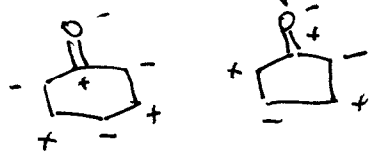
Chem 233

so much to learn so we use models to help us remember that 3D structures matter

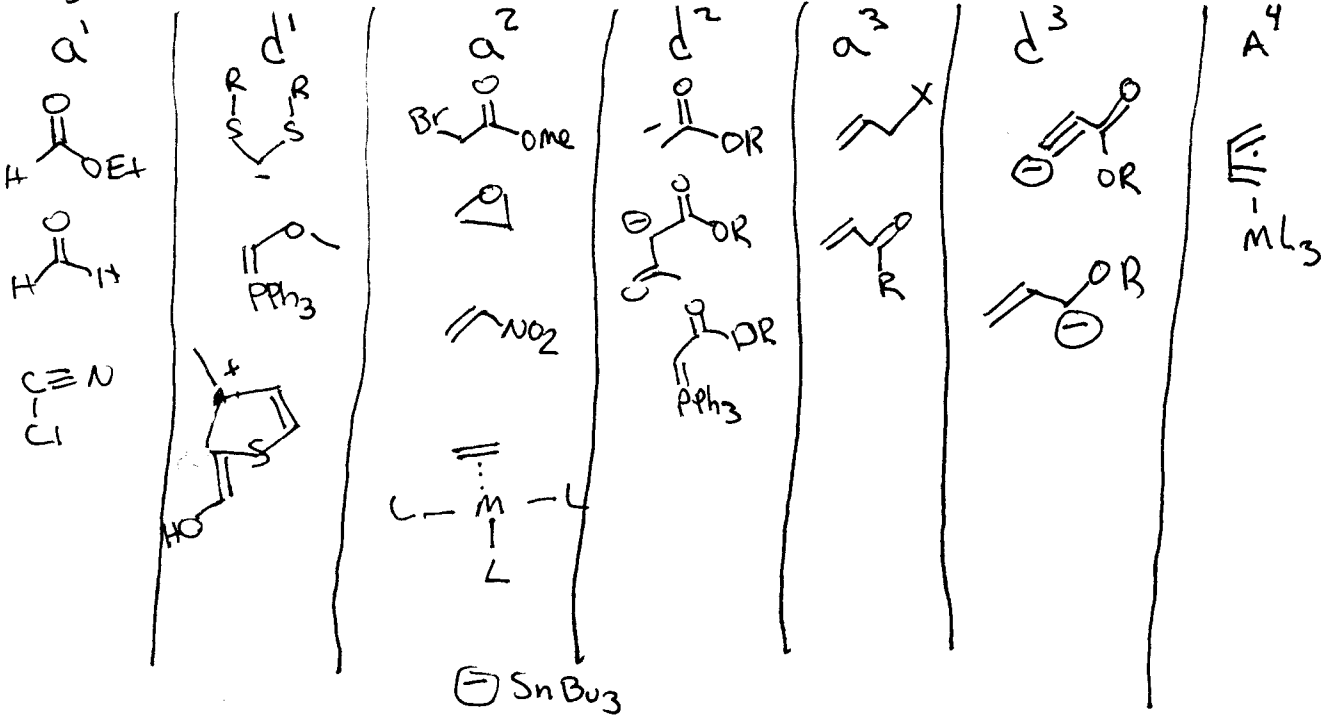
Basic strategy



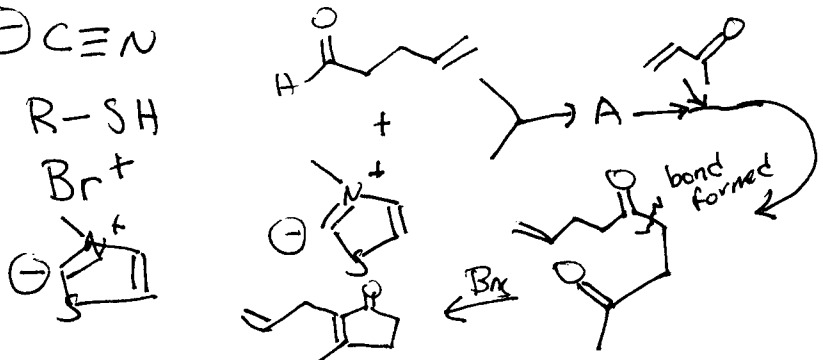
dissonant compounds require a polarity reversal (umpolung) harder to make

☺ consonant ☹ dissonant

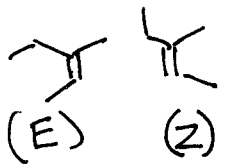
Synthons

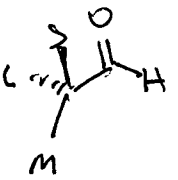


umpolung reagents



Nomenclature

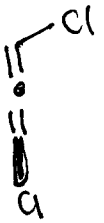




Si = top

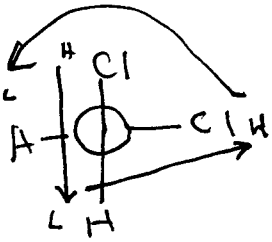
Re = bottom

CIP rules



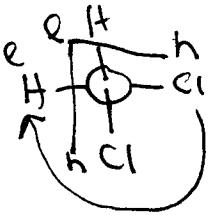
1) place highest priority in front if same pick one

2) label groups on carbons as highest and lowest priority



= S

left



= R

right

3) go A → L on front system across axial plane and then on back system

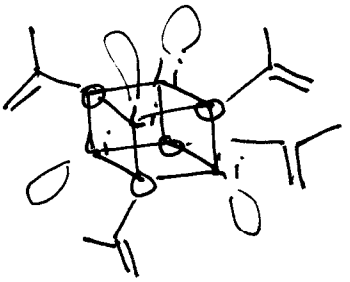
Reactivities

cations	sp^2	
radicals	$sp^3 \rightarrow sp^2$	(depends on other groups) sp^2 if next to sp^2
anions	$sp^3 \rightarrow sp^2$	
carbenes	singlet and triplets	

Think 3D

for instance 

in benzene
in THF
A dimer



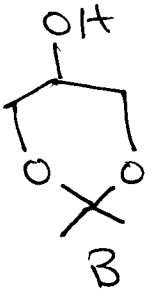
A tetramer

HMPA → monomer

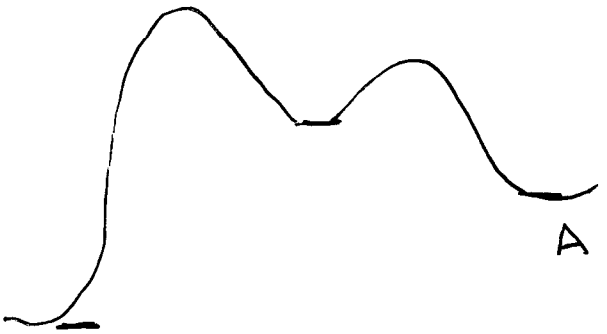
Aggregation effected by solvent and can change reactivity

Think Kinetics / thermodynamics (effected by conditions)

A

or 

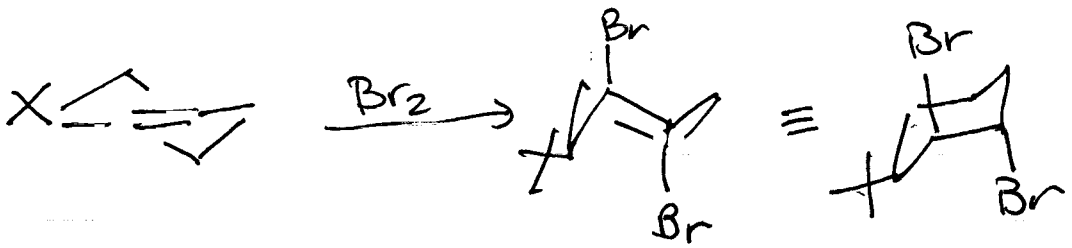
B

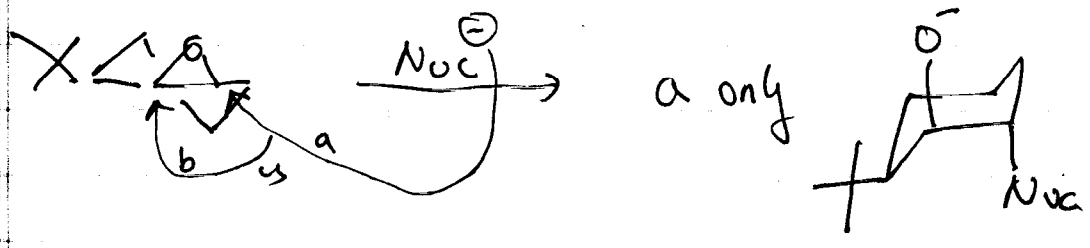


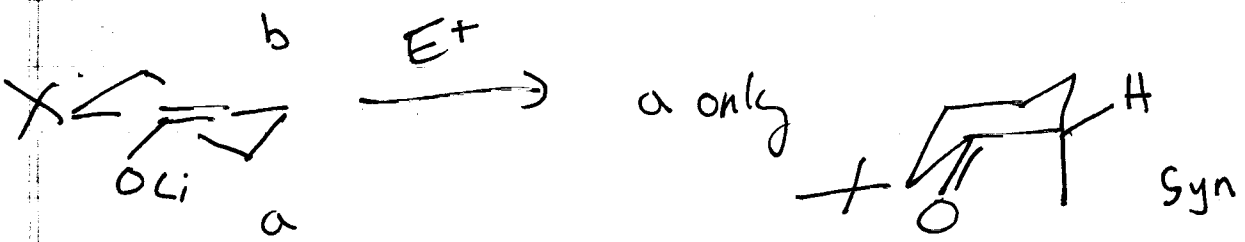
A forms faster
fives form faster

B more stable
sixes more stable

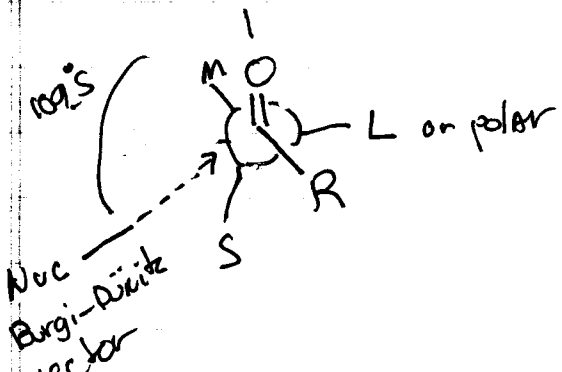
First Platerae applies to more than cyclohexenes

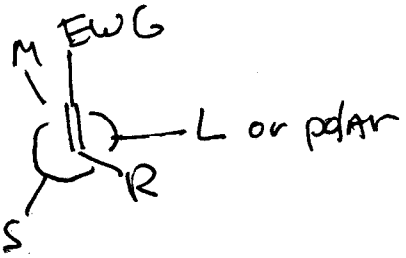


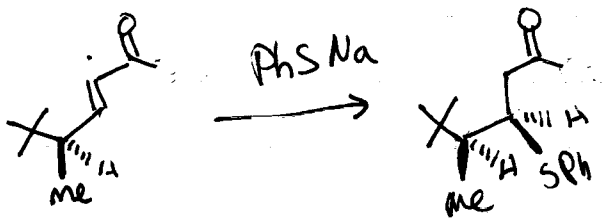




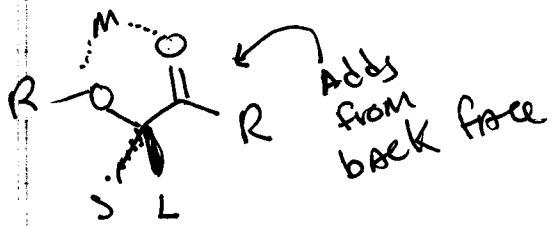
Models evolved for additions to carbonyls and enons



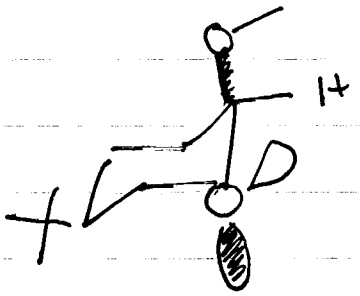




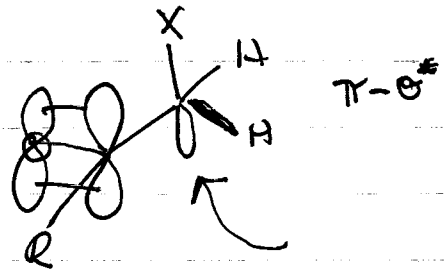
Chelation reverses



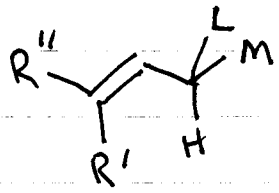
Anomeric effect $\sigma^* - n$ stabilization



not undifferent from stabilization in S_N2 displacement adjacent to π system



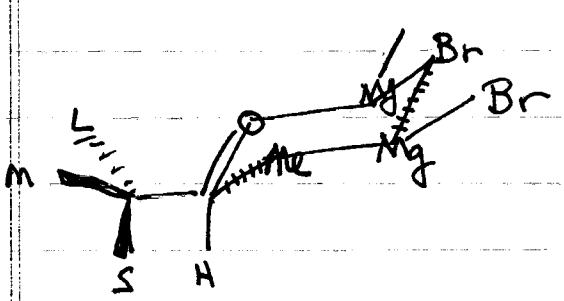
Allylic strain



reactions occur from medium side

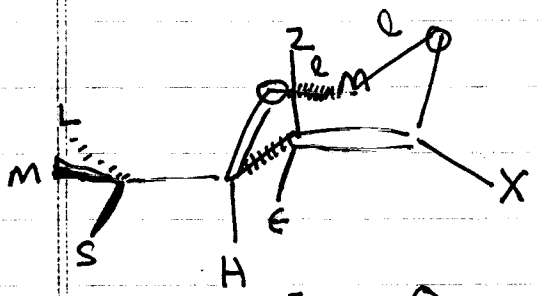
Baldwin Rules

Addition of Me-Mg-Br to chiral aldehyde considering Felkin-Ahn and cation transport



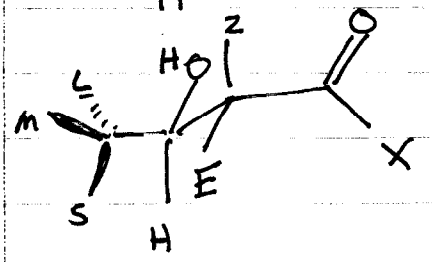
dimer complex has lower energy constraints

Now consider an enolate of an ester or amide Zimmerman-Traxler T.S.



E → anti

Z - syn



E anti to OH

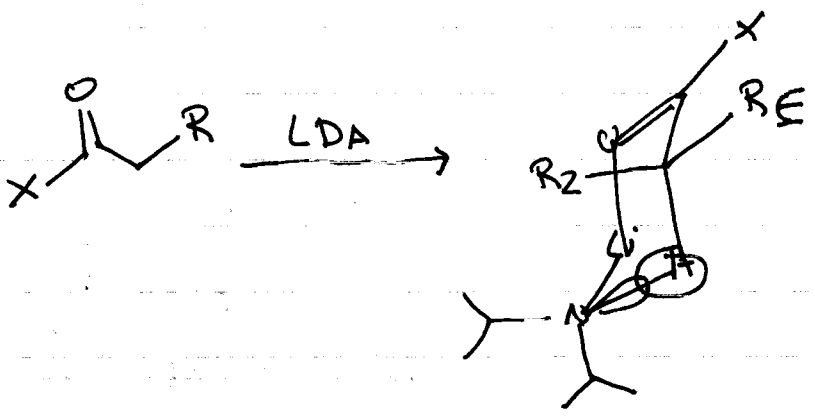
Z syn to OH

M =	B	1.51 Å	most selective
	Li	1.92 Å	
	Zn	2.18 Å	least selective

(Q)

Ireland Paradigm

Closed T.S. explains enolate geometry



if X is big then R_2

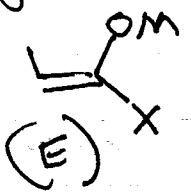
if X is small then R_E

$O-CH_3$ small $X \rightarrow R_E$

amides big $X \rightarrow R_2$

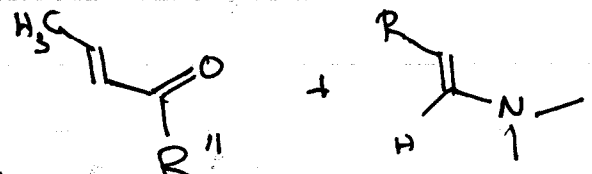
HMPA favors O.T.S. gives Enolate

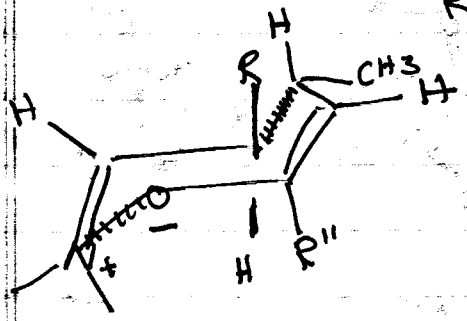
consider position of R



Electrostatic Closed Sevin TS.

consider



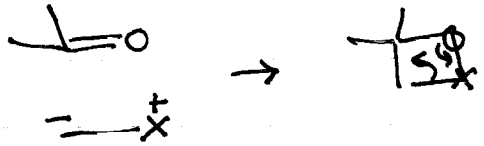


Sevin orientation

charges minimized

Alkenes

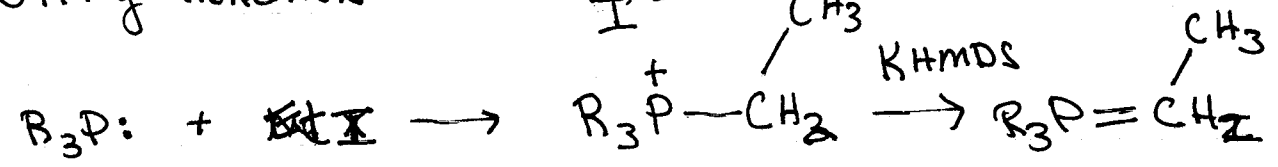
I) From Ketones and other carbonyls

basic strategy  driven by strong X=O bond

Si–O	110 Kcals
P–O	95 Kcals

disposal of X=O

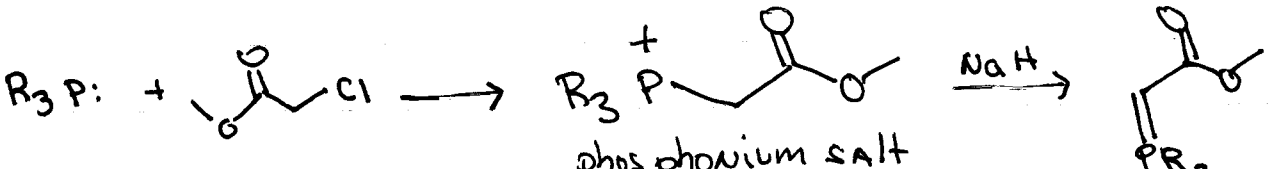
Ia
Wittig Reaction



salt free best
favors cis (Z) 85:15
but very basic
best with non enolizable systems

phosphonium salt
pKa >25

ylide
non stabilized



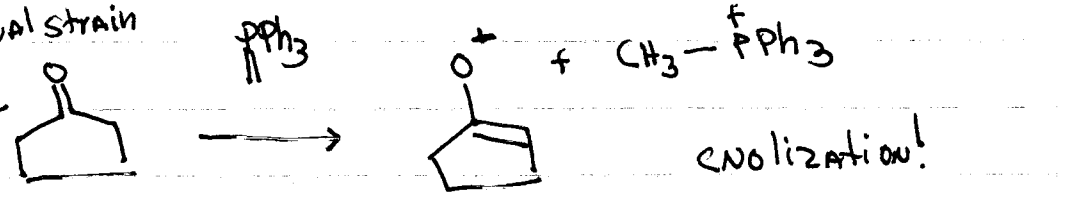
salt free best
favors tran (E) 90:10
but not very reactive
aldehydes only!

phosphonium salt
pKa ≃ 13

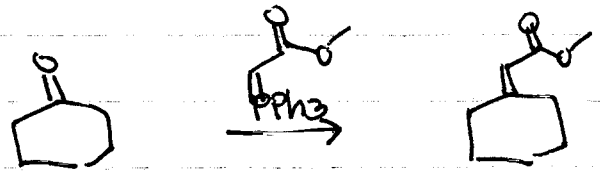
stabilized ylide

Example of Wittig Problems

torsional strain
more acidic



enolization!

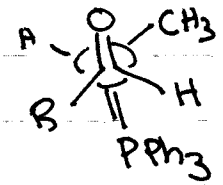


low yield
less than 20%
poor reactivity

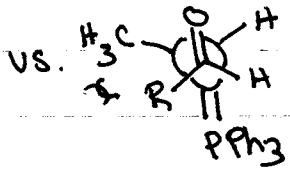
Could use other phosphines with stabilized systems but non-enolizable phosphine needed for non stabilized systems (PPh_3)
$^{-}O-\overset{+}{P}Ph_3$ disposal & problem and so is reaction work-up

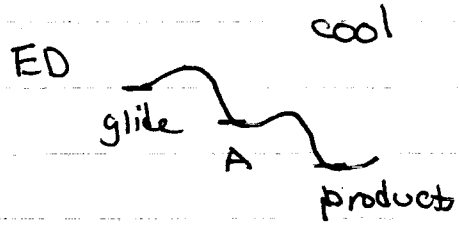
Port gou models to work!

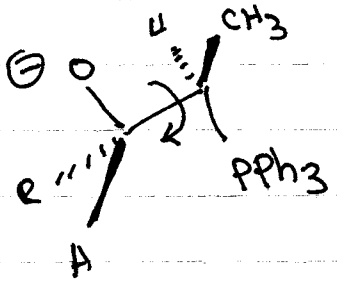
non stabilized

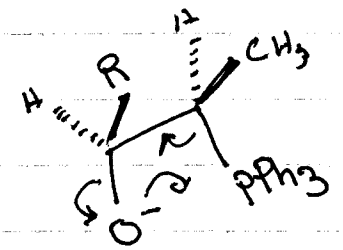


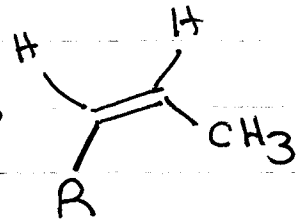
favored











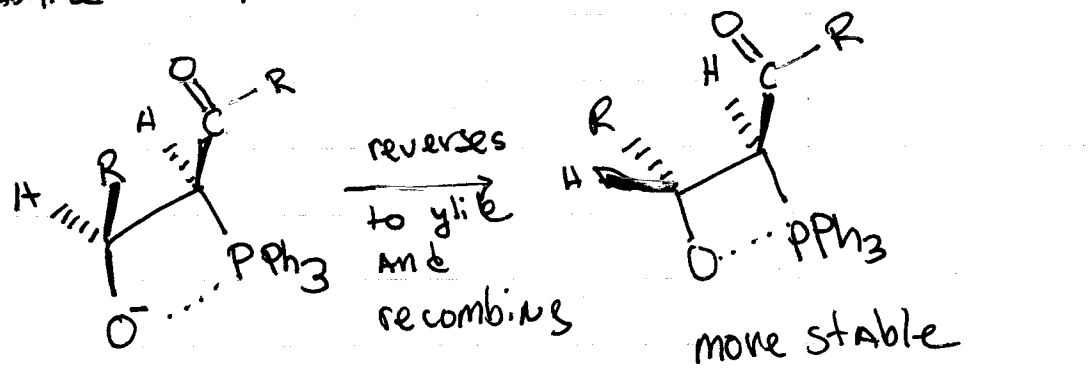
A

cis product

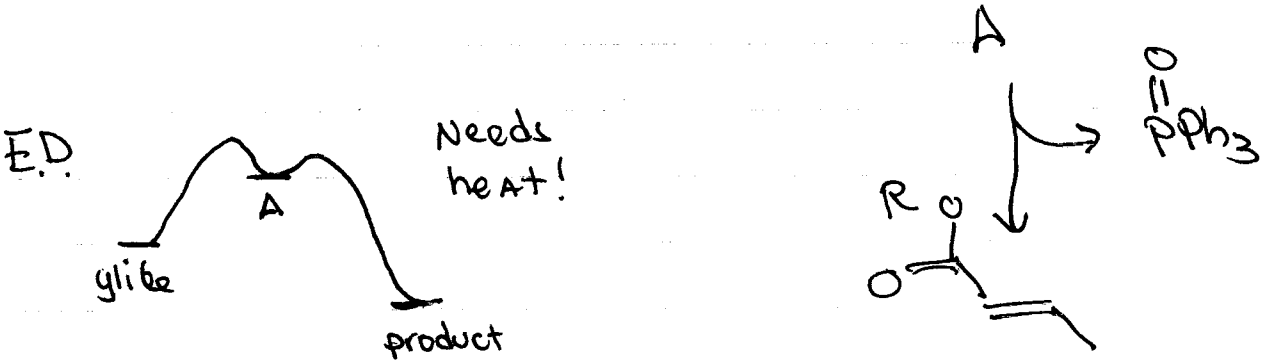
A is more stable than non stabilized glide

Stabilize same applies but A is less stable than stabilized ylide

more stabilize → more trans

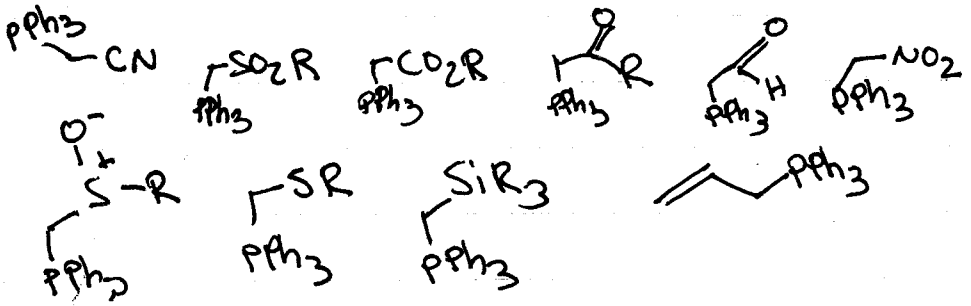


more stable

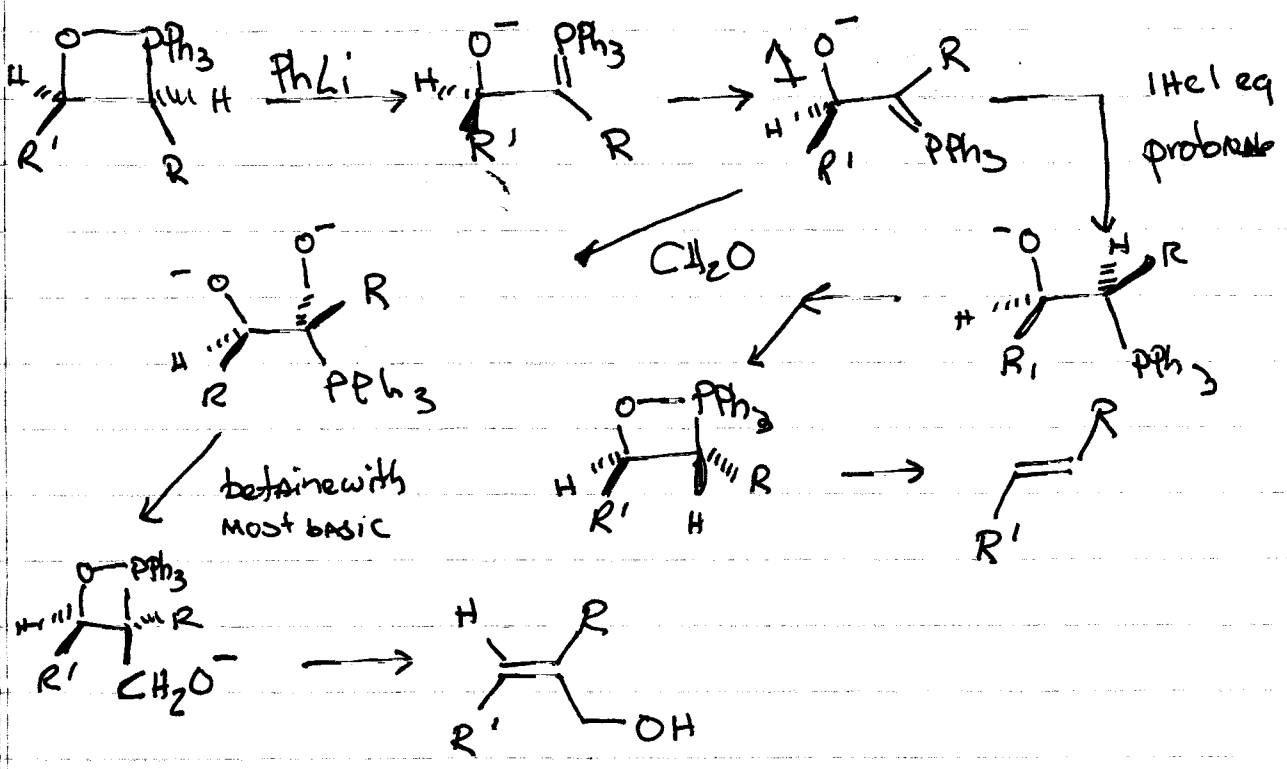


exception α-Alkyl Aldehydes give cis with stabilized ylide

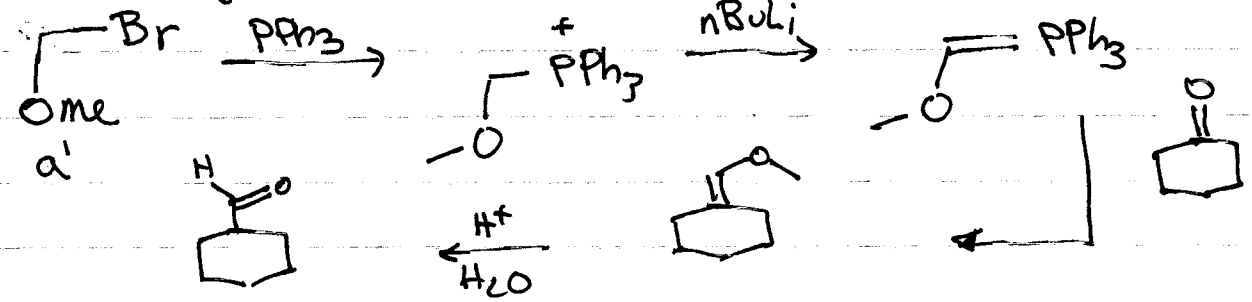
Stabilizing groups



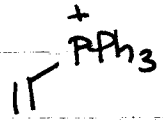
Schlosser trick for non stabilized



Another very useful Wittig Reagent

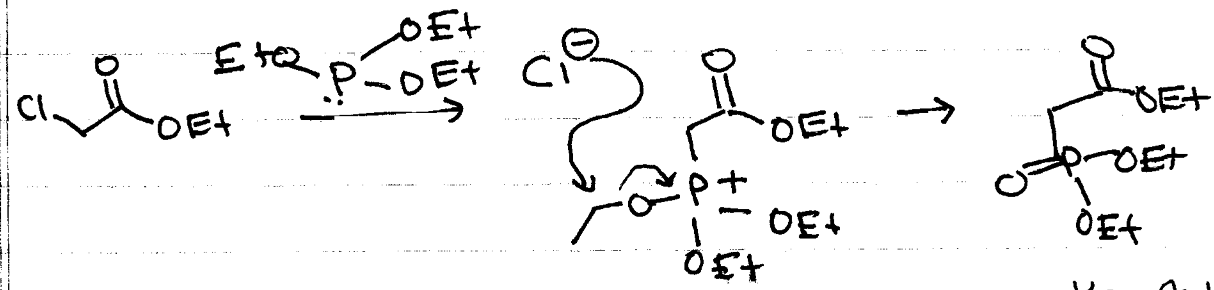


list of common Wittig salts and glides



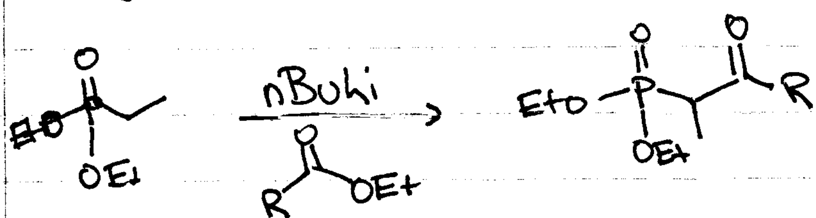
Horner Wadsworth Emmons : water solubility

Arbuzov : preparation of the reagent

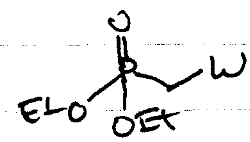


pKa ≃ 15

or by Claisen conditions



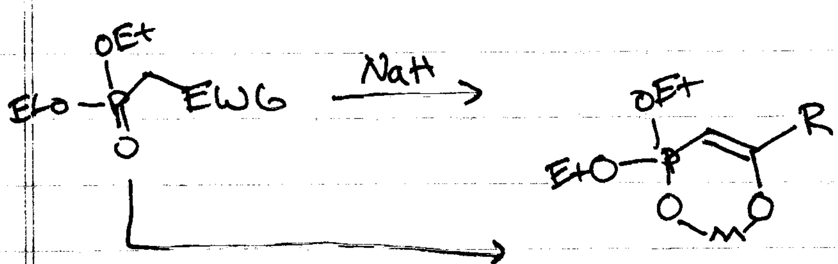
General Form



w ≠ H, Alkyl

w = CN, CO_2R, C(O)R CHO

SO_2R , Ph

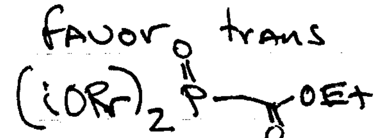


LiCl Hünigs

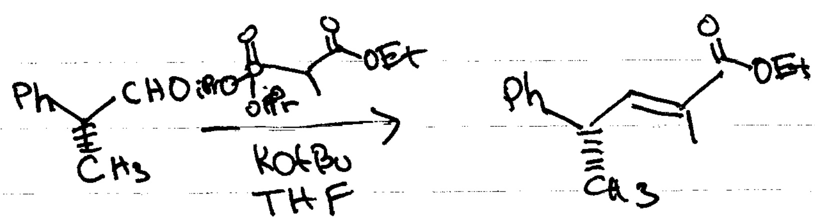
if EWG chelates

lowers pKa

big phosphonates favor trans



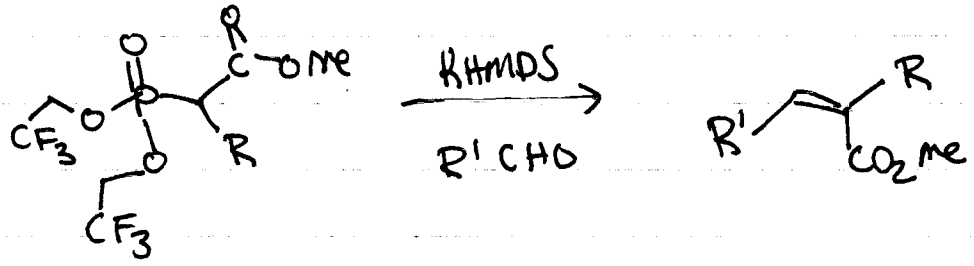
equilibrium driven



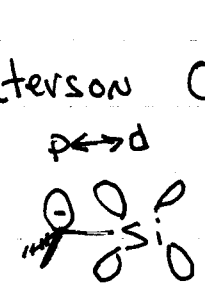
95 : 5

E : Z

Still trick ($(CF_3CH_2O)^-$ better L.G. ∴ kinetic control)



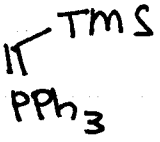
Peterson Olefination (Si–O)



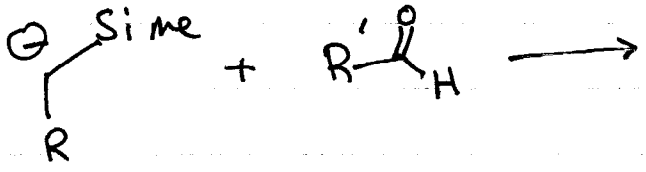
No conformation requirement

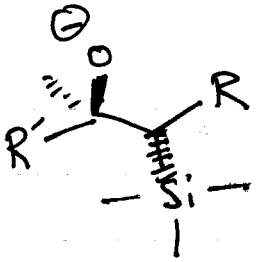
NON stabilized

very basic



Not good for disubstituted olfenins

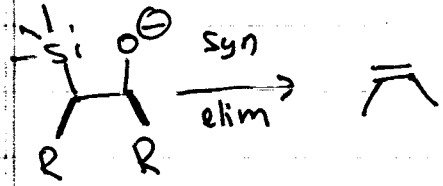




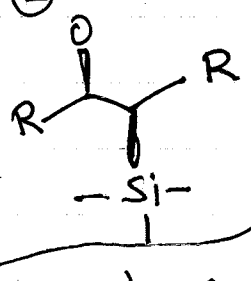
+

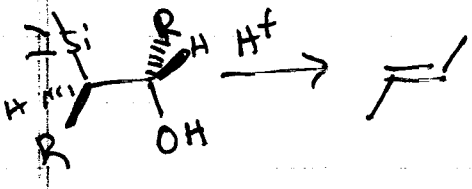
No stereo control
No Z.I.

However

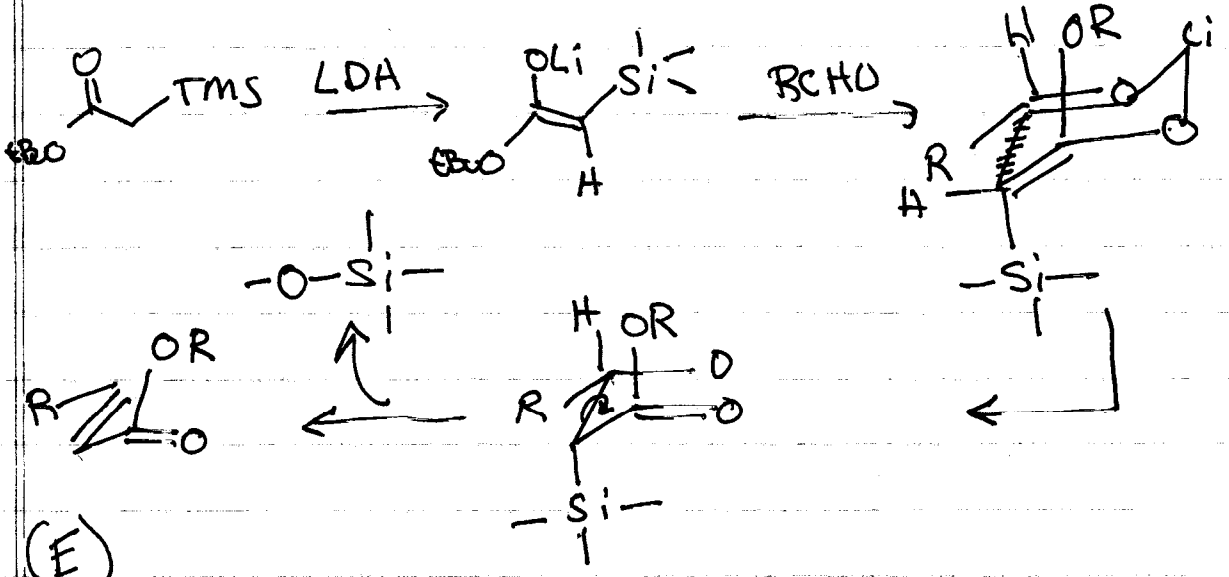


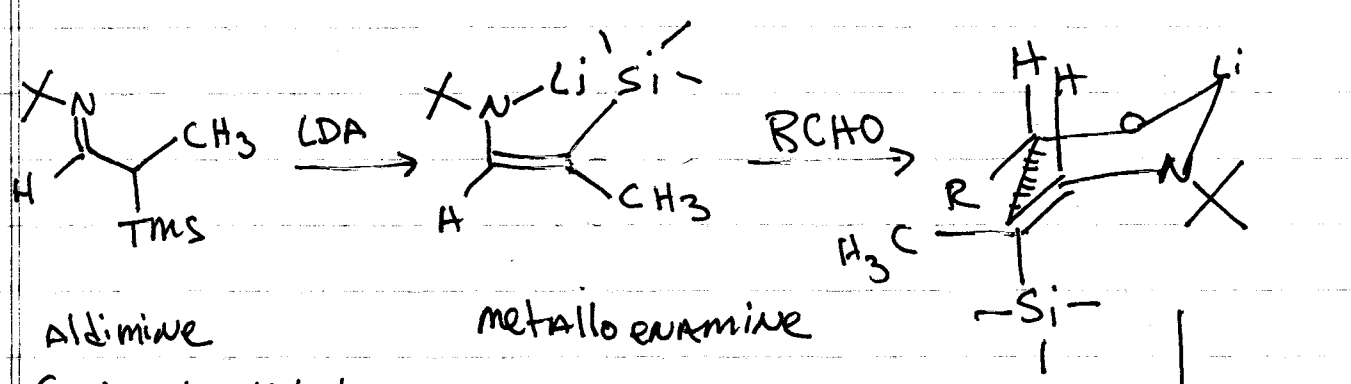
Stereospecific

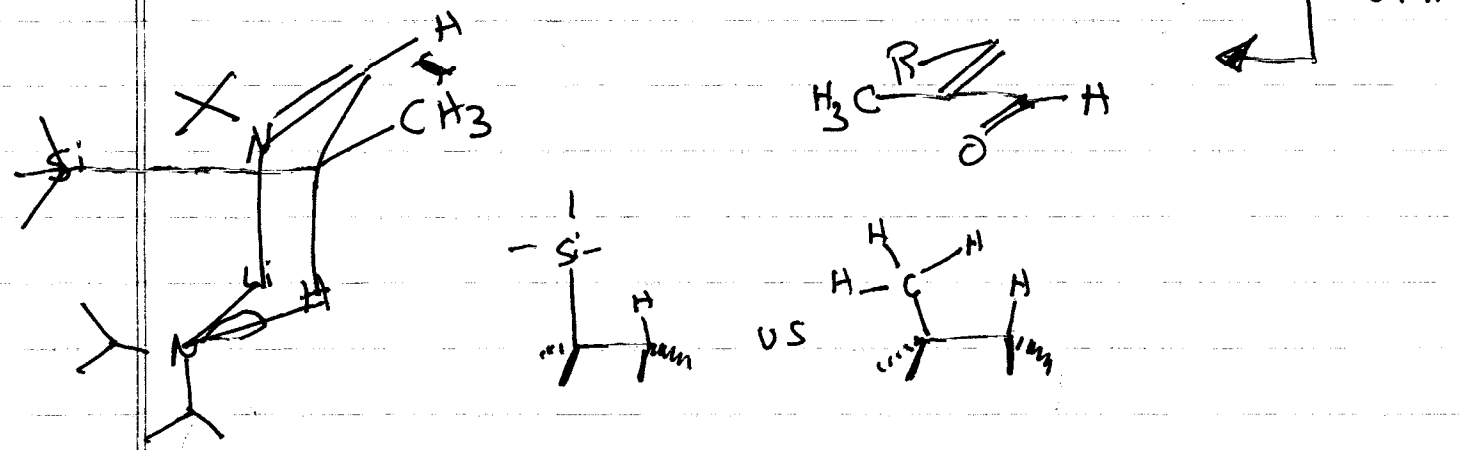




stabilized Peterson Reagents (stereocontrol)



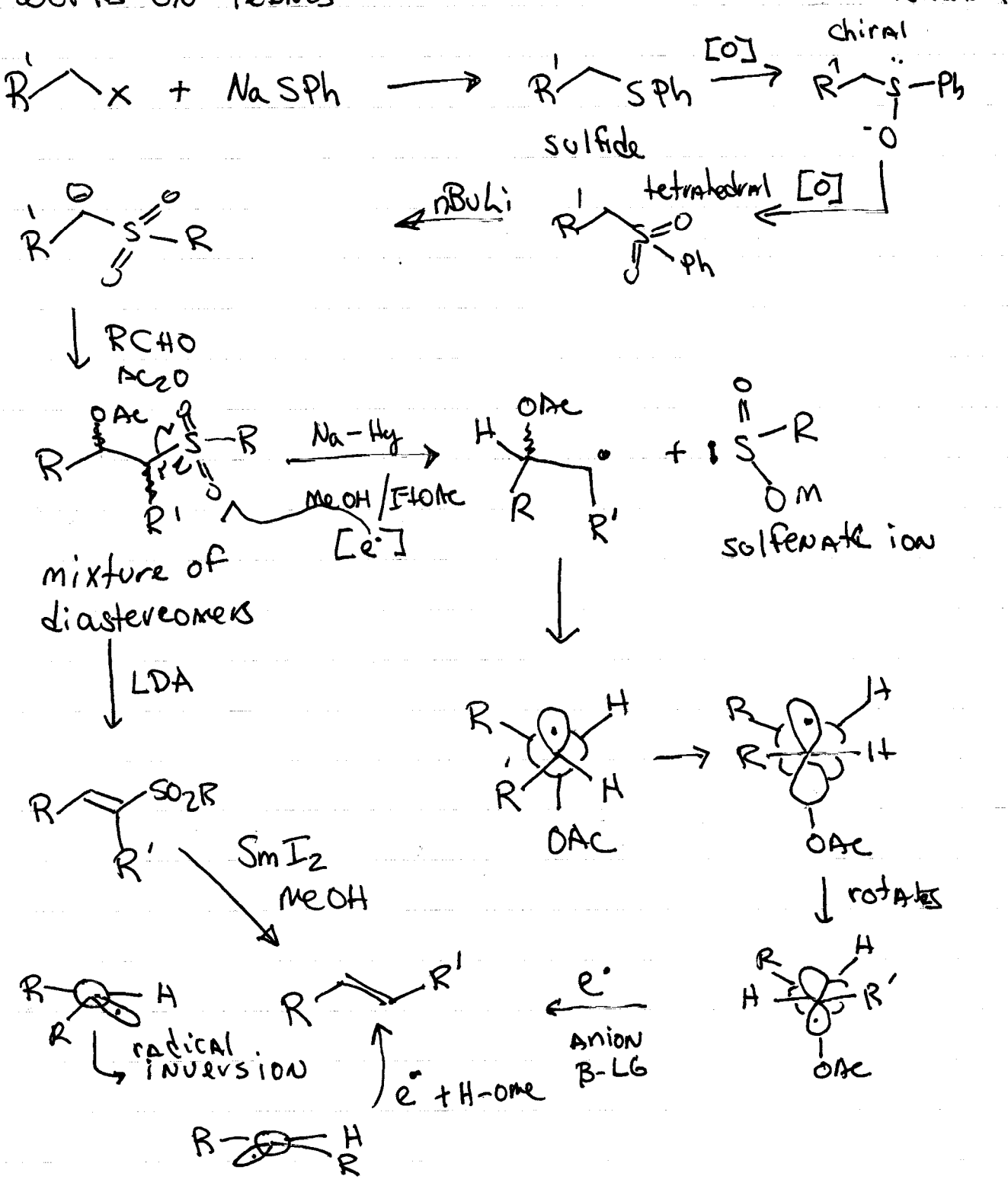




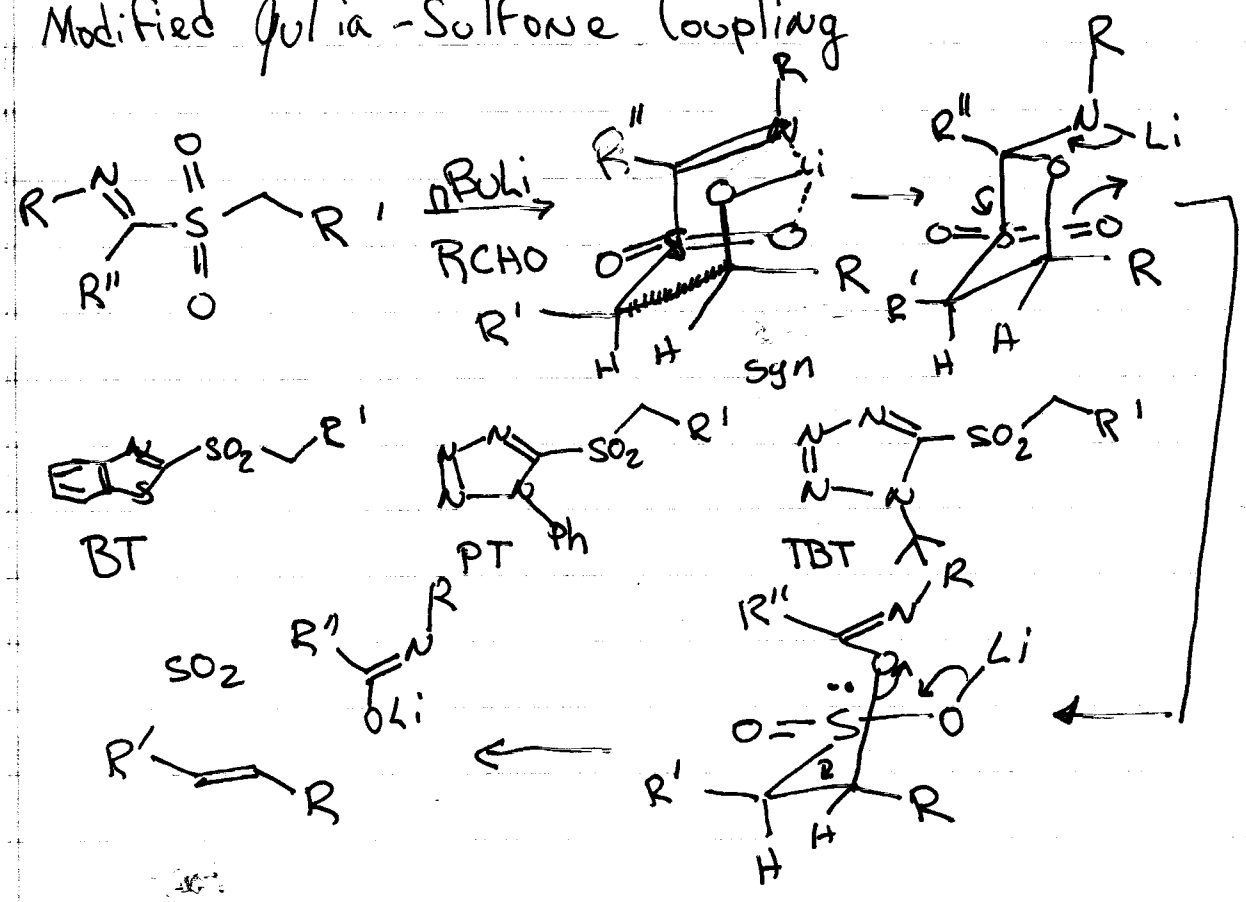
Julia-Sulfone Rxn

often used to bring key pieces together

works on Ketones



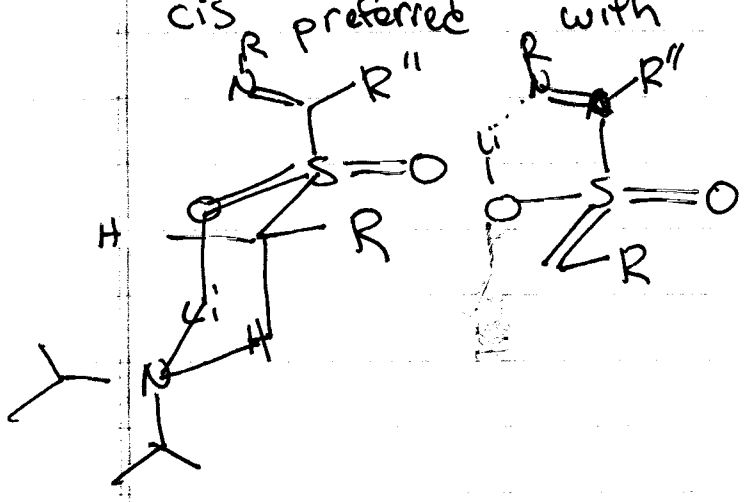
Modified Julia-Sulfone Coupling

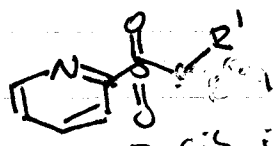


syn → trans (E) fast
anti → cis (Z) slowly R' & R torsional strain

trans preferred with BT, PT

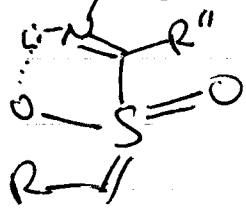
cis preferred with TBT AND





cis is electronic effect for (anion stability)

But if R'' get big



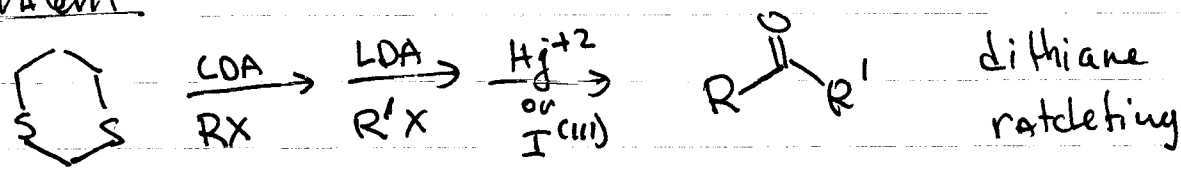
explains TBT

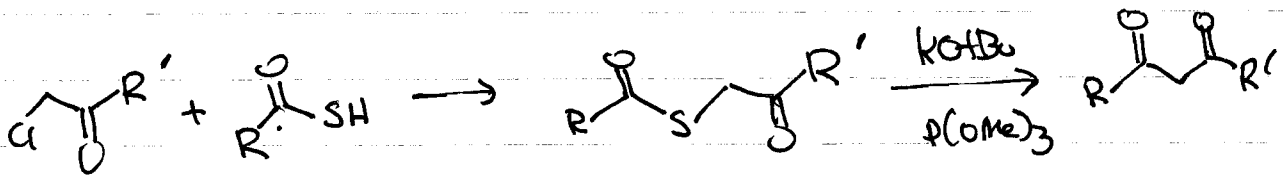
ASIDE: Sulfur Chemistry (hypervalent)

8 10 12 valency

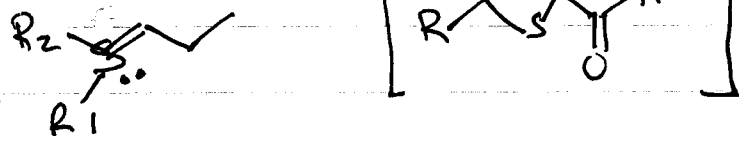
di tri tetra

Divalent

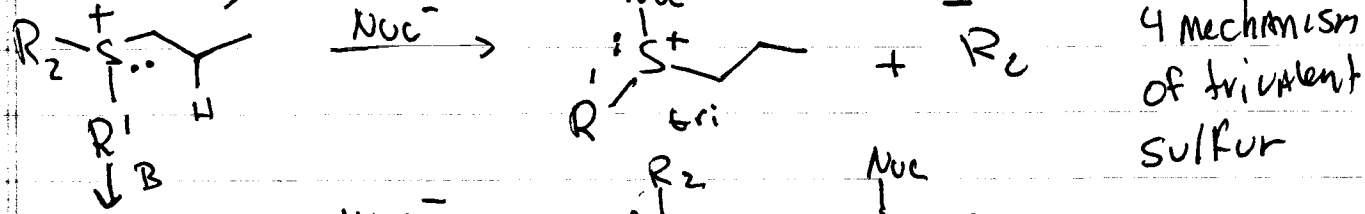


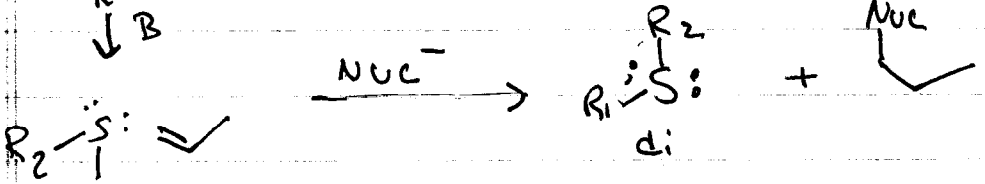


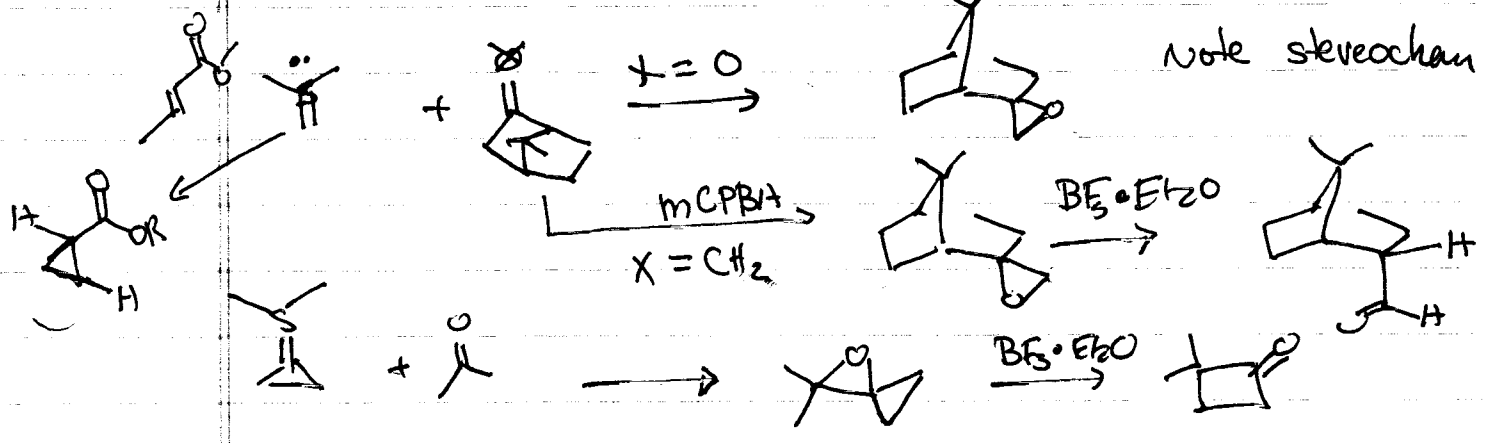
ligation



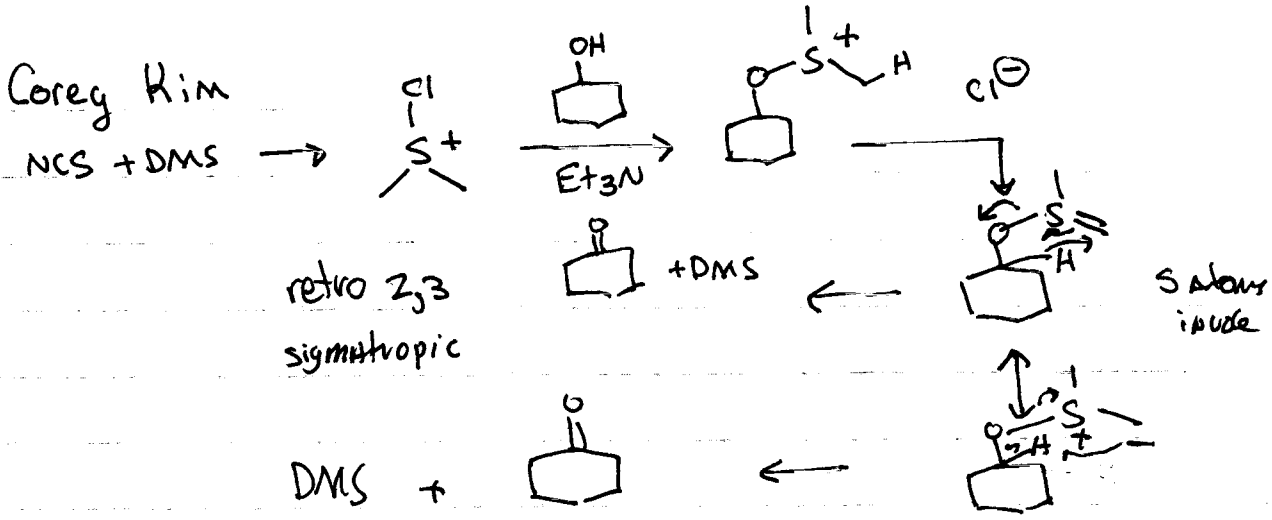
Trivalent



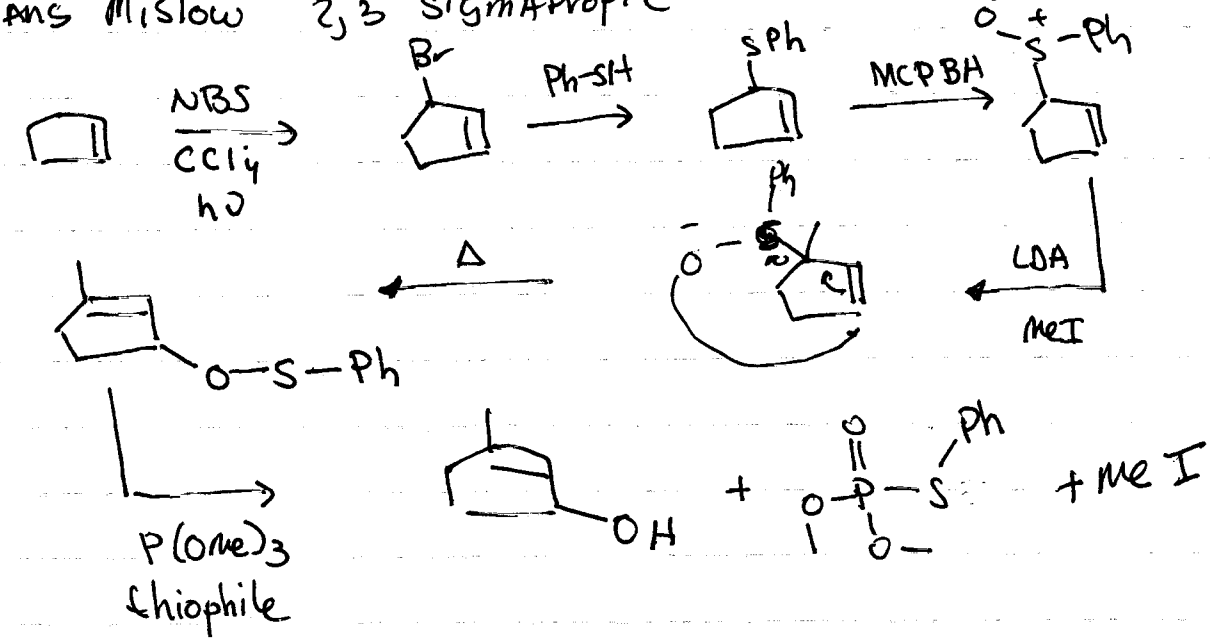




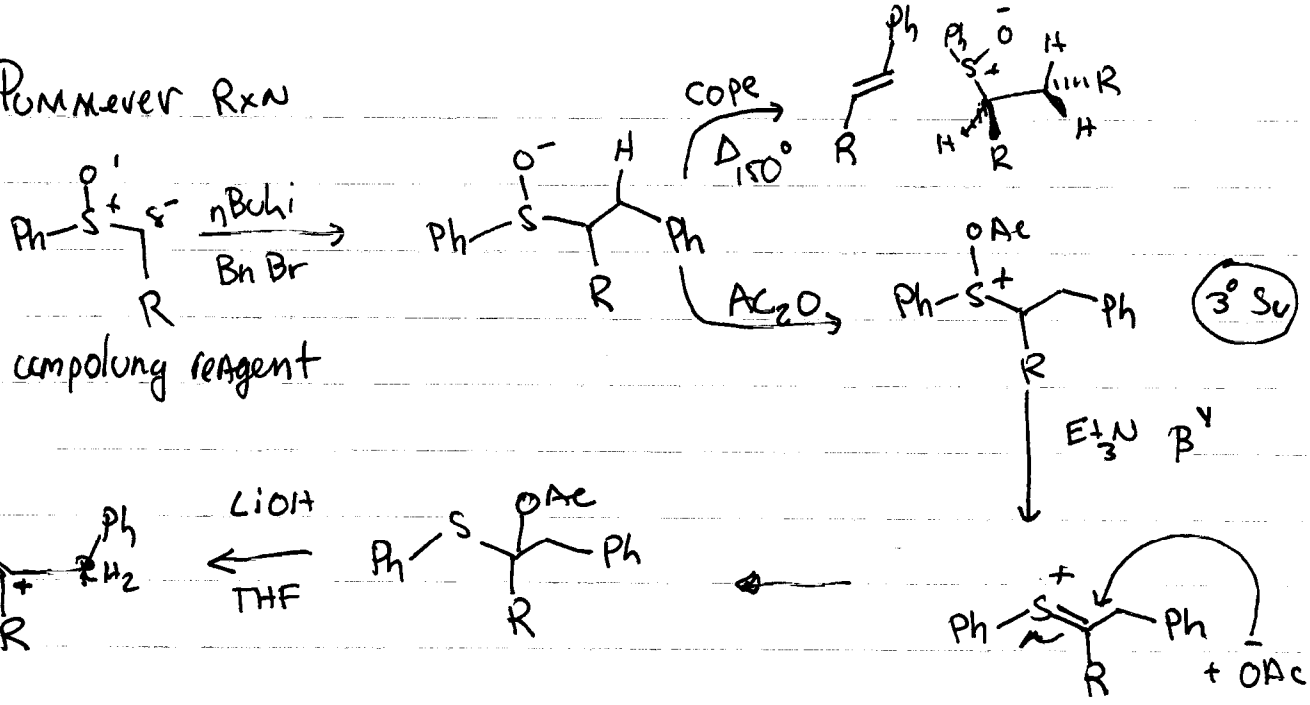
Corey Kim



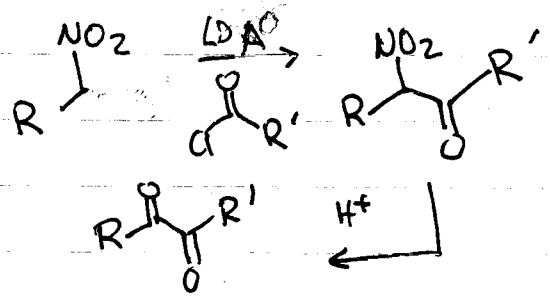
Evans Mislow 2,3 Sigmatropic

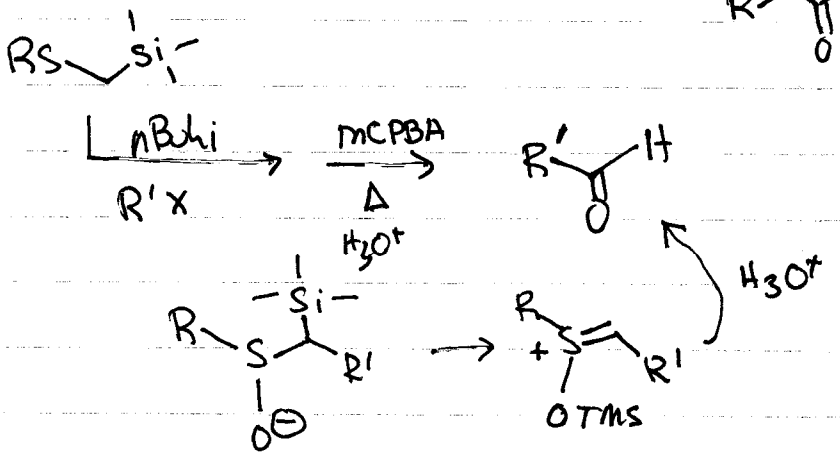


Pummerer Rxn

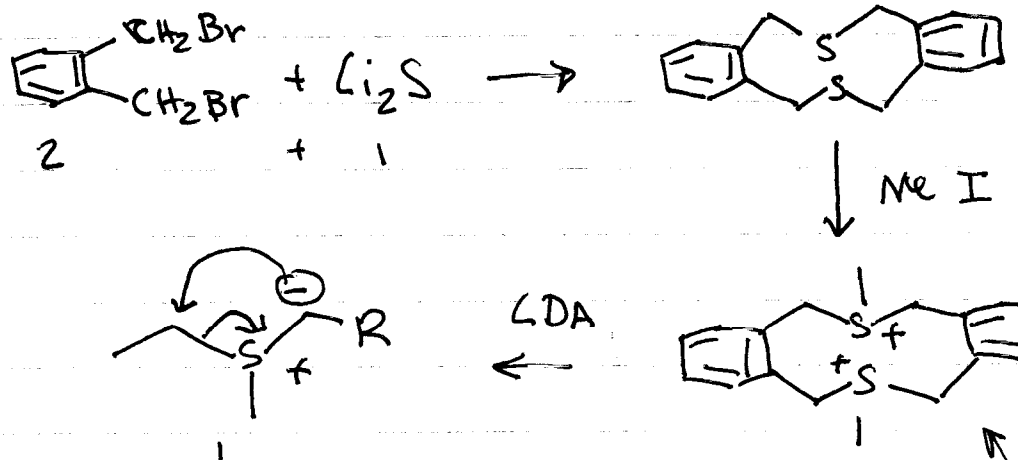


Nitro equivalent (Nef Rxn)

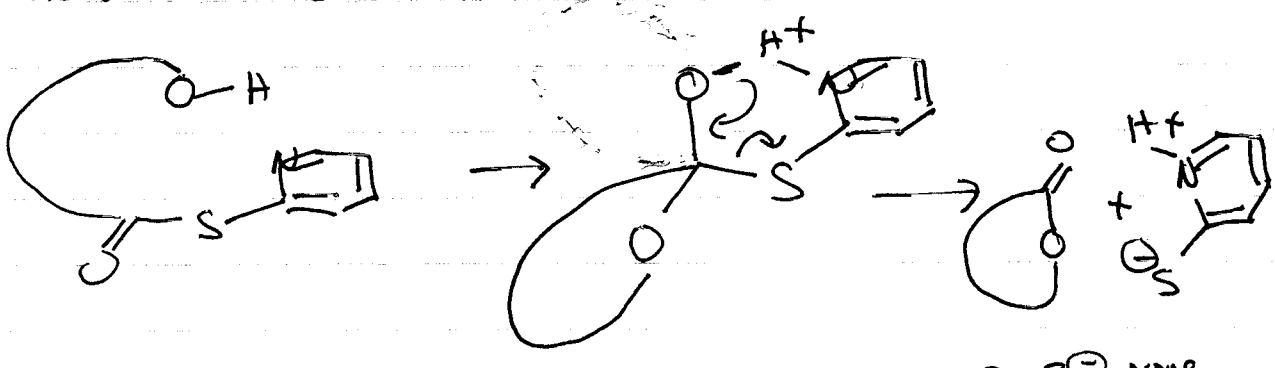




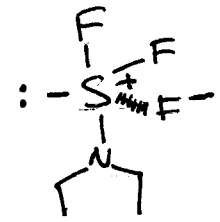
Alkyl bromide ⟶ Alkene



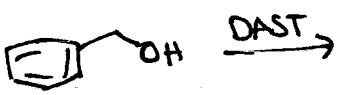
MACro lACtonizAtion

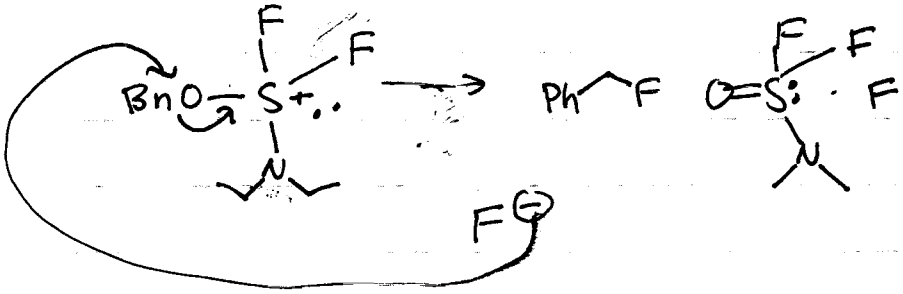


tetra coordinate Sulfur



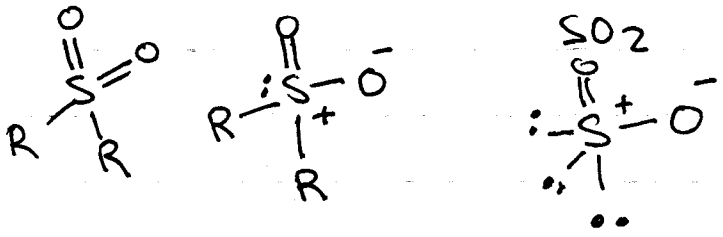
DAST

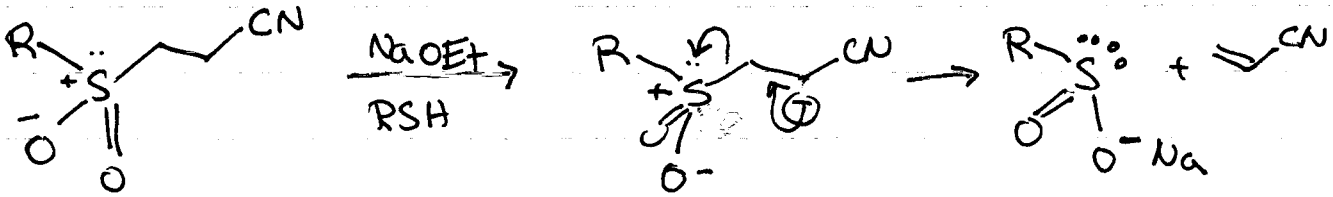


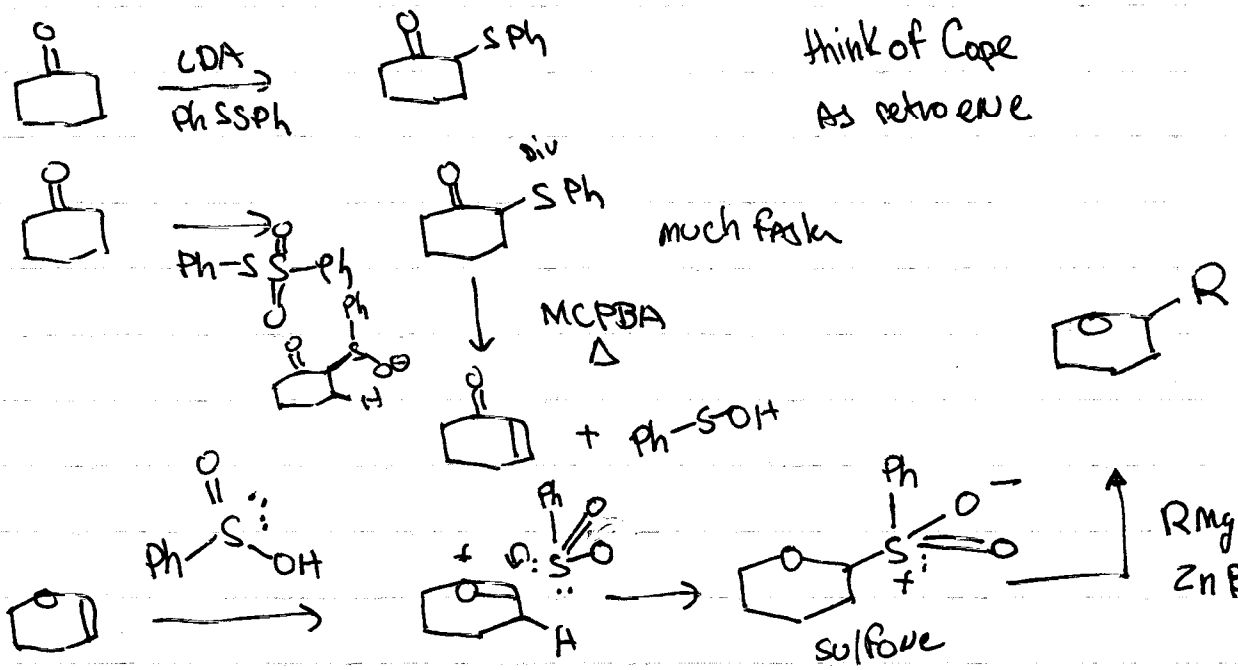


bivy!

sulfone



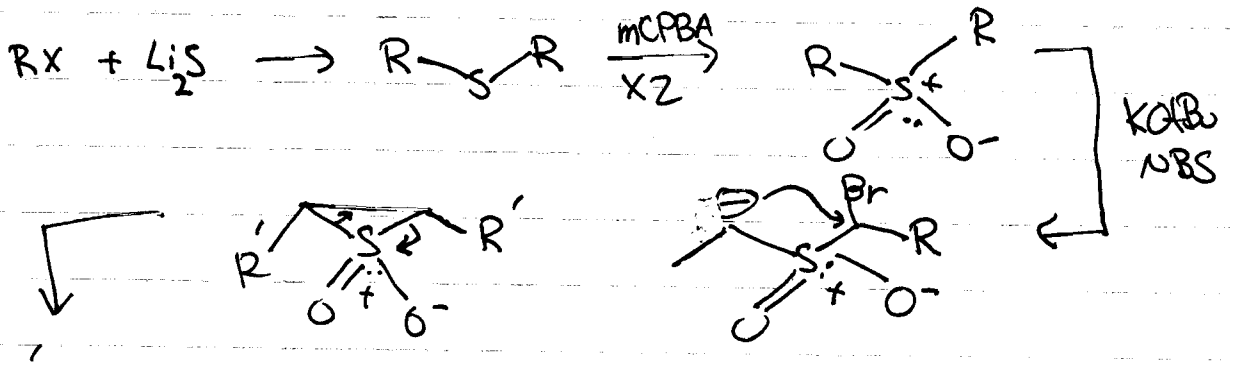


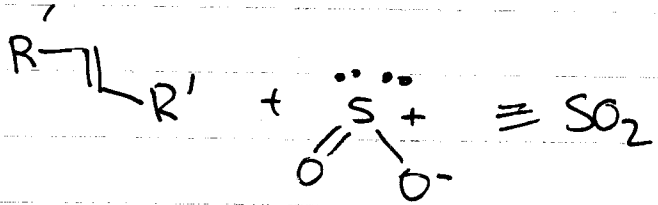


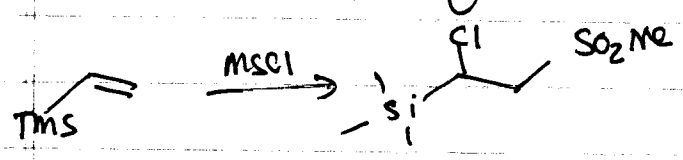
think of Cope
As retro ene

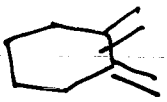
much faster

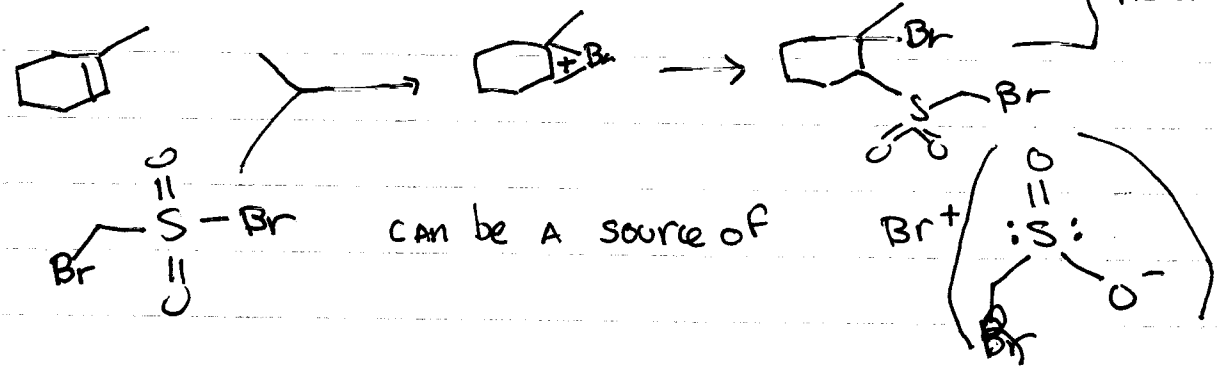
Ramberg Backlund

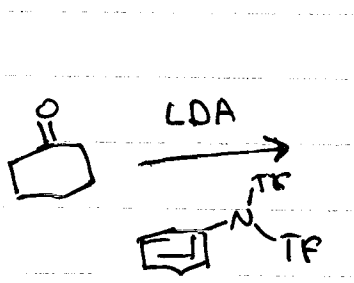


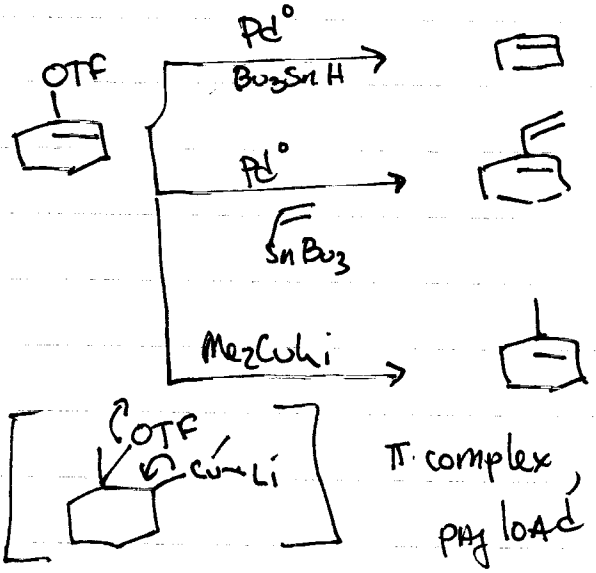




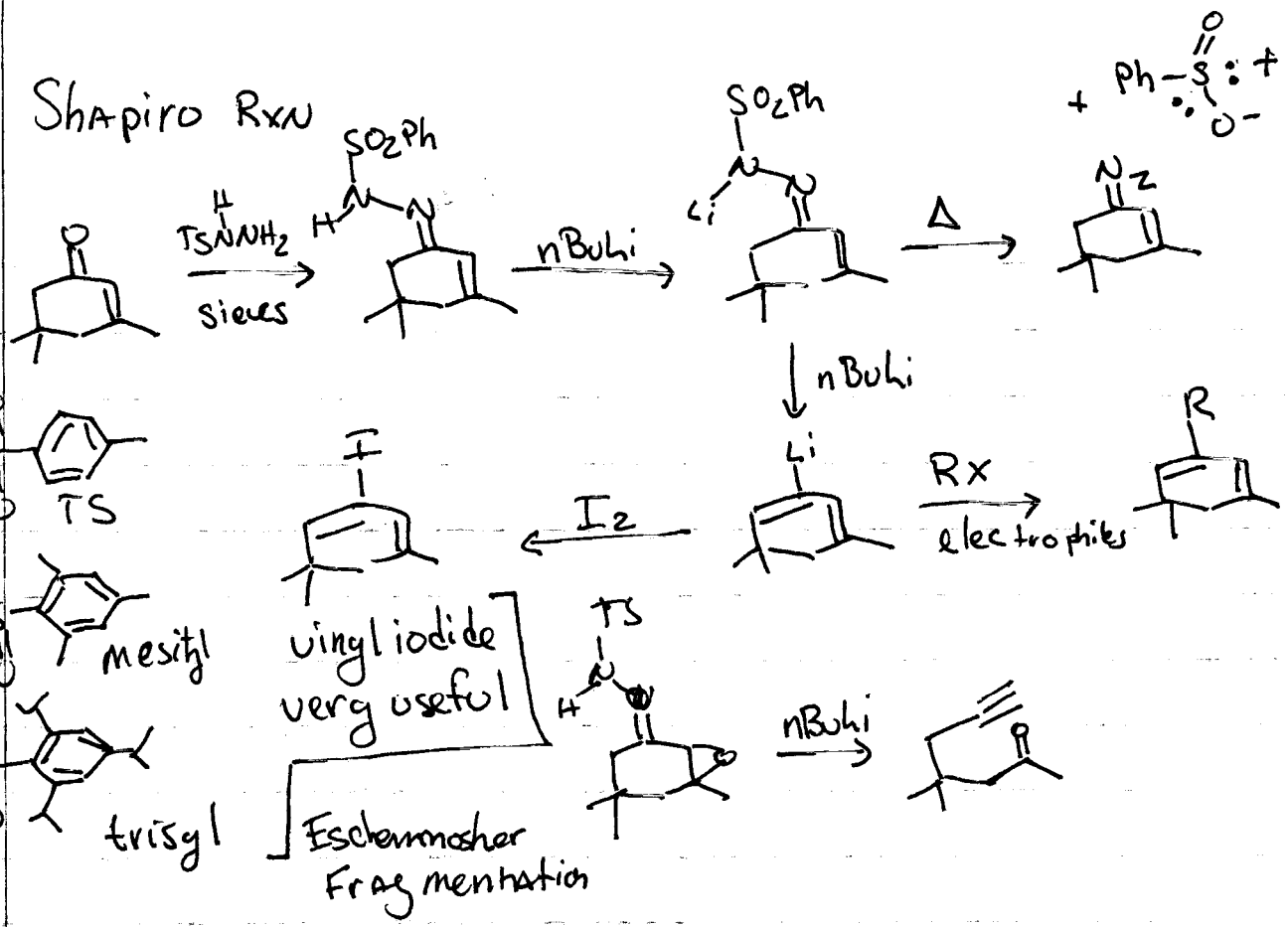






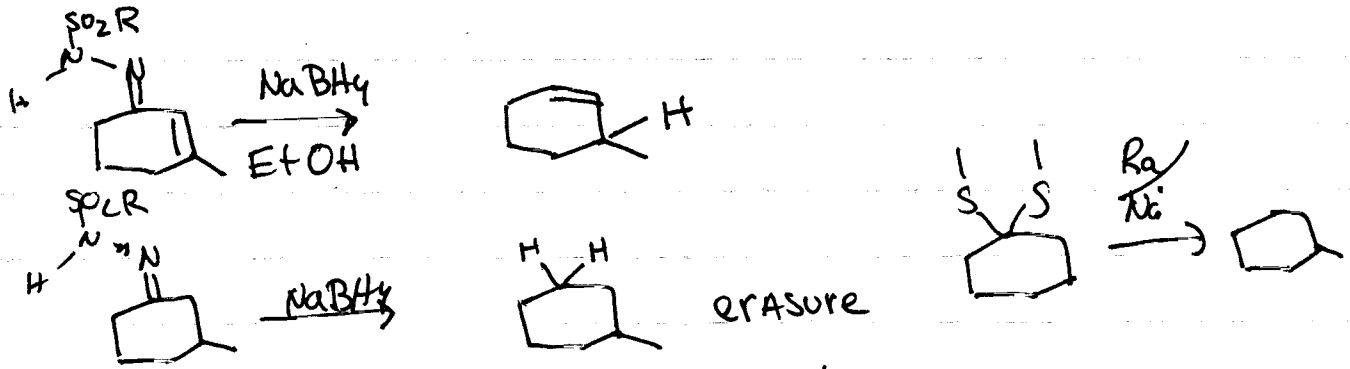


Shapiro Rxn

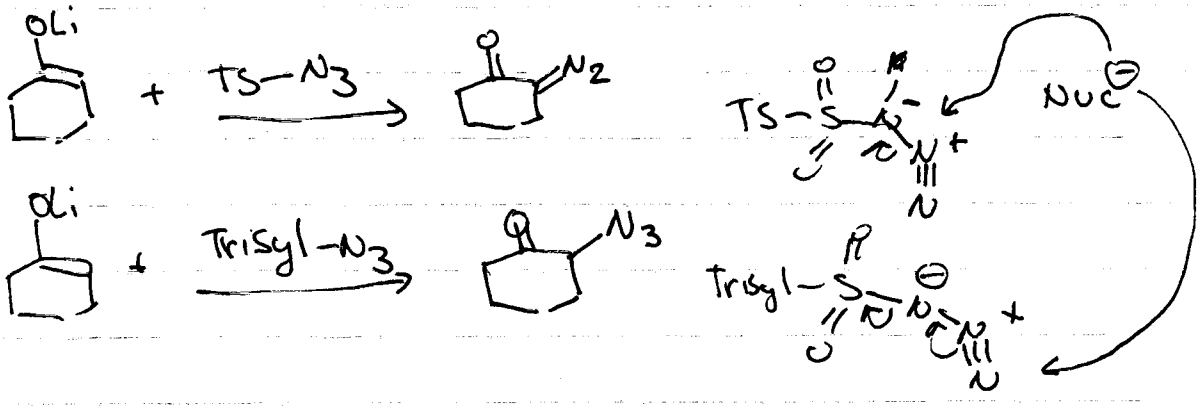


NO
α-lithiation

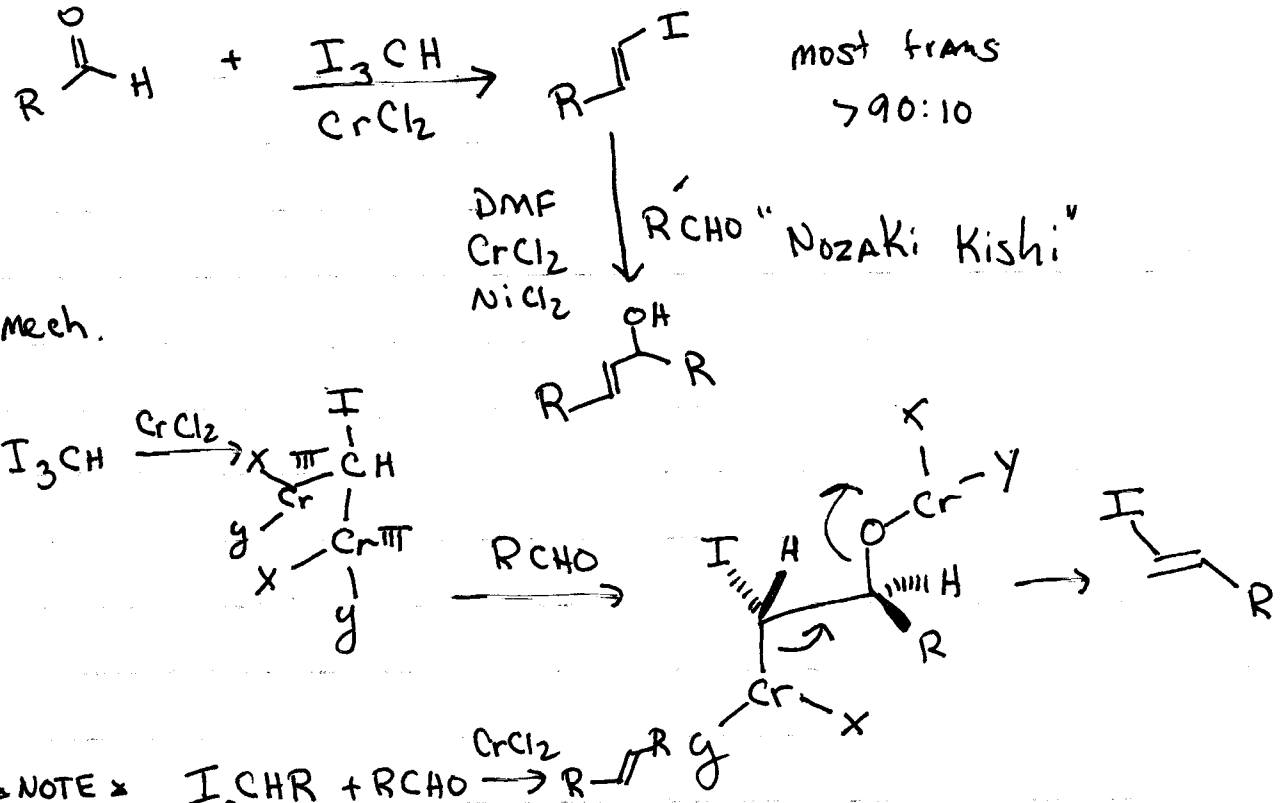
Bamford Stevens



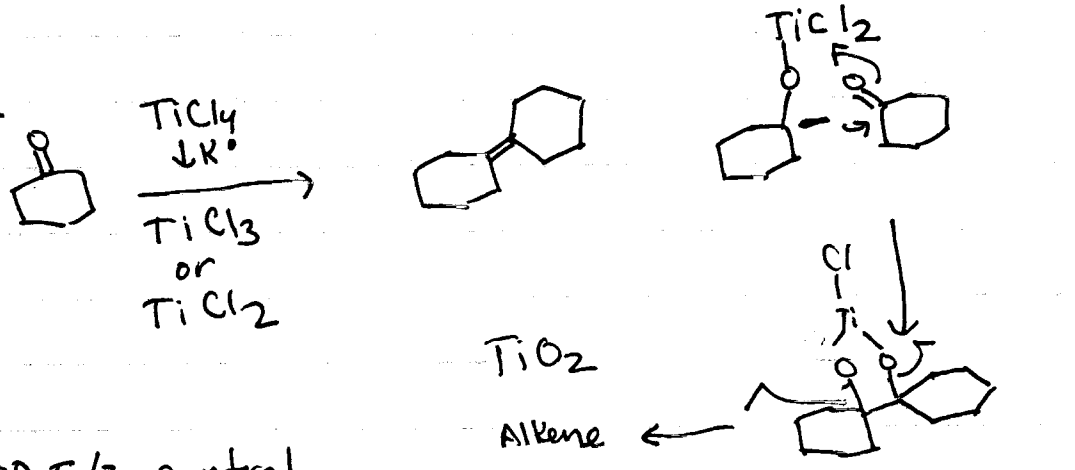
Both have problems with C=C elsewhere



Takai

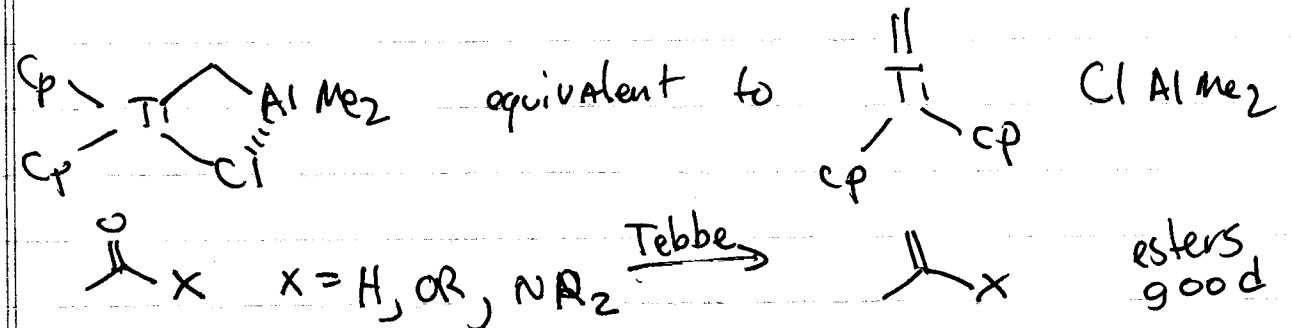


McMurry



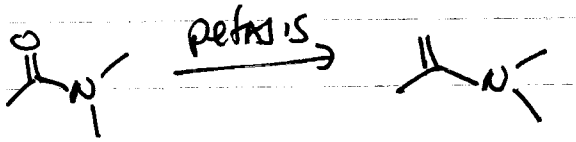
NOT GOOD E/Z control

Tebbe NON BASIC methylenation

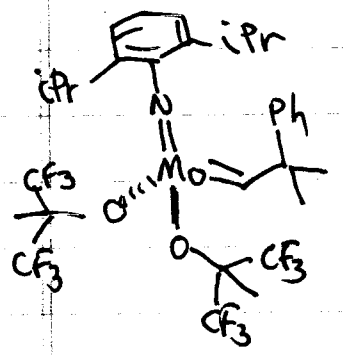


Petasis better for amides, less air sensitive

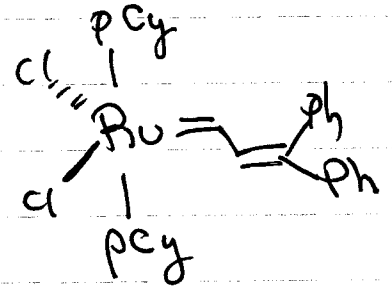
$Cp_2TiCl_2 + 2MeLi \longrightarrow Cp_2Ti$



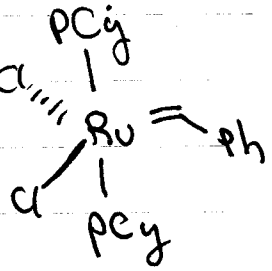
Olefin Metathesis (RCM)



Schrock

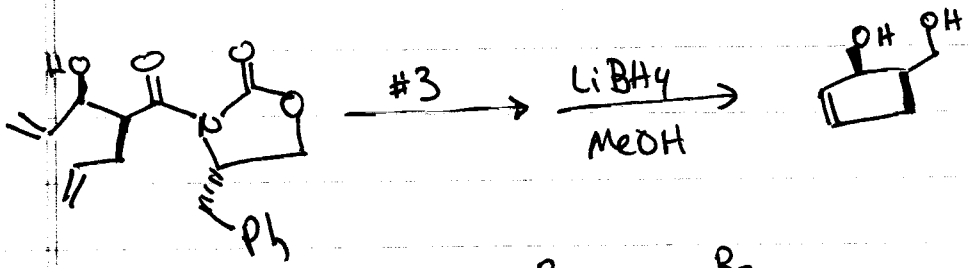


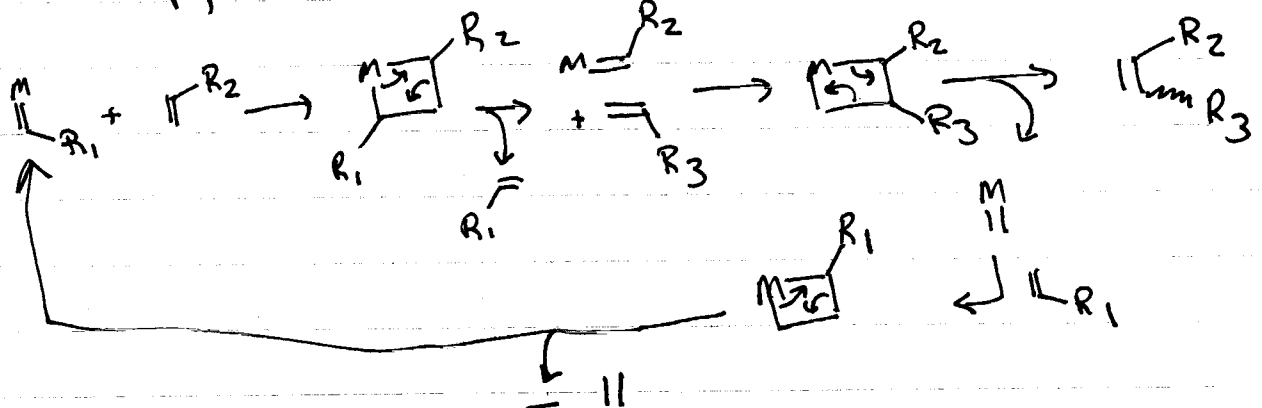
Grubbs #2



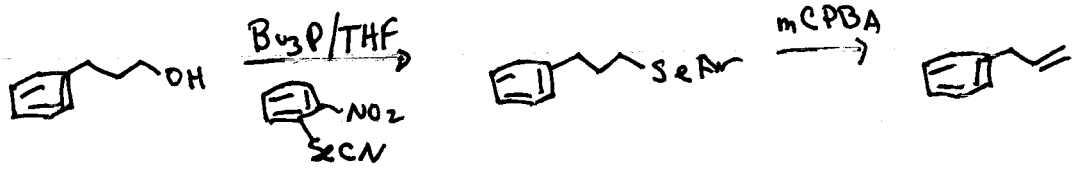
Grubbs #1

example

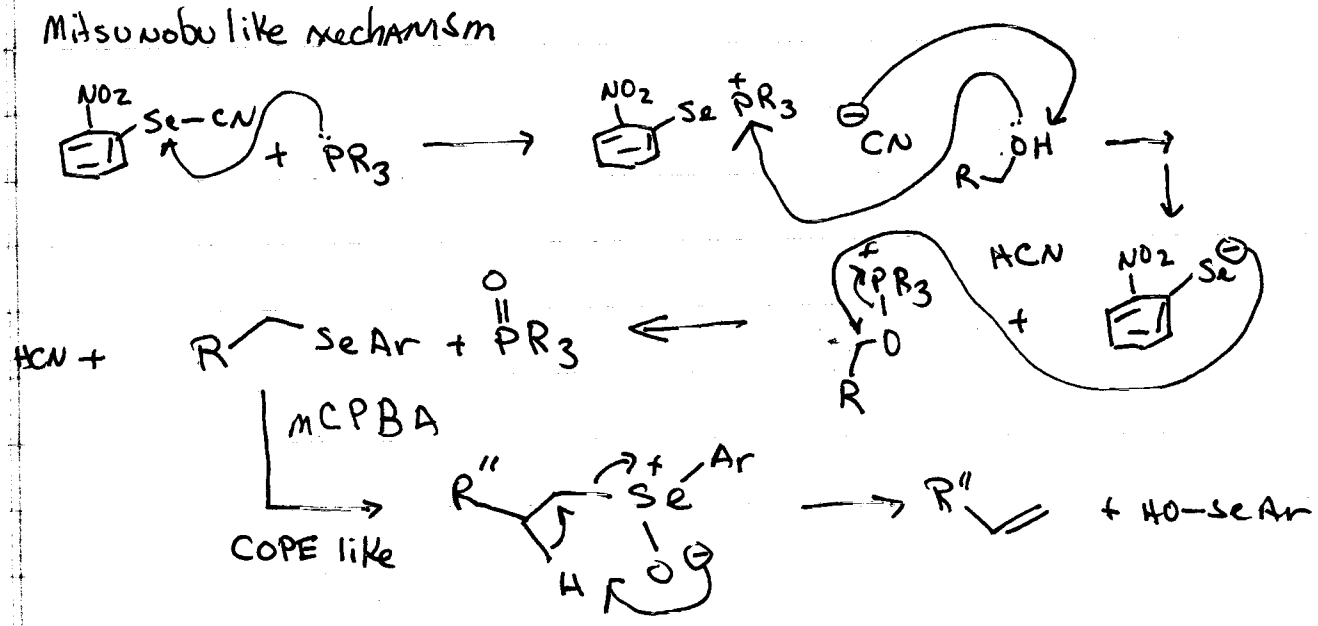




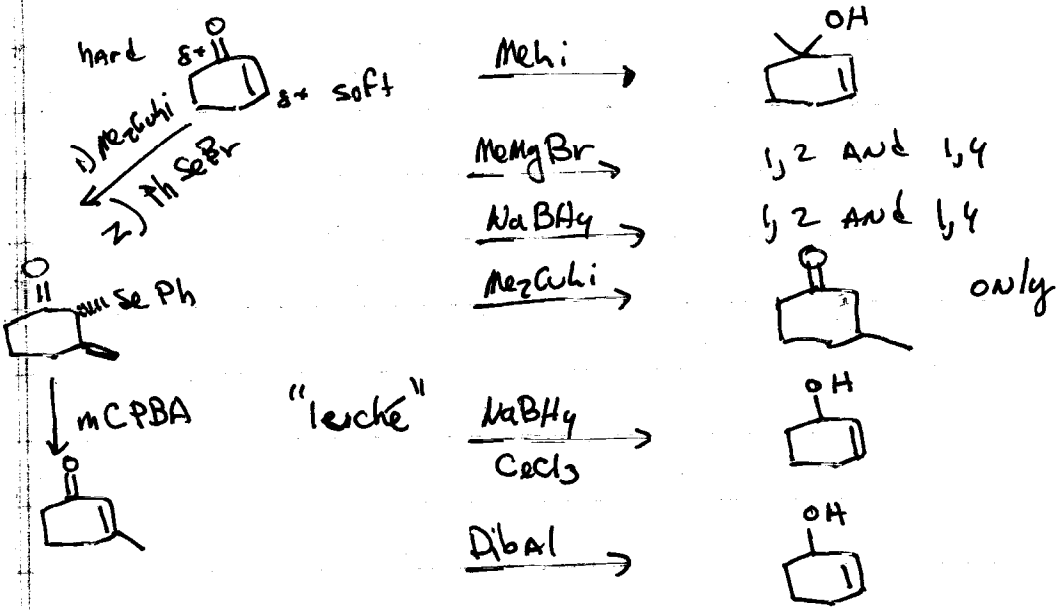
Selenoxide for terminal alkenes



Mitsunobu like mechanism

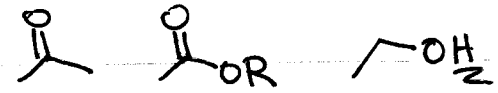


Little Review of hard and soft

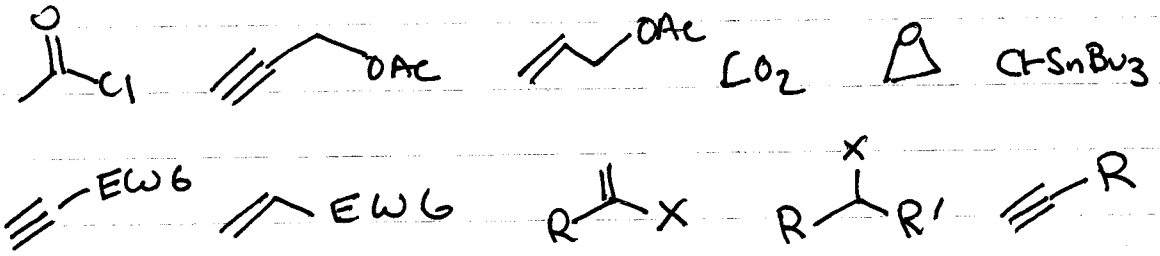


Cuprates ($R_2\bar{C}u\,\overset{+}{L}i$)

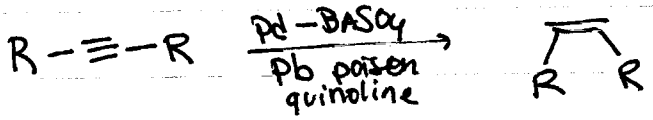
are inert towards



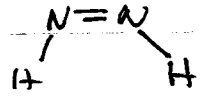
react with

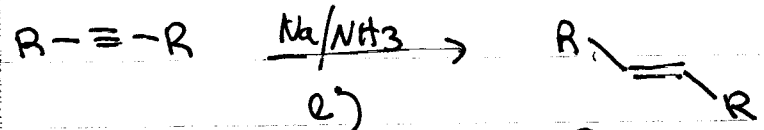


Alkynes → Alkenes



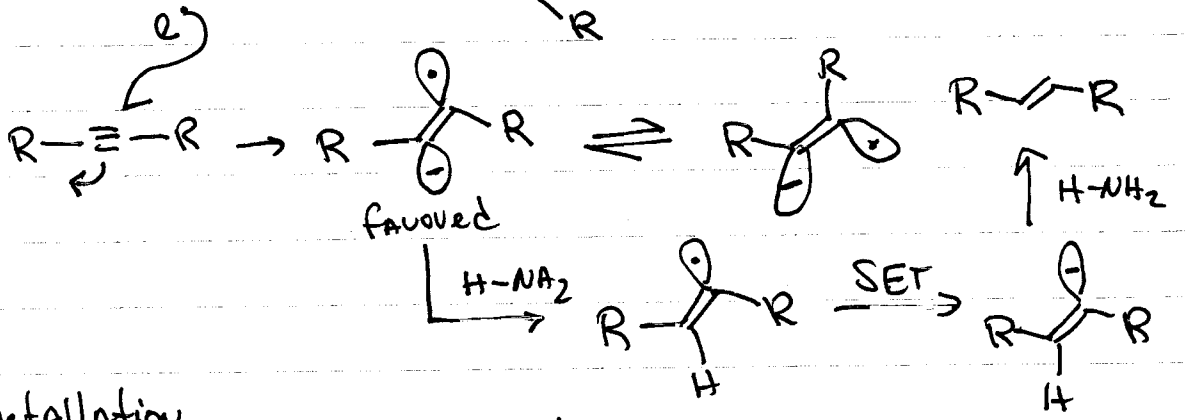
other cis Agents



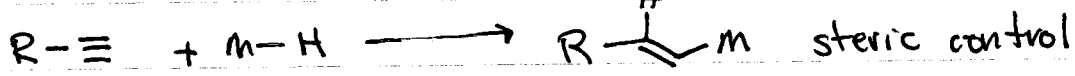


other trans Agents

mech



hydro metallation

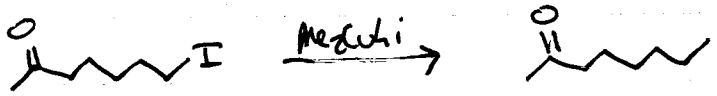


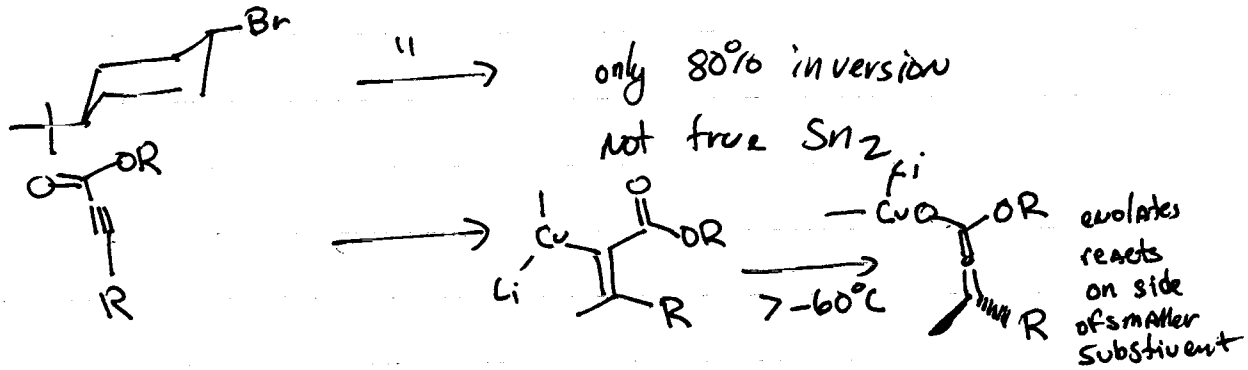
steric control

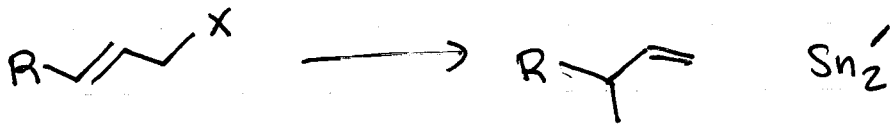
carbo metallation

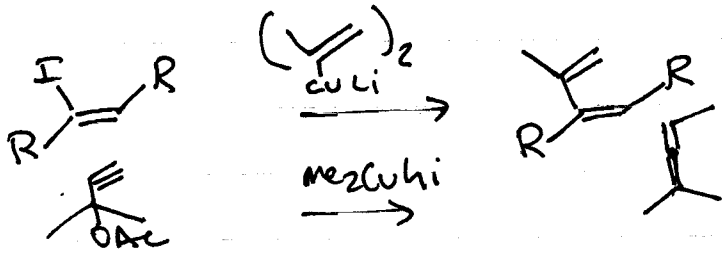
steric control

Reactions of Cuprates $CuBr + 2RLi \rightarrow [R_2Cu]^- Li^+$ (loss of one R^-)









New Procedure

$RLi + CuCN \xrightarrow[-40]{} [R-Cu-\underline{CN}]Li$

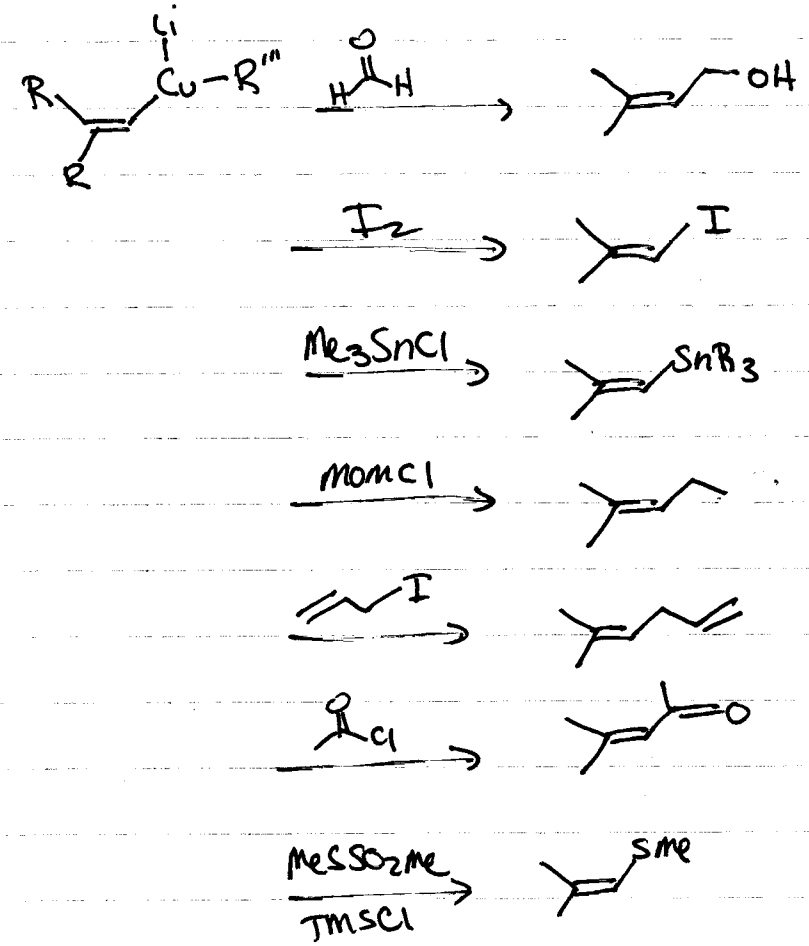
Air stable

non hydroscopic

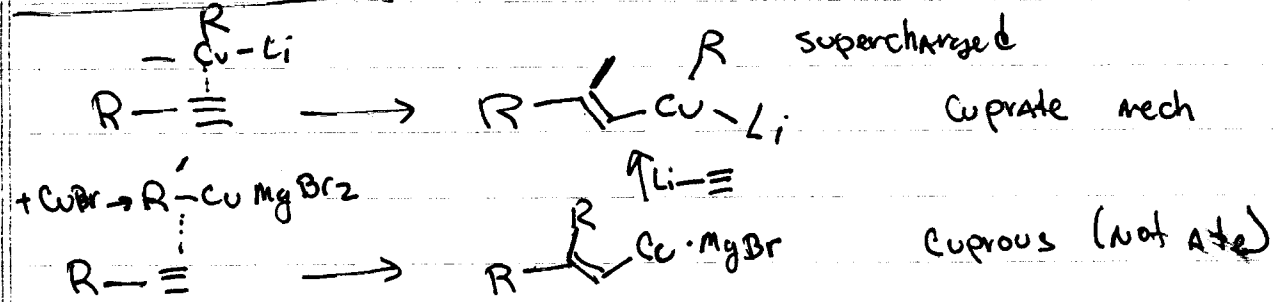
dummy Ligand

$sp^3 > sp^2 > sp$ (back bonding)

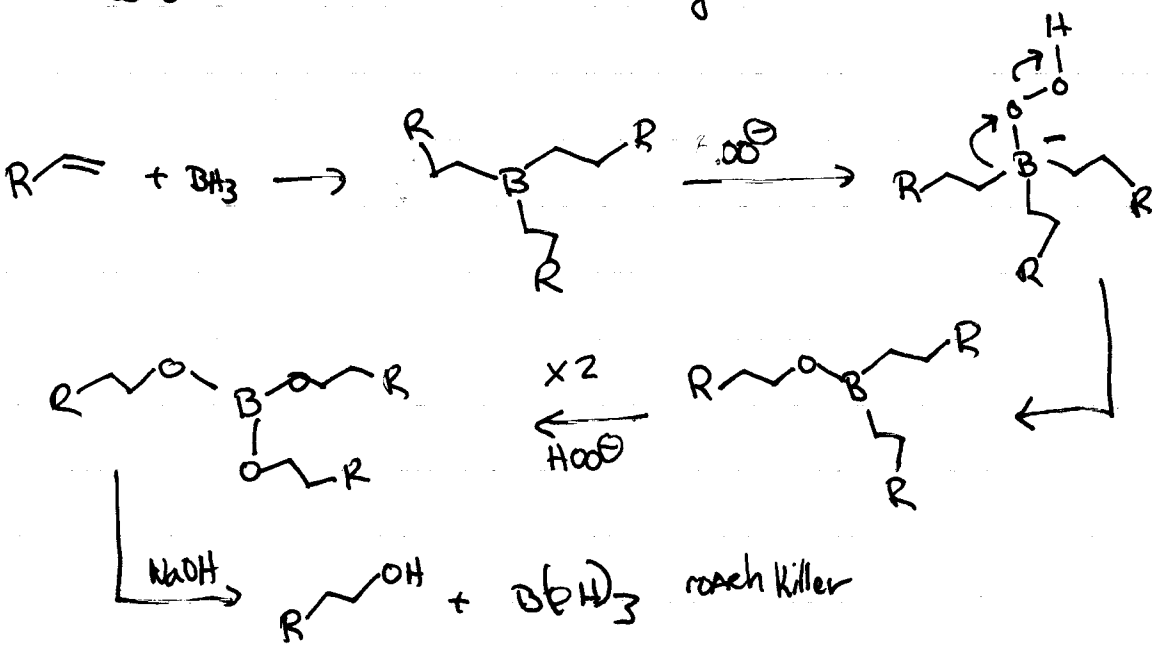
Utility of Cuprates

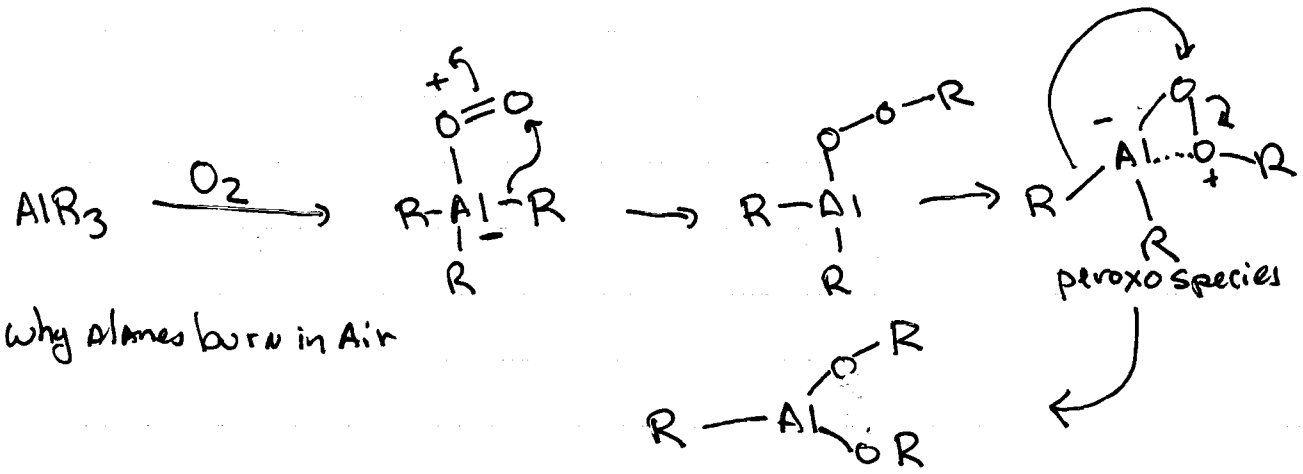


cartoon mechanism

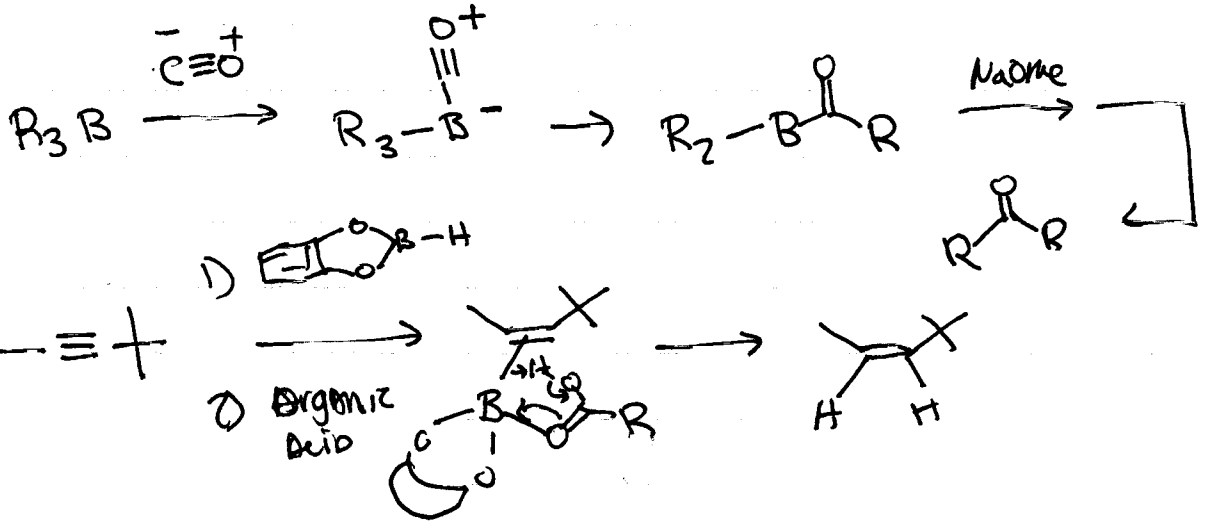


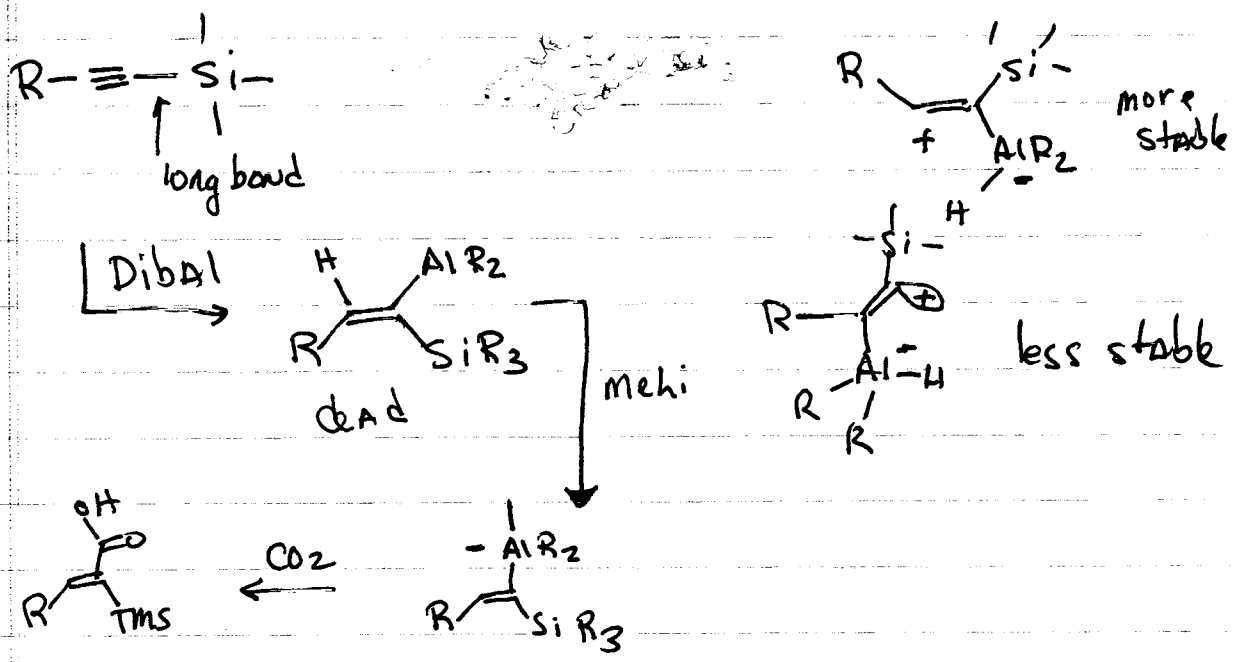
A Review of some "Ate" chemistry





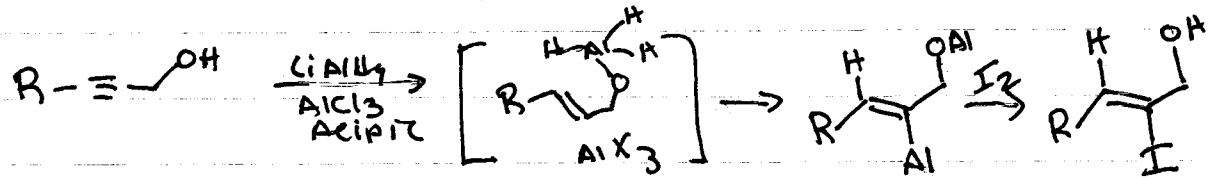
why alanes burn in Air

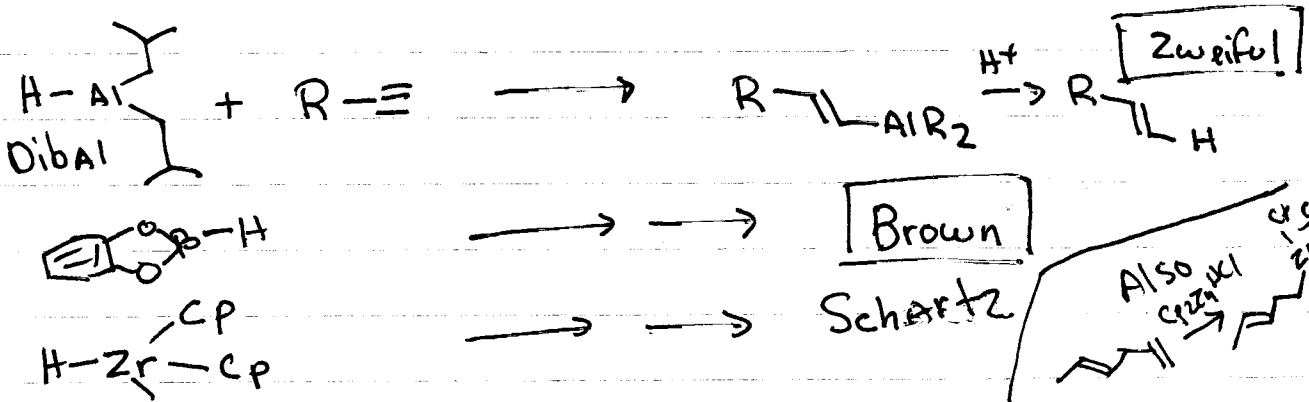




Al	$sp > sp^2 > sp^3$	ligand transfers
Cu	$sp^3 > sp^2 > sp$	
B	$sp > sp^2 > sp^3$	
Sn	$sp > sp^2 > sp^3$	

propargyl alcohols useful building block





A Little Organometallic Chemistry

Transition metals likes 18 electrons in outermost shell

Pd° $s^2 d^8 \longrightarrow s^{\circ} d^{\underline{10}}$

Pd^{+2} $s^{\circ} d^{\underline{8}}$

Sc → Ni

Y → Pd

La → Pt

PPh_3 $d^{10} + 8e = 18e$

$Ph_3P : Pd : PPh_3$ Pd° because all ligands neutral

PPh_3 palladium tetrakis

PPh_3

$Ph_3P\ Rh\ Cl$ Rh^{I} because one -1 ligand

PPh_3

CrO_3 $Cr^{\overline{VI}}$

Neutral 2e donors

h^1

$R\ddot{O}R$ $\ddot{P}Ph_3$ $R\text{-}\ddot{O}H$

$C \equiv O$

Neutral

2e h^2

$=$

$\equiv$

-1, h^1

$-Cl$

$-Br$

$-H$

-2 h^-

$=O$

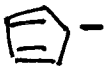
-1 h^3

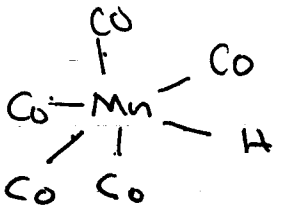
Neutral

4e h^4

-1

6e h^5





Mn^{I}

Mn° d^7

Mn^{+1} d^6

$+ \quad \underline{12}$

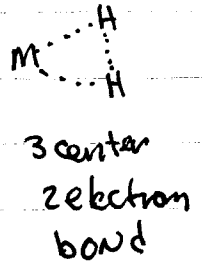
18e

Basic Mechanisms

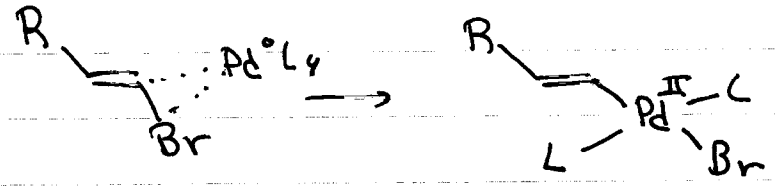
1) oxidative insertion
metal → 0° → M^{+2}

σ donors facilitate
π acceptors suppress

a) concerted, agostic

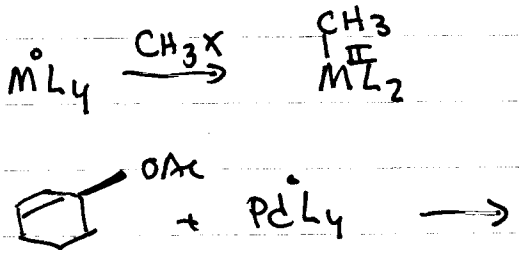


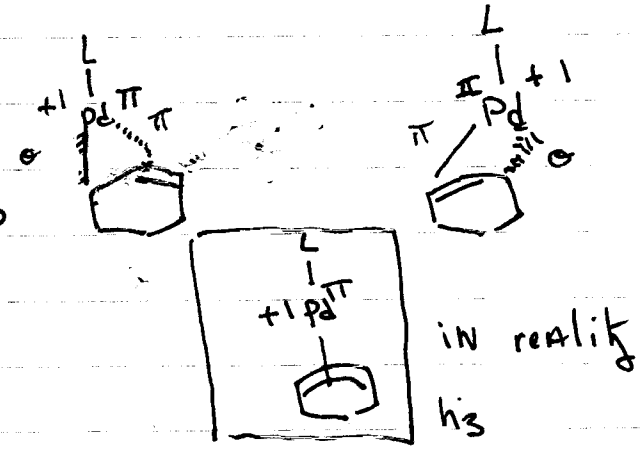
3 center
2 electron
bond



I > Br > OTf > Cl

b) S_N2 mechanism

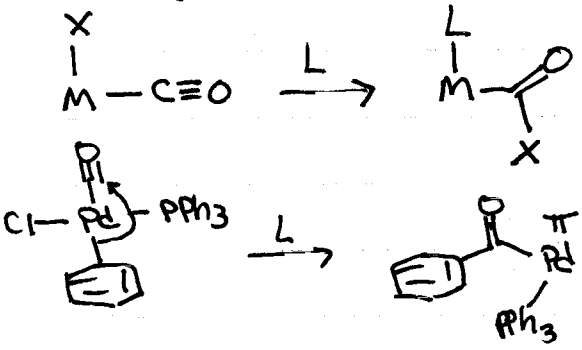


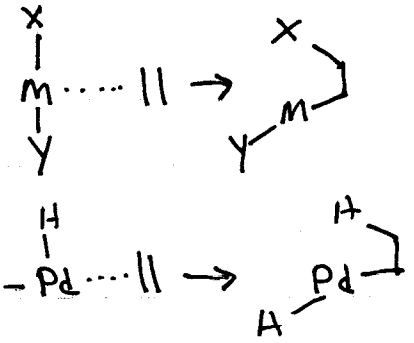


in reality
h^3

c) cycloaddition
2+2+1

2) migratory insertion or its reverse

a) 

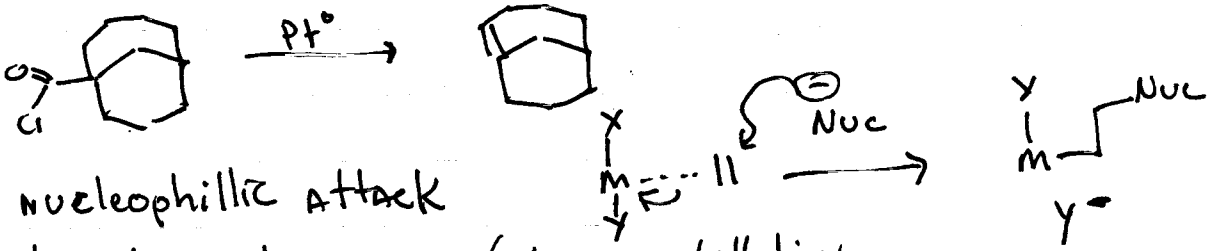
b) or 

Aptitude

Alkyl > Alkyl > vinyl > Aryl > hydride

decarbonylation
β-elimination

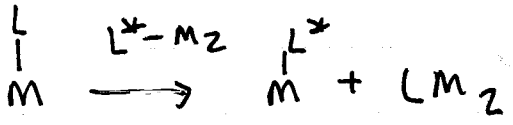
explain the following

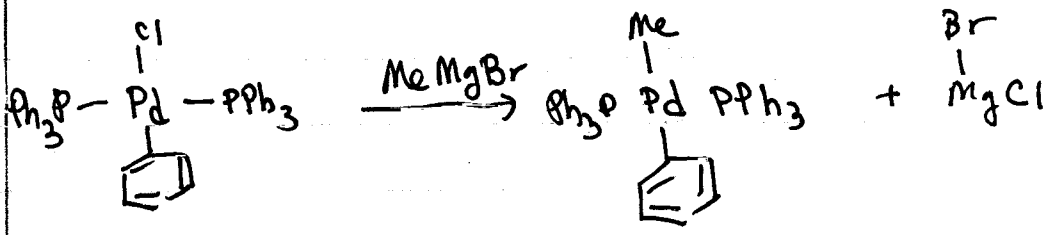


3) nucleophillic attack

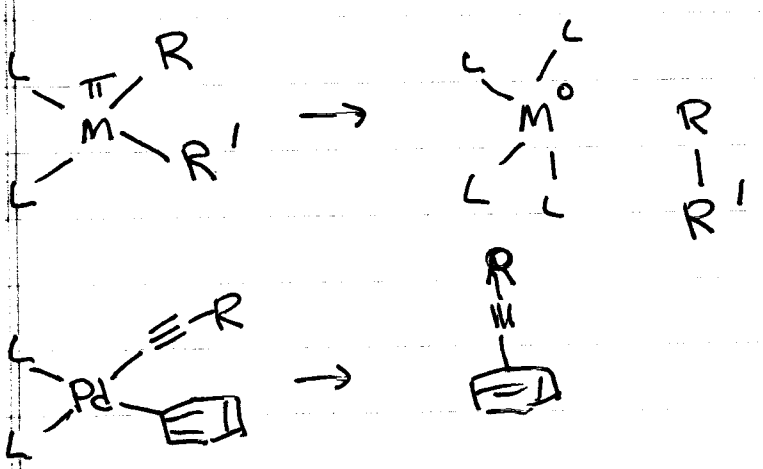
4) ligand exchange / transmetallation

M_2 = Cu, Zn, TL, Mn
Mg, Sn, B



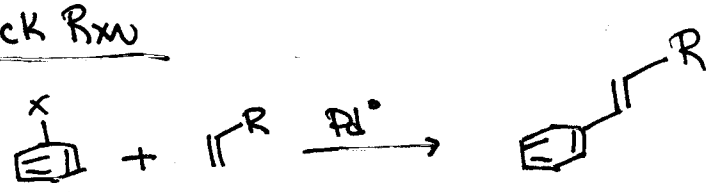


Reductive Elimination σ donor suppress
π acceptors facilitate



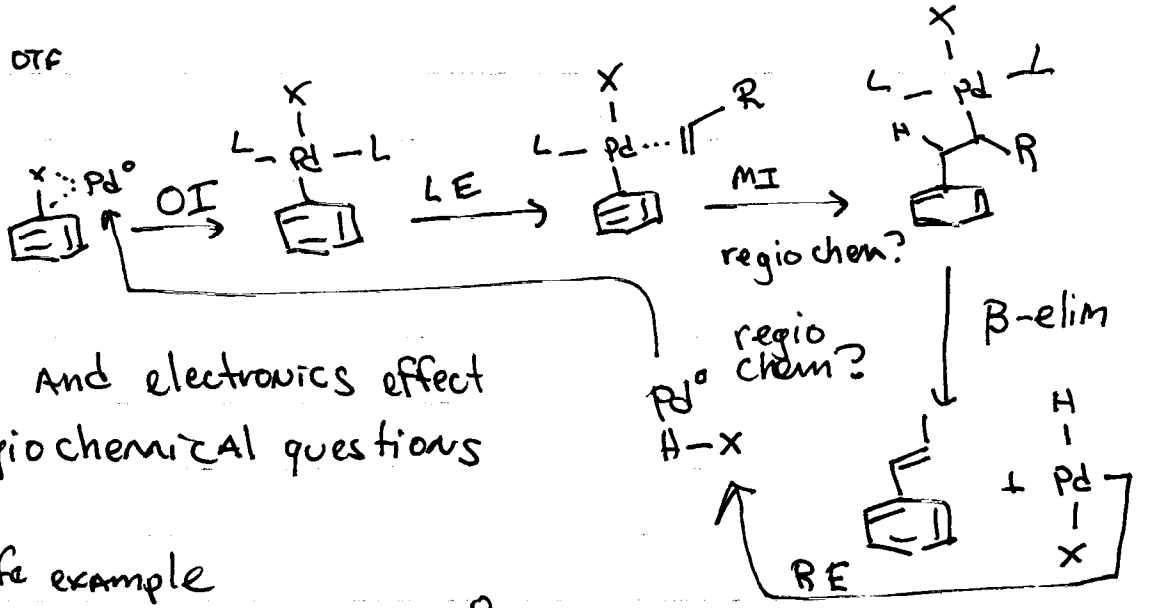
groups must be cis

Heck Rxn



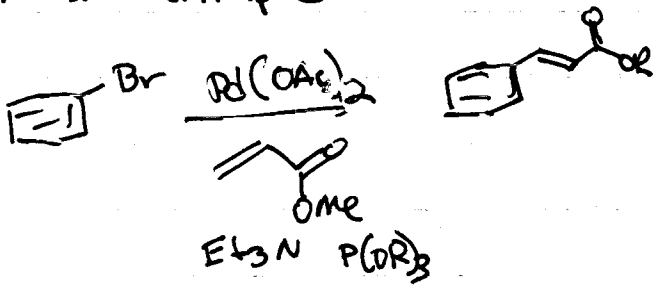
X = I, Br, OTf

mech:

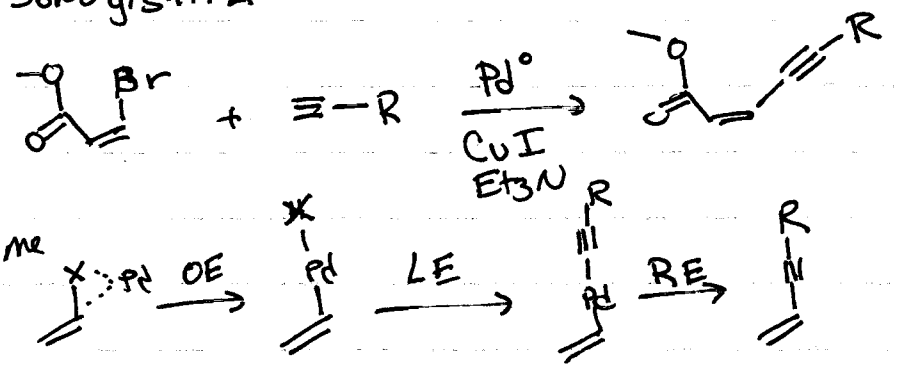


sterics and electronics effect the regiochemical questions

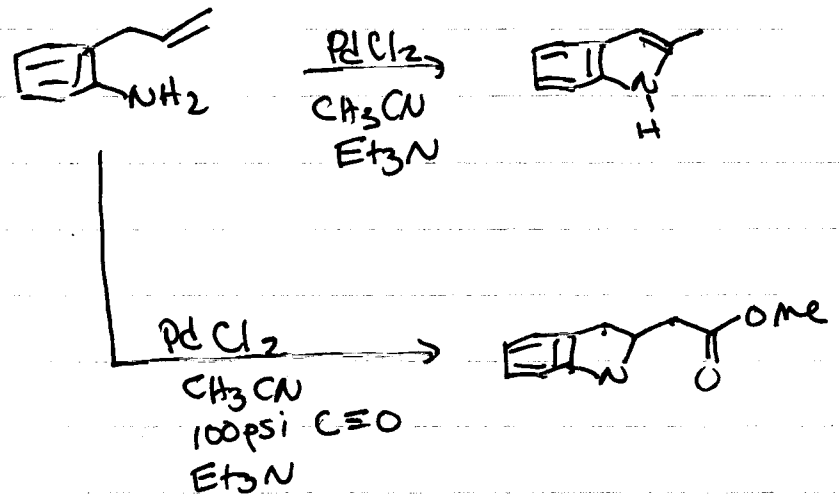
Real Life example



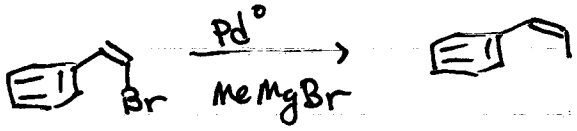
Sonogashira



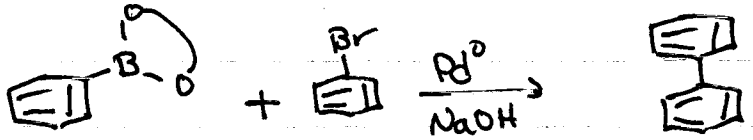
Hetero Heck



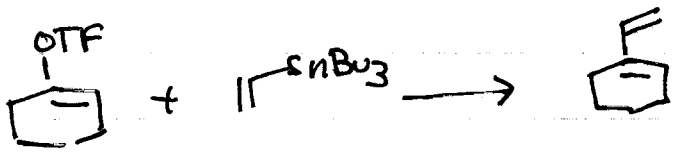
Kumada



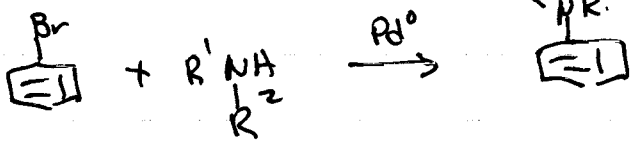
Suzuki



Stille



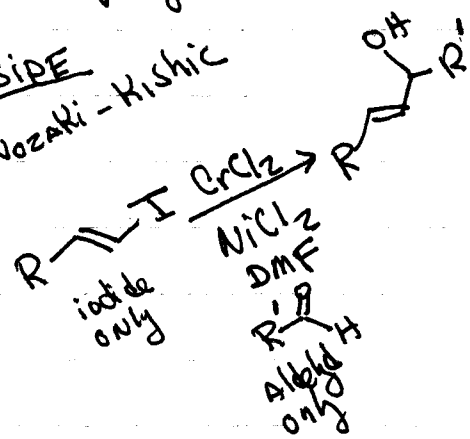
Buchwald-Hartwig



ASIDE

Nozaki-Kishic

Very mild

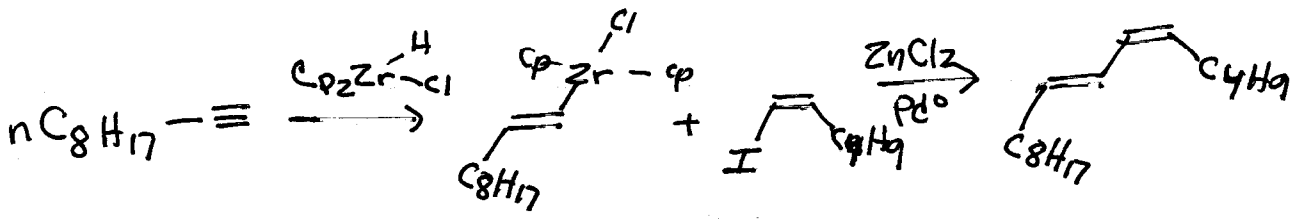


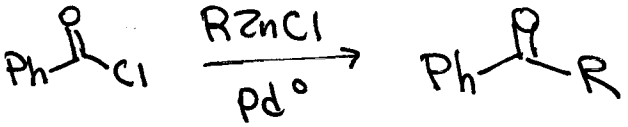
Negishi Modification

$$R-X + R'-M \xrightarrow[ZnCl_2]{Pd} R-R'$$

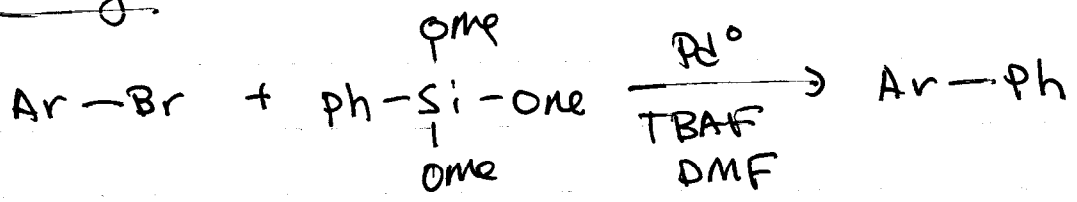
R = vinyl, acetylene

M = ~~AlR_2~~ $-MgX$, Li, $ZrClCp_2$



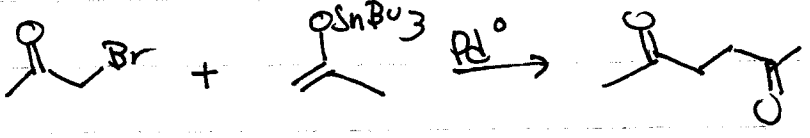


Deshong

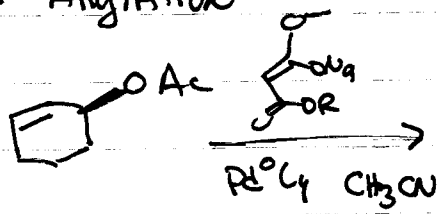


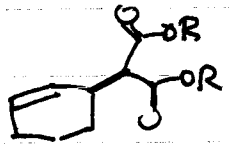
via hypervalent silicon

Migata



Trost Allylation

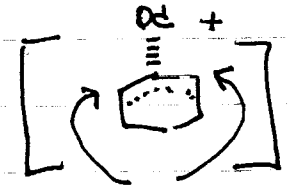




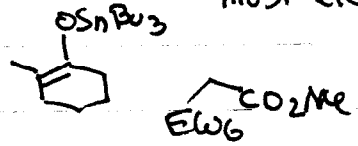
double inversion

catalytic

Metal and Nuc on opposite SIDES usually

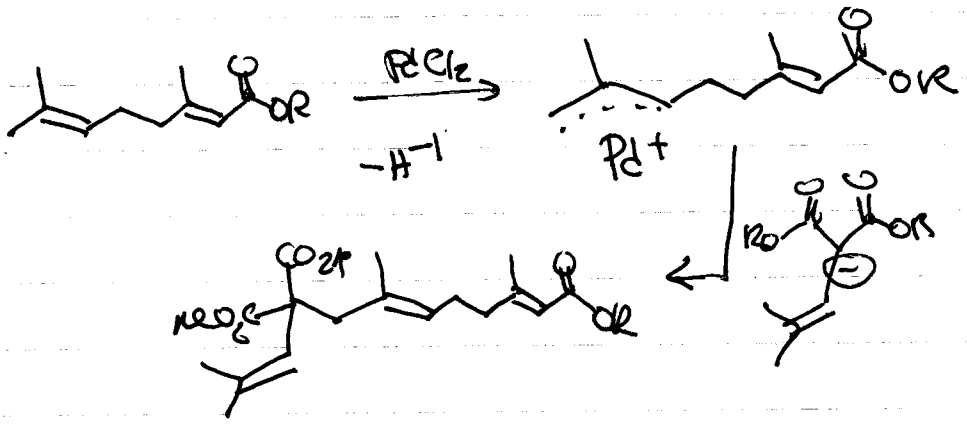


substrate symmetric or Nuc attacks least substituted most electroposition

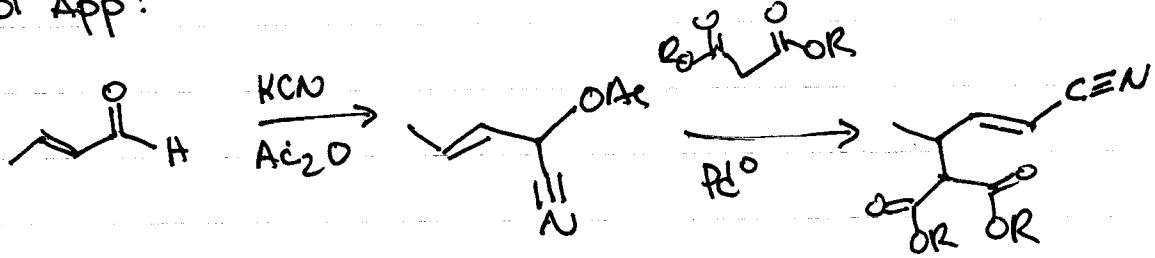


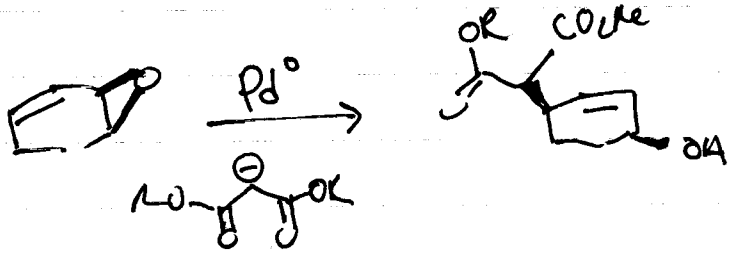
soft nucleophiles

original chemistry stochiometric in Pd H^- abstraction

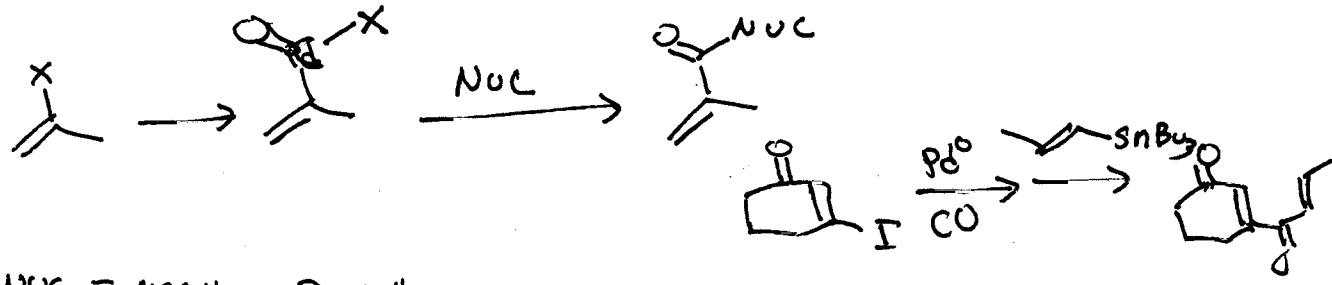


Cool App!

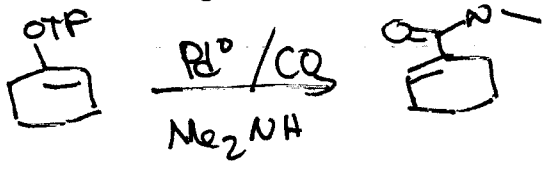


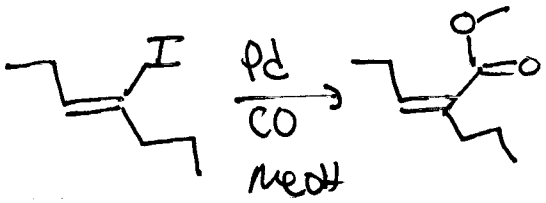


Carbonylations

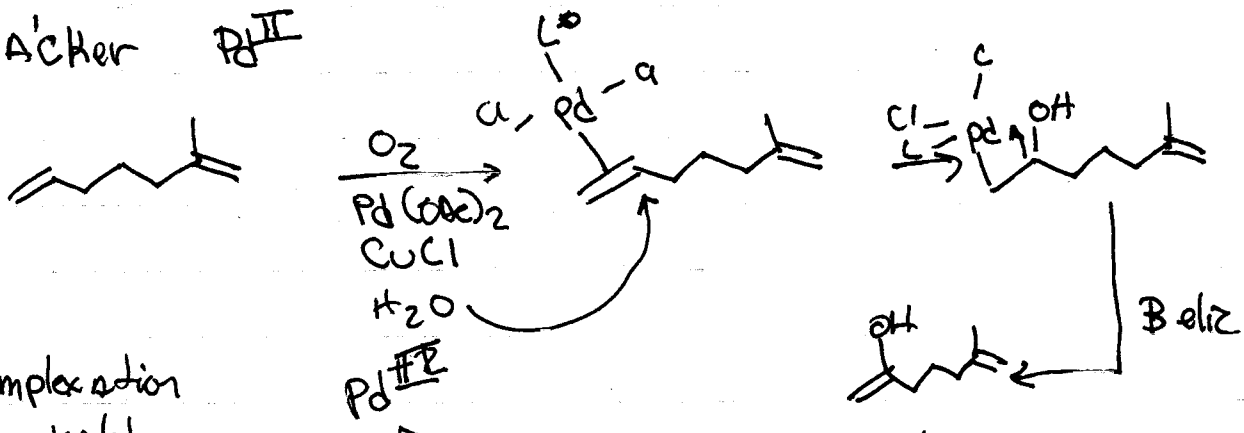


Nuc. = MeOH, R_2NH,



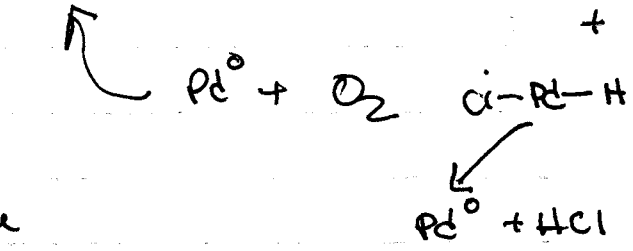


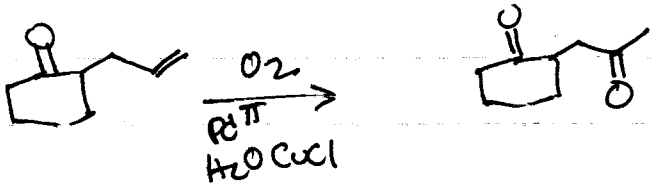
Wacker Pd^{II}



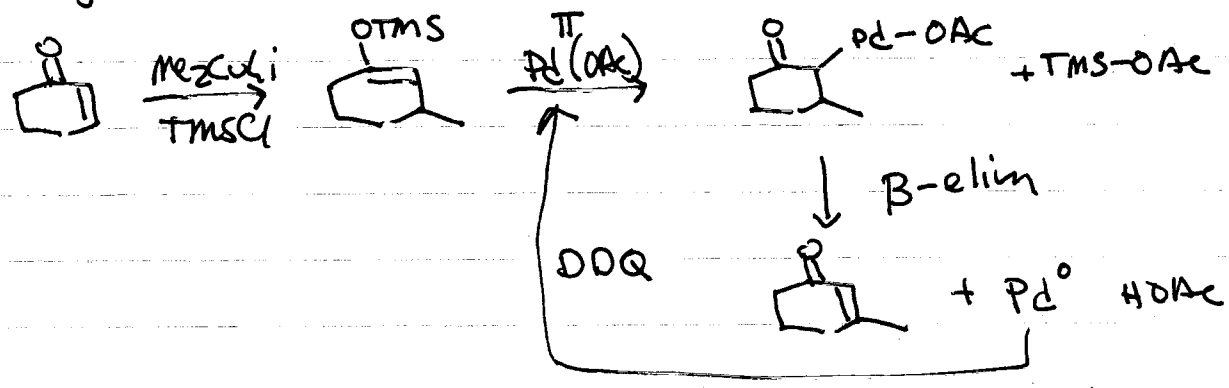
complexation controlled By sterics

H_2O adds to most electro positive

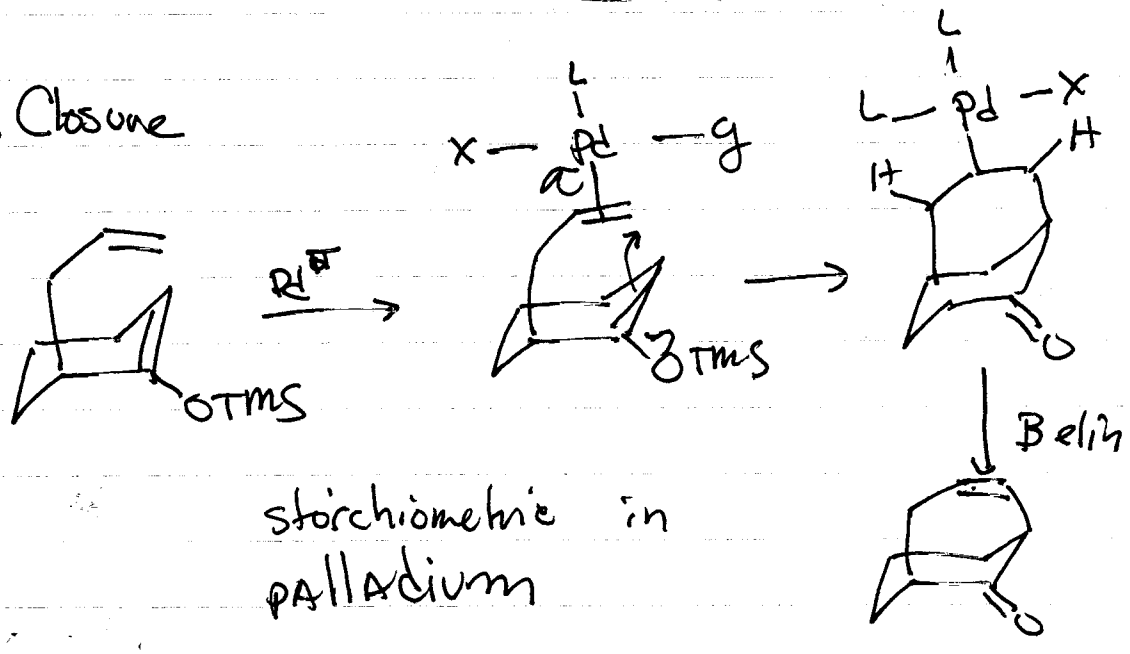




Saegusa



Hende's Closure



stoichiometric in palladium

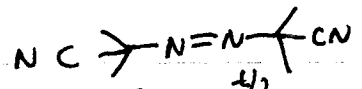
Radical Rxn Tolerate a range of Functional Groups (OH NH)

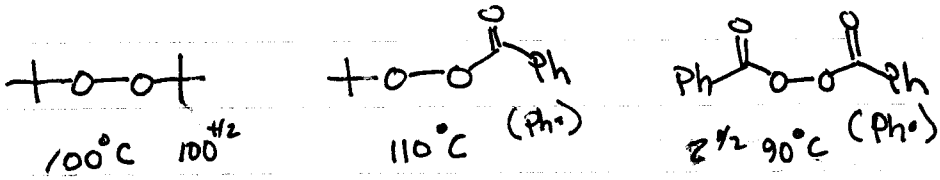
Neutral conditions R· B = initiator

No charge

mechanisms

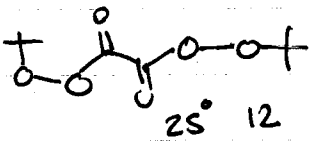
1) $B-B' \longrightarrow B\cdot + B'\cdot$ initiation





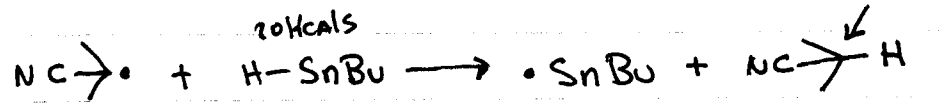
BEt_3/O_2 RT

heat or light

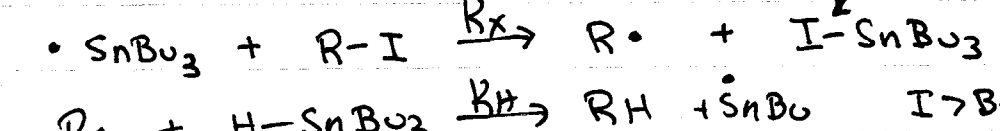


Strong bond

propogation 1 2) $B\cdot + AX \longrightarrow A\cdot$ $B-X$

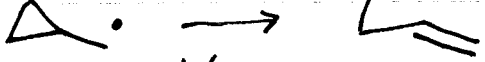


or



propogation 2 3) $A\cdot \xrightarrow{K_a} C\cdot$

H· abstraction

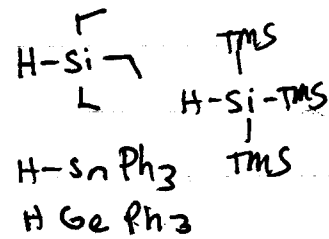


propogation 3) $A\cdot + D \xrightarrow{K_a'} A-D\cdot$

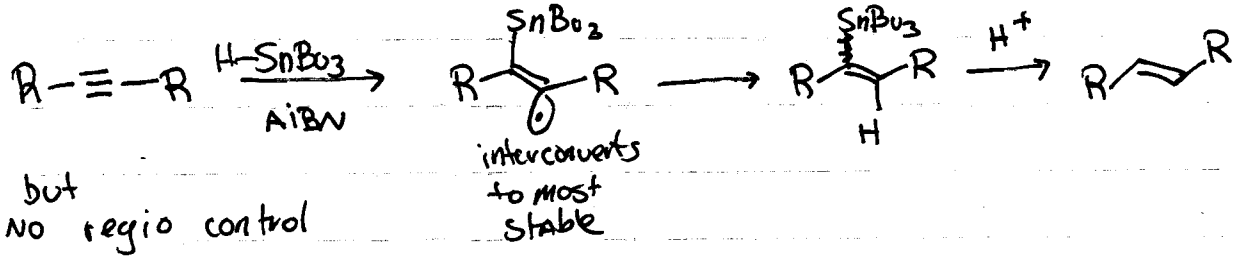
termination 4) $R\cdot + R'\cdot \longrightarrow R-R'$

use low $H-SnBu_3$ conc to maximize K_a or K_a'

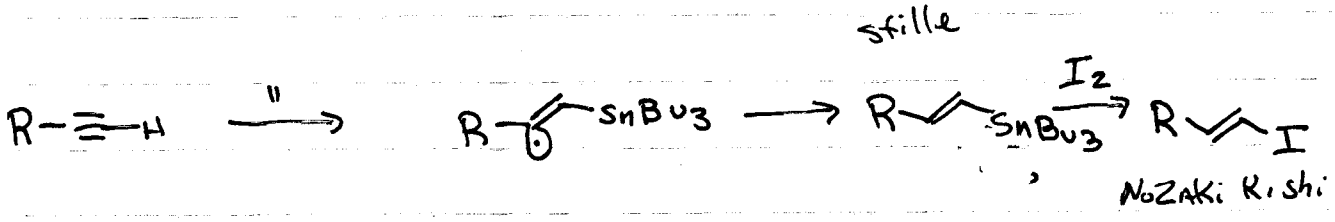
if K_H is faster than K_a, it dominates



For trans alkene synthesis

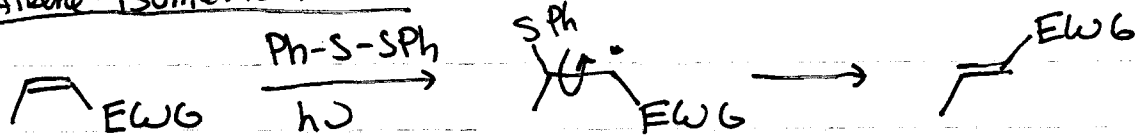


but
No regio control



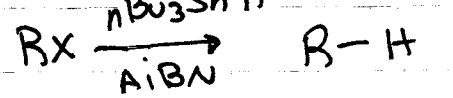
Nozaki Kishi

Alkene isomerization



I• and Bu_3Sn• also work in these reactions

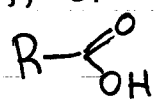
Reduction wide scope



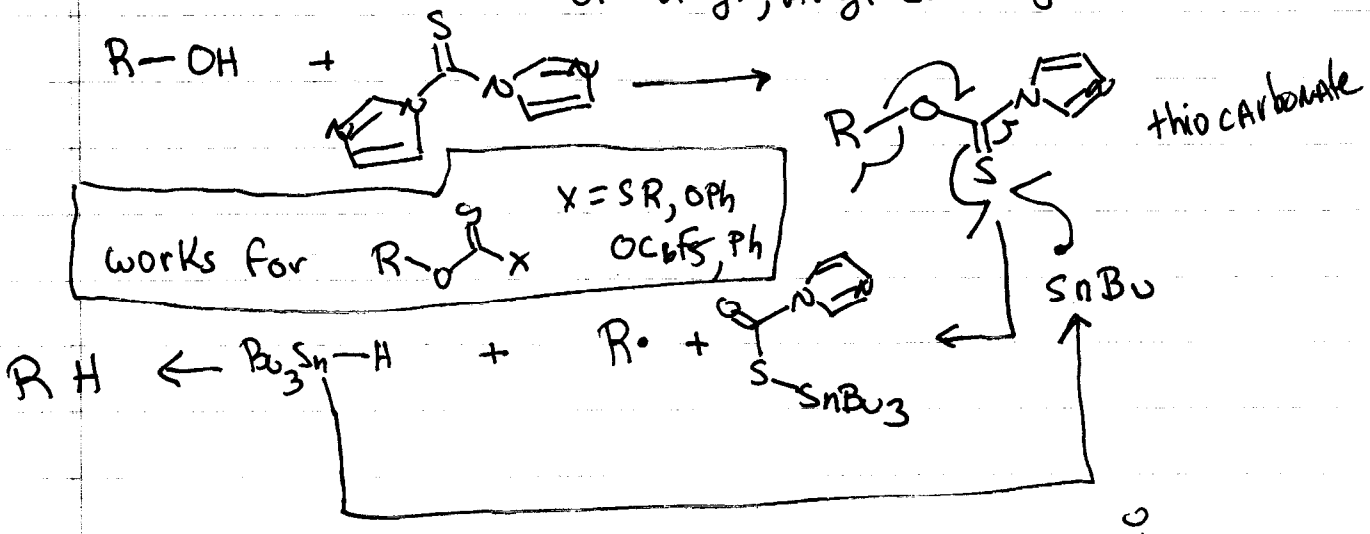
X = –halogen, –SR, –SeR
$-NO_2$ $-\overset{+}{N}\equiv C-$ –Hg–X

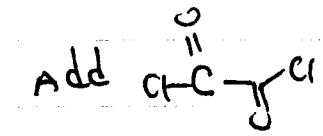
InR $CH_3 > CH_2$
faster

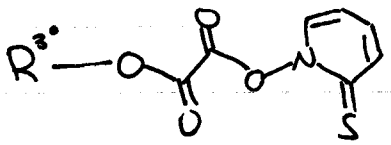
tricks required for 1°, 2°, 3° R–OH



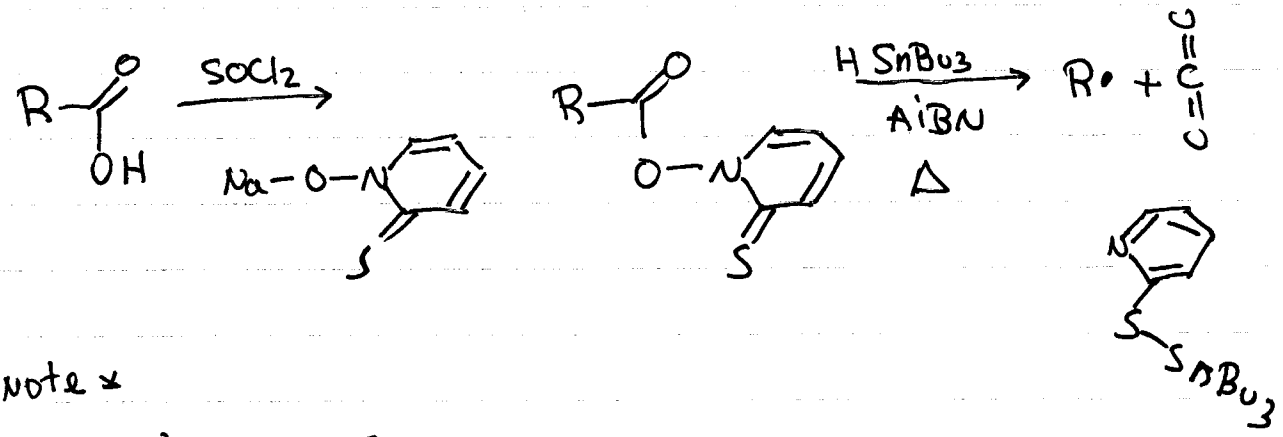
Barton, McCombie Alcohol erasere 1°, 2°
or vinyl, aryl carboxyls



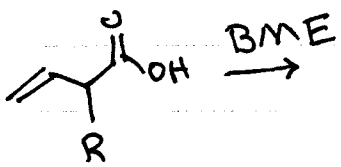
work for 1°, 2° in case of 3° add 
first to make



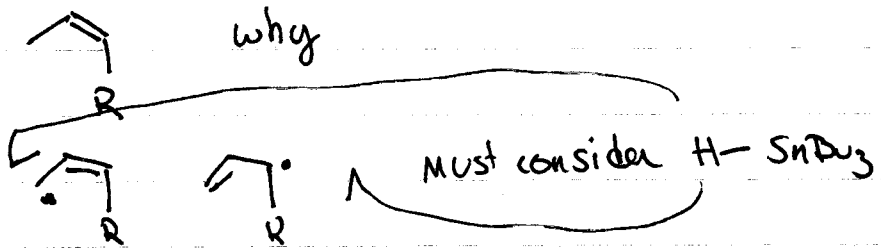
Barton Motherwell carboxylate erasere

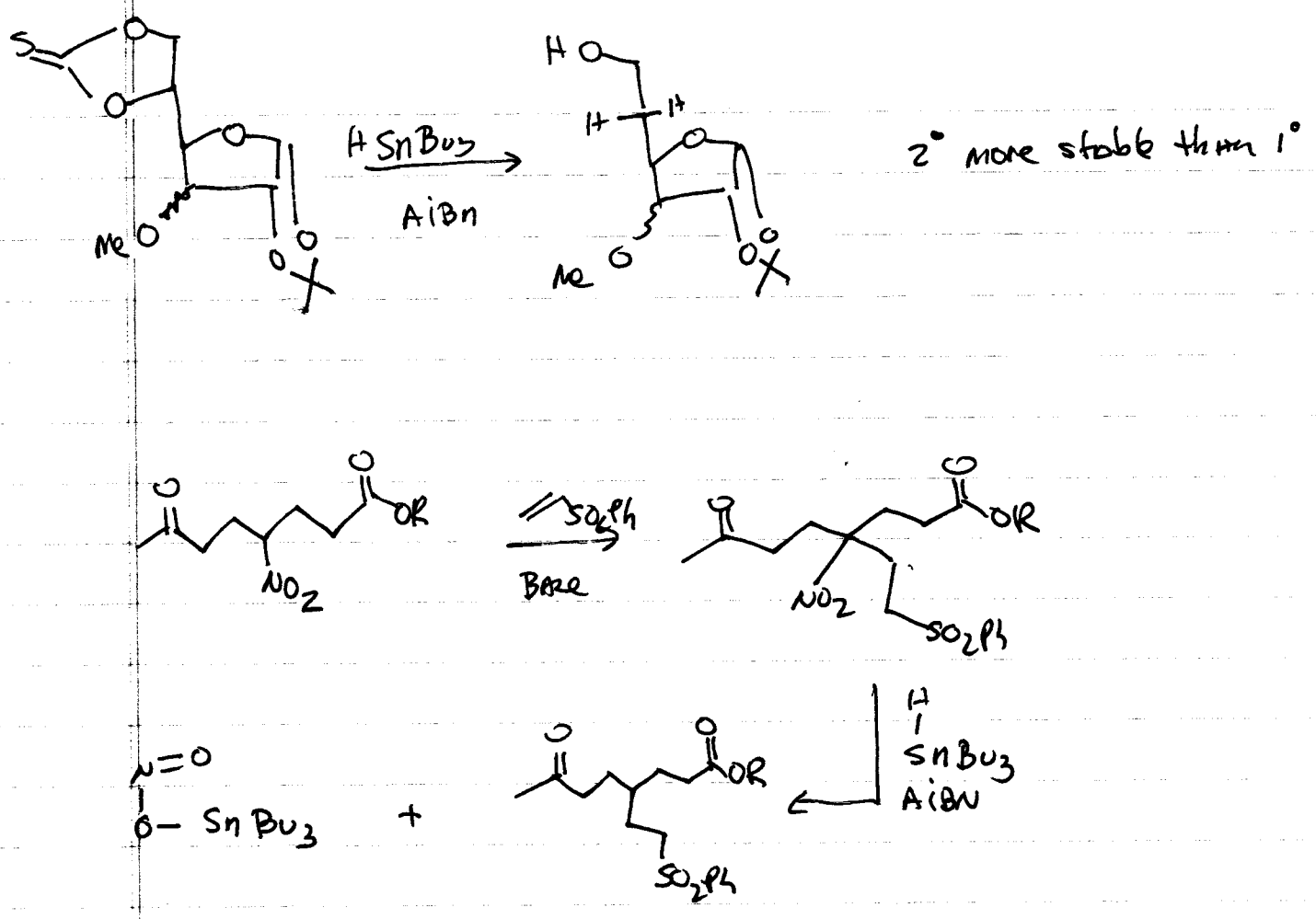


note

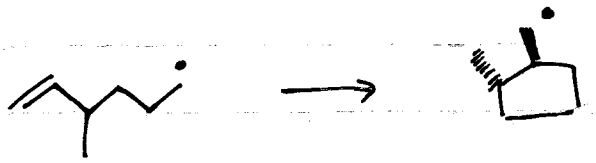


why

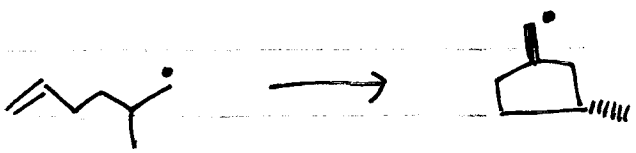



HSnBu3
AiBn
2° more stable than 1°
BASE
LiAl(OtBu)3
BASE
reduced product
Bu3SnH
X = NO2 SPh SO2Ph, SePh
Ph-SH
Et3B in It

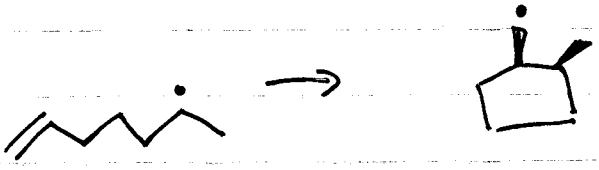
Intramolecular Reactions



Almost always 5-exo prefered

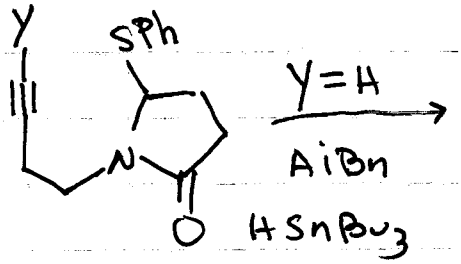


trans prefered



cis preferred

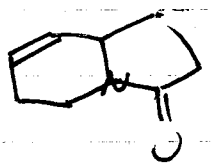
Some substituent control in cyclizations



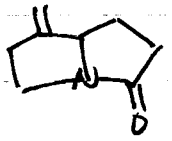
Y=H

AiBn

$HSnBu_3$

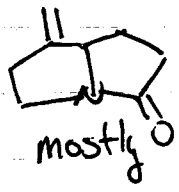


mostly



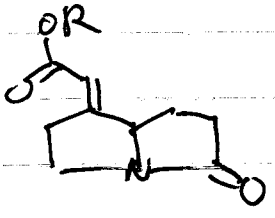
A litte

Y=TMS



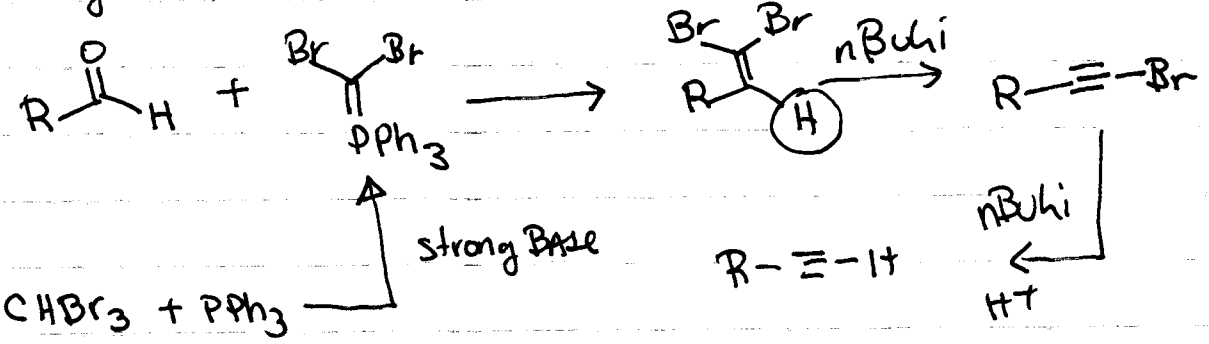
mostly

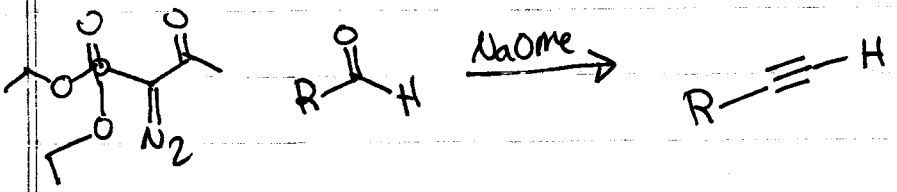
Y=CO_2R



ADDENDUM

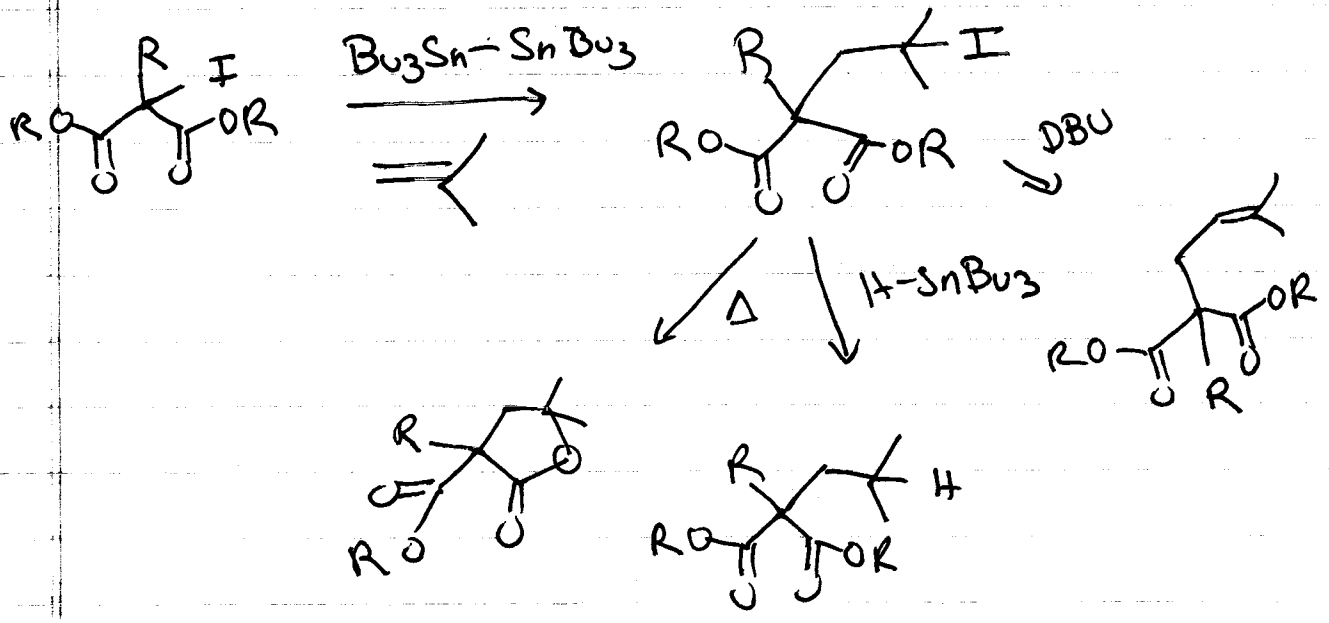
Corey-Fuchs



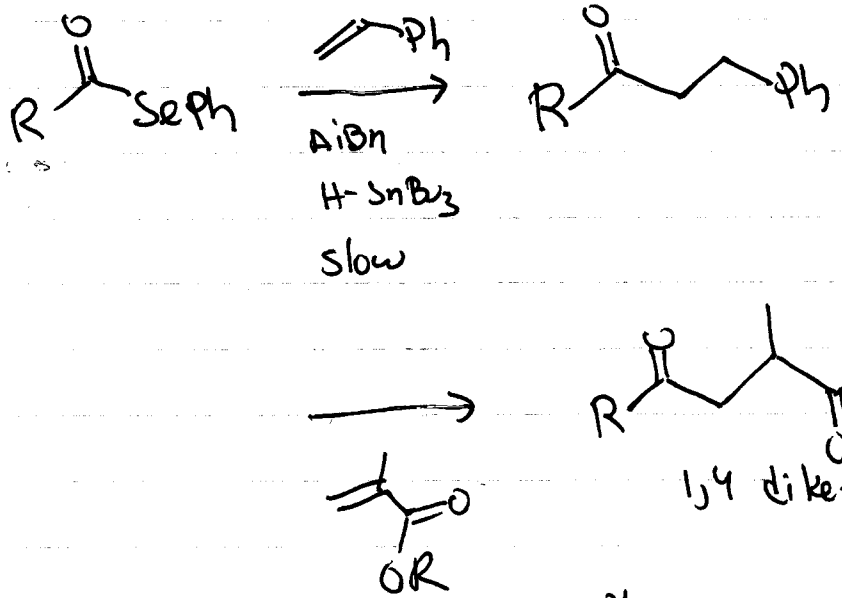


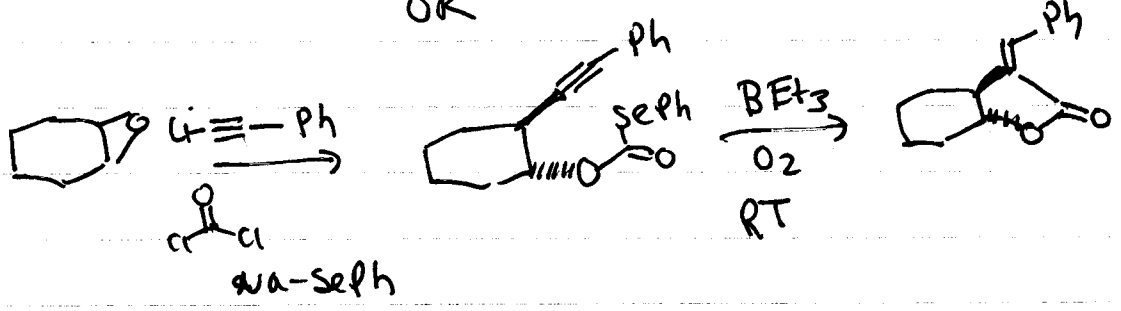
spts for pdf of first App

Atom transfer ($Bu_3Sn\ SnBu_3$)

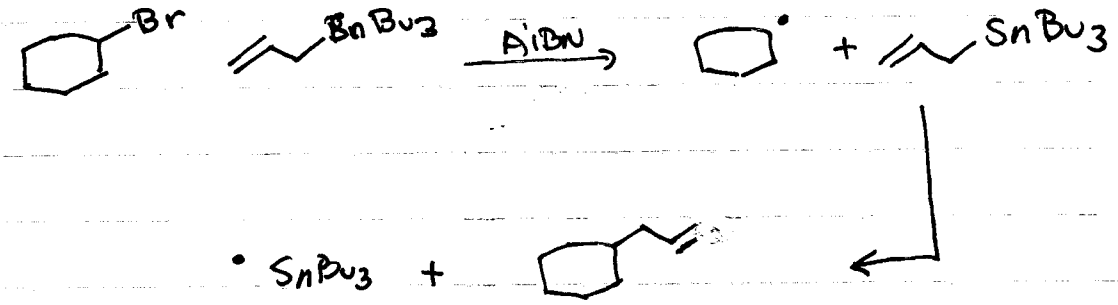


Acyl Radicals

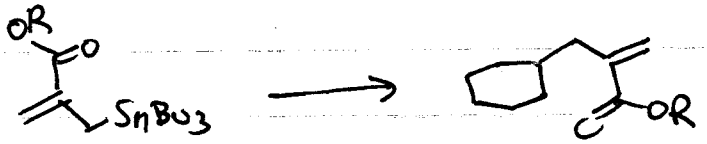


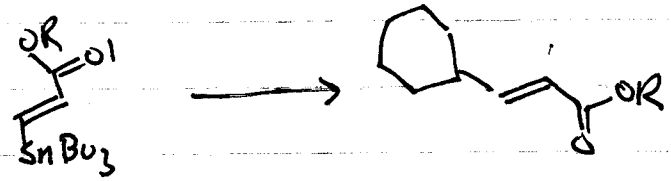


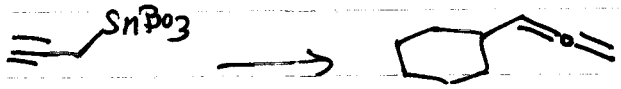
Heck : TRANSFer Propogating reactions

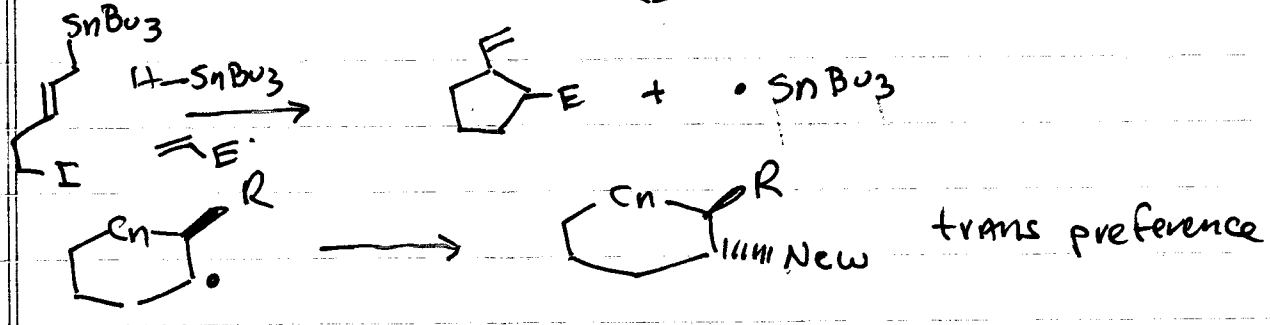


II



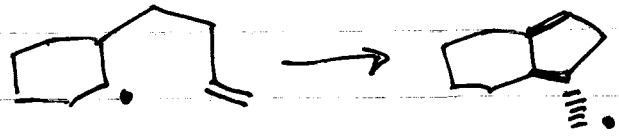






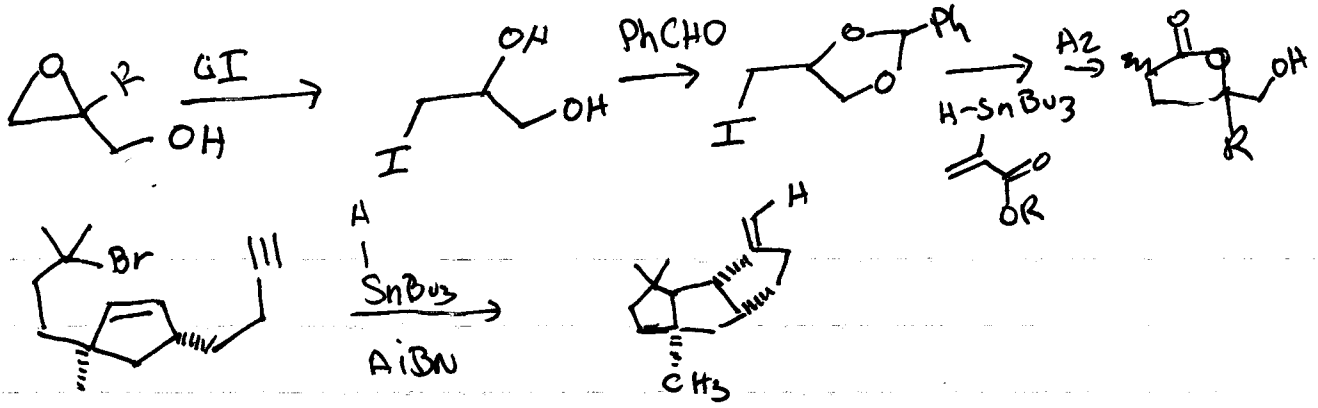
trans preference

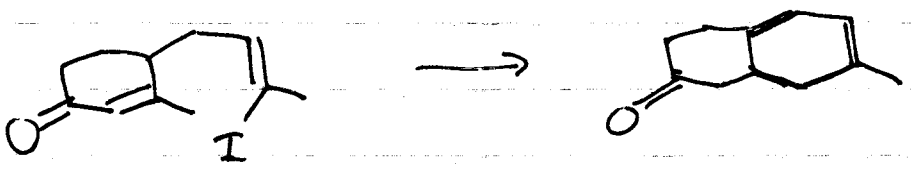
but



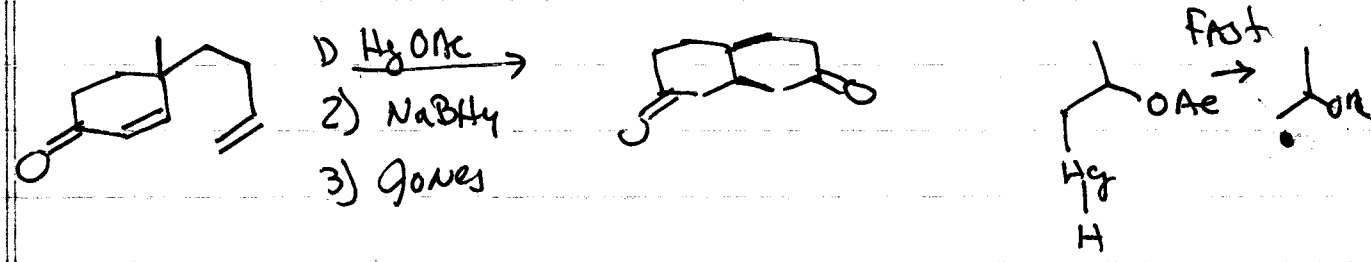
cis preference

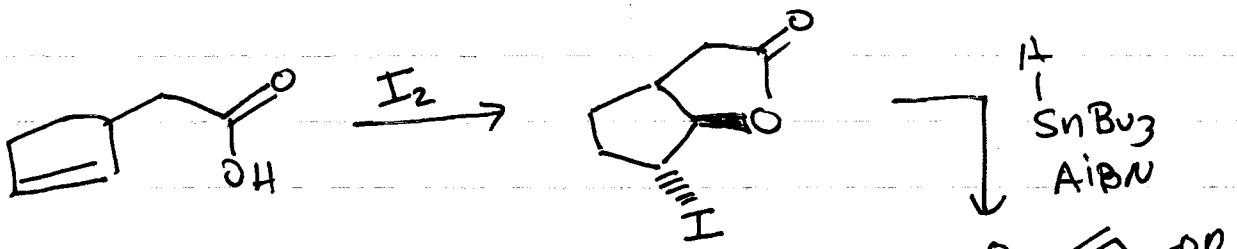
Inter molecular reactions

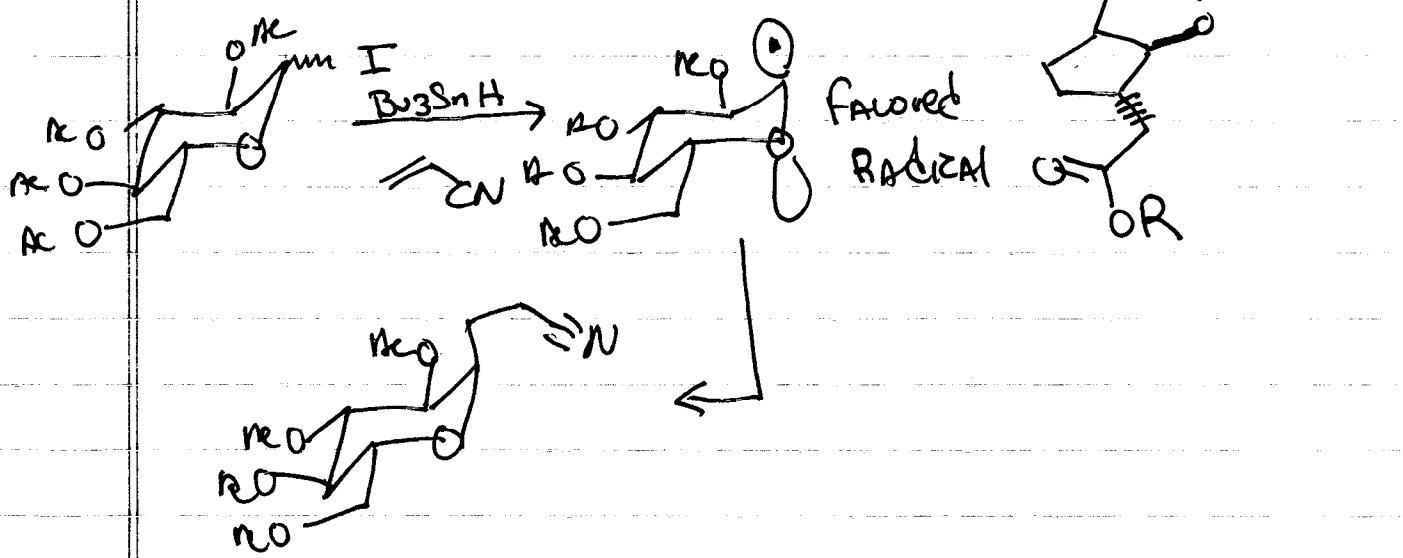




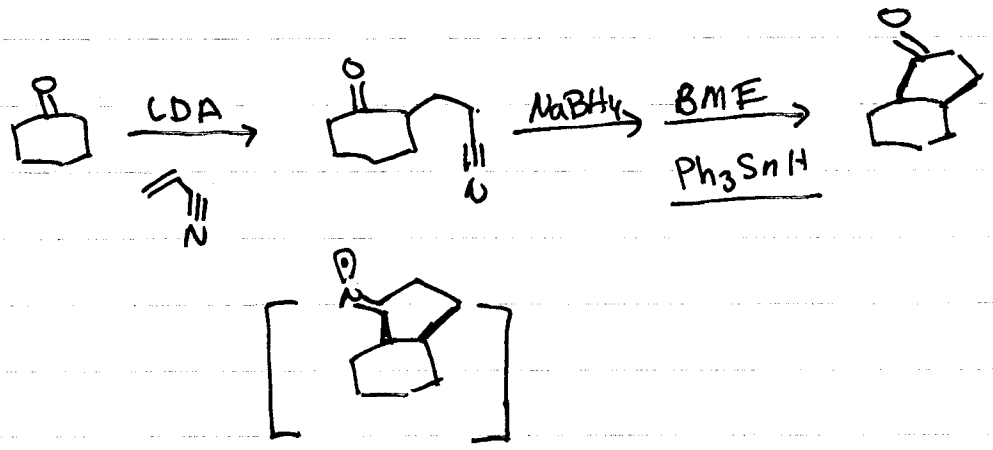
vinyl radicals less stable than Alkyl/cyclize faster

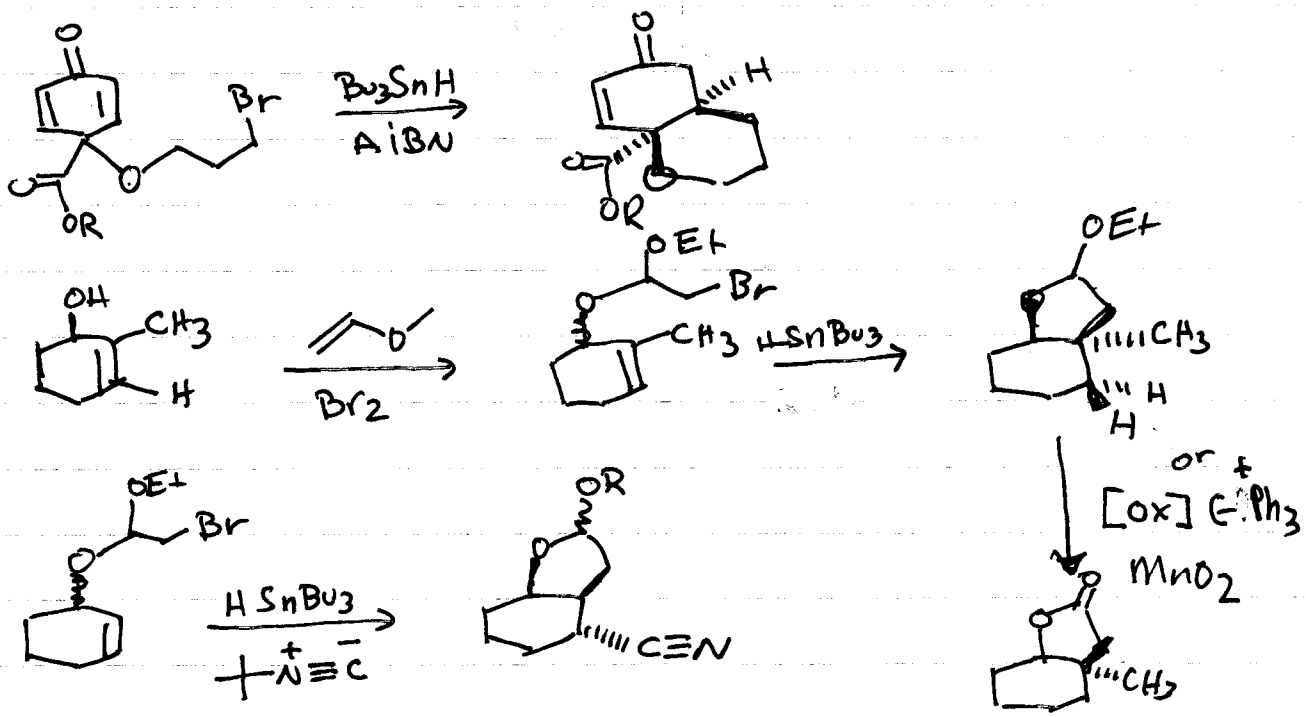






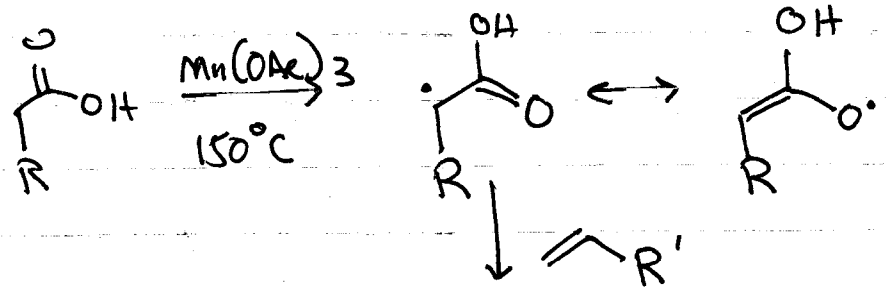
Stork Chemistry

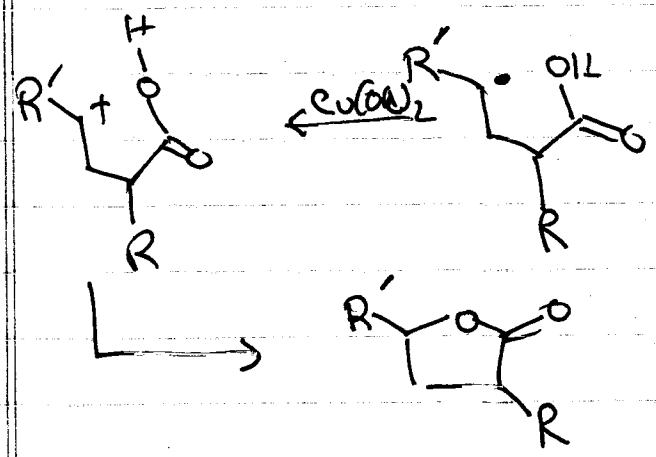




Radical Rxns Cont.

Snider (Mn^{III})



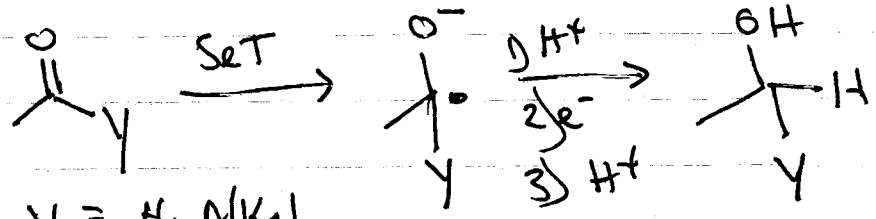


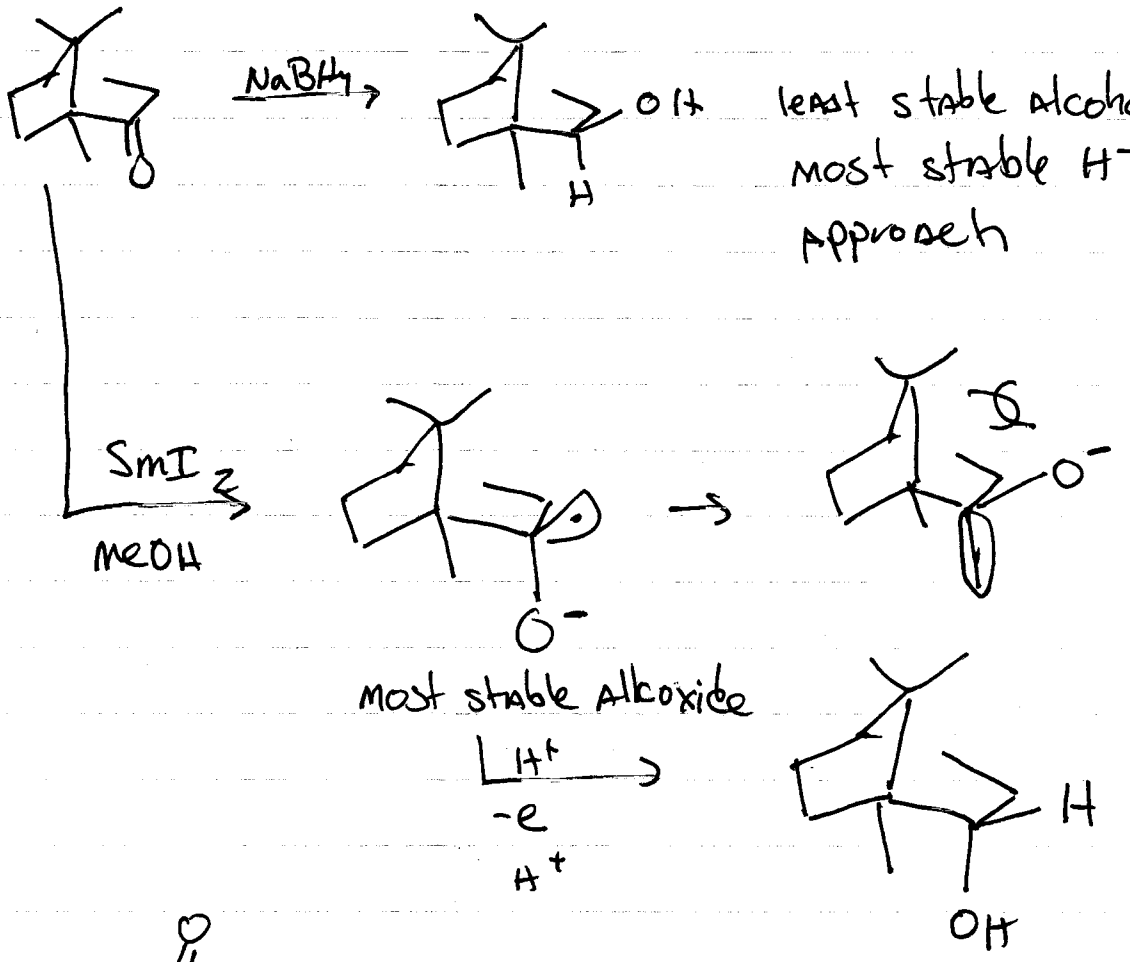
Set chemistry

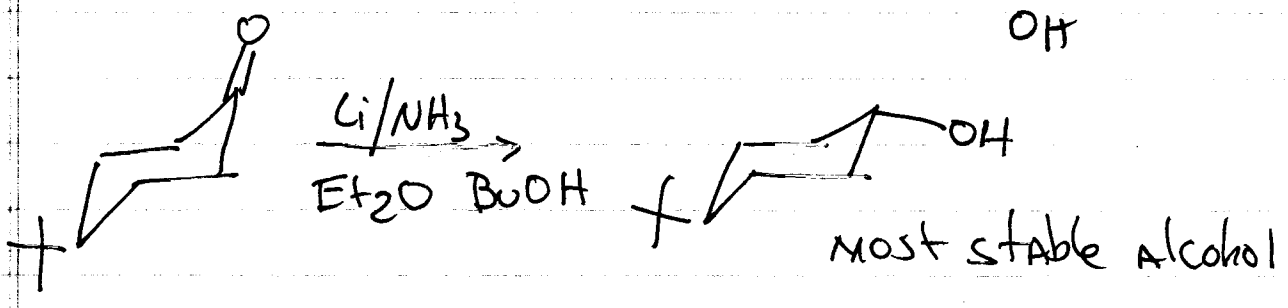
Dominated by SmI_2, LiDPP, Sodium Napthalide, Li/NH$_3$

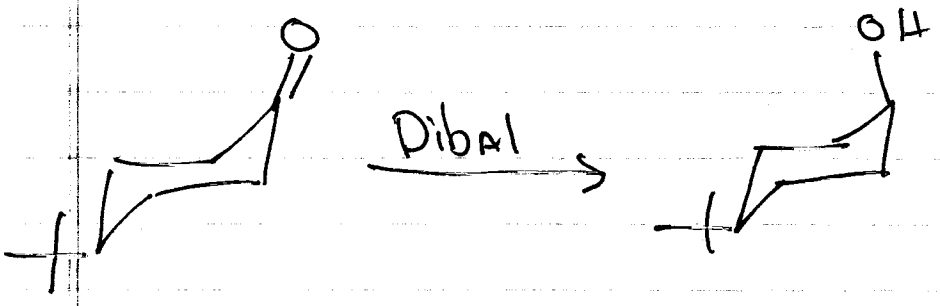
e⁻

Chemistry:

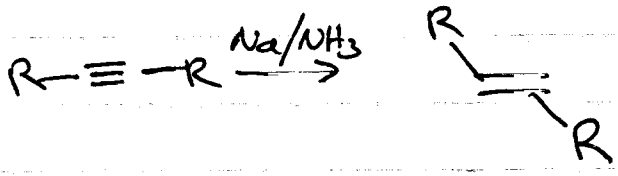


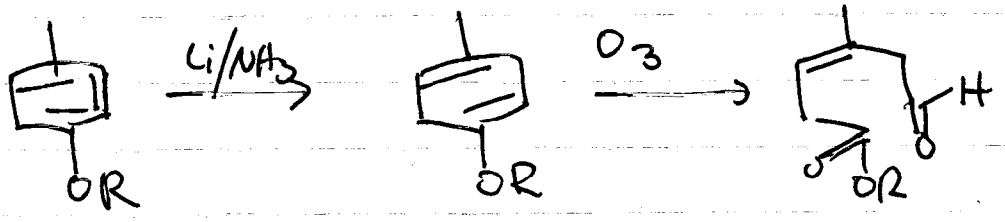

NaBH4
OH
H
least stable alcohol
most stable H⁻
approach
SmI2
MeOH
O⁻
most stable alkoxide
H+
-e
H+
H
OH


Li/NH3
Et2O BuOH
OH
most stable alcohol

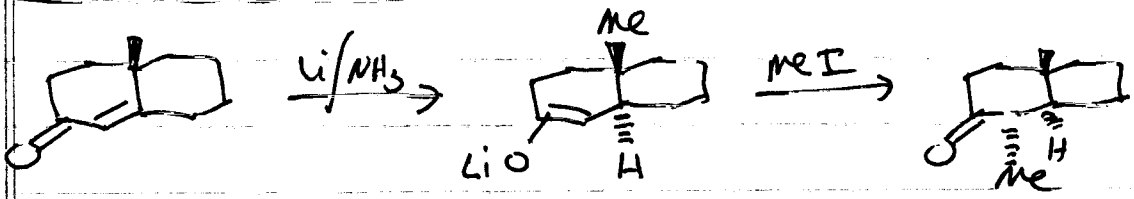

Dibal
OH

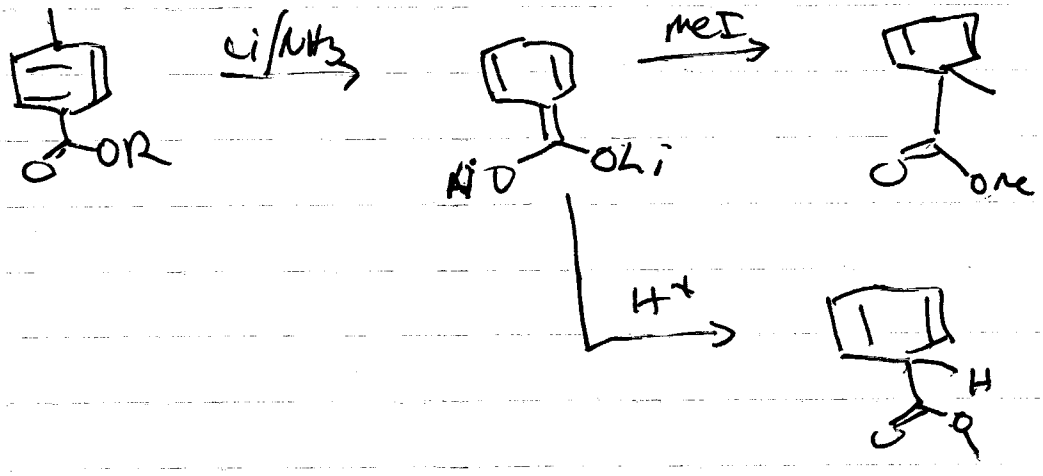
Other SET Reduction



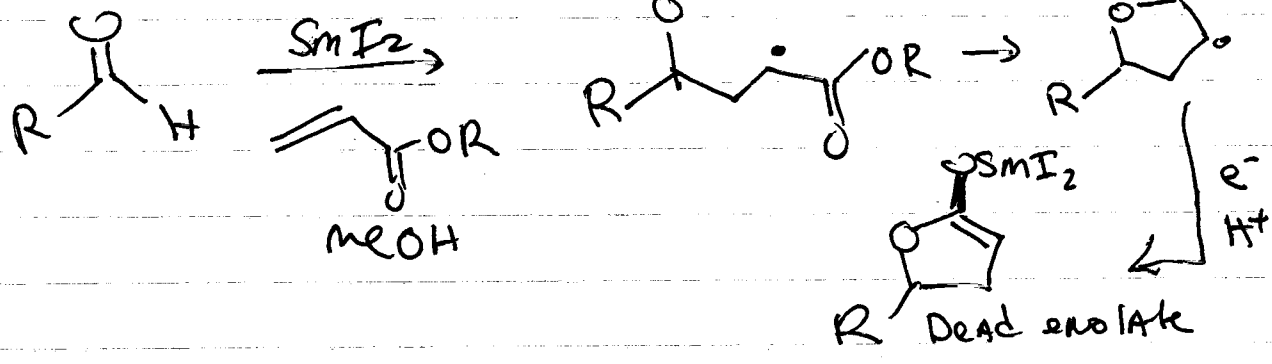


reductive Alkylation

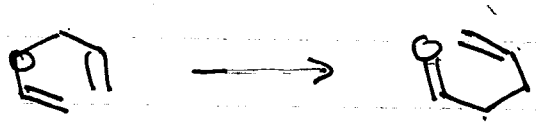




Couplings



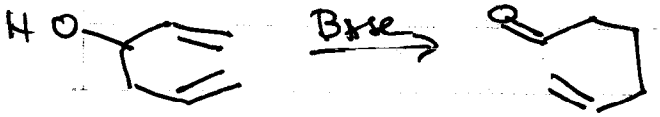
3,3 Sigmatropic Rearrangements



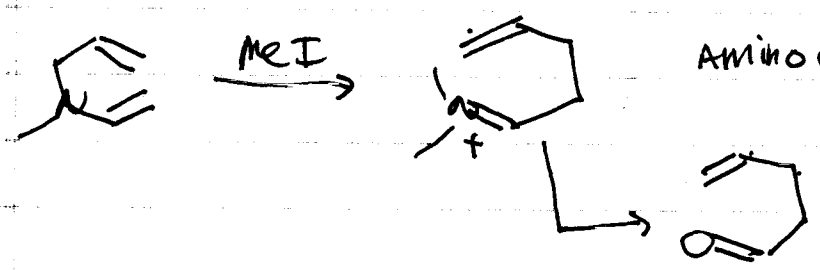
Claisen

Cope

Chair T.S.

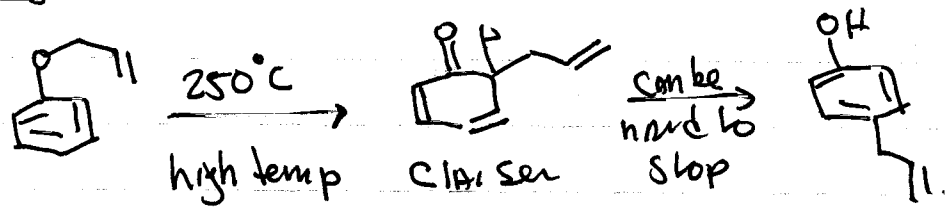


Oxycope

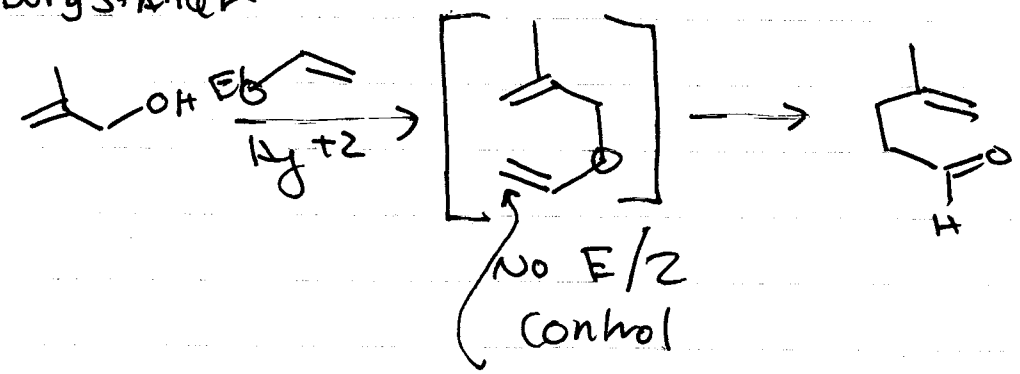


Amino Claisen

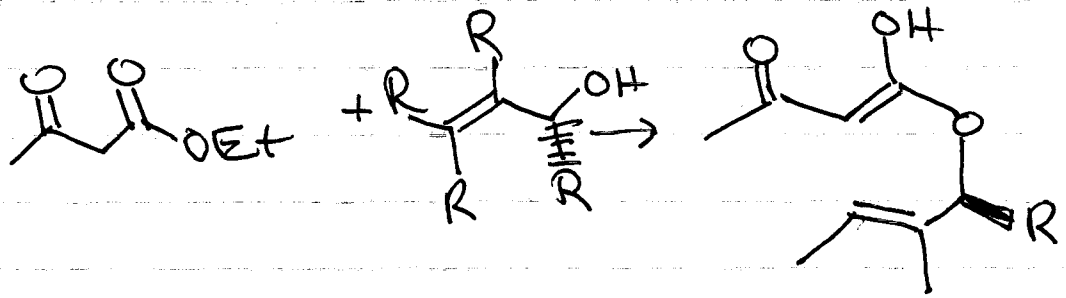
Aryl Claisen

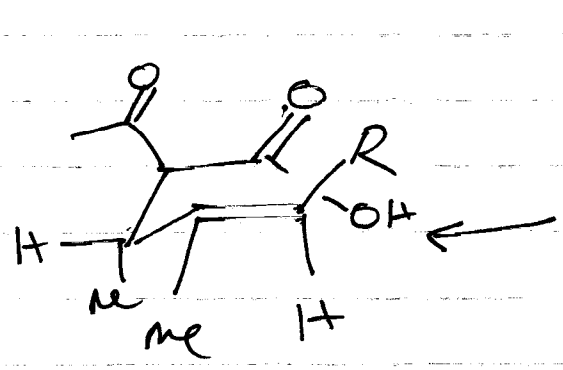


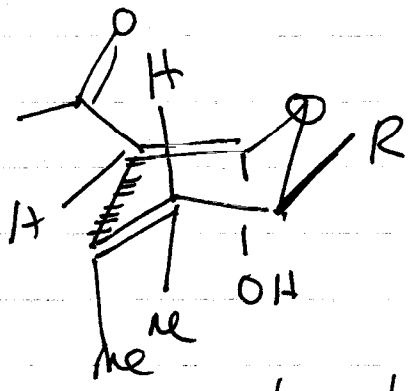
Burgstahler



Carrol



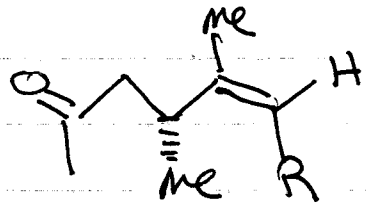




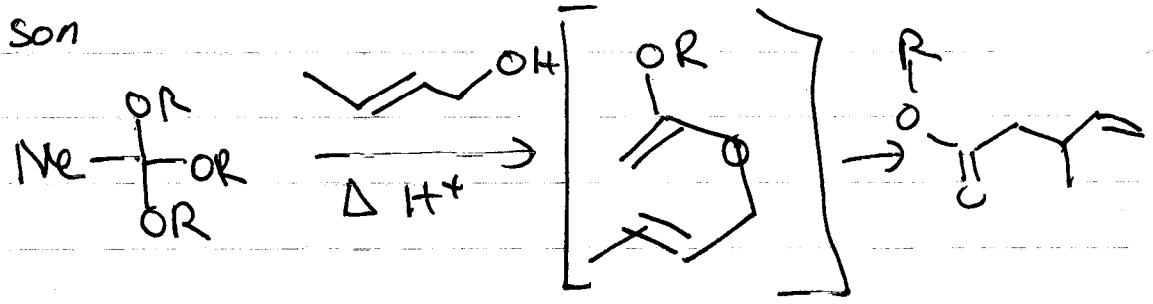
R controls stereochem

lowest energy chair

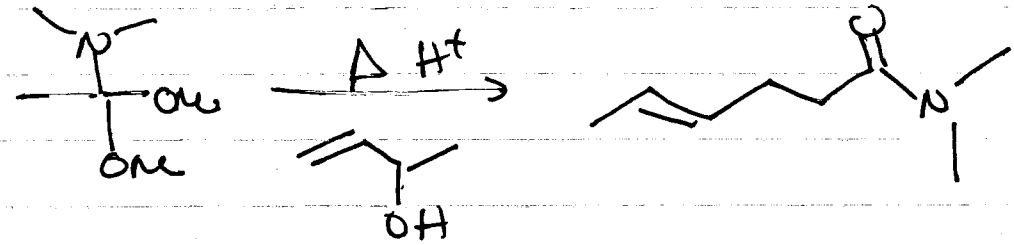
Decarboxylate



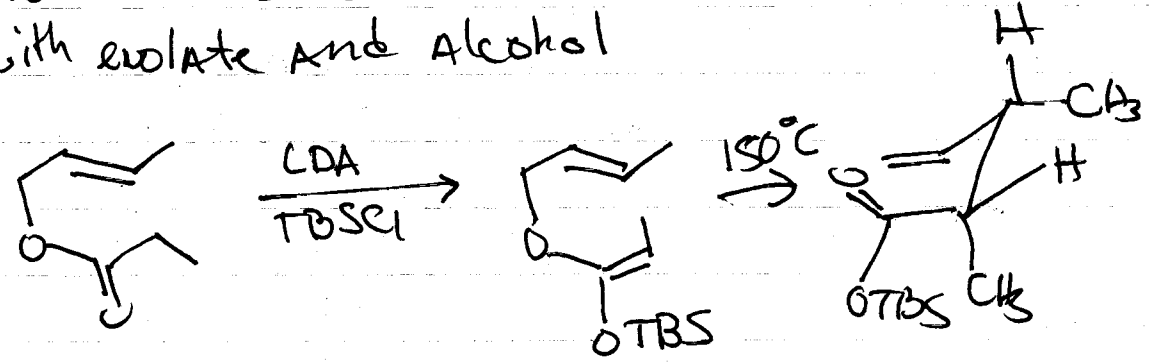
Johnson

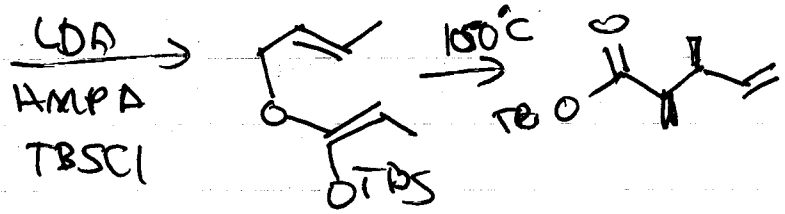


Eslen Mosler

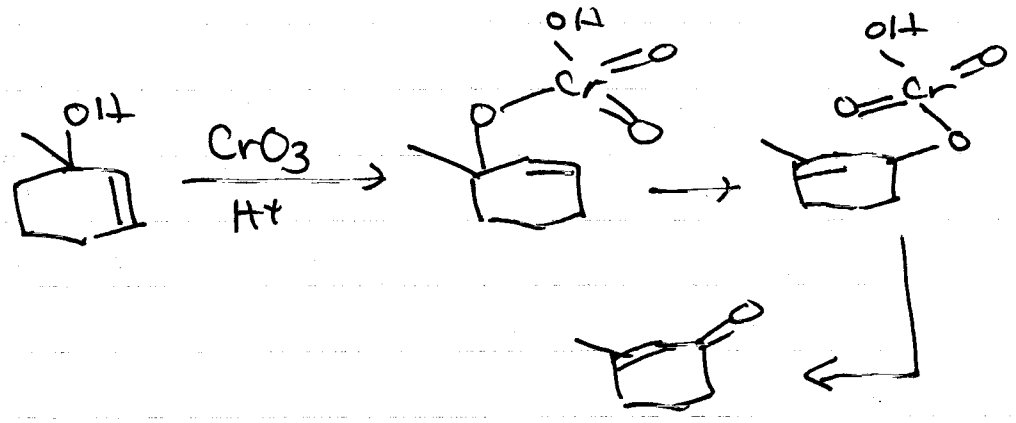


Ireland - E-Z control with enolate and Alcohol





Other 3,3 sigmatropic rearrangements

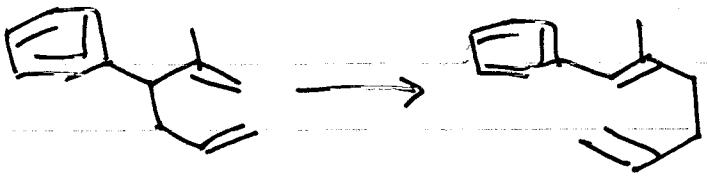


Cope

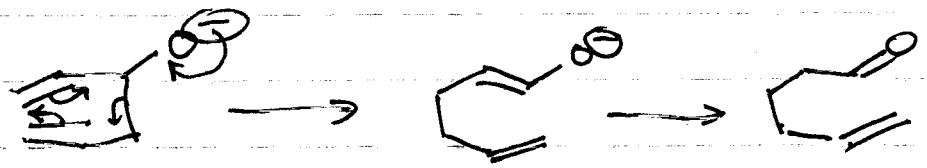
not much driving force

to go

1) conjugation
2) make ketone
3) release strain
4) discharge cation



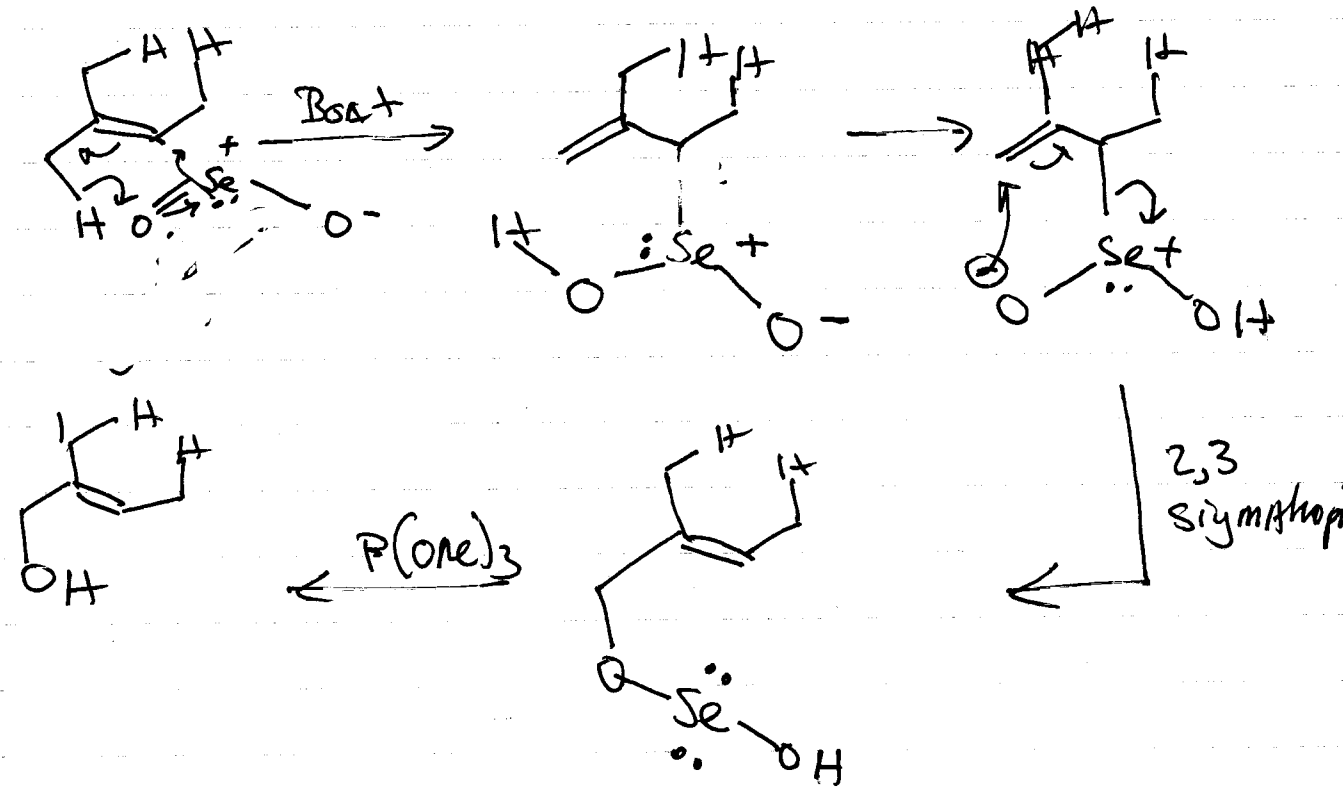
EXTENDED CONJUGATION

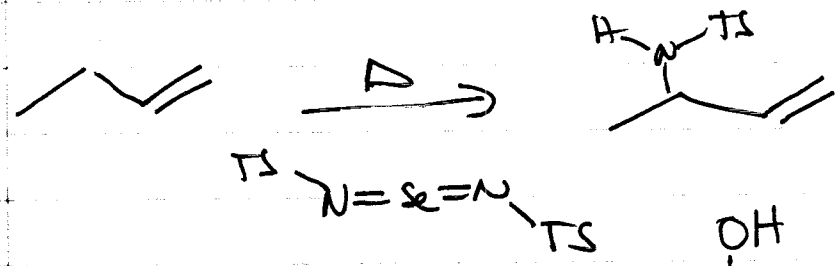


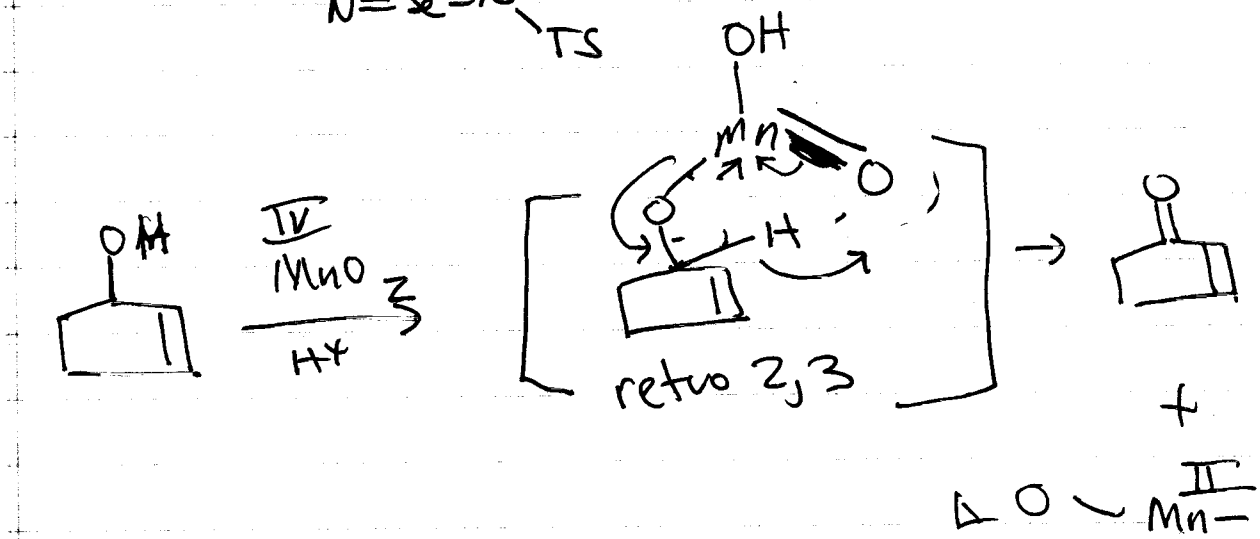
δ-e

1

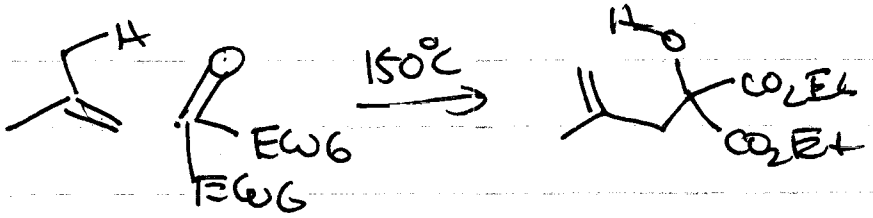
Ene Rxns

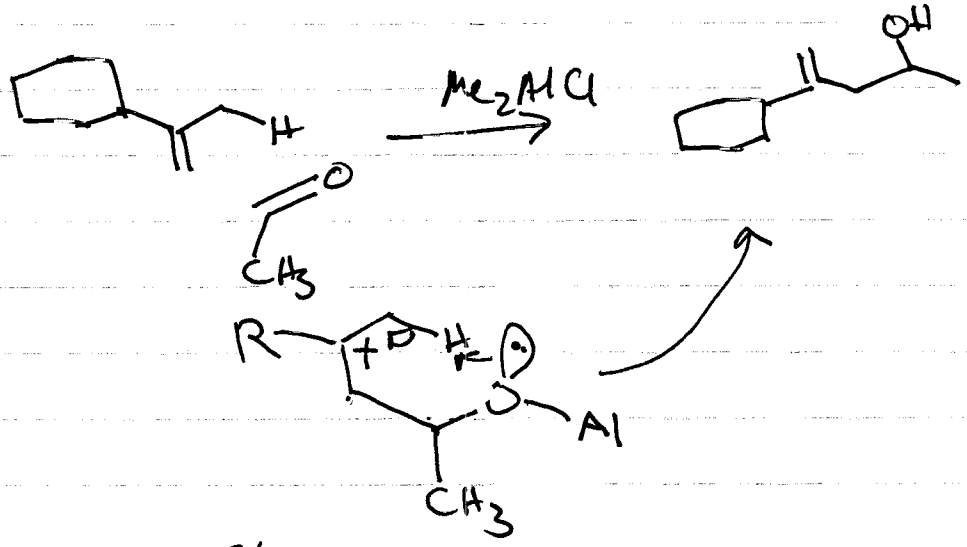

BsO+
Se
2,3
sigmatropic
P(OMe)3
OH

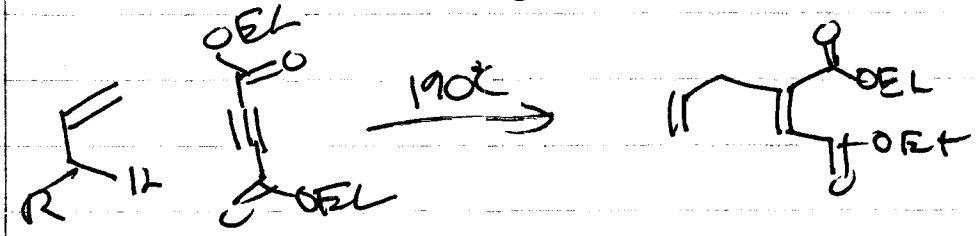

Δ
Ts
N=Se=N
Ts

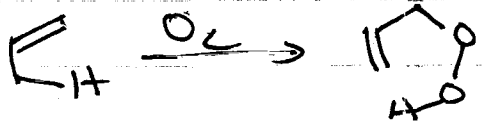

OH
IV
MnO2
H+
Mn
H
retro 2,3
+
II
Mn–OH

Other ene rxns

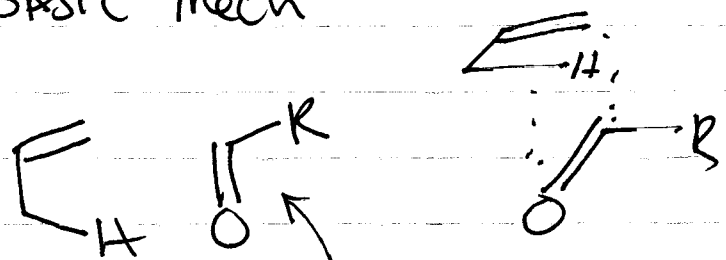








Basic Mech



Boat TS

X = C, N

Y = C, O, S, N

OXIDATION

1) Allylic oxidation 

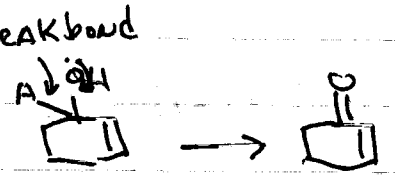
a) SeO_2 $tBuOOH$ $AcOH$ $EtOH$

b) py CrO_3

c) $Co(OAc)_2$ $NH_4^+ BrO^-$

d)  CrO_3

e) O_2 Δ followed by DMS, O_2 hν similar

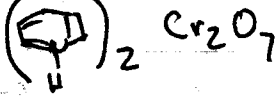
2) Allylic Alcohol 

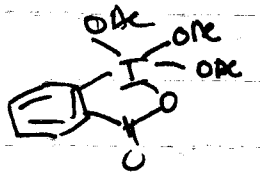
a) MnO_2

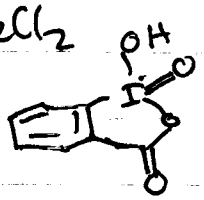
b) most others (watch out for rearrangement)

3) Alcohols ⟶ Aldehydes

a) PCC  Cl^- CrO_3 weakly acidic in CH_2Cl_2

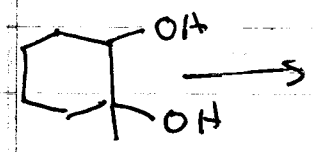
b) PDC  Cr_2O_7 nearly neutral in CH_2Cl_2

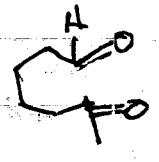
c) Dess Martin  I^{V} in CH_2Cl_2

IBX 

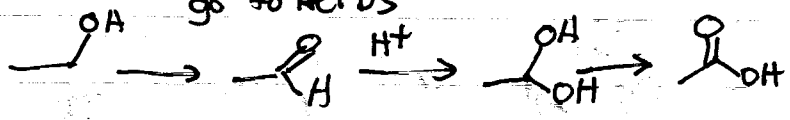
d) TPAP $Pr_4N^+ RuO_4^-$ NMO

mild

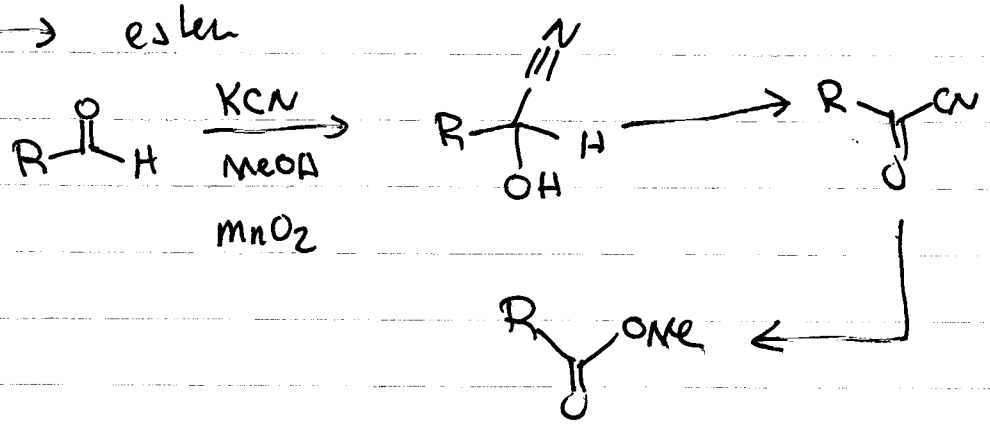
problems 



why do some stop at aldehydes and others go to acids

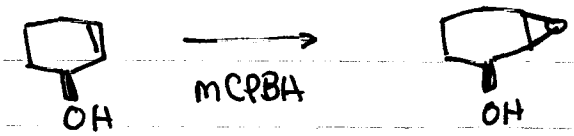


Aldehyde → ester

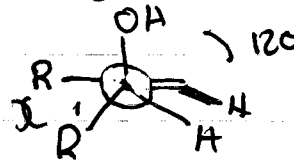
a) 

Double bond → epoxide

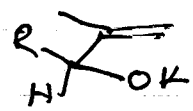
a) Per Acid



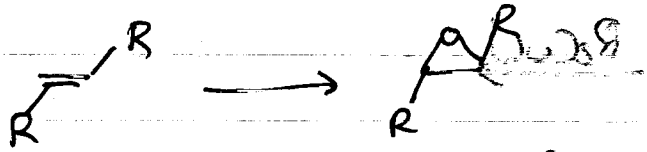
obeys Allylic Strain



work for equatorial alcohols



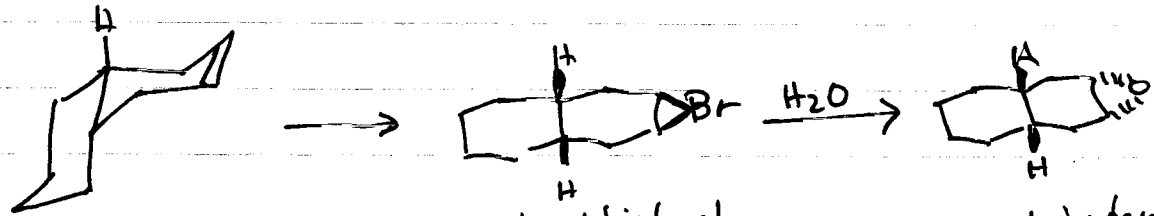
not good!



stereochem is retained

b) DMDO  very mild not directed

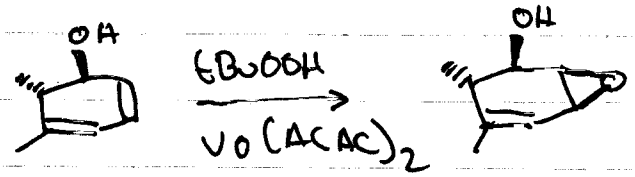
b) NBS, Ag^{I}, H_2O

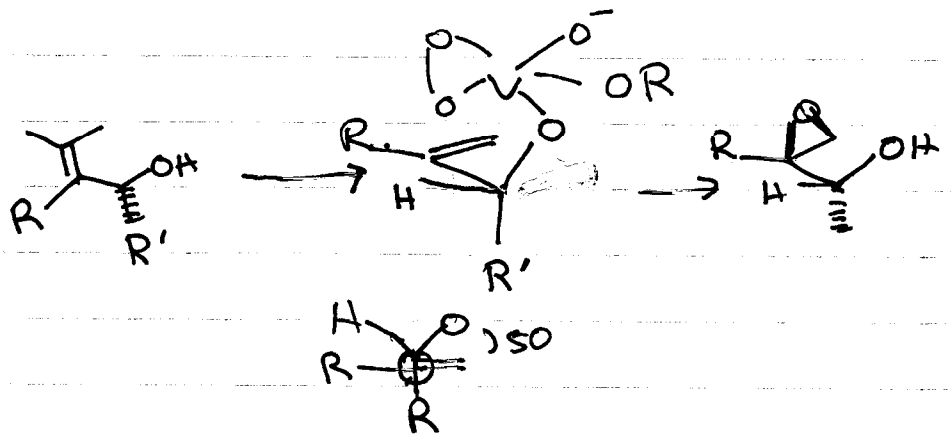


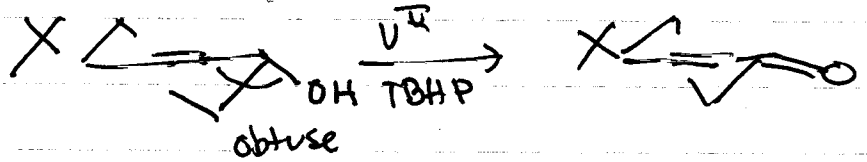
least hindered bromonium

most hindered epoxide

c) $VO(ACAC)_2$ tBuOOH (strict angle requirement)

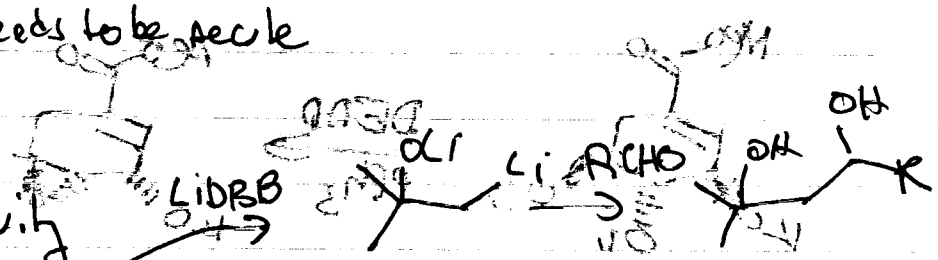




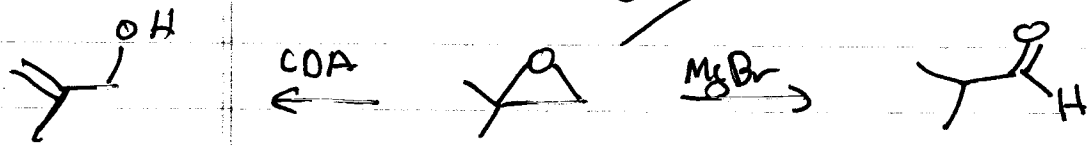


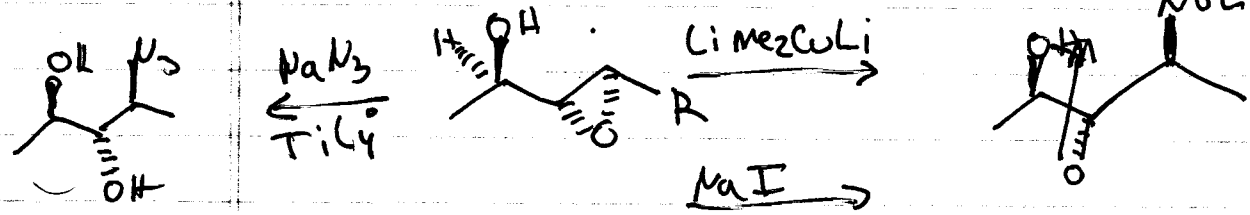
obtuse

needs to be Accle

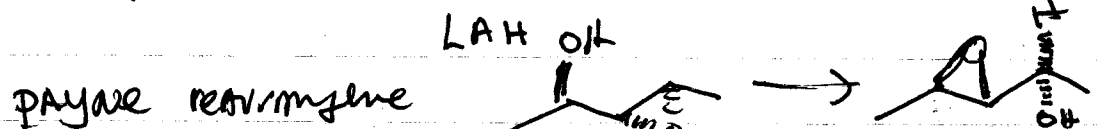


epoxide reactivity



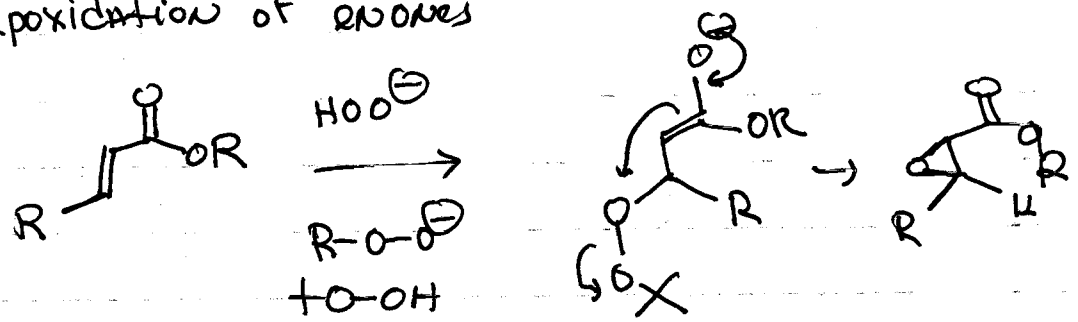


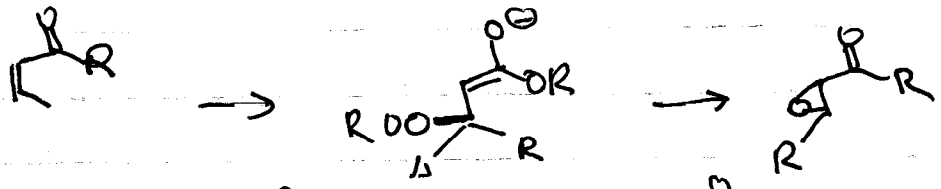
opens disfav



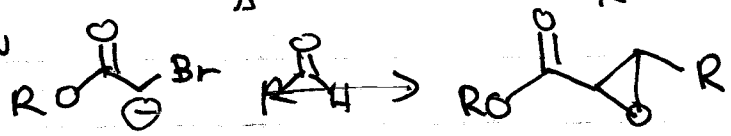
Payne rearrangement

epoxidation of enones



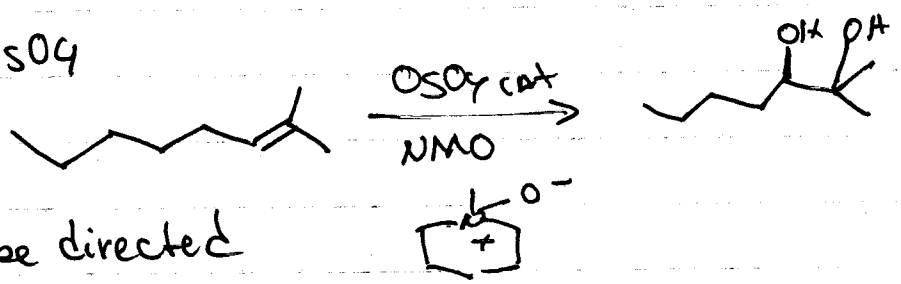


DARZONS RXN

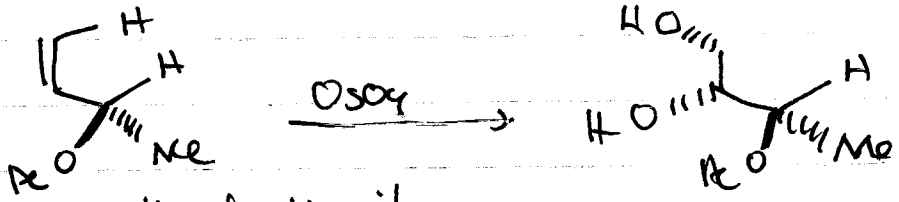


dihydroxylation

OsO4



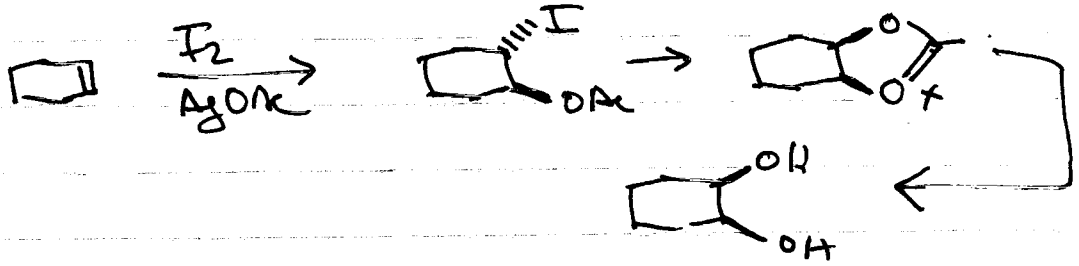
can be directed



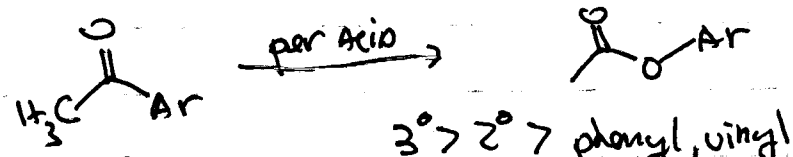
makes back side more electrophillic

Kishi paradigm

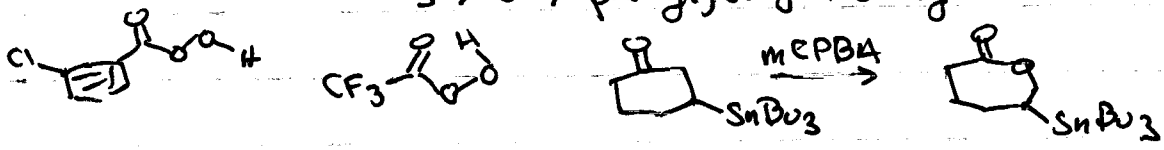
Woodward prevost (dihydroxylate more hindered side)

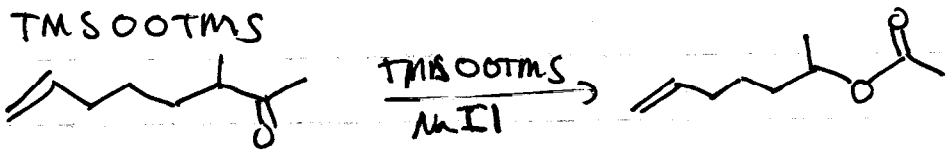


Baeyer Villiger



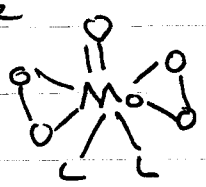
$3^\circ > 2^\circ >$ phenyl, vinyl $>$ benzyl $> 1^\circ$



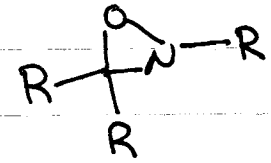


JOC 1982, 902

enolate ⟶ hydroxketone

a) MoOPh  $Mo(O_5)Py$ HMPA

b) oxaziridines



c) TMSCl, DMDO, H^+

Alkene ⟶ diol

a) OsO_4, NMO

b) RuO_4

Alkene ⟶ cleavage

a) ozone — aldehyde, ketol, acid, ester

b) RuO_4 — acid (wicked oxidant)

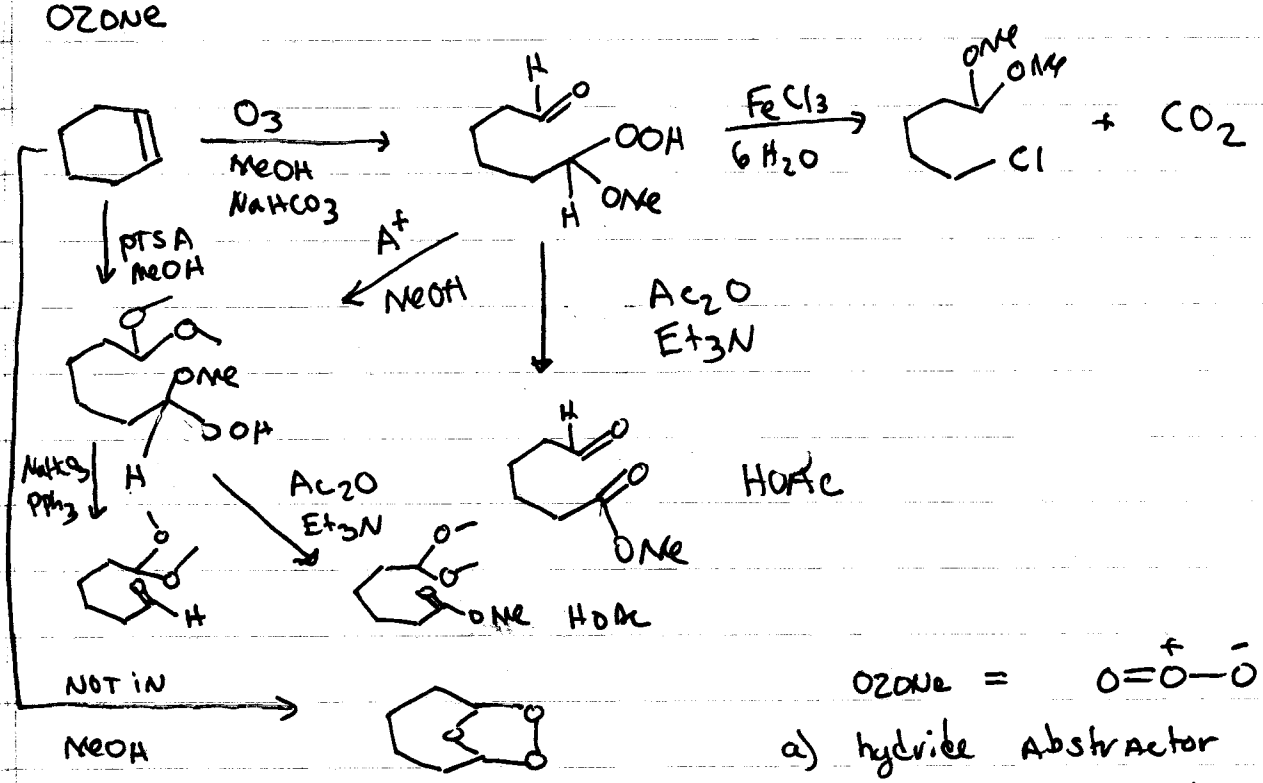
c) $KMnO_4$ — acid (not mild)

d) $BaMnO_4$ — milder (stops at aldehyds)

diol ⟶ cleavage

a) $KMnO_4$ X = OH
b) $NaIO_4$
c) HIO_5 X = H
d) $Pb(OAc)_4$ X = OH
e) most metal oxidants
f) RuO_4

OZONE

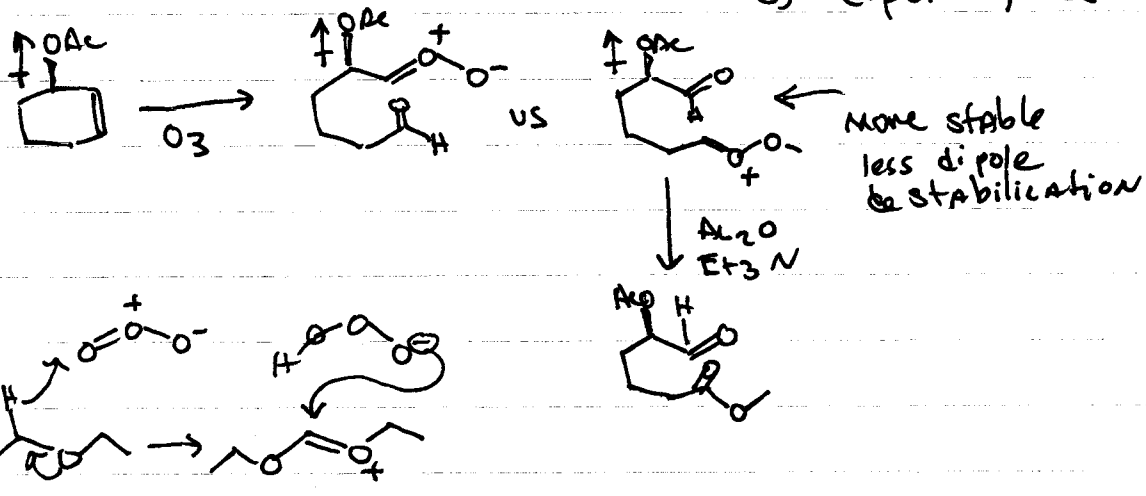


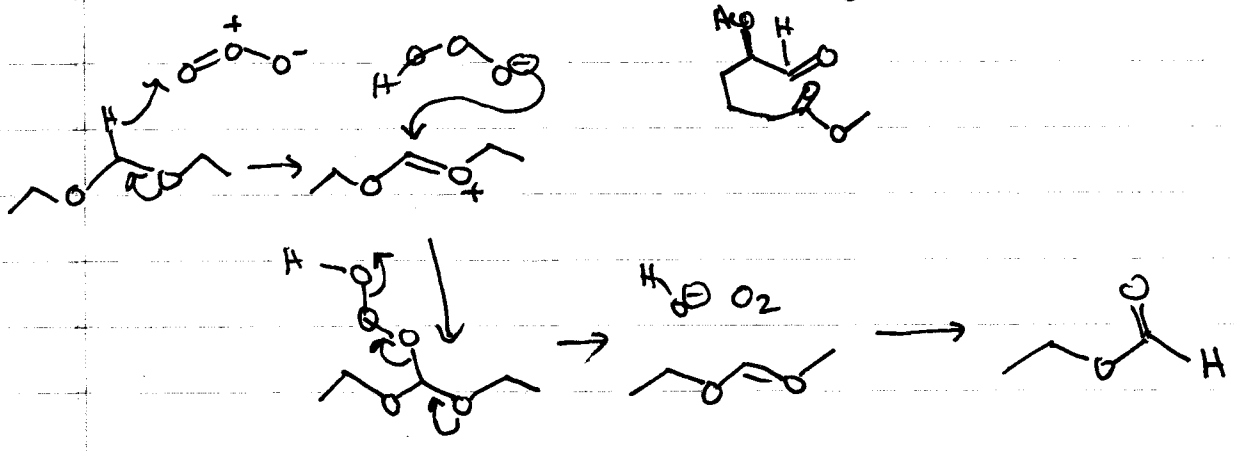
OZONE = $O=\overset{+}{O}-\overset{-}{O}$

a) hydride Abstractor

b) epoxidizes strain/conjested Alkenes

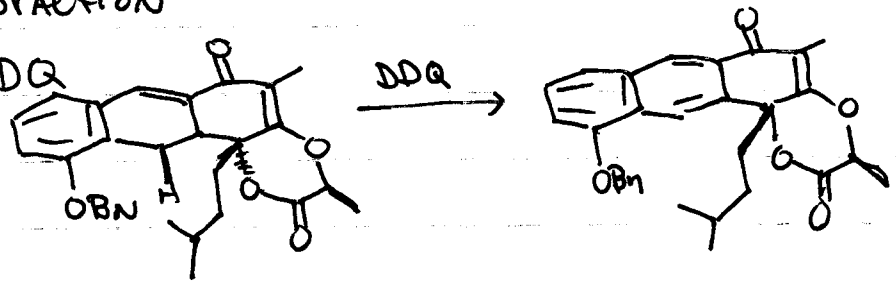
c) dipolarriphile





Hydride Abraction

a) DDQ

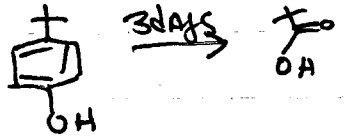


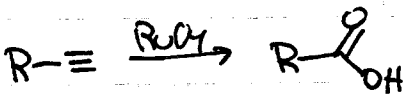
b) RuO_4 (powerful) electron deficient

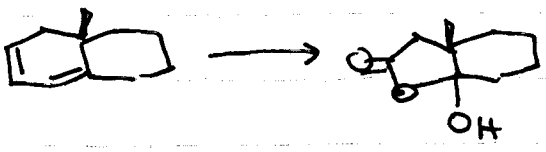
(CCl_4 / $RuCl_3$ / H_2O / $NaIO_4$)

five membered rings only

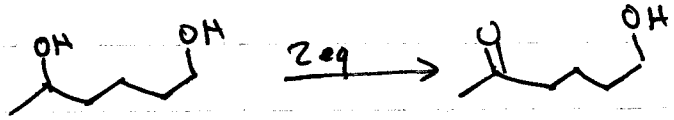
but



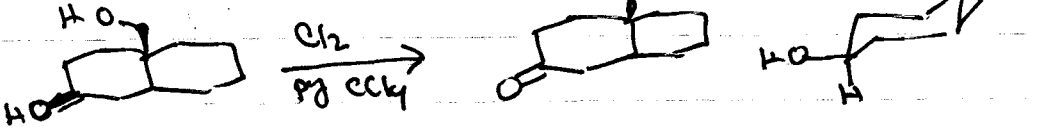


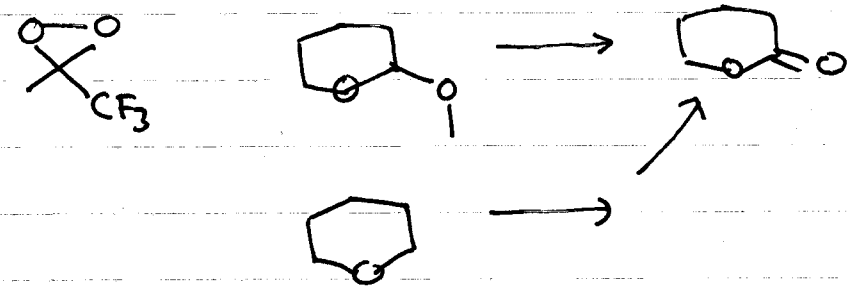


c) $Ph_3C^+ BF_4^-$

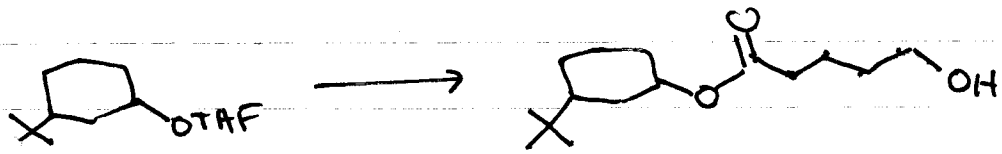


d) NBS or Br_2 or Cl_2

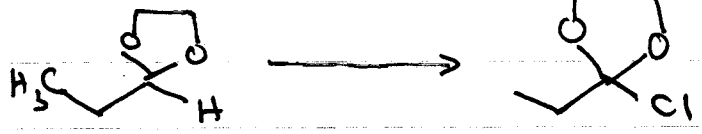


e) 

f) oxone wet alumina



g) $Et_3\overset{+}{N}(Cl_3)^-$

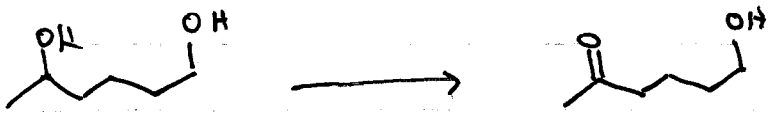


h) MCPBA + $BF_3 \cdot Et_2O$

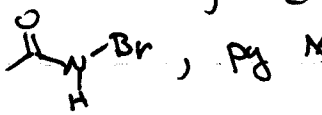
lactol ⟶ lactone

a) Ag_2CO_3

b) most alcohol oxidants



a) $Ph_3C^+ BF_4^-$, CH_2Cl_2

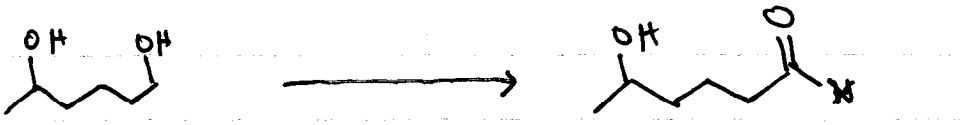
b)  , pg MeOH

c) Ag_2CO_3, Celite

d) $(Bu_3Sn)_2O$, Br_2 CH_2Cl_2 $-25^\circ C$

e) $VO(acac)_2$ TBHP

f) NaOCl, HOAc



a) $RuCl_2(PPh_3)_3$

b) Cp_2ZrH_2

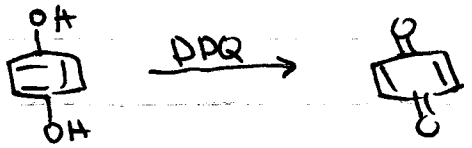
c) NMO, NaOCl

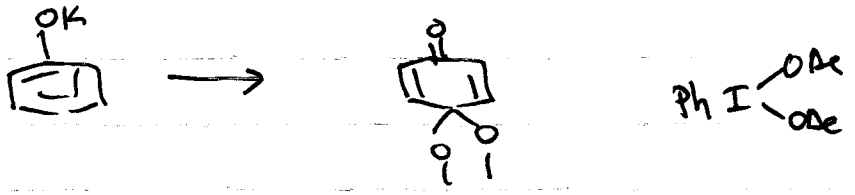
to acid X = -OH

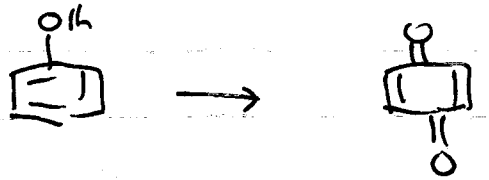
to aldehyd X = -H

Ketone ⟶ enone

a) a) TMSOTf, $PdCl_2$ Saegusa
b) IBX, DMSO Δ
c) DDQ
d) LDA, PhSeBr, [O] Δ

phenol 





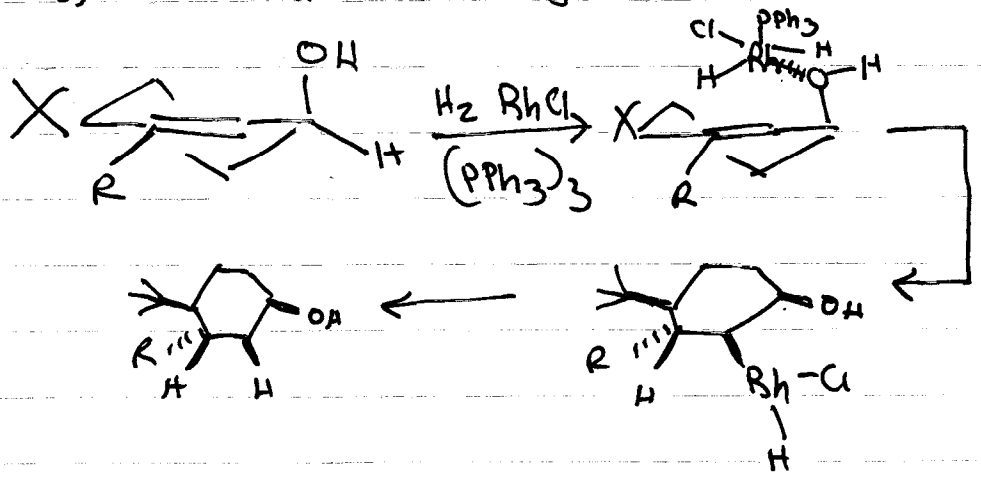
Co-Salen

Reduction

olefin ⟶ alkane

a) Pd/C H_2 not directed, sterics

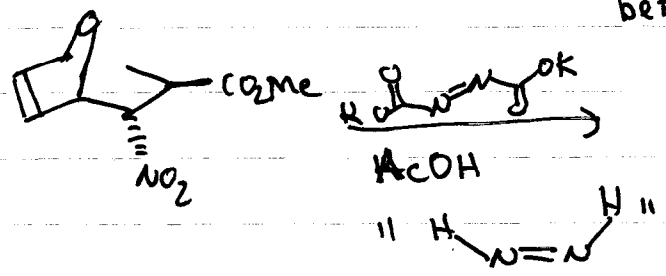
b) Wilkinson (homogeneous) can be directed



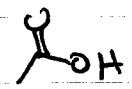
c) Crabtree's also directed

$[R_3P\,Ir(COD)py]^+\ PF_6^-$

d) Diimide (sterically congested, electron rich) better



e) HBR_2 can be directed

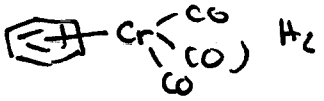
R_2BH / 

Alkynes ⟶ cis Alkenes

a) Lindlars $Pb-BaSO_4/Pd$ / Quinoline H_2
cyclohexene prevents over reduction

b) di-imide

c) Borane / $R\overset{O}{\underset{}{\overset{\|}{C}}}OH$ R_2BH also works

d) 

e) $H-SnBu_3$ AIBN / A^+

Alkynes ⟶ trans Alkene

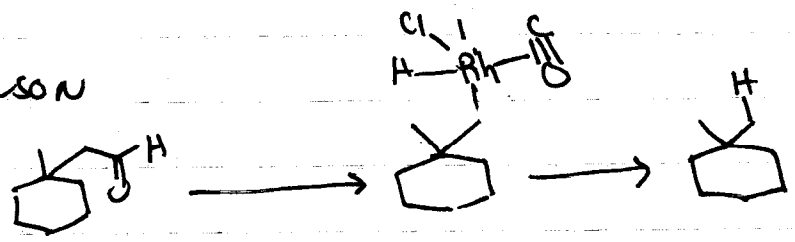
a) Li / NH_3

b) DibAl / H^+

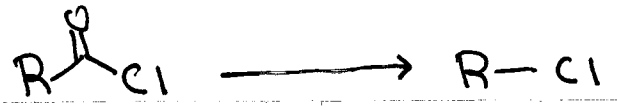
c) $CrSO_4$ / H_2O

Aldehyde ⟶ -H decarbonylation

a) Wilkinson

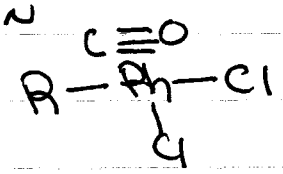


b)

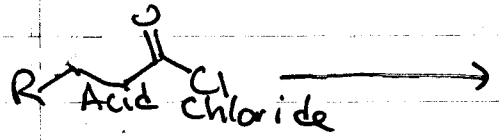


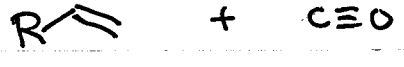
(decarbonylation)

a) Wilkinson

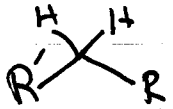


NO H_2





a) Pt°



a) Clemmenson $Zn-Hg$ HCl

b) Wolf Kishner H_2N_2 KOH

c) Mozingo 2xR-SA , Zn

d) $NH_2-NH-TS$, $NaBH_4$

a) X = GLG

$LiEt_3BH$ aka super hydride

b) X = Br, Cl, I, 

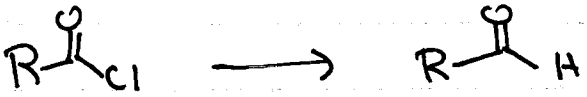
$H\text{-}SnBu_3$ / AiBN

c) X = GLG

LAH

d) X = vinyl Triflate

$H\text{-}SnBu_3$, Pd°



a) Rosemund reduction Pd° / H_2

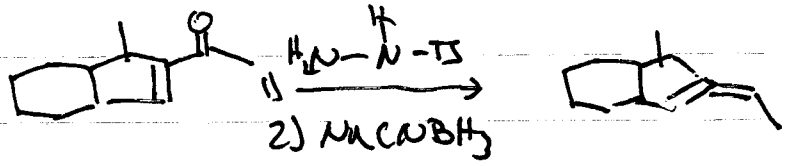
b) $LiAl(OtBu)_3H$

a) DibAl

Weinreib Amide

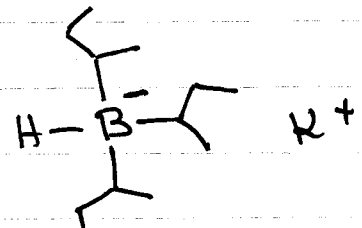
a) DibAl

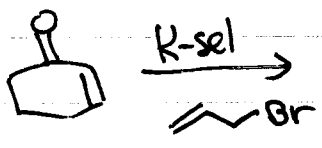
enone → isomerized Alkene



enone → enolate

a) K-selectride





enone ⟶ Allylic alcohol

a) $NaBH_4$ / $CeCl_3$ Luche
b) Dibal

enone ⟶ Ketone (no enolate)

a) $RhCl(PPh_3)_3$ TESH
b) Dibal Me Cu
c) SET (Na/NH_3) or SmI_2
d) Stryker (Ph_3P) Cu H
e) M-H $Fe(CO)_4$

Nitrile ⟶ 1° amine

a) LAH

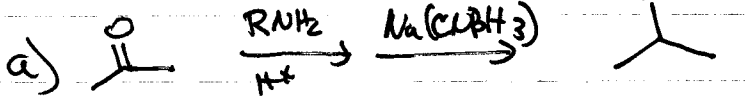
AMIDE ⟶ AMINE

a) R_2BH
b) LAH

AMINE ⟶ R-H aryl

H^+, $NaNO_2$ / H_3PO_2

Iminium → Amine

a) 

Nitro → Amine

a) $NaBH_4 / CeCl_3$

b) LAH

Acid → R-OH

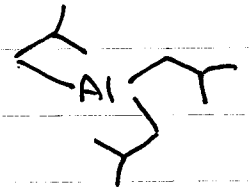
a) BH_3 not BR_2H

b) LAH

Ketones ⟶ Alcohols

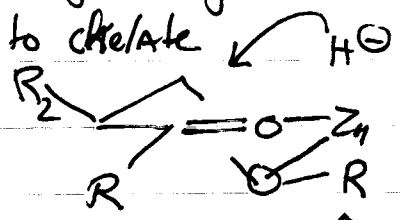
a) $NaBH_4$

b) TibAl



very bulky

likes to chelate

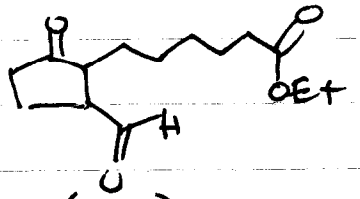


OMe, OBu, OBOM

OSi not good

c) $ZnBH_4$

d) $NaBH_4 / CeCl_3$



e) $Me_4N(OAc)_3BH$

must exchange

internal delivery from OH

Ester ⟶ Alcohols

a) DibAl (Hexane)

b) $LiBH_4$ / MeOH

c) $NaBH_4$ / $TiCl_3$

Ester/lactone ⟶ Aldehyde/lactol

a) Dibal (THF)

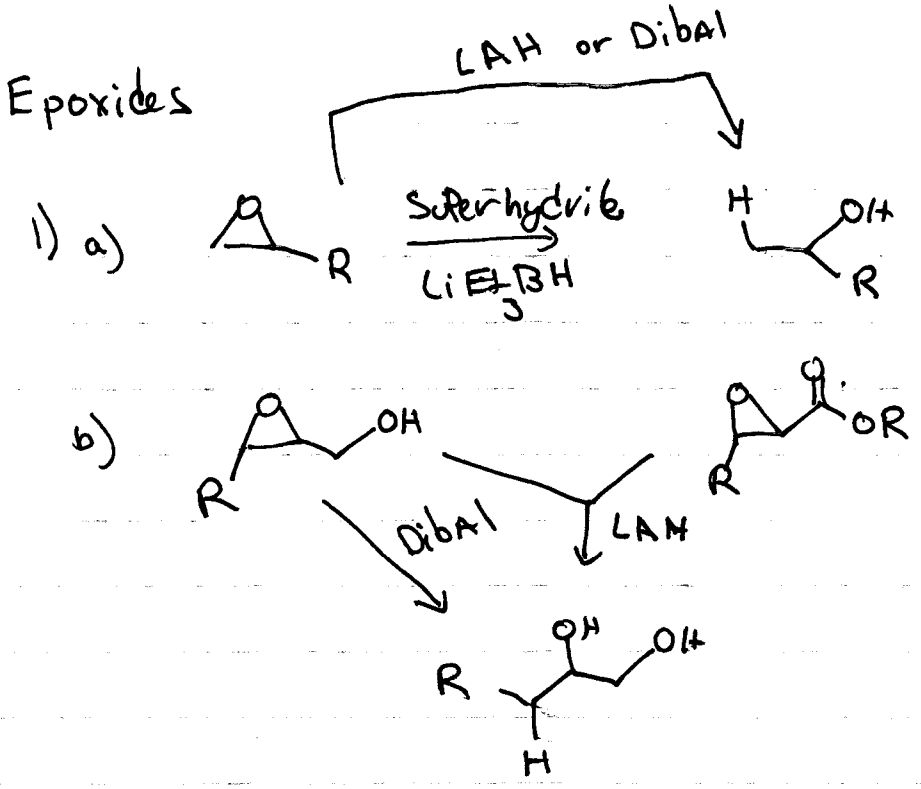
Aldehyds ⟶ Alcohols

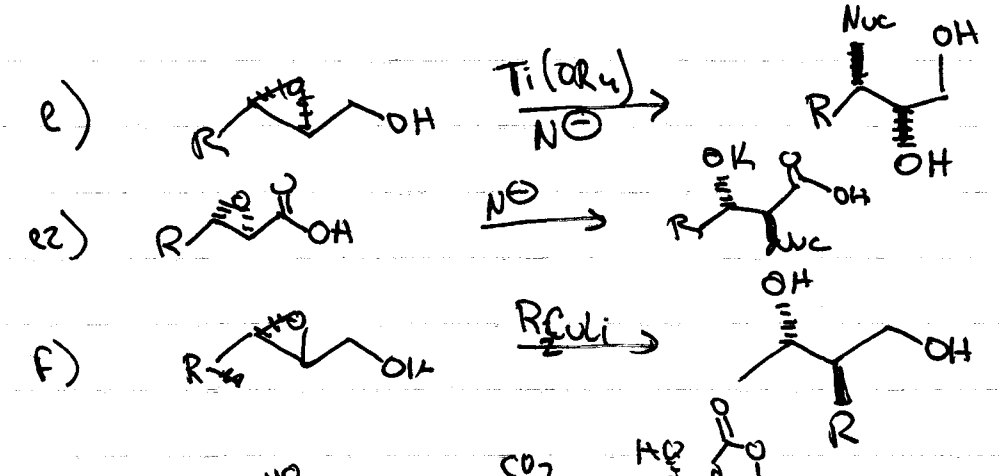
a) $LiAl(OtBu)_3H$

b) $Me_4N(OMe)_3BH$

Some Reactions of Epoxides

Epoxides





watch out for payne