

LEC (21)

CHEM 30A

Nov 19th

- NUCLEOPHILIC SUBSTITUTION

- ① LEAVING GROUP cont
- ② SOLVENT
- ③ REARRANGEMENT
- ④ SUMMARY
- ⑤ NEIGHBORING GROUP PARTICIPATION
- ⑥ PHASE-TRANSFER CATALYSIS
- ⑦ ELIMINATION

MIDTERM (2) MONDAY

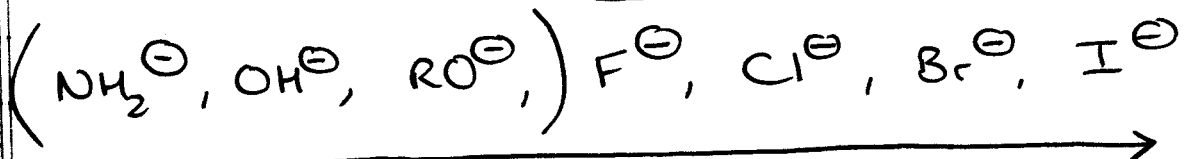
LAST NAME A-N (CSSϕ)  
 O-Z (BUNCHE 1209B)

Problems: 8.4, 8.5, 8.6

OFFICE HOURS  
 FRI 2-4 pm  
 SUN 3 pm

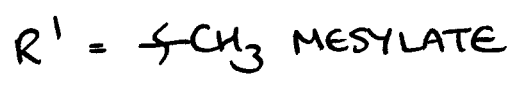
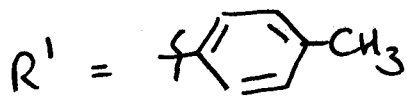
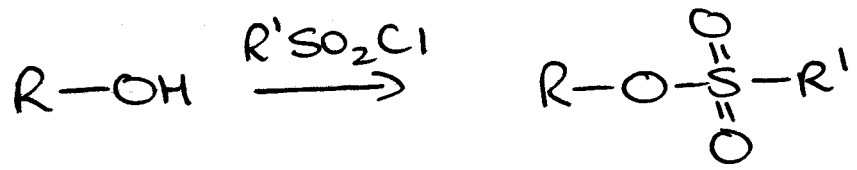
① LEAVING GROUPS

LG ABILITY

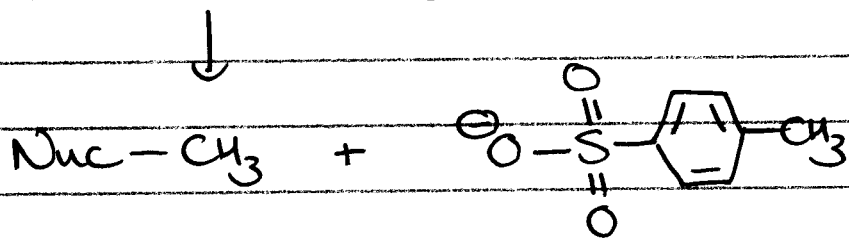
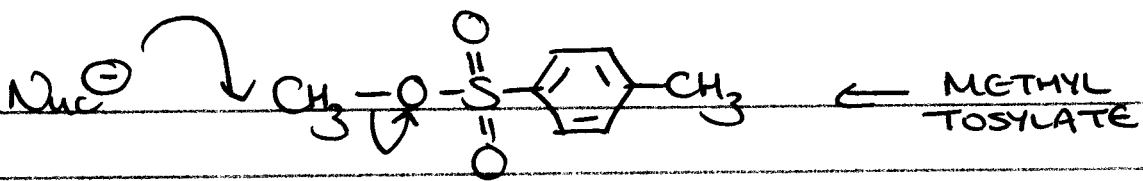


stability of anion  
 (lower pKa of conjugate acid)

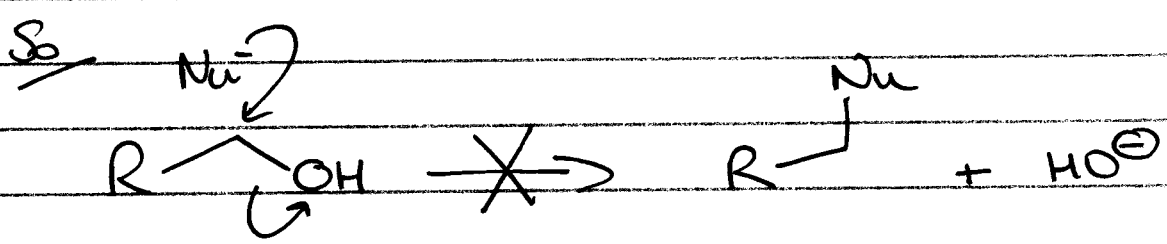
- Good leaving groups derived from alcohols



2

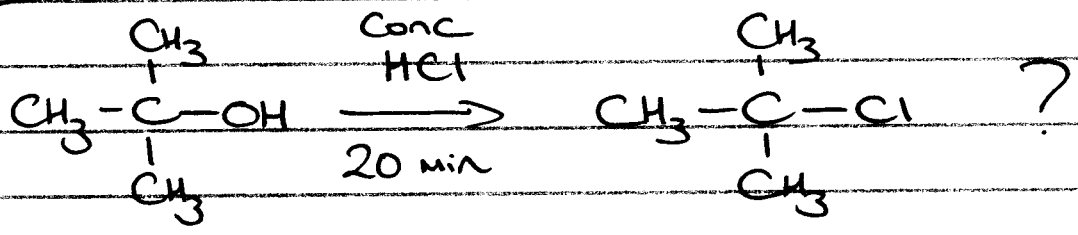


TOSYLATE/MESYLATE AS GOOD AS / BETTER IODIDE

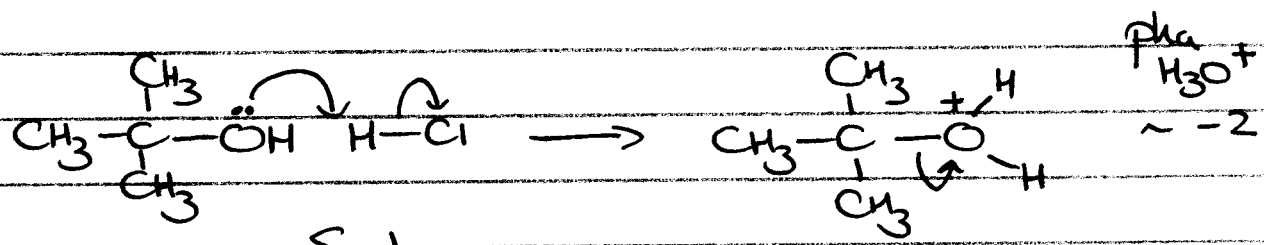


DOES NOT HAPPEN

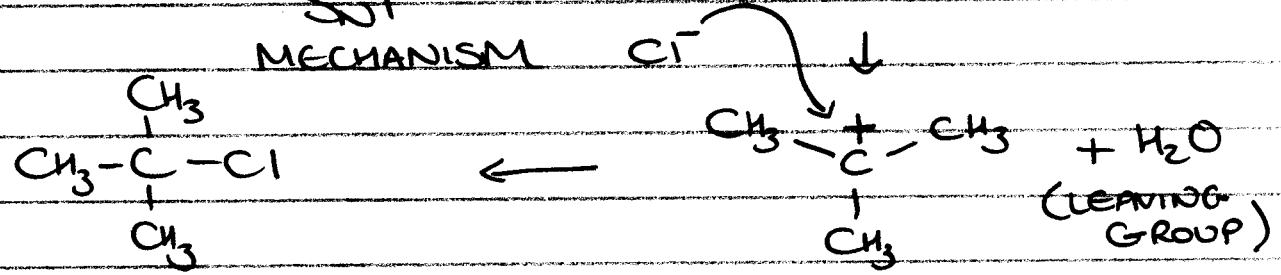
BUT



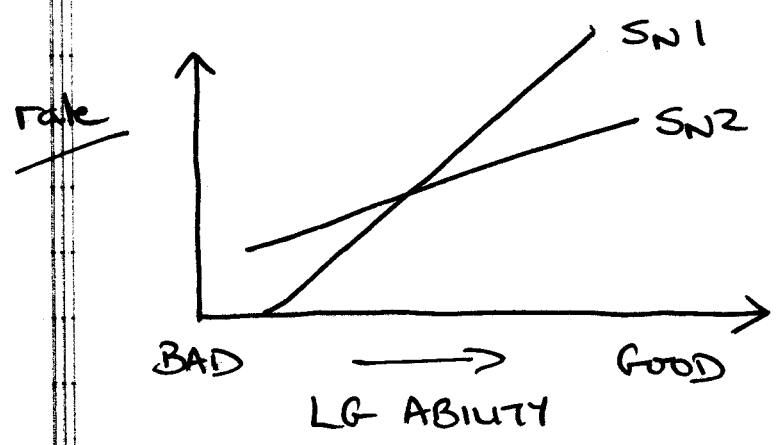
-OH is converted into a better LG



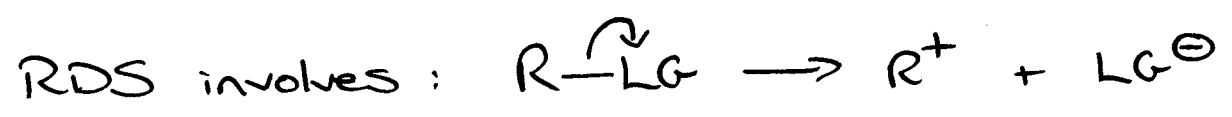
S<sub>N</sub>1 MECHANISM



### SN1 vs SN2



SN1 mechanism MORE SENSITIVE to the leaving group ability →



— Whereas in SN2 reaction:

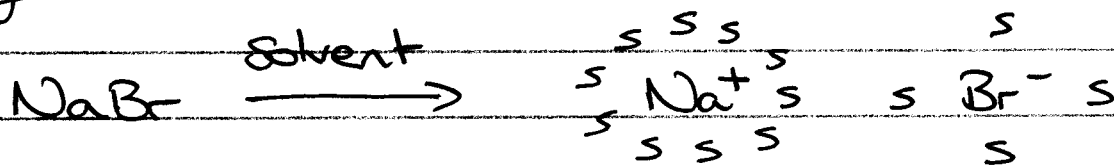
as long as  $LG^-$  is more stable than  $Nu^-$ , then the reaction can proceed.

BUT deciding on LG ability alone, not easy to figure out SN1 vs SN2

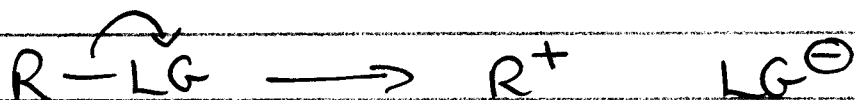
### ② SOLVENT

SN2 REACTIONS ⇒ POLAR APROTIC SOLVENTS  
 ↓  
 solvate CATIONS well,  
 but not ANIONS

eg.

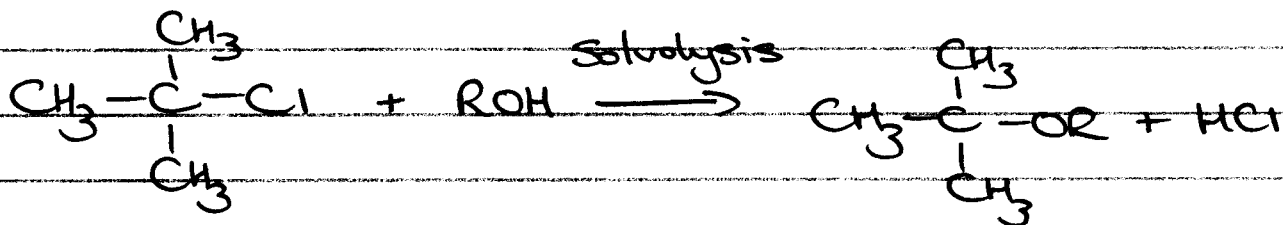


$S_N1$  Reaction



creation and separation of charge

$\Rightarrow$  more polar the solvent the better



(ROH)

Water/Ethanol

Relative Rate

100	0	100,000
80	20	14,000
40	60	100
0	100	1

~~So~~  $S_N2$  REACTIONS

Disfavored in PROTIC SOLVENTS

(ground state energy lowered by SOLVATION)

5

## S<sub>N</sub>1 reactions

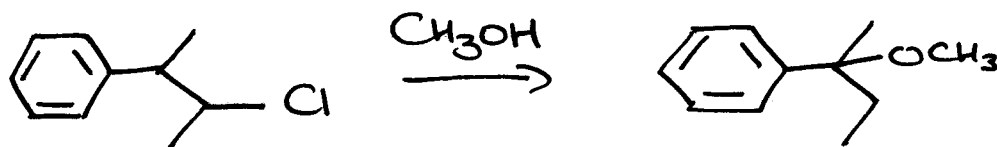
Favoured in POLAR PROTIC SOLVENTS

(transition state energy lowered by solvation)

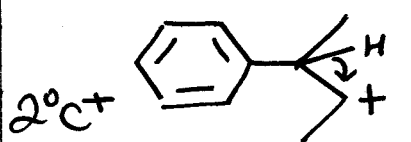
### ③ REARRANGEMENT

S<sub>N</sub>1 reaction → goes through a CARBOCATION INTERMEDIATE, so rearrangement is a possibility.

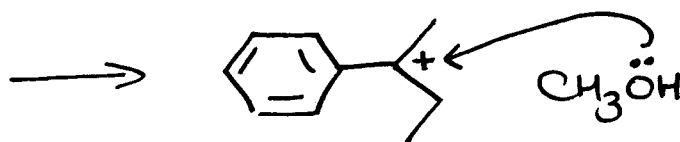
e.g.



↓ S<sub>N</sub>1



1,2 HYDRIDE SHIFT



3° and BENZYLIC C<sup>+</sup>

### ④ SUMMARY

Electrophile

Me / 1°

S<sub>N</sub>2

✓

S<sub>N</sub>1

✗

2°

GOOD NUCLEOPHILES  
POLAR APROTIC SOLVENTS

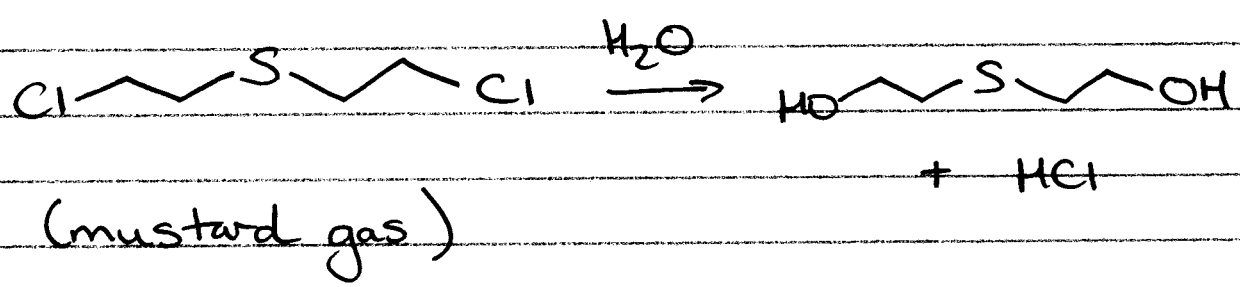
POOR NUCLEOPHILES  
POLAR PROTIC SOLVENTS  
(V. GOOD LEAVING GROUPS)

3°

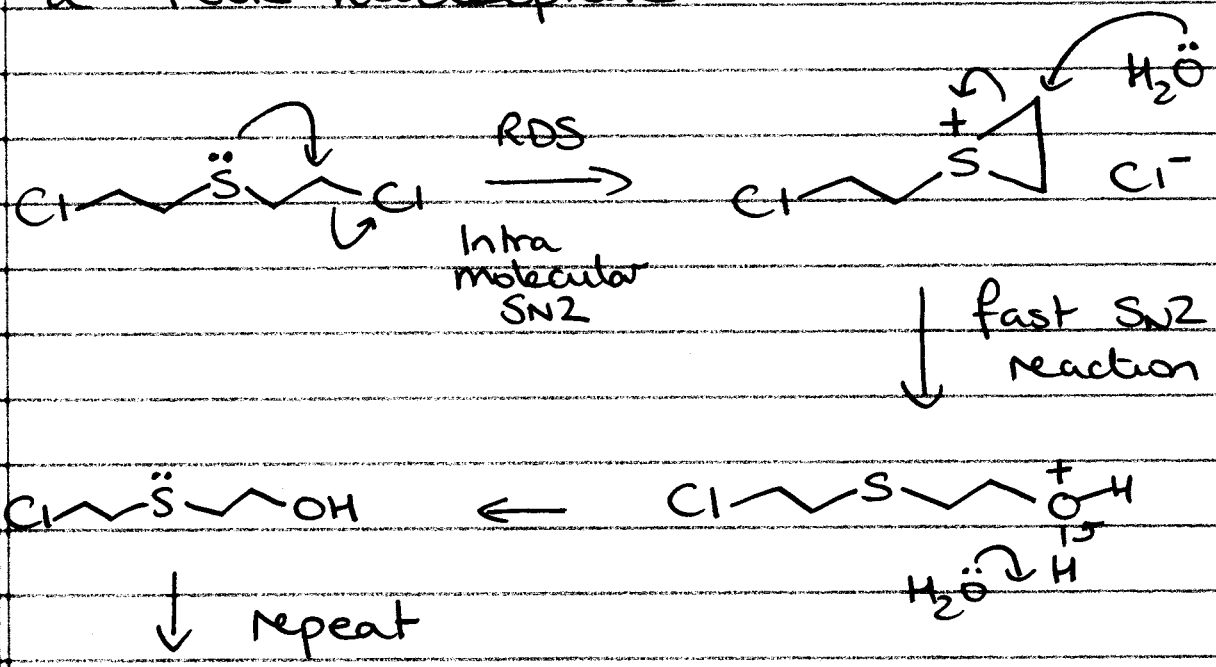
✗

✓

5) NEIGHBORING GROUP PARTICIPATION



Very rapid reaction, even though H<sub>2</sub>O is a poor nucleophile



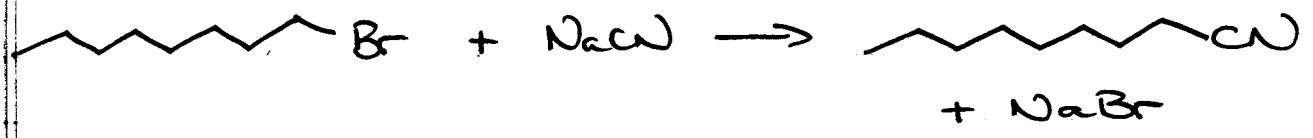
$$\text{overall rate} = k [\text{Cl}-\text{CH}_2-\text{S}-\text{CH}_2-\text{Cl}]$$

Independent of concentration of Nuc

Two consecutive SN2 reactions, with kinetics of an SN1 reaction

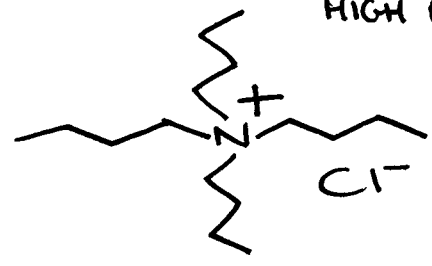
# ⑥ PHASE TRANSFER CATALYSIS

consider:



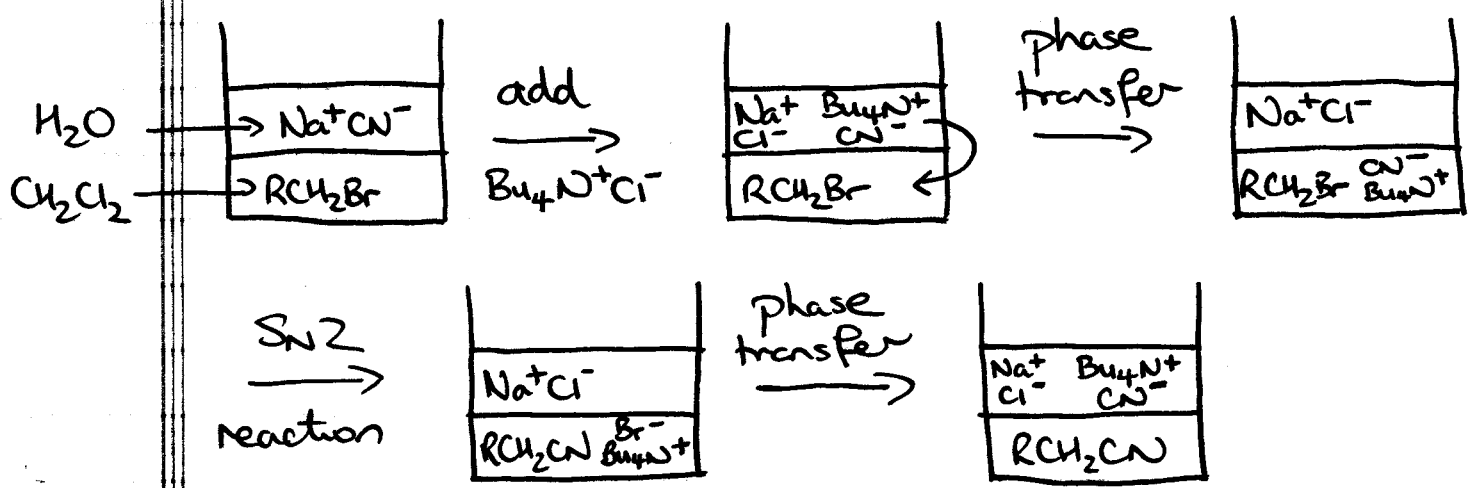
HYDROPHOBIC ORGANIC (non polar organics)      IONIC SALT (water)      COULD USE 189 - DMSO, DMF - 153 (EXPENSIVE, WATER SOLUBLE (RECOVERY) HIGH BOILING)

PHASE TRANSFER CATALYST



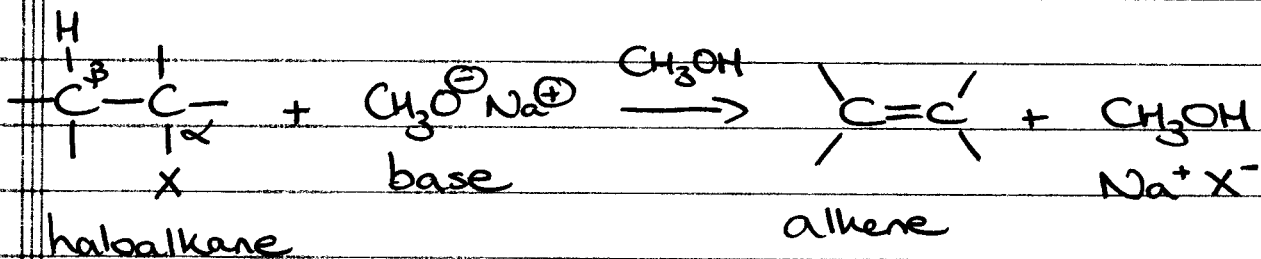
TETRABUTYL AMMONIUM CHLORIDE

TRANSPORTS THE ANION (NUCLEOPHILE) INTO THE ORGANIC PHASE

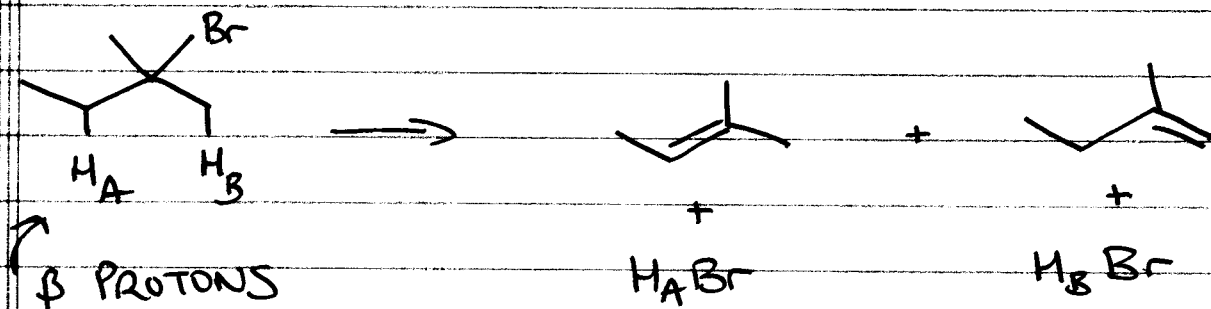
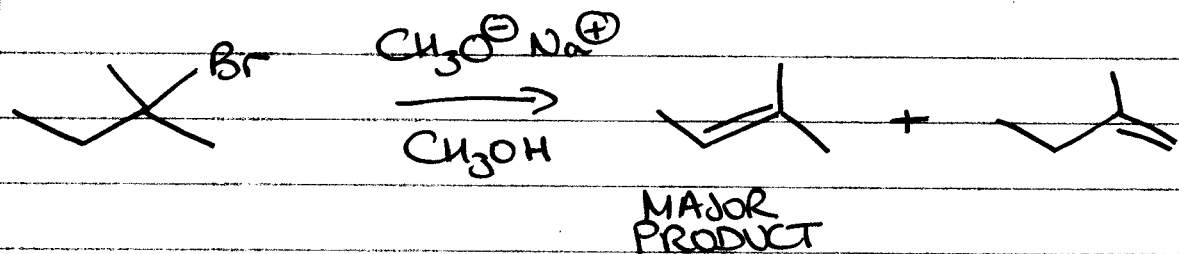
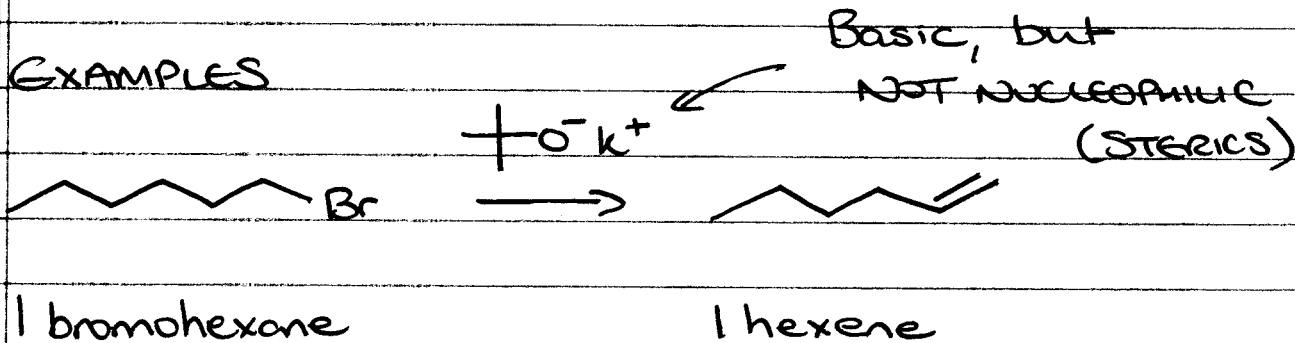


# ⑦ β-ELIMINATION REACTIONS

- one example DEHYDROHALOGENATION



SUBSTITUTION }  
ELIMINATION } COMPETING REACTIONS





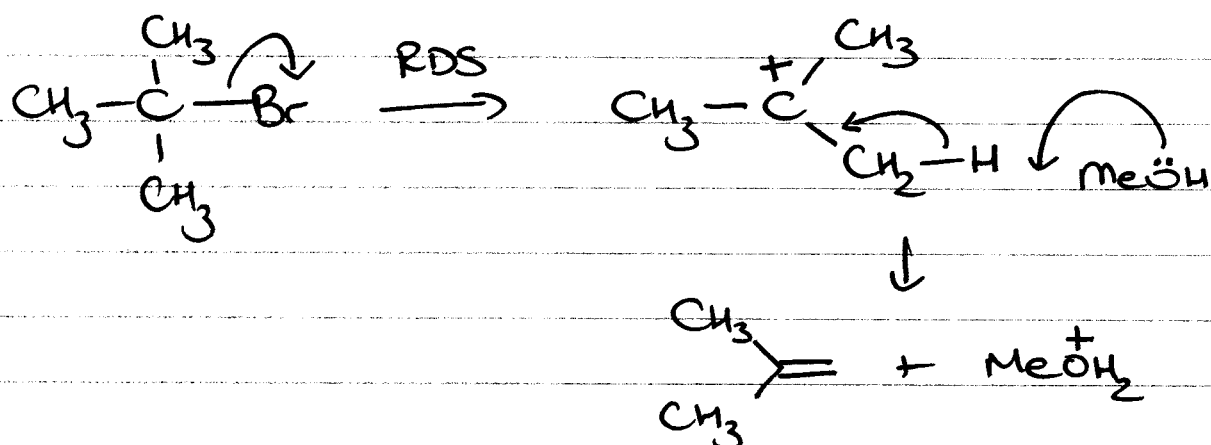
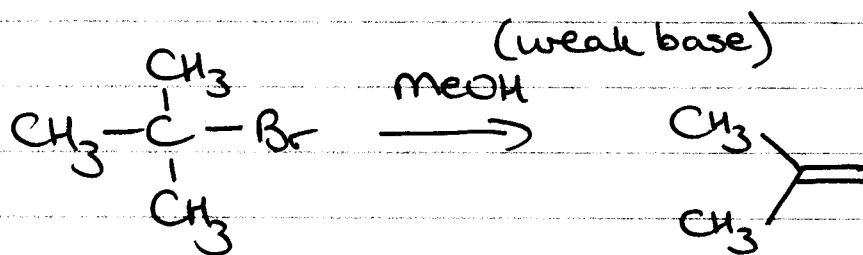
9

ZAITSEV'S RULE  $\rightarrow$  major product is the MOST SUBSTITUTED alkene

Mechanisms for  $\beta$ -ELIMINATION

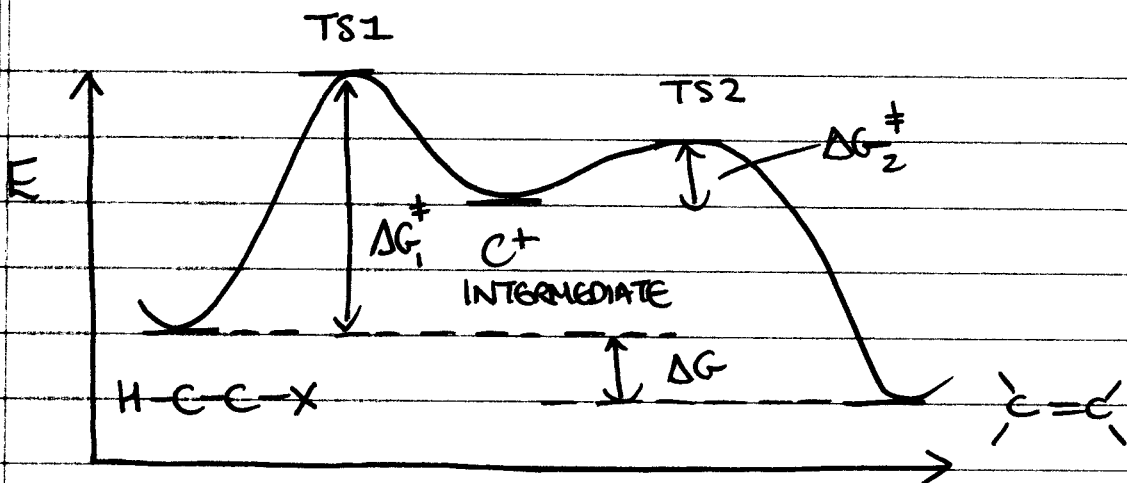
TWO LIMITING MECHANISMS

E1 (elimination unimolecular)

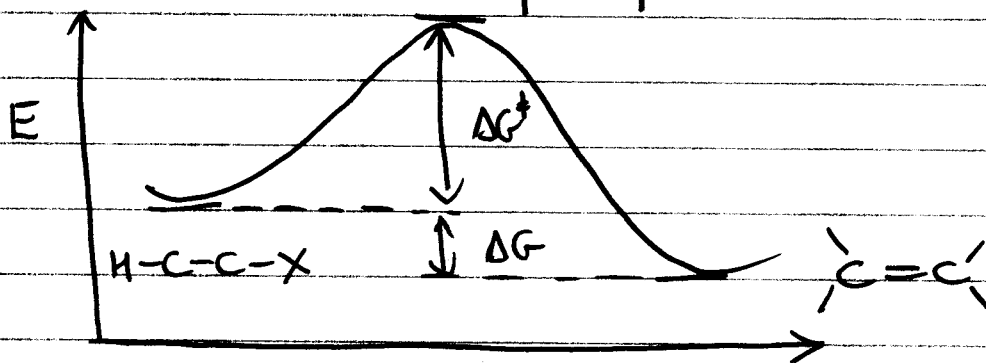
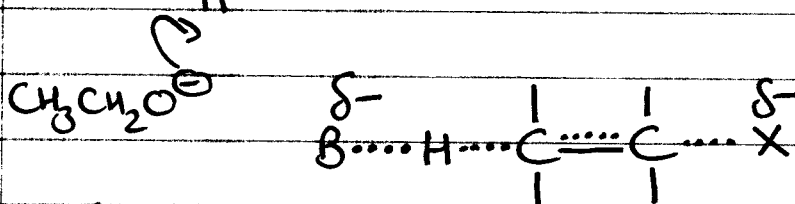
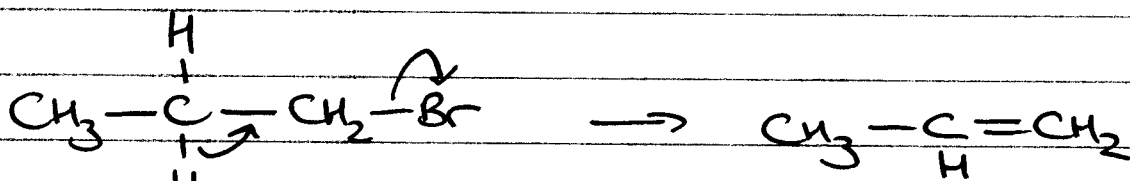
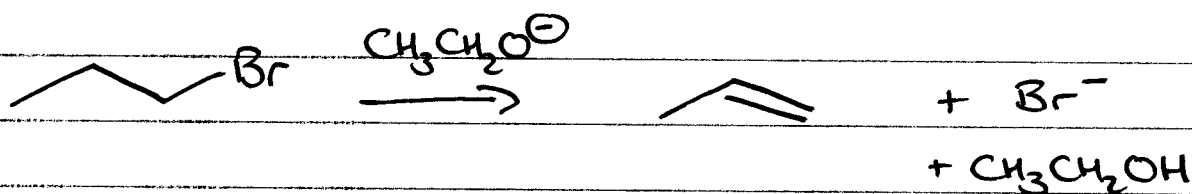


(competes with the S<sub>N</sub>1 reaction)

$$\text{rate} = k_1 [(\text{CH}_3)_3\text{C}-\text{Br}]$$



E2 (elimination bimolecular)



$$\text{rate} = k_2 [\text{alkyl bromide}] [\text{Base}]$$