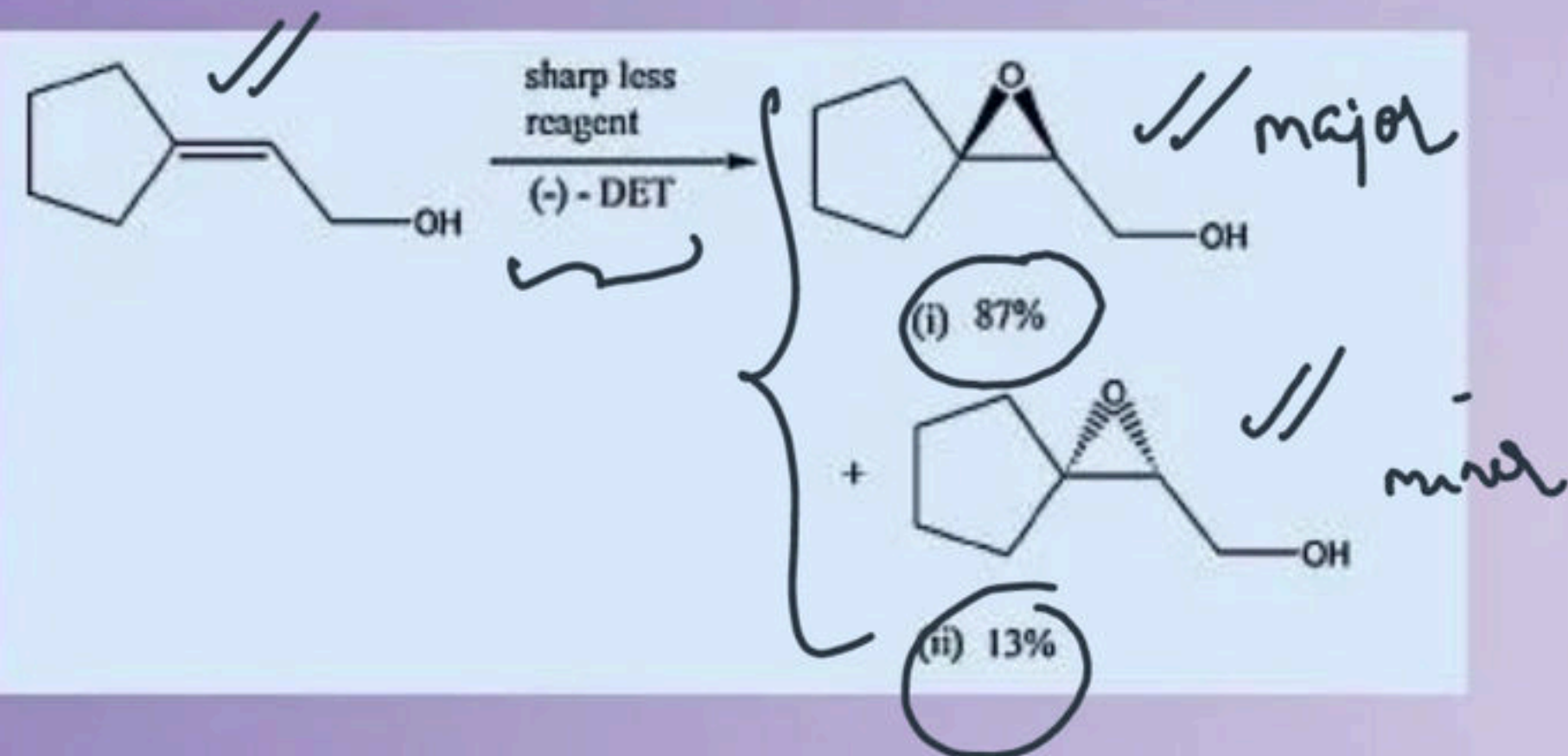
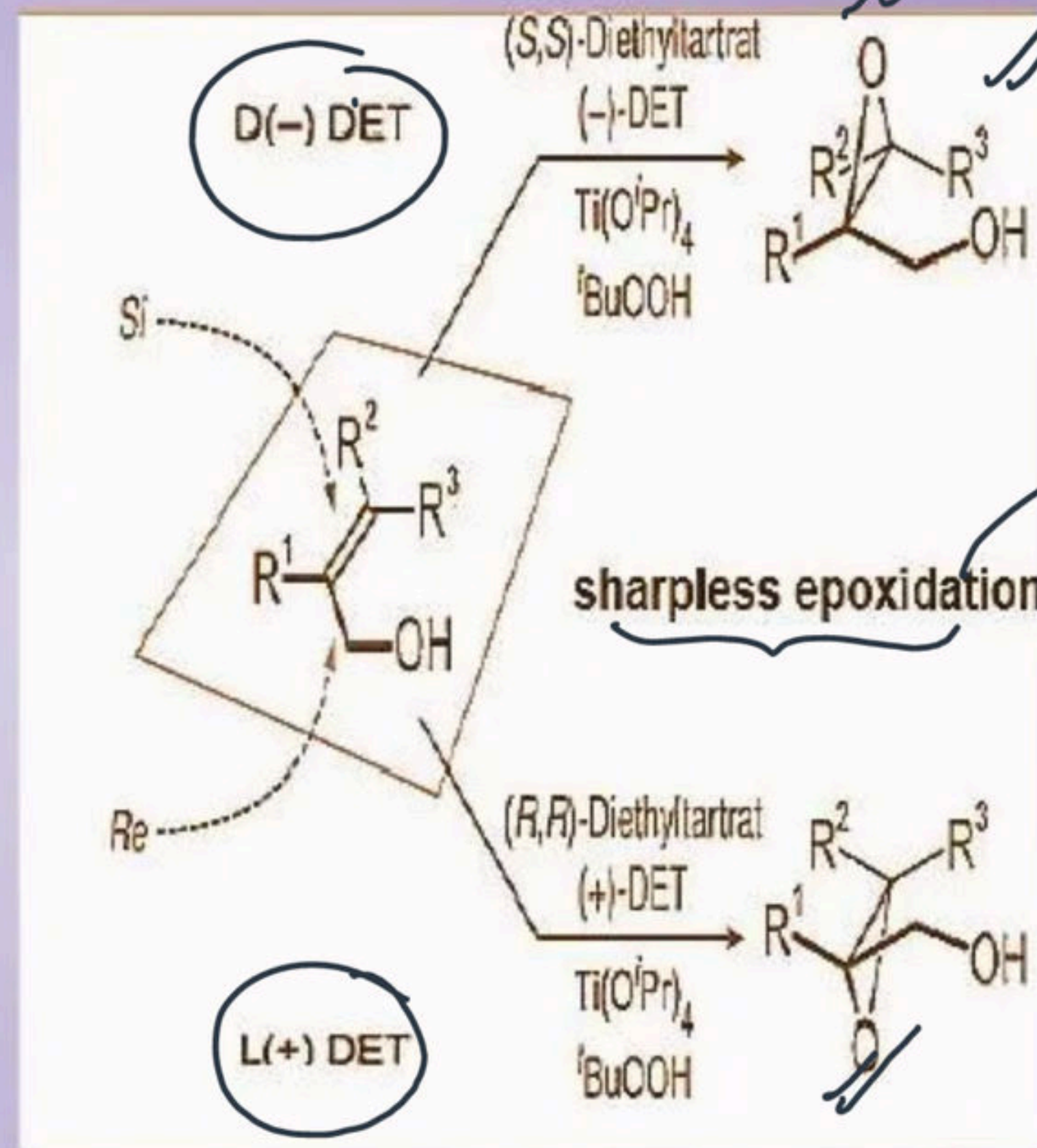


Enantioselectivity

Enantioselectivity is defined as the formation of one of the two enantiomers exclusively. It is achieved by using chiral reagent catalyst or solvent



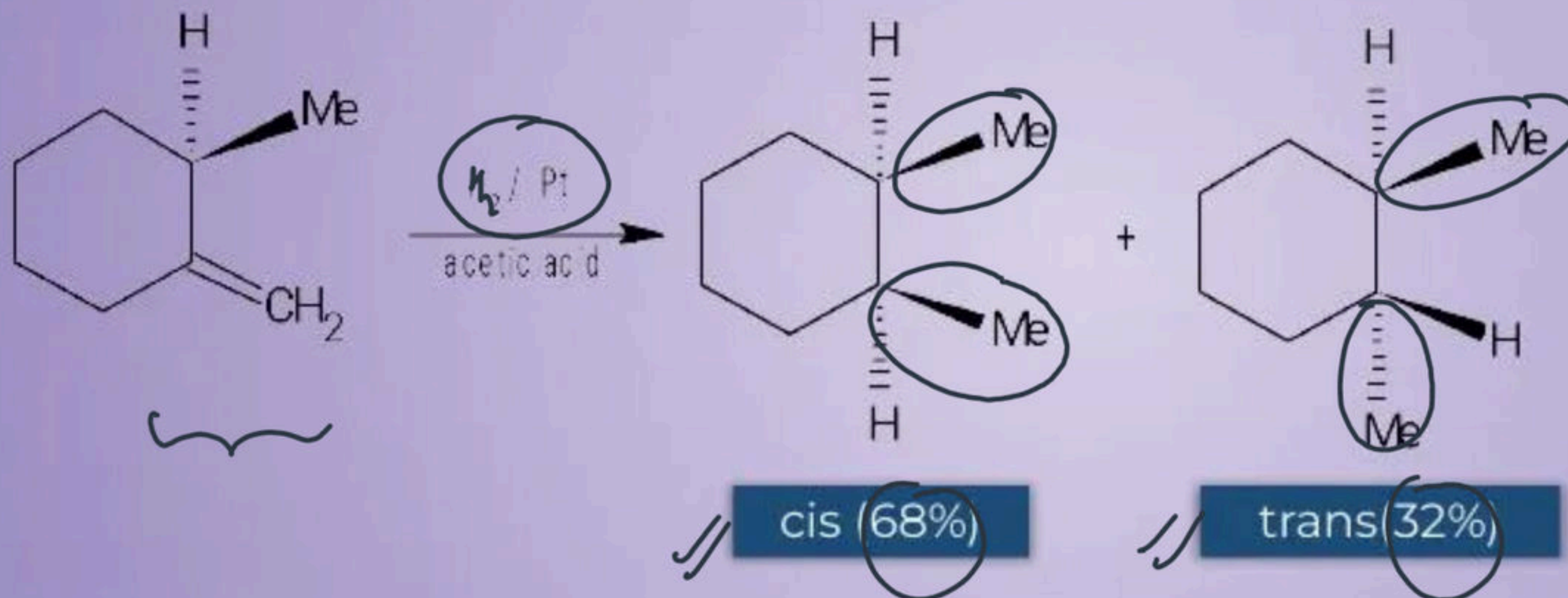
Enantioselectivity





Diastereoselectivity

Diastereoselectivity is defined as the formation of one of the two ~~diastereomers~~ predominantly.



Non Mirror Image

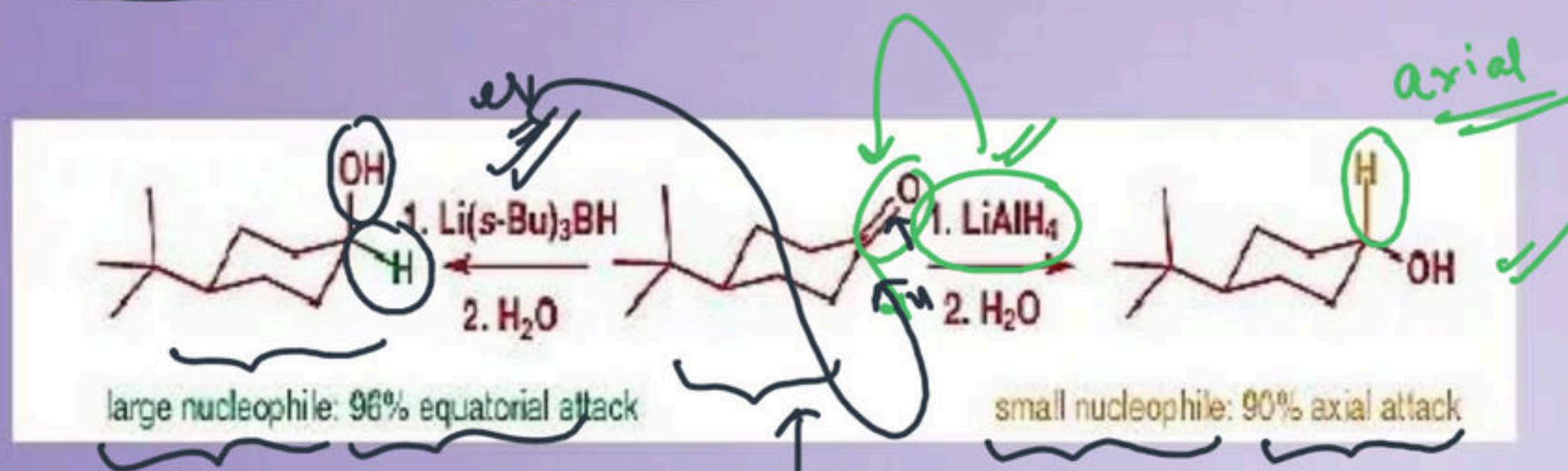
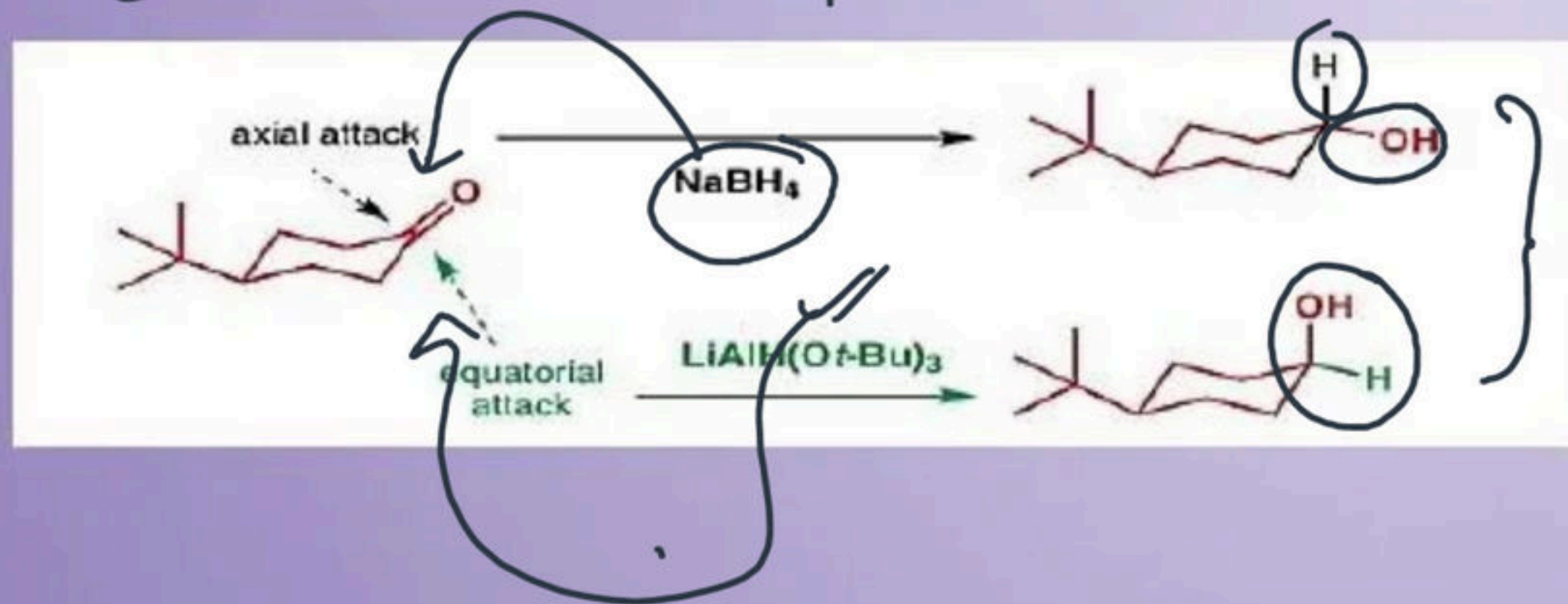
Isomer



Diastereomer

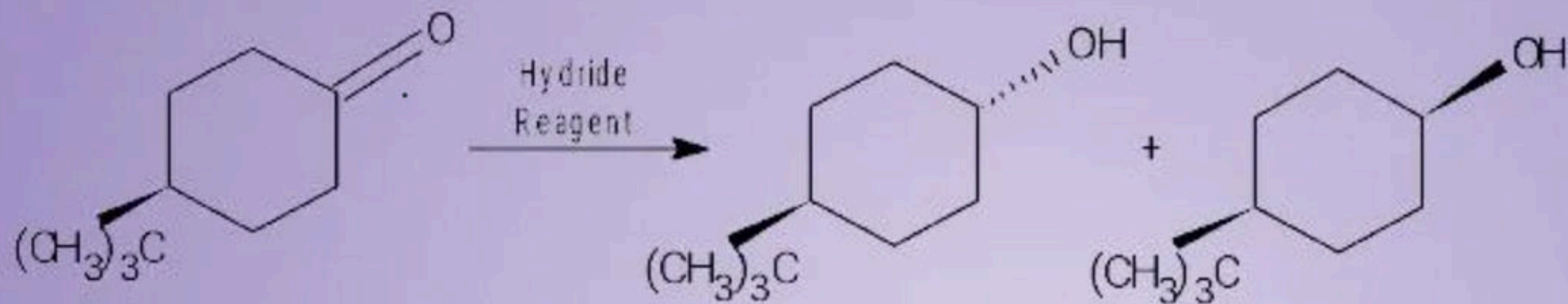
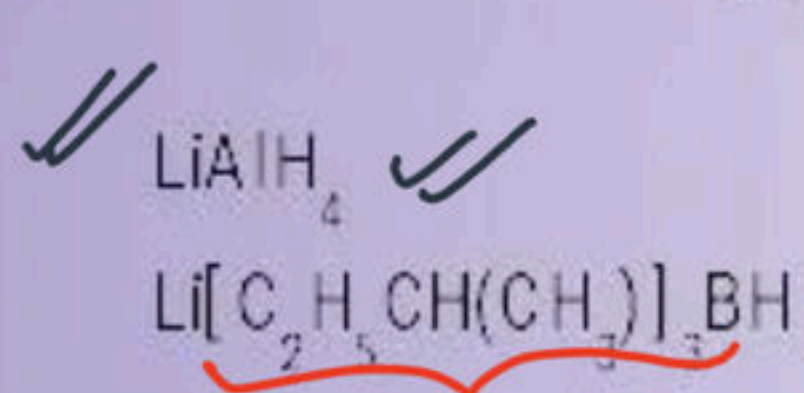
Diastereoselectivity

In general, large nucleophiles attack equatorially and small nucleophiles attack axially.



Nucleophile	% of product resulting from	
	Axial attack	Equatorial attack
$\text{HC}\equiv\text{CLi}$	88	12
MeLi	35	65
PhLi	42	58
MeMgBr	41	59
EtMgBr	29	71
$i\text{-PrMgBr}$	18	82
$t\text{-BuMgBr}$	0	100

Diastereoselectivity



Trans

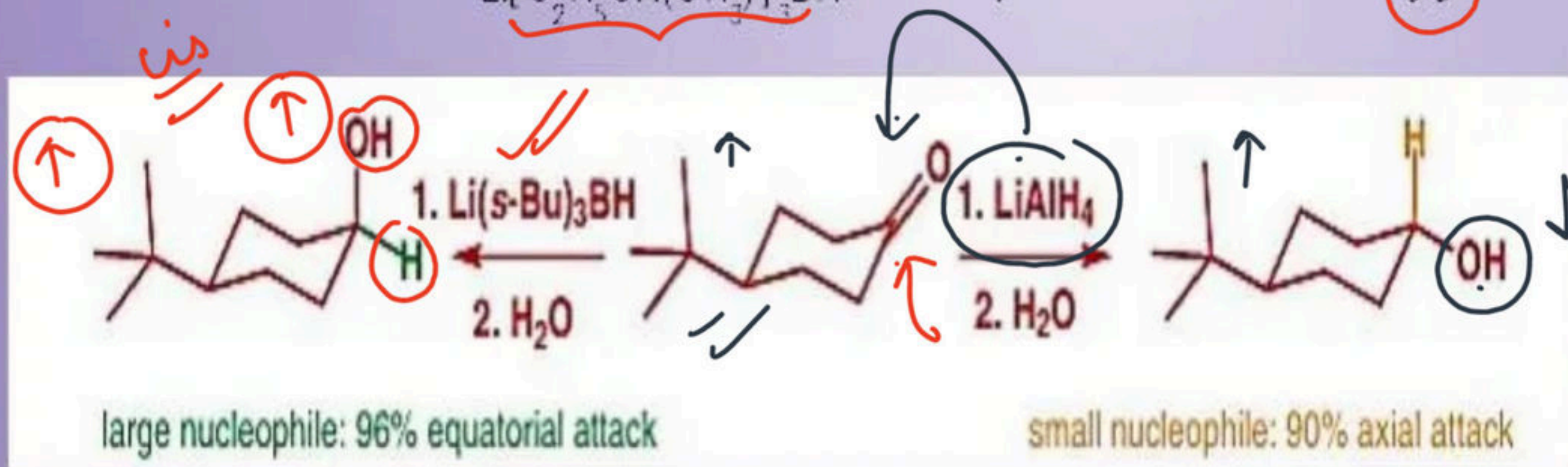
92

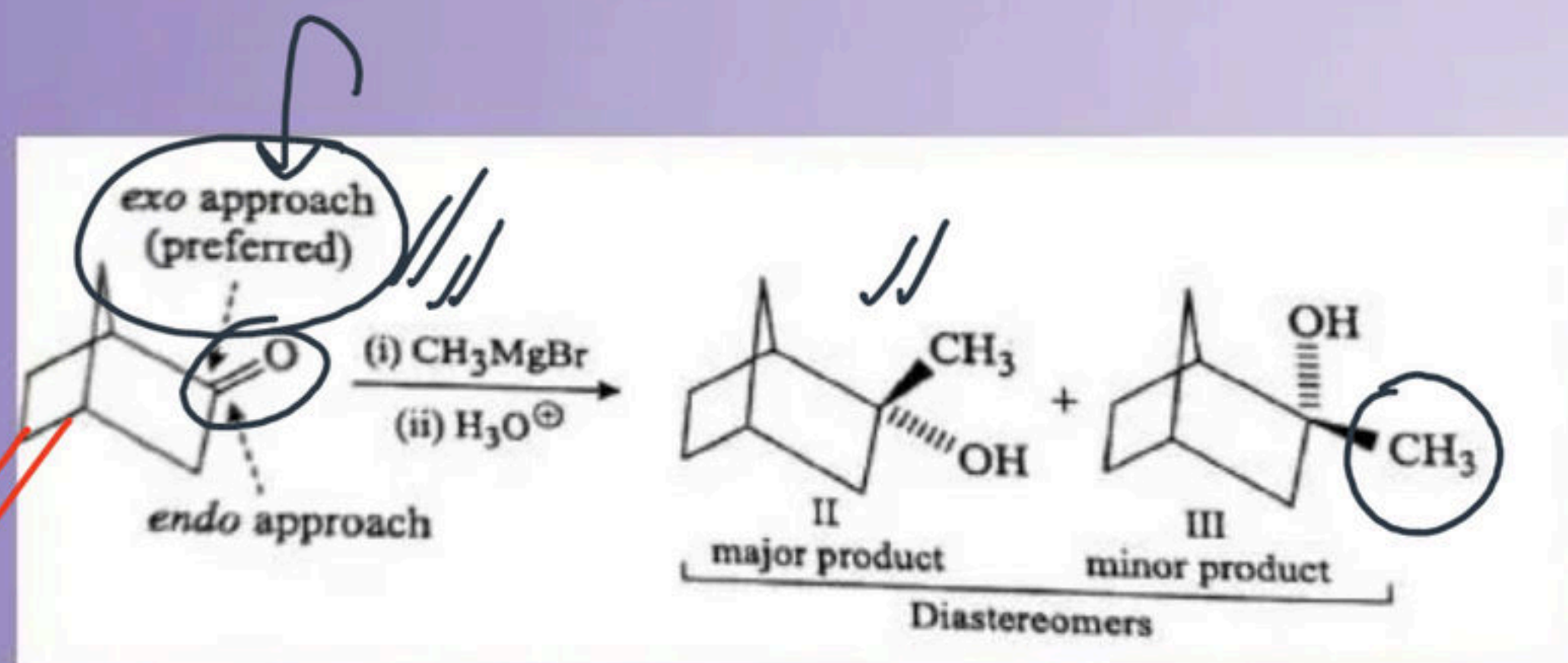
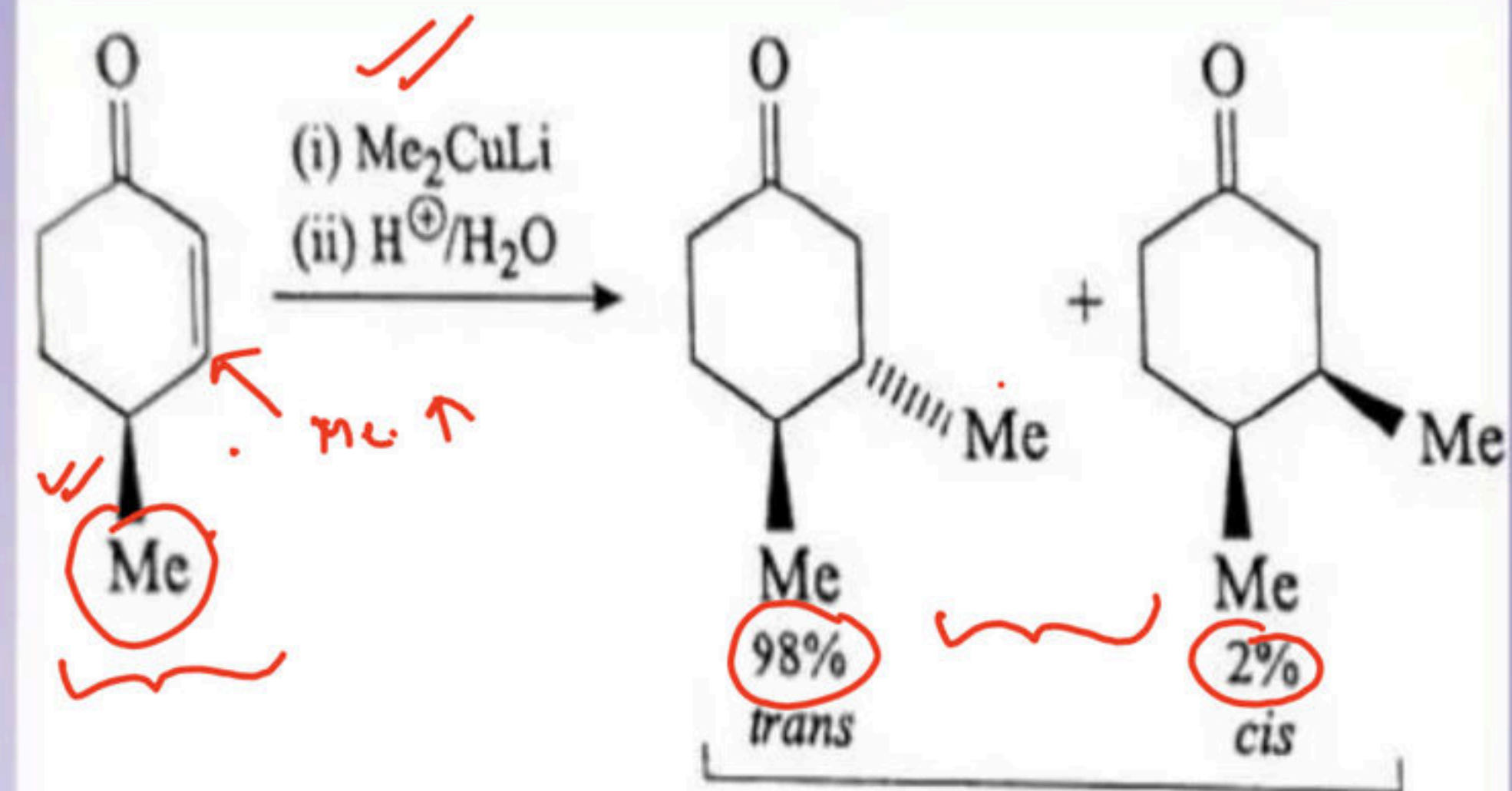
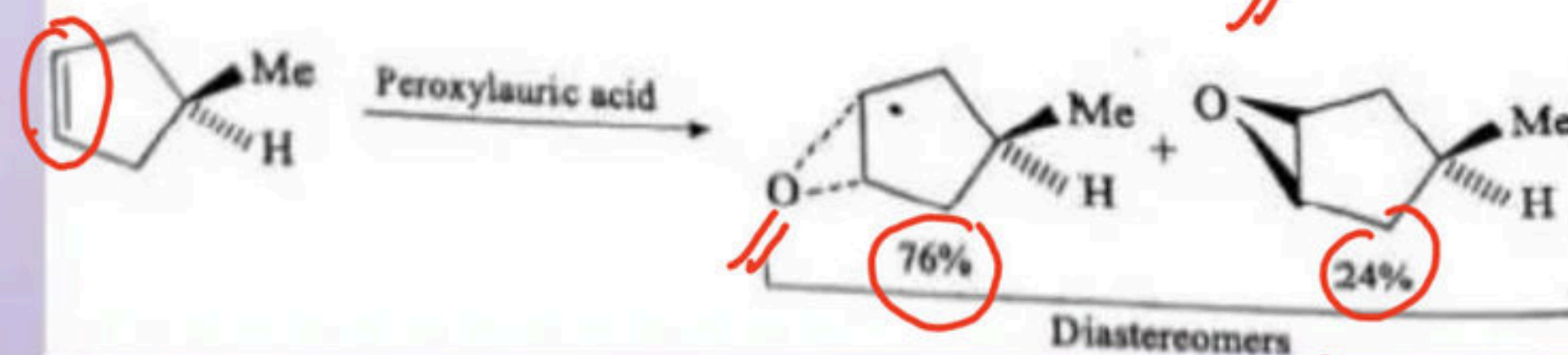
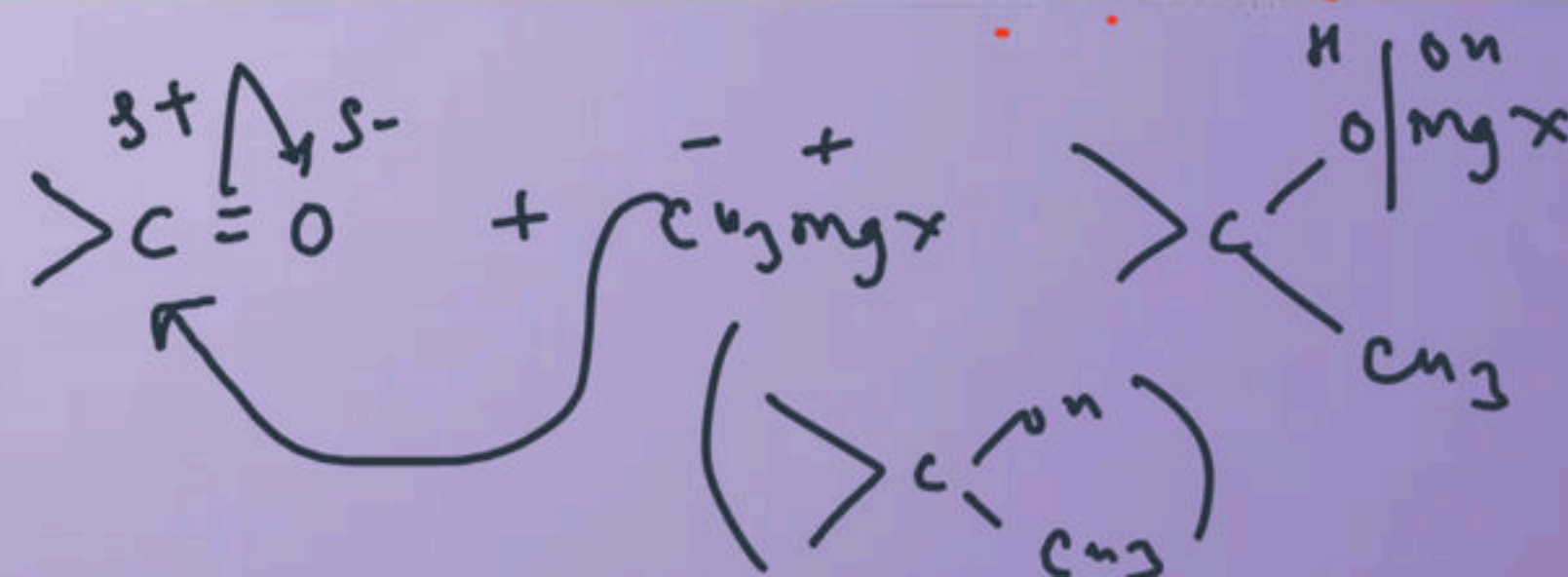
7

cis

8

93

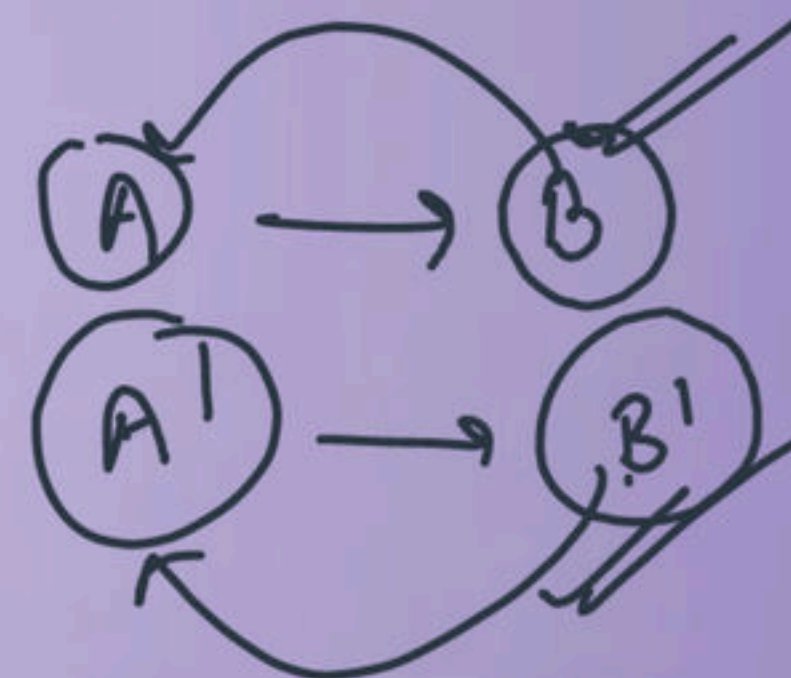




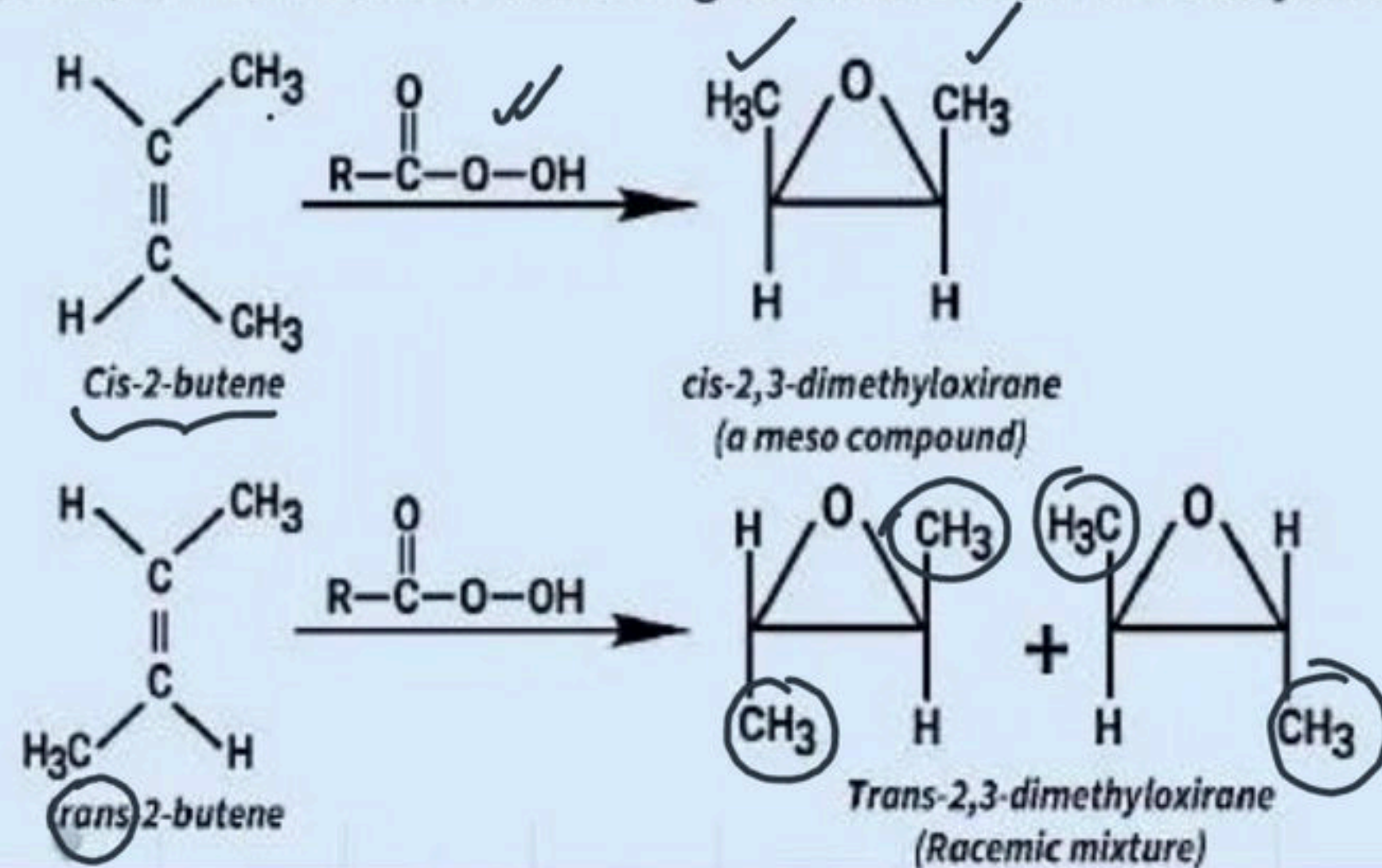
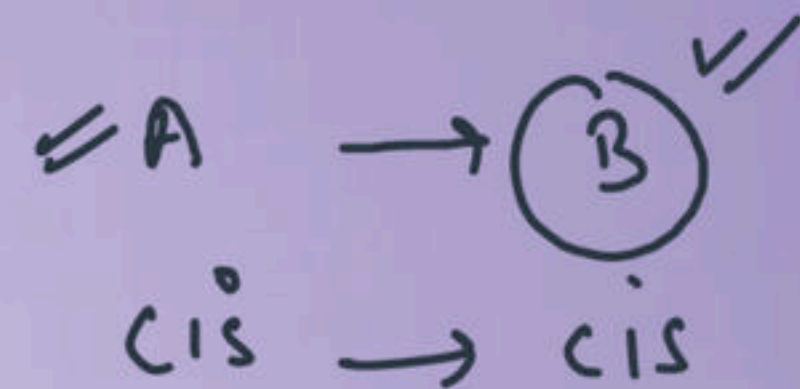
STEREOSPECIFIC REACTIONS

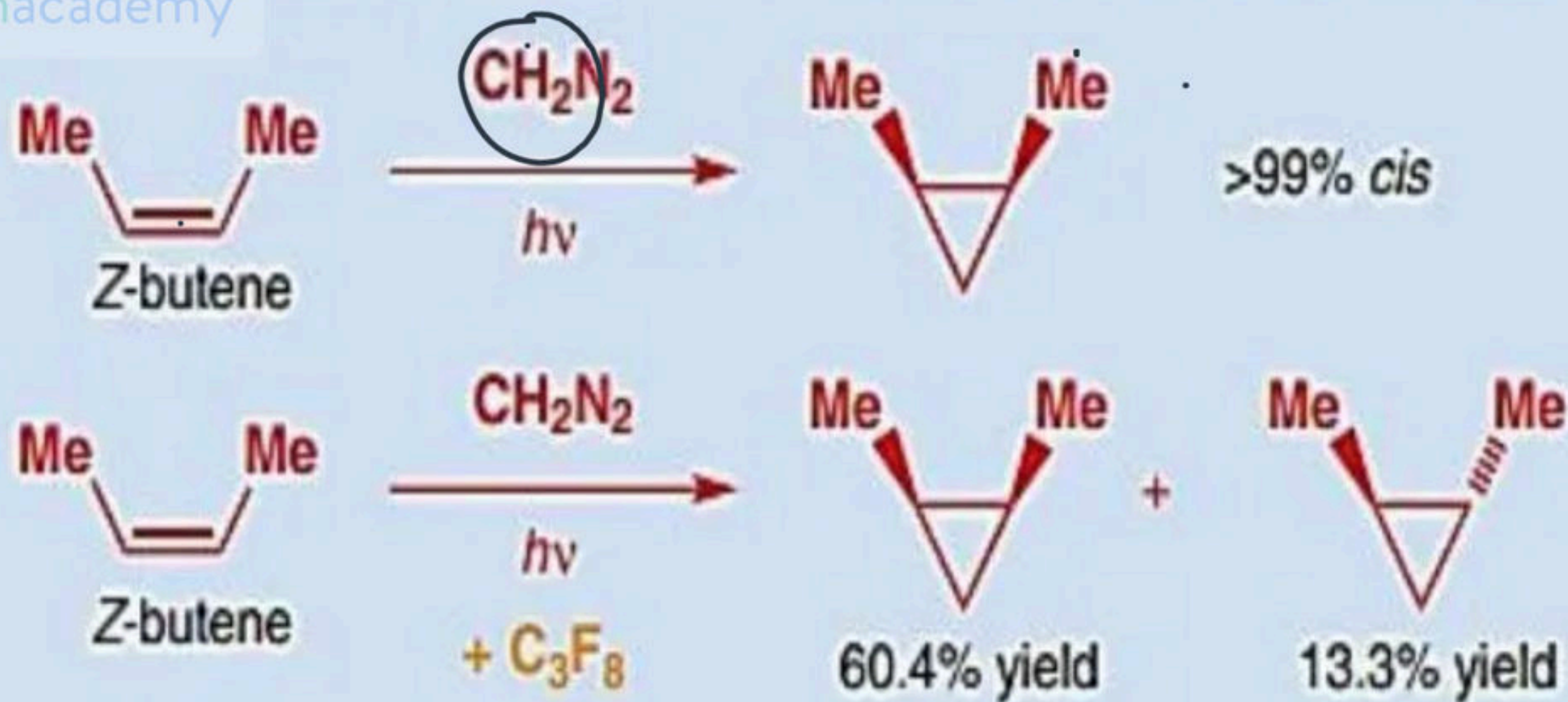
Stereospecificity is the property of a reaction mechanism that leads to different stereoisomeric reaction products from different stereoisomeric reactants.

A stereospecific process is necessarily stereoselective but stereoselectivity does not necessarily imply stereospecificity.



The formation of epoxides (oxiranes) from alkenes on treatment with peracids is stereospecific reaction. For example, cis-2-butene gives cis-2,3-dimethyloxirane, while trans-2-butene gives trans-2,3-dimethyloxirane.

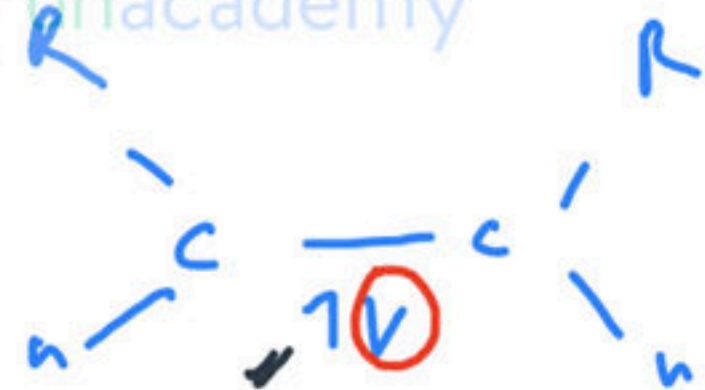
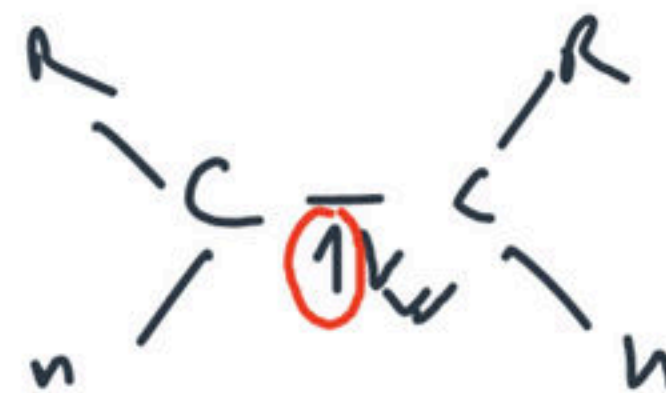




stereospecific:
singlet carbene

stereoselective:
triplet carbene

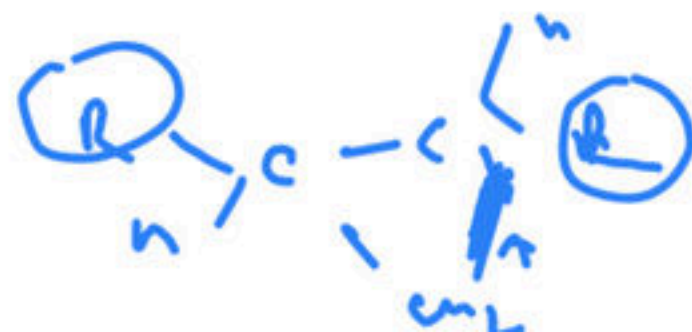
Carbene



Spi Inversion

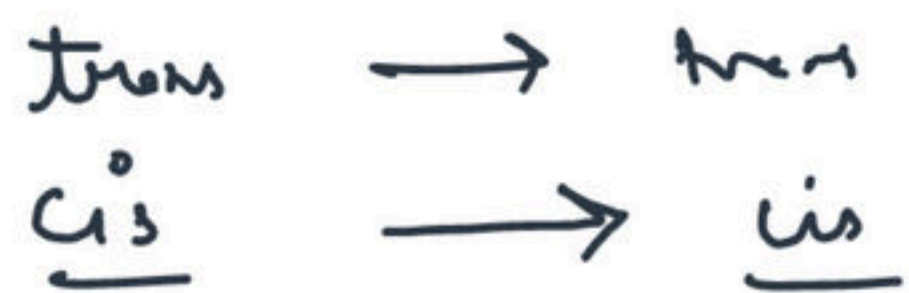
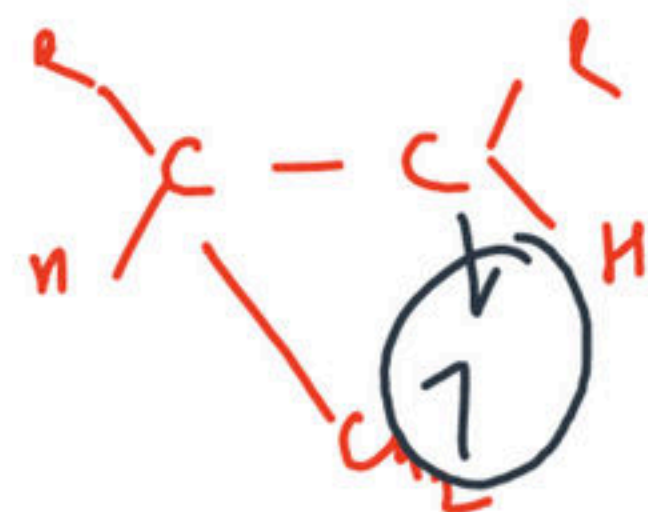
Spi " along

with bond Rotation



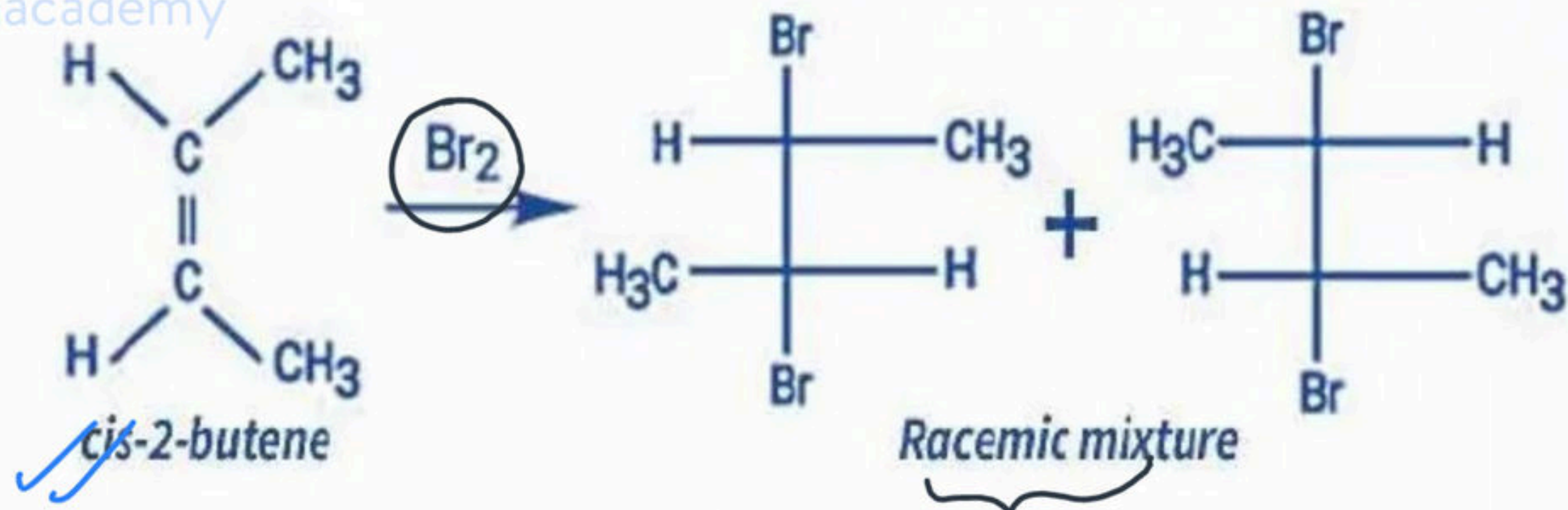
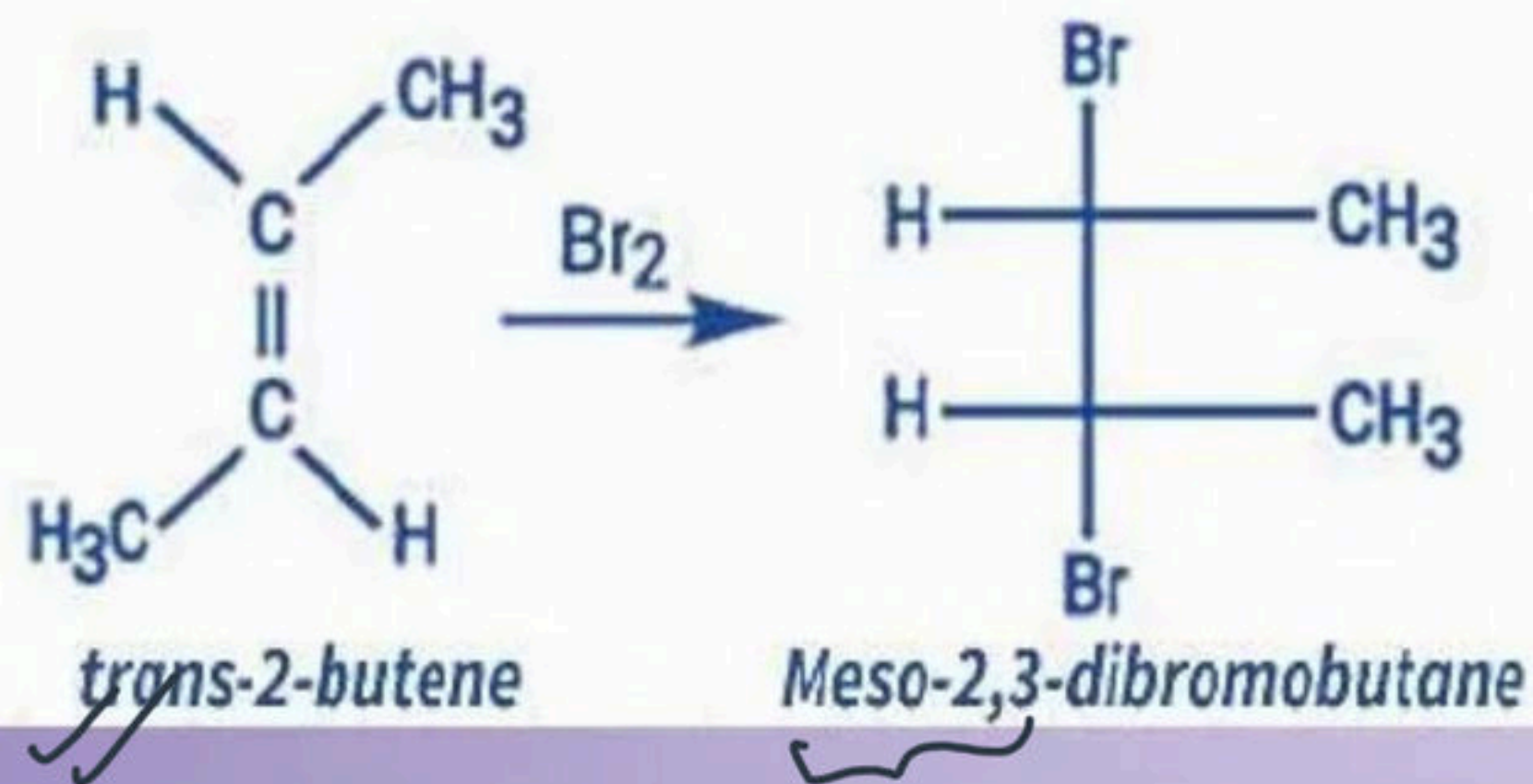
Singlet $\uparrow \uparrow$ Spi Paired

Triplet $\uparrow \uparrow$ Spi Parallel



Addition of bromine to cis 2-butene and trans 2-butene gives different products.....?





trans $\Rightarrow$ $\ominus$

cis $\Rightarrow$ $\oplus$

R.M $\Rightarrow$ $\ominus$ ✓

meso $\Rightarrow$ $\oplus$ ✓

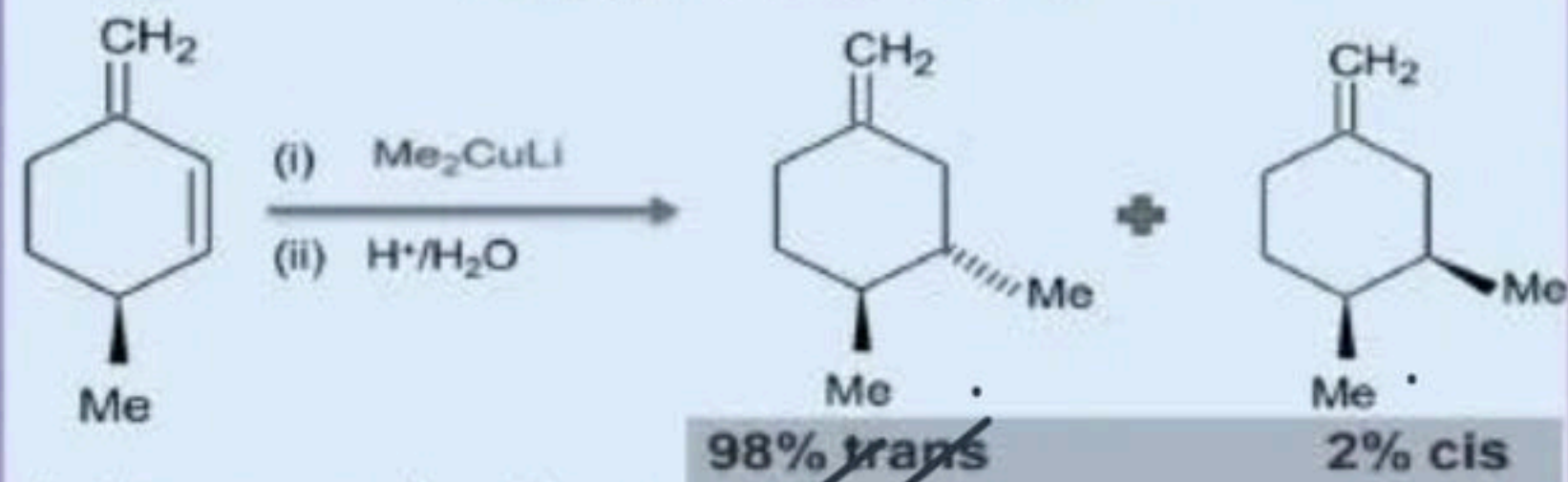
cis + Br₂ $\rightarrow$?

$\oplus$ $\ominus$ $\ominus$ Racemic

trans + Br₂ $\rightarrow$?

$\ominus$ $\ominus$ $\oplus$ Meso

It is an example of ?

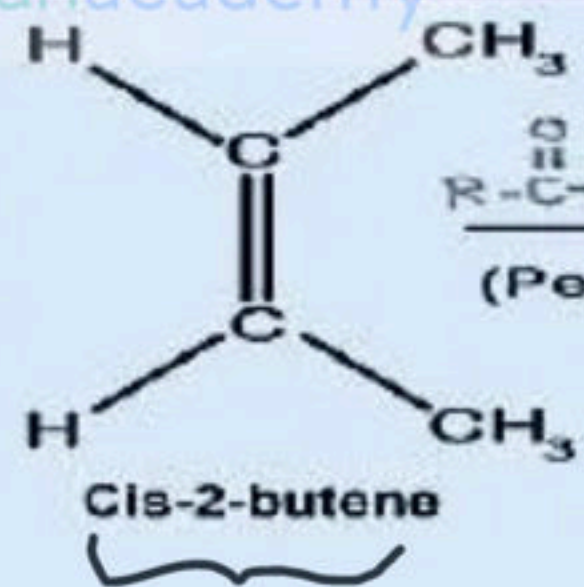
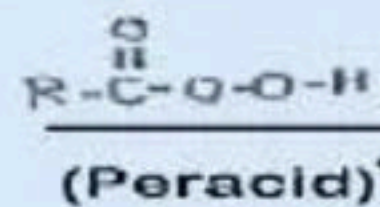
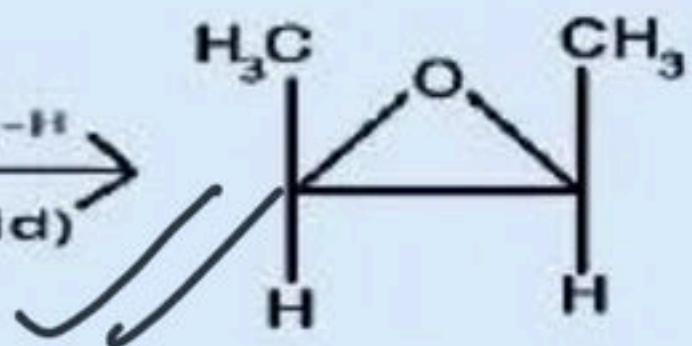
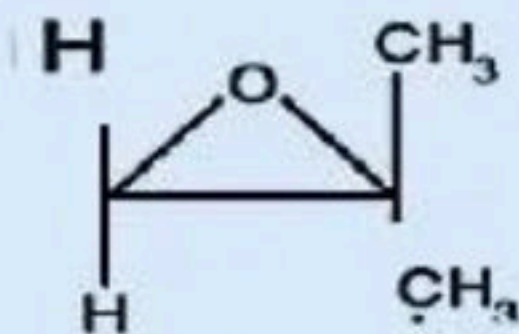
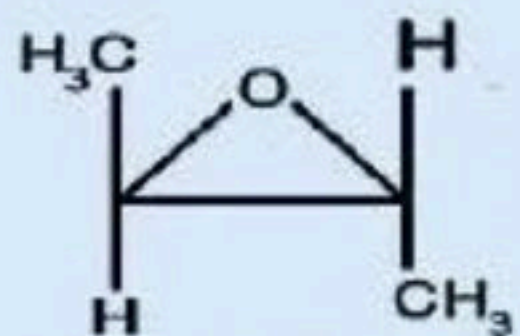


(a) Stereoselective Reaction

(b) Stereospecific Reaction

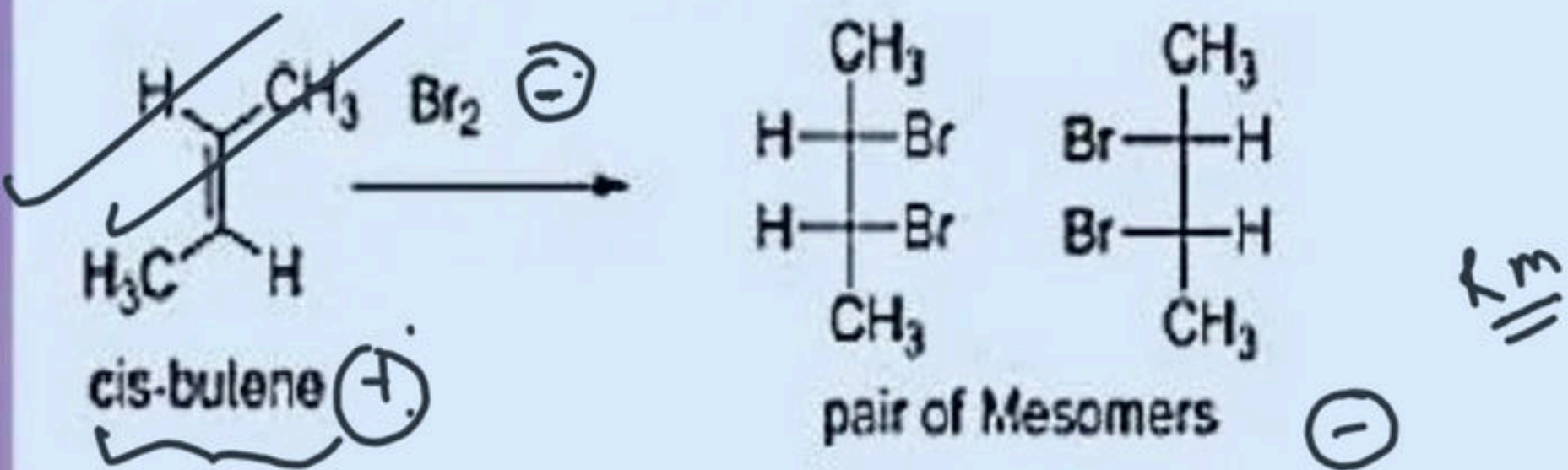
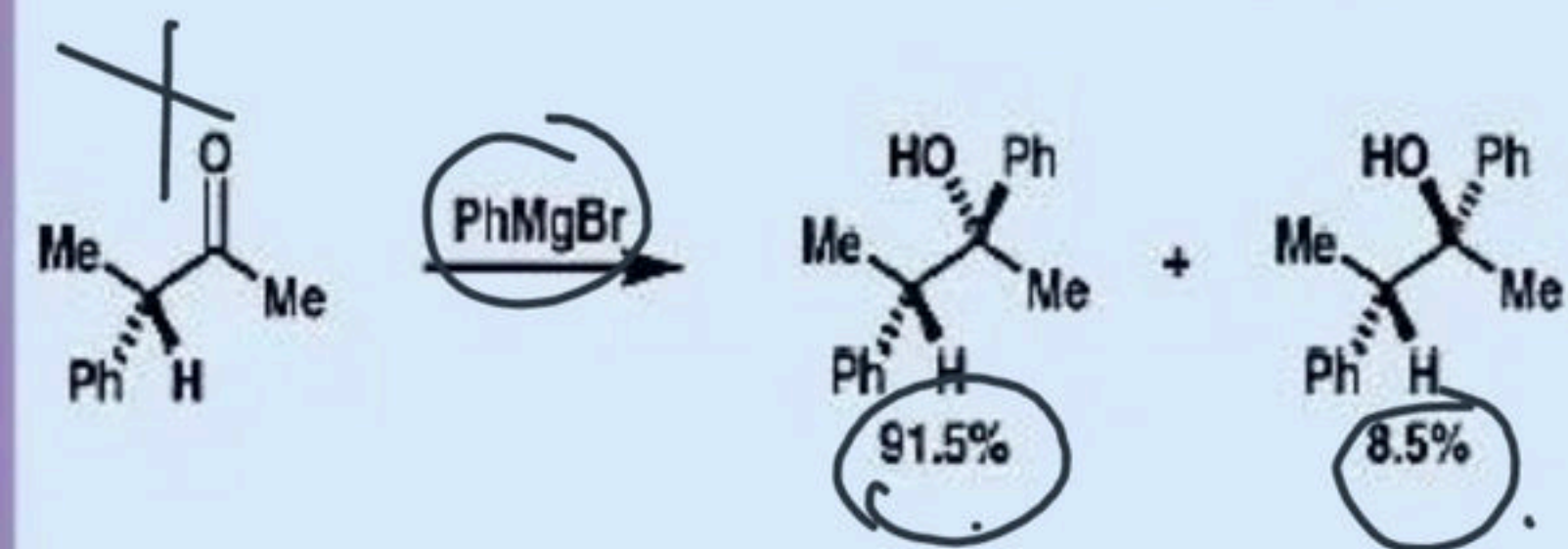
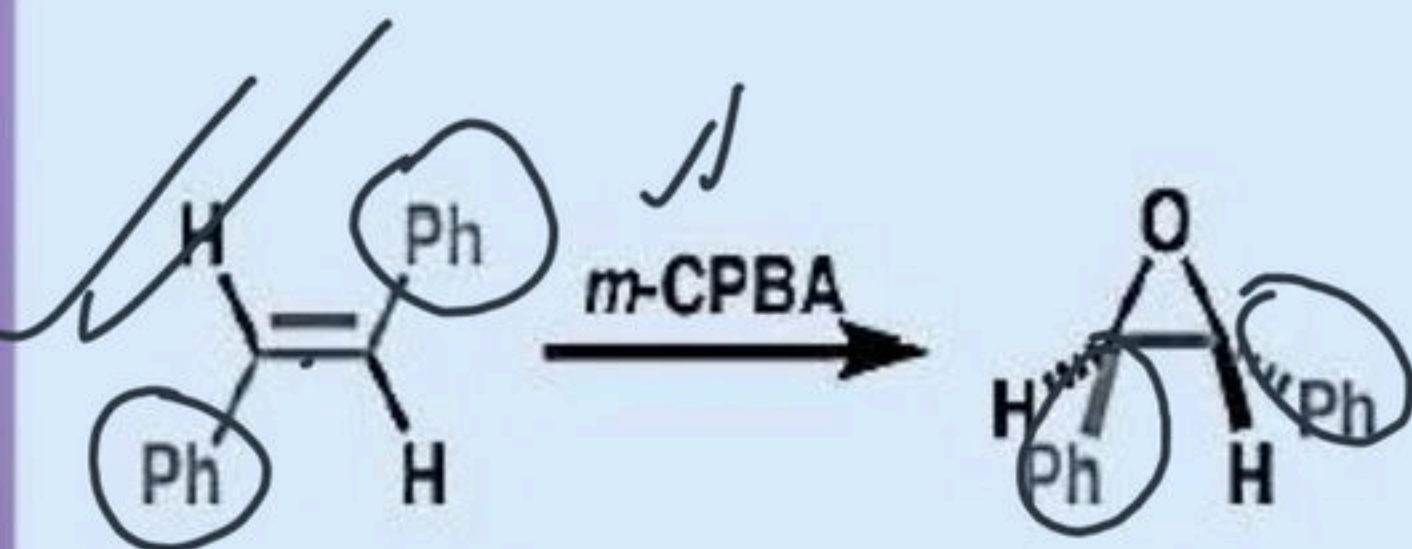
(c) none

(d) Catalysis



None

Out of these, which reaction is / are example of stereospecific Reaction?



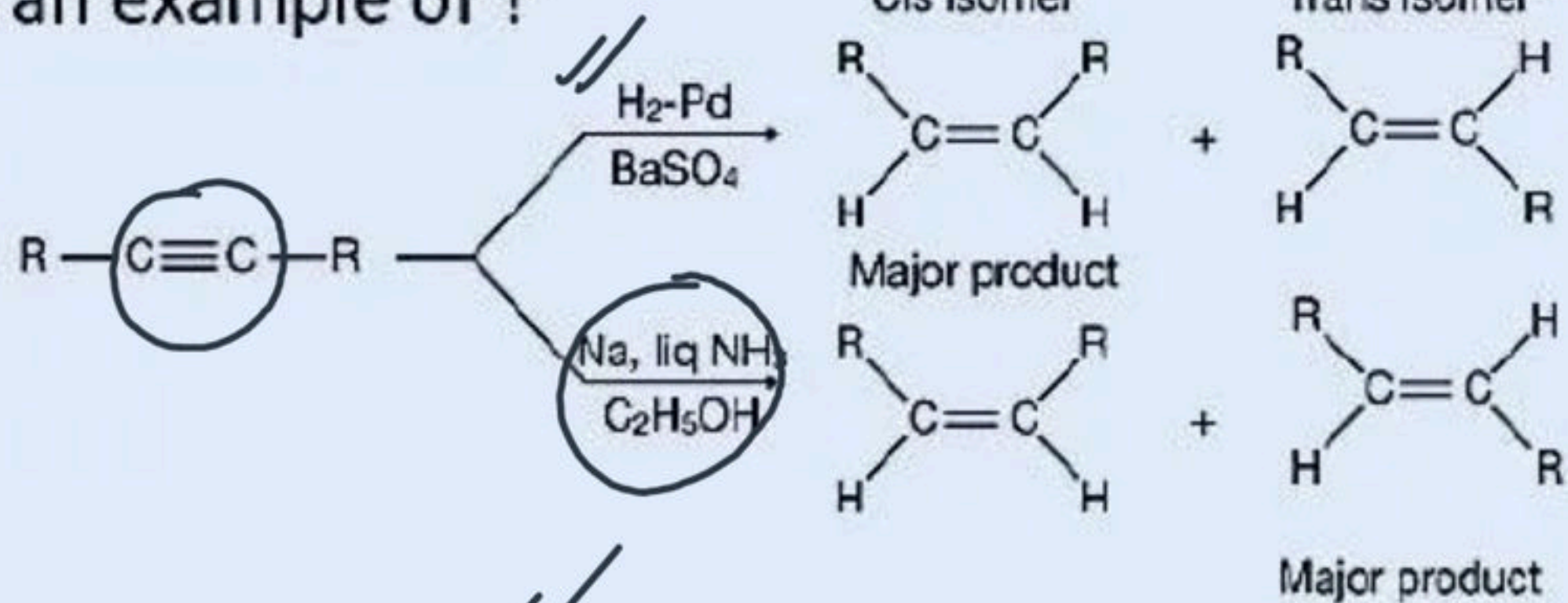
(a) A

~~(b) A & C~~

(c) A, B, C

(d) B, C

It is an example of ?



(a) Diastereoselective ✓

(b) Enantioselective

(c) Stereospecific

(d) All

Addition of bromine to trans-2-butene in dichloromethane would afford :

- (A) Only a pair of enantiomer
- (B) A pair of enantiomer and a meso-compound
- (C) Only a pair of diastereoisomers
- (D) Only a meso-compound

Asymmetric synthesis

Synthesis in which prochiral unit converted into chiral unit, result in unequal amount of stereoisomers is called Asymmetric synthesis.

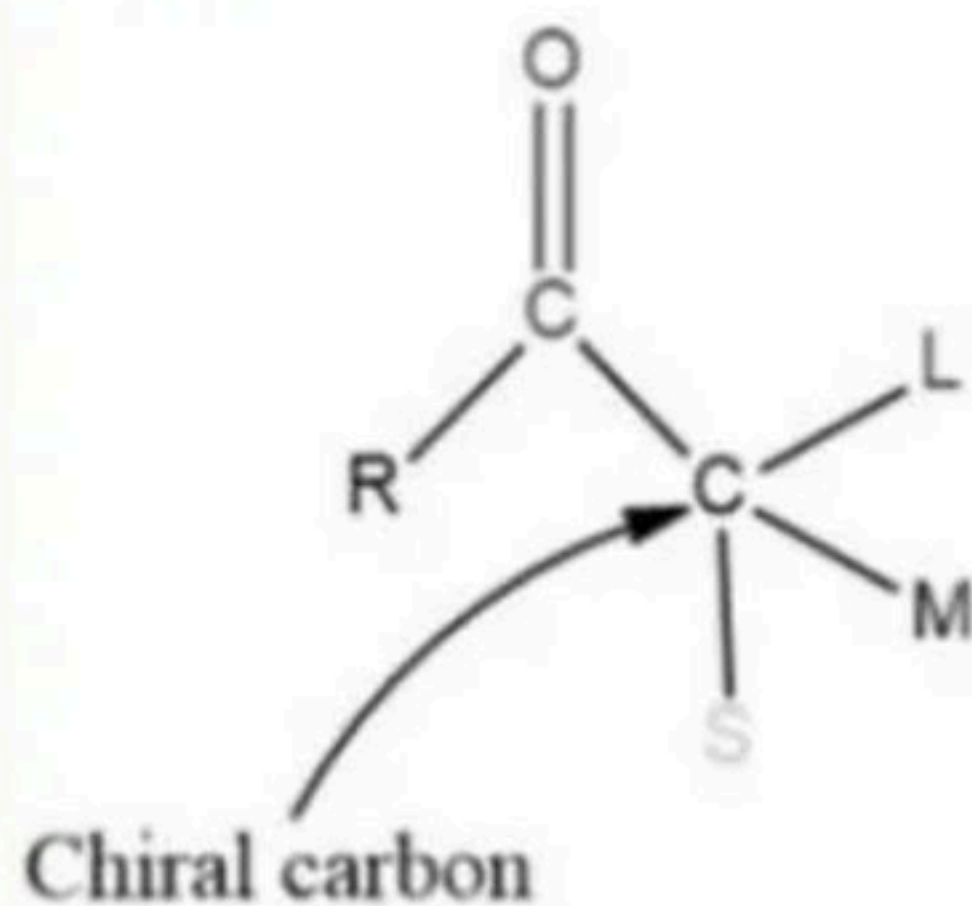
When reaction generate one or more new stereocenter in a chiral molecule, diastereomeric products are formed.

Cram rule predict diastereoselectivity i.e. which diastereomer will predominate, decided by Cram rule.

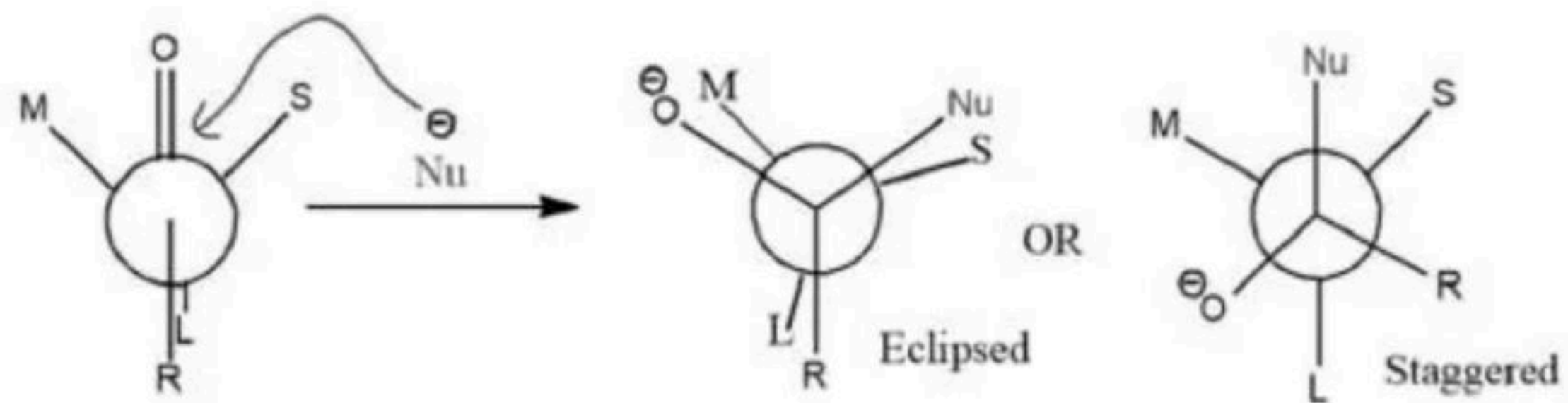
The direction of attack by reagent is determined by group already present in compounds.

For example during nucleophilic addition reaction, nucleophile or incoming group preferentially attack from small sized group.

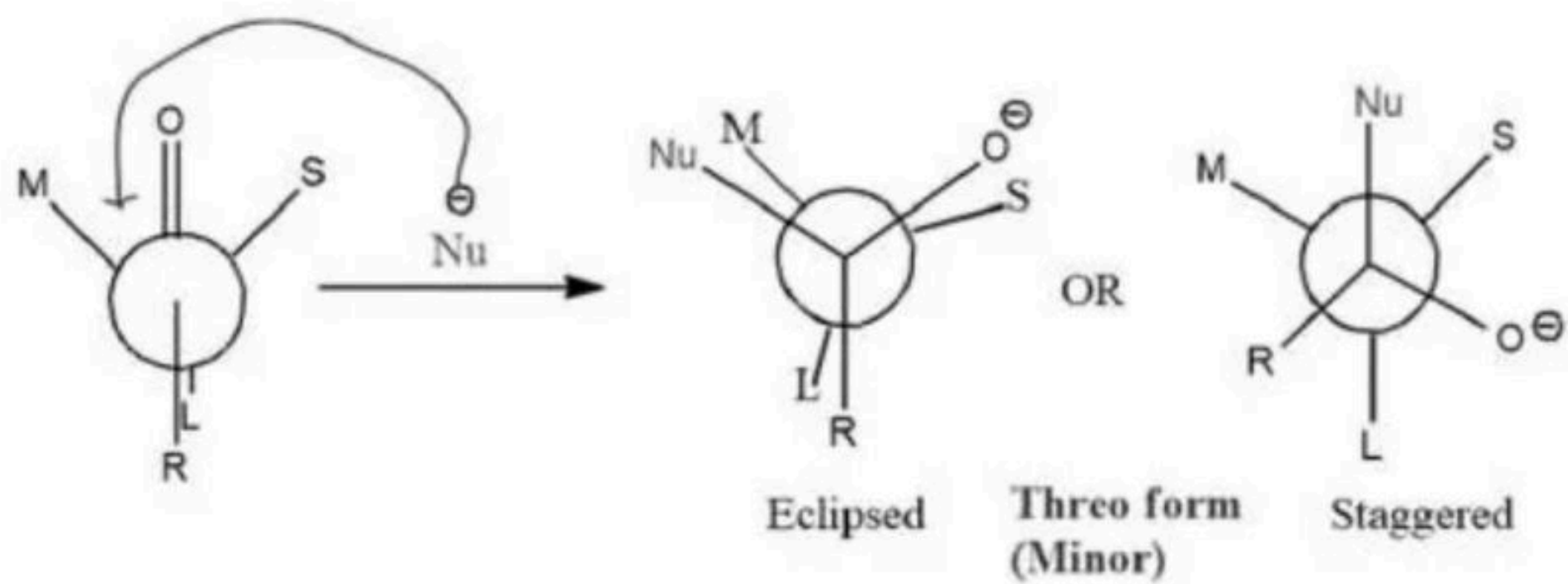
Using Cram's rule predict the major product from the reaction of Alpha phenylpropionaldehyde with methyl magnesium bromide??



L=Large group
M=Medium group
S=Small group

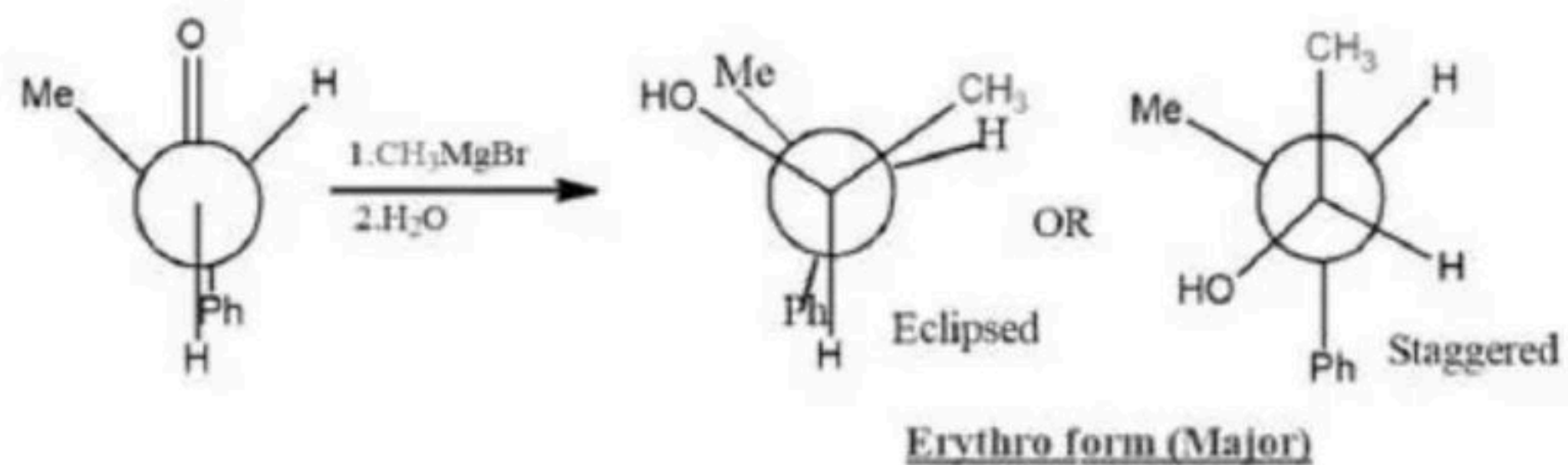
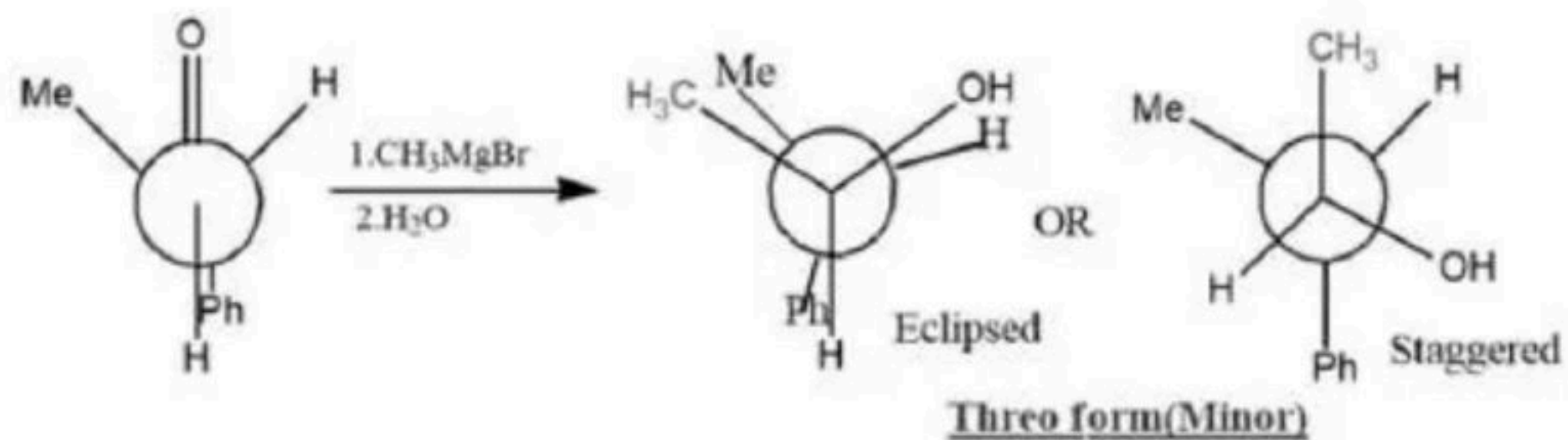


Erythro form (Major)

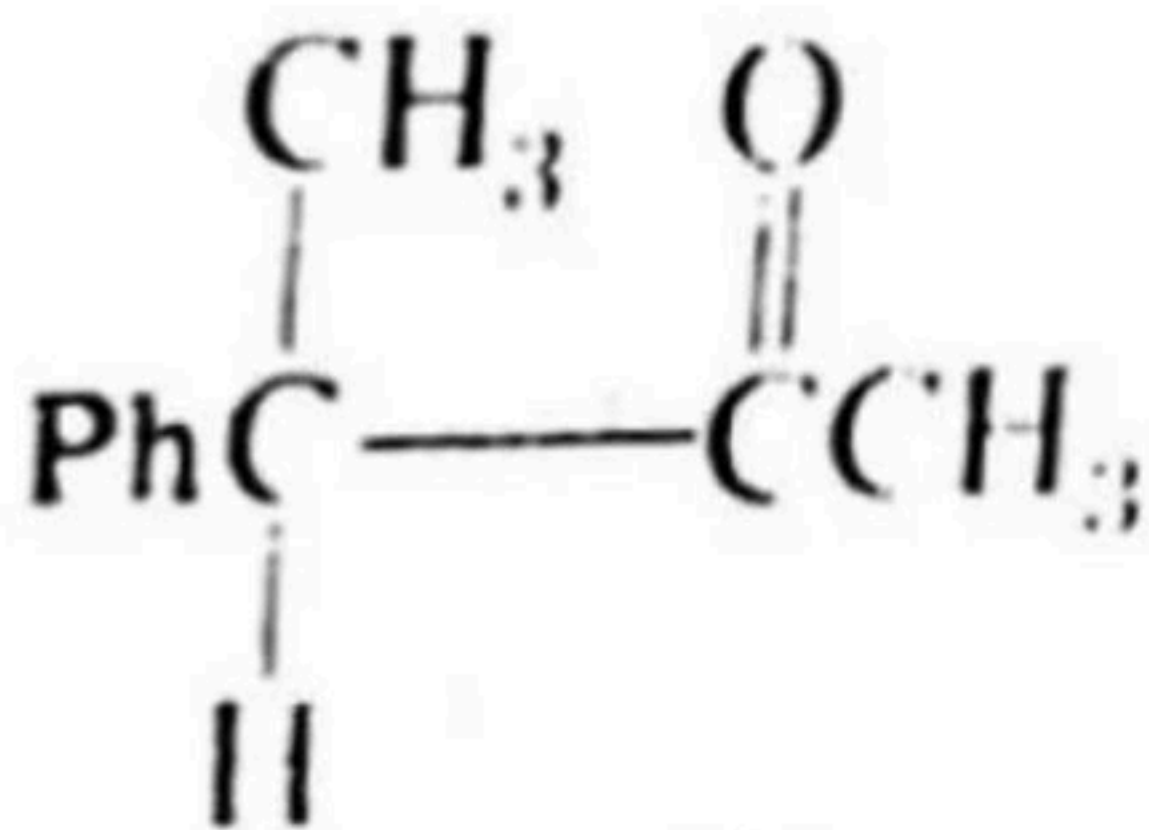


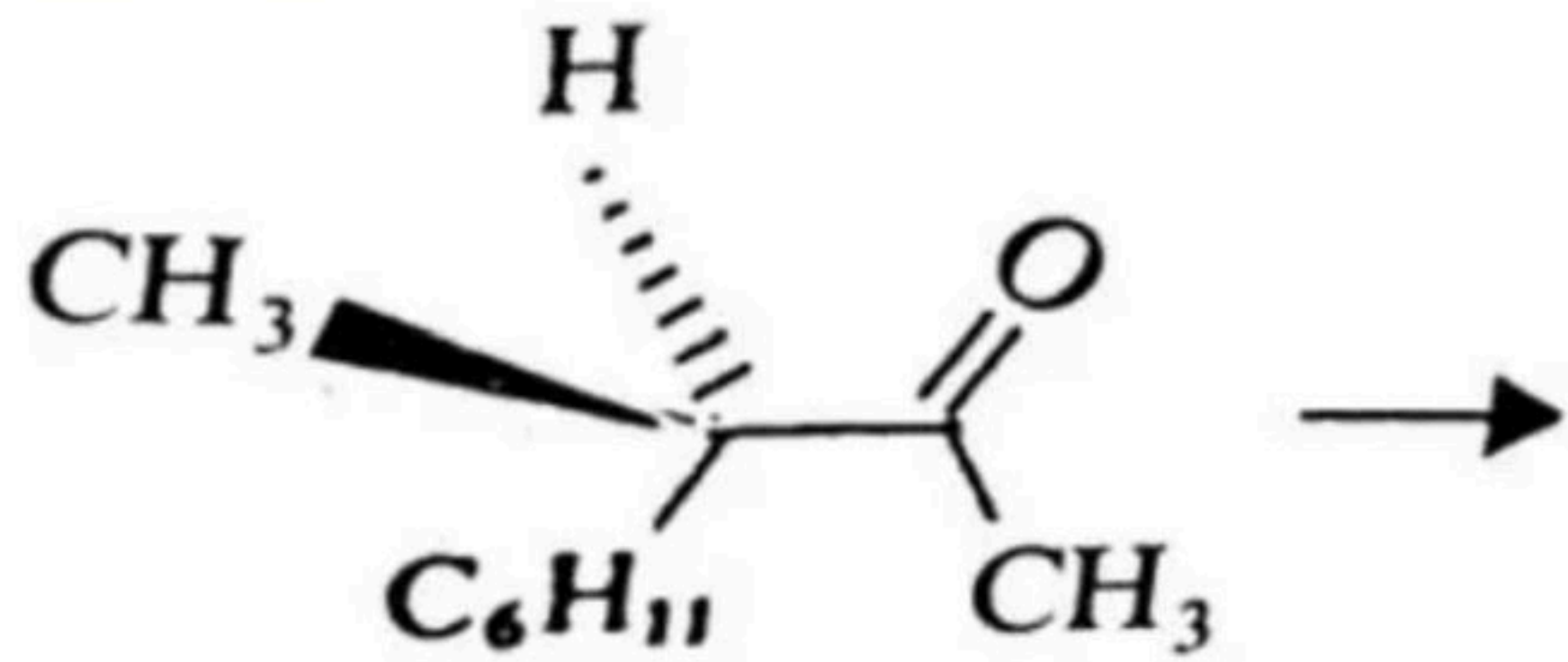
Threo form (Minor)

2-phenyl propionaldehyde when treated with Methyl magnesium Bromide(CH_3MgBr), erythro-3-phenyl butane-2-ol is obtained as the major product. Let's see an example.

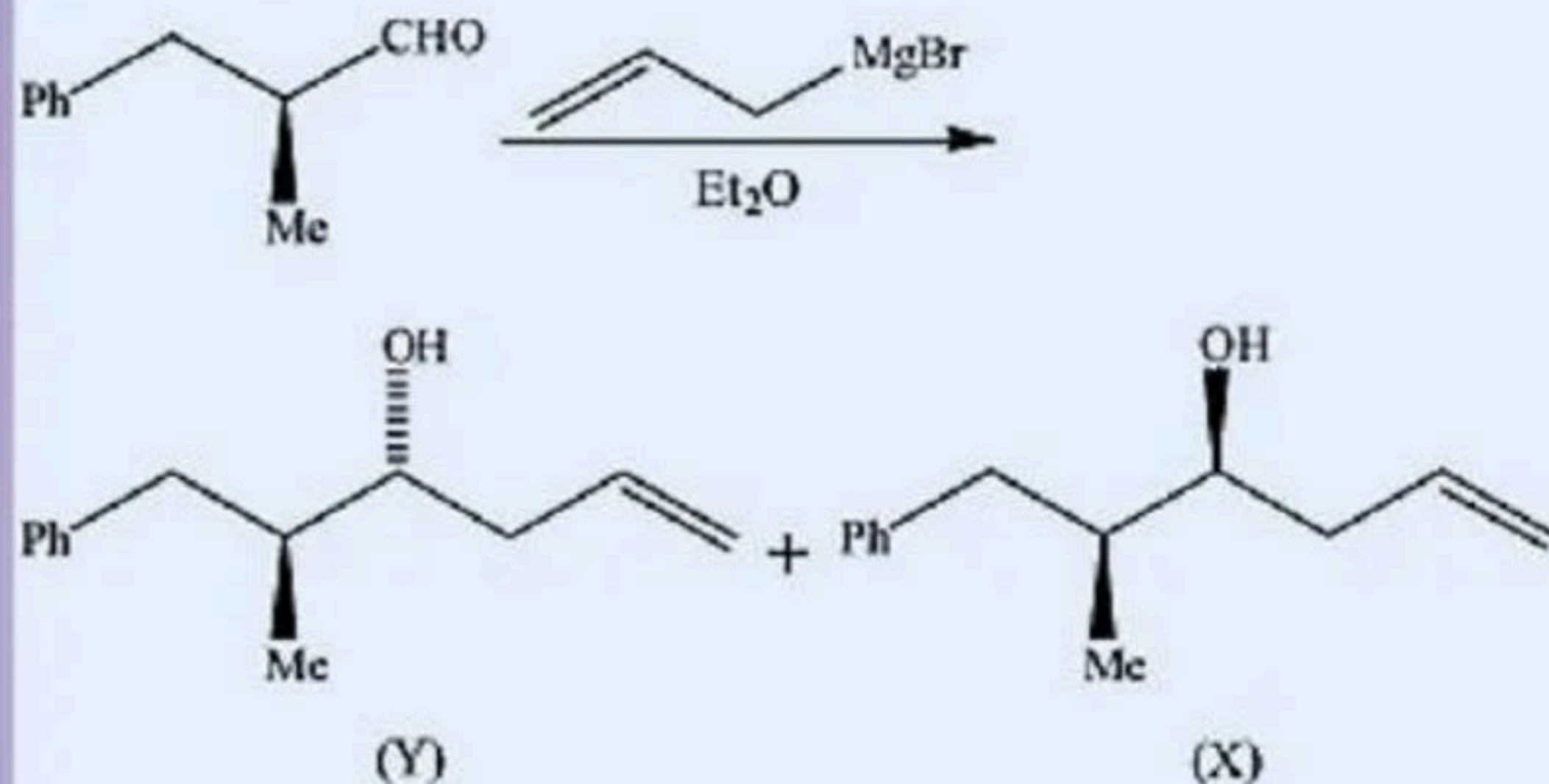


2. Which major diastereomer will be formed by the reduction of ketone (a) with LiAlH_4



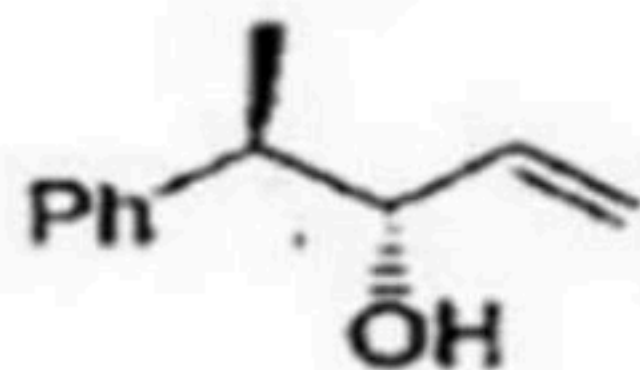
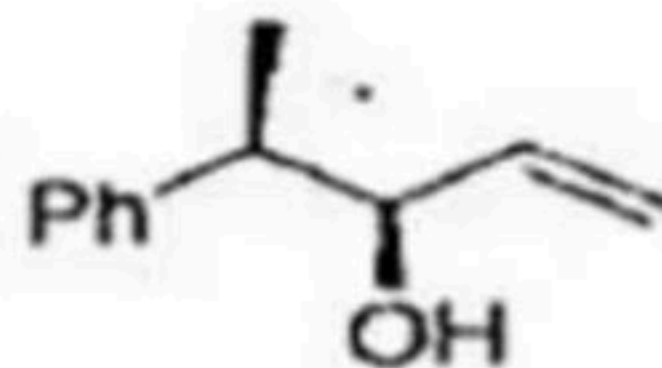
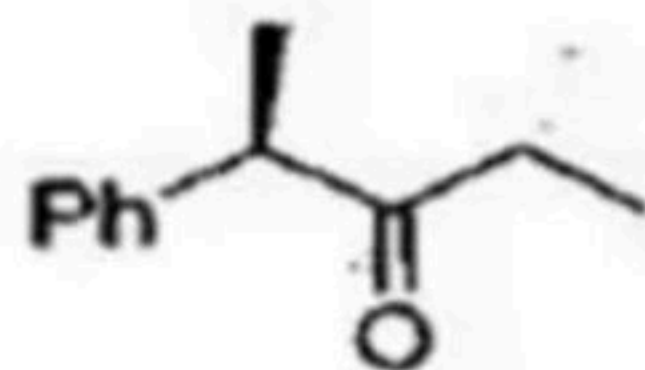
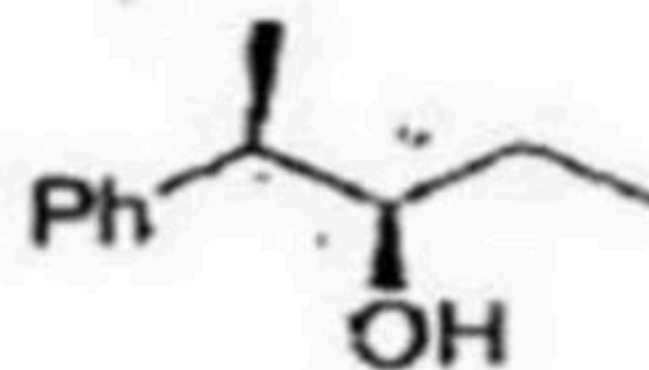


Which statement is *true* for the following transformation?

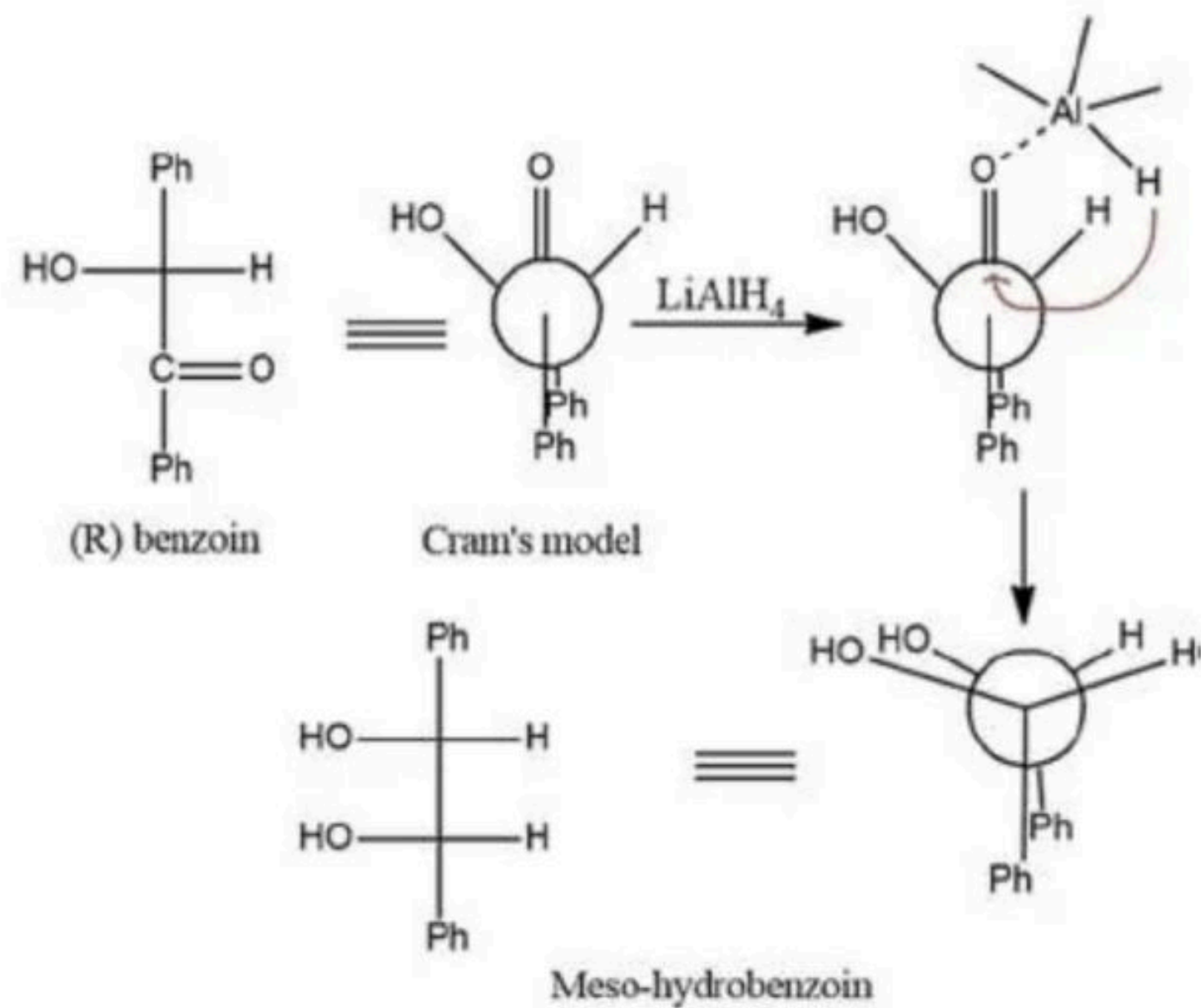


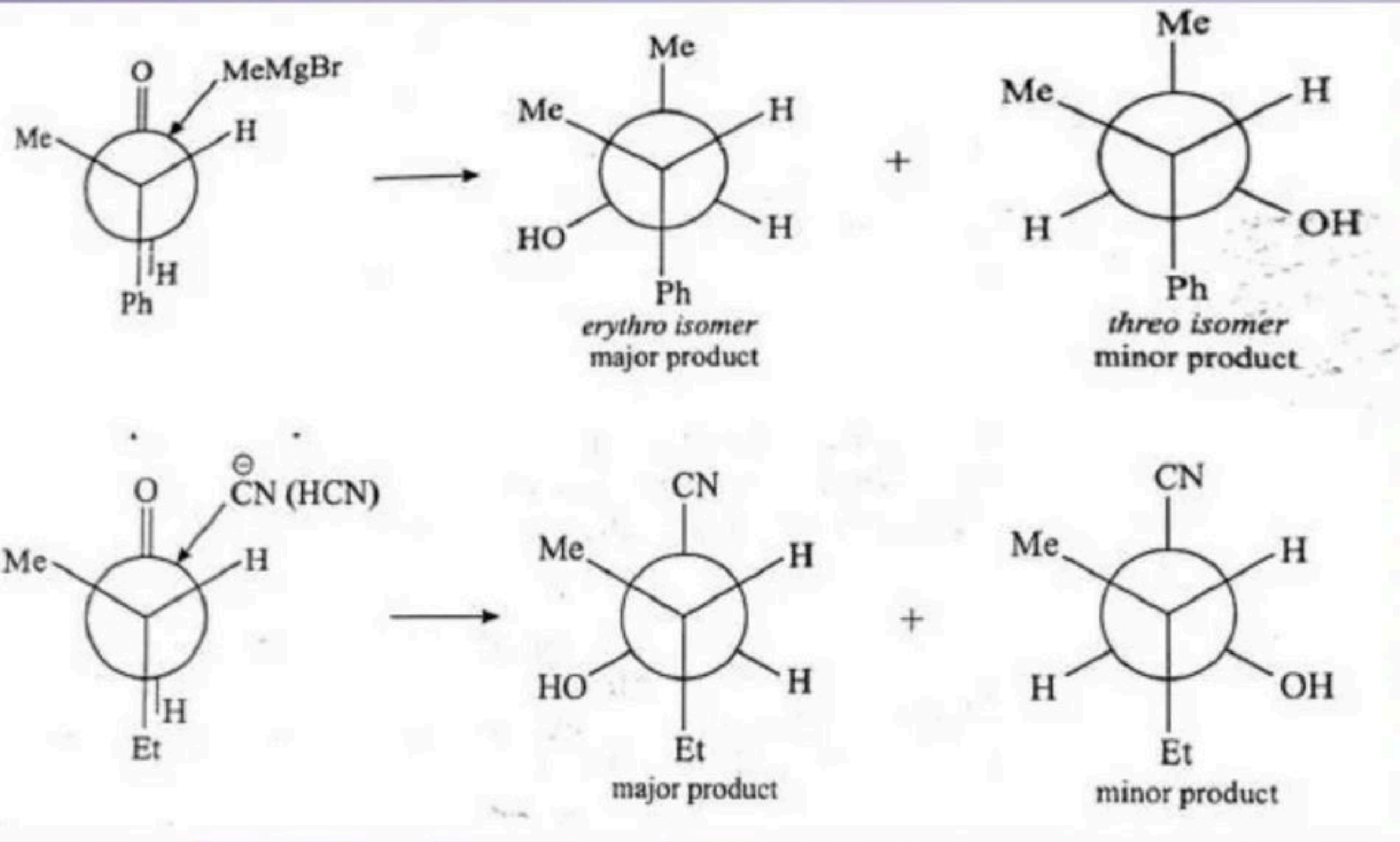
- (A) (X) is major and it is Cram product.
- (B) (X) is major and it is anti-Cram product.
- (C) (Y) is major and it is Cram product.
- (D) (Y) is major and it is anti-Cram product.

The major product formed in the following reaction is



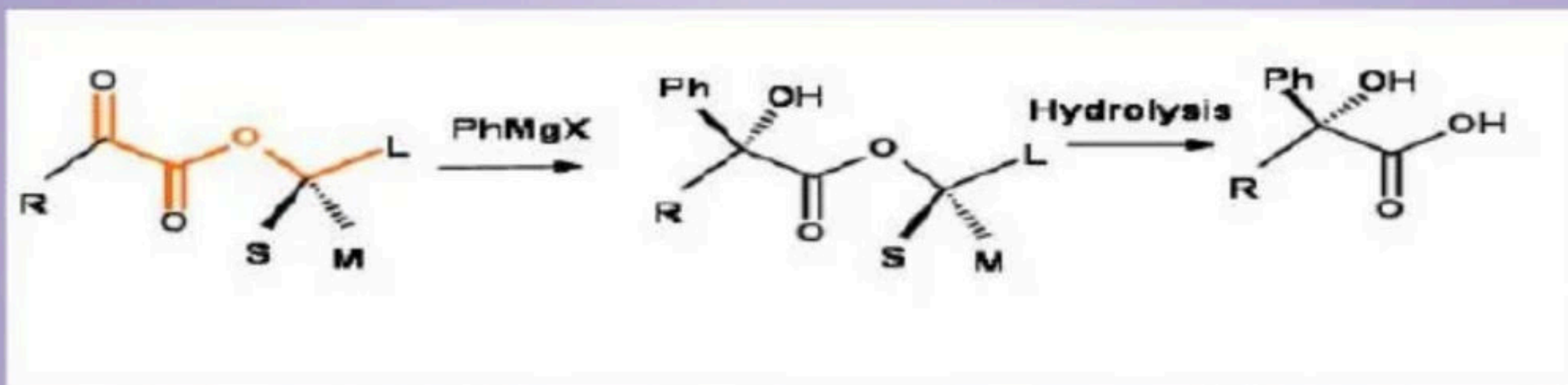
When benzoin having S OR R configuration is reduced with lithium aluminum hydride, meso-hydrobenzoin is obtained as the major product. This can be explained by using Cram's rule.





Prelog's rule

Prelog's rule relates the course of asymmetric synthesis when Grignard reagent is added to ketonic C=O of an alpha keto-ester.



Thank You