Massachusetts Institute of Technology 5.12, Spring 2005
Problem Set 6, Due 4pm April 7

1. Consider the following reaction.

$$CH_3Br \quad OH^- \xrightarrow{\text{acetone}} CH_3OH \quad Br^-$$

SN2

small 1° substrate

aprotic solvent

rate = $k[OH^-][CH_3Br]$

a. If $[CH_3Br]$ is doubled, the rate of the reaction is:

quartered halved same (doubled) quadrupled

b. If $[OH^-]$ is doubled, the rate of the reaction is:

quartered halved same (doubled) quadrupled

c. If both $[CH_3Br]$ and $[OH^-]$ are doubled, the rate of the reaction is:

quartered halved same doubled (quadrupled)

2. Consider the following reaction.

$$(CH_3)_3CBr \xrightarrow{H_2O} (CH_3)_3COH \quad HBr$$

SN1

rate = $k[R\text{-}Br]$

a. If $[(CH_3)_3CBr]$ is doubled, the rate of the reaction is:

quartered halved same (doubled) quadrupled

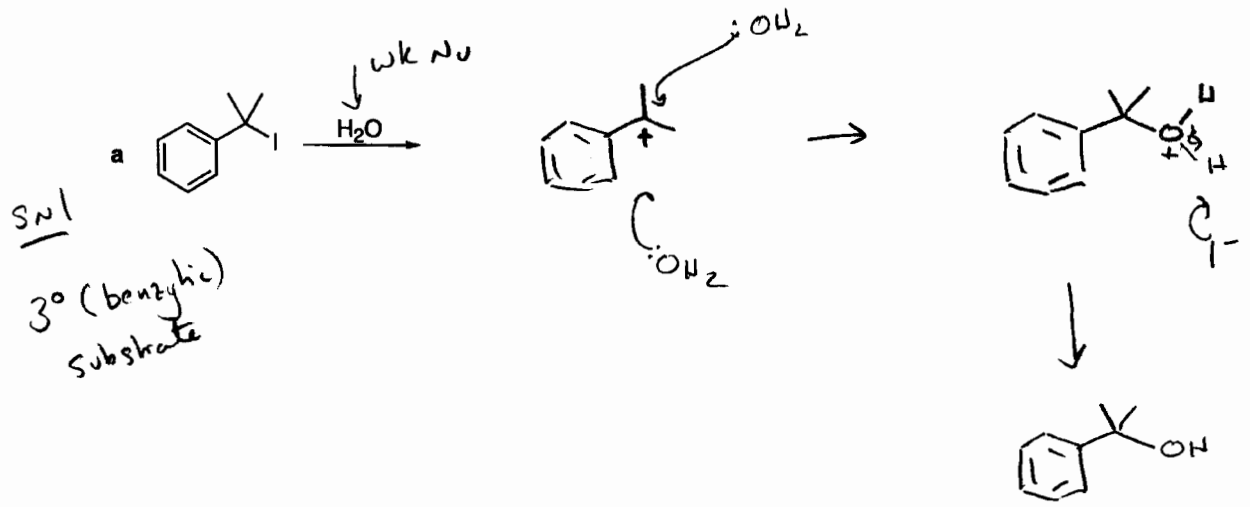
b. If $[H_2O]$ is doubled, the rate of the reaction is:

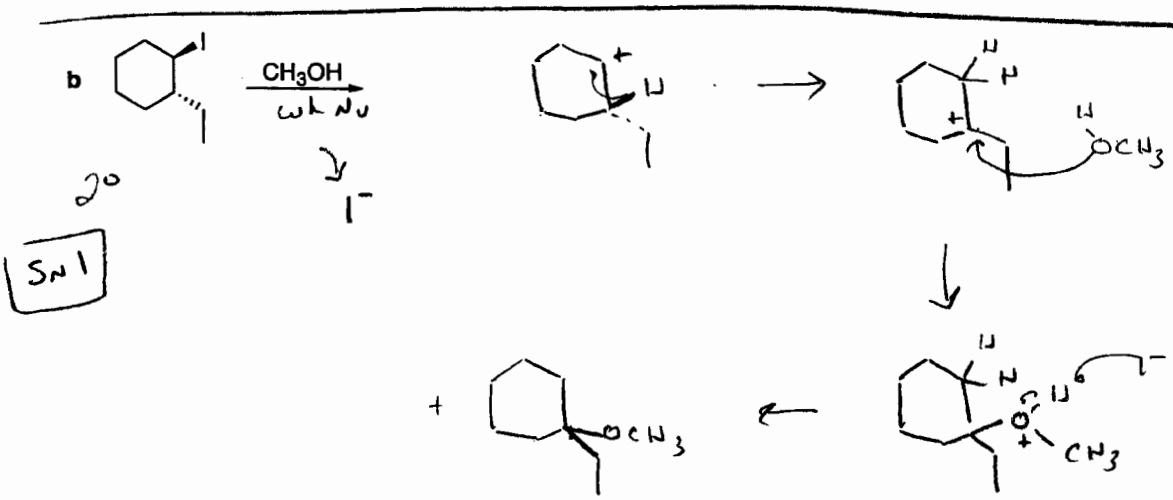
quartered halved (same) doubled quadrupled

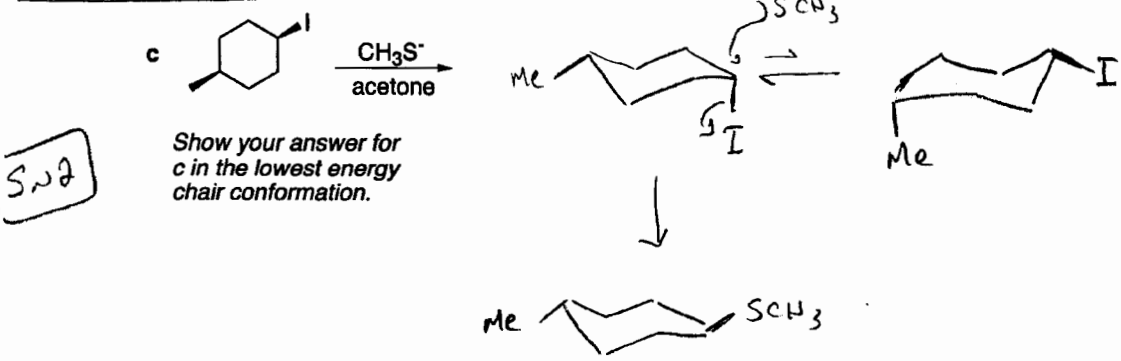
c. If both $[(CH_3)_3CBr]$ and $[H_2O]$ are doubled, the rate of the reaction is:

quartered halved same (doubled) quadrupled

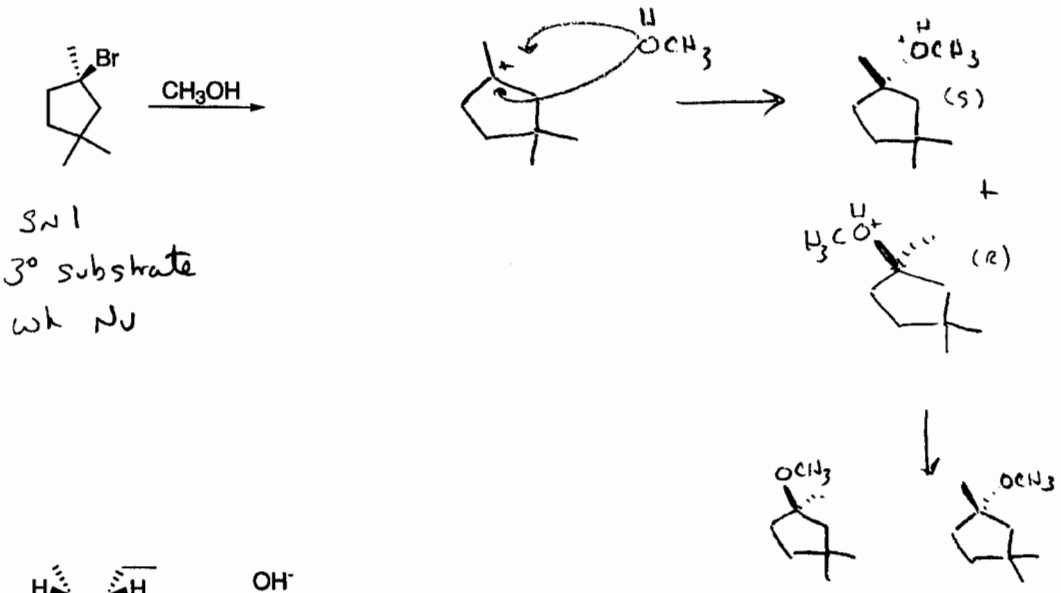
3. Draw the mechanism of the following reactions and the resulting products. Use curved arrows to indicate the direction of electron flow and show any reaction intermediates.





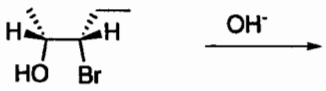


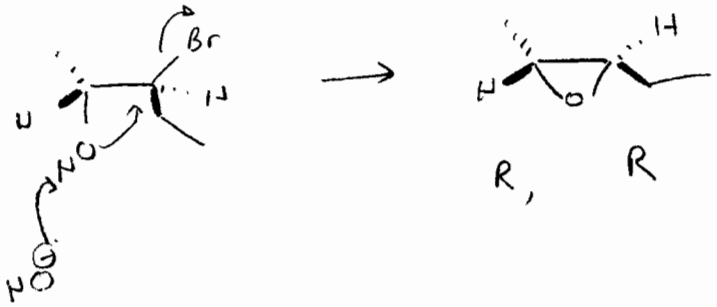
4. Draw the products of the following reactions. Indicate the sterochemistry of the products.



S_N1
3° substrate
wk NU

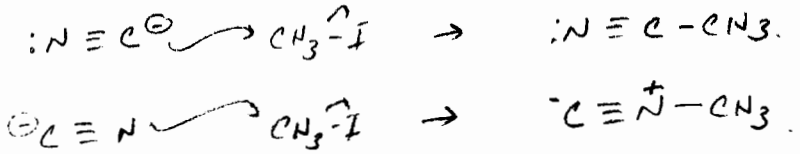
S_N2



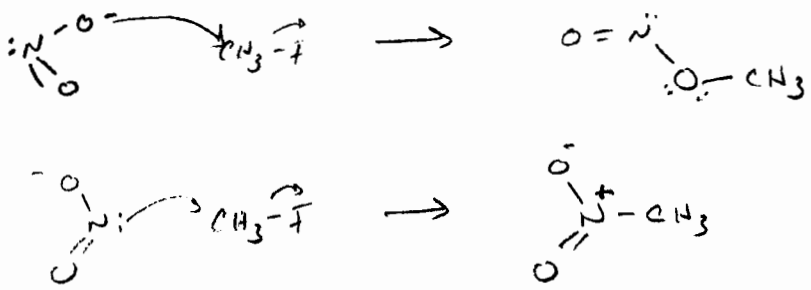


5. Some molecules have more than one nucleophilic center. Draw the possible products of the following reactions.

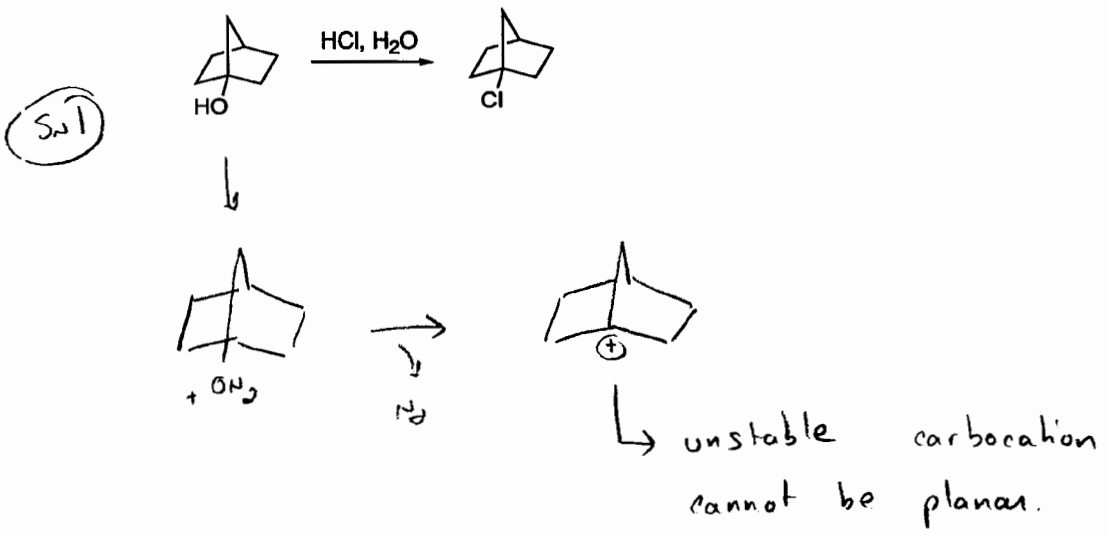
i $^{-}C{\equiv}N:$ CH_3I polar aprotic solvent →



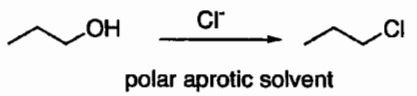
ii $O{=}\ddot{N}{-}O^{-}$ CH_3I polar aprotic solvent →



6. Explain, in one sentence plus a chemical structure, why the following reaction will not occur



7. The following reaction does not occur. Explain why in 1-2 sentences.



must by SN2

1° alkyl group

Hydroxide does NOT ACT as LG!

ophion => convert to better leavs group (i.e $SOCl_2$)

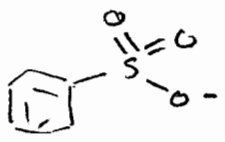
8a. Rank the following series of nucleophiles in methanol. 1 is the best.

Cl^-	OH^-	F^-	SH^-	H_2O
2	3	4	1	5

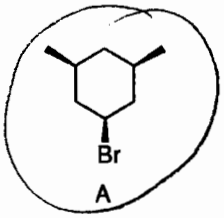
b. Rank the following series of leaving groups. 1 is the best

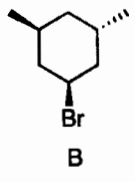
CH_3O^-	$C_6H_5SO_3^-$	H_2N^-	H_2O
3	2	4	1

$C_6H_5SO_3^-$ =

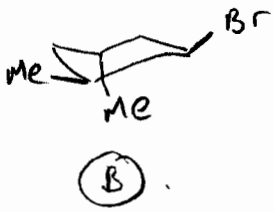


9a. Which reacts faster by the S_N2 mechanism, compound A or B? Why?

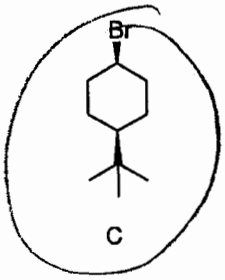


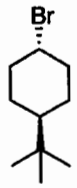


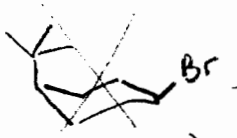
A will react faster:
Br less sterically hindered.



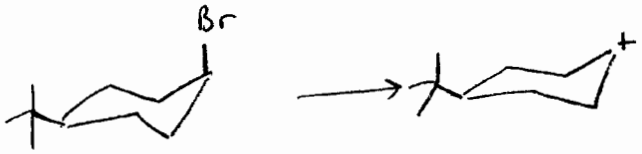
b. Which reacts faster by the S_N1 mechanism, compound C or D? Why?





(C): 

(tBu should be equatorial)



(less stable)

(D): 

(more stable

—— = C
- - - - = D

smaller $\Delta G^{\ddagger}$ for C

10. For the following pairs of reactions predict which is faster and explain why.

a. $(CH_3)_2CHCH_2Cl + N_3^- \xrightarrow{MeOH} (CH_3)_2CHCH_2N_3 + Cl^-$

$(CH_3)_2CHCH_2I + N_3^- \xrightarrow{MeOH} (CH_3)_2CHCH_2N_3 + I^-$

I^- better LG than Cl^-

b. $(CH_3)_3CBr \xrightarrow{H_2O} (CH_3)_3COH + HBr$

$(CH_3)_2CHBr \xrightarrow{H_2O} (CH_3)_2CH_2OH + HBr$

wk Nu (H_2O) → SN1 conditions

3° substrate better

c. $CH_3CH_2Br + CN^- \xrightarrow{MeOH} CH_3CH_2CN + Br^-$

$CH_3CH_2Br + CN^- \xrightarrow{DMF} CH_3CH_2CN + Br^-$

SN2 => 1° substrate

SN2 better in aprotic

d. $CH_3Br + (CH_3)_3N \longrightarrow (CH_3)_4N^+Br^-$

$CH_3Br + (CH_3)_3P \longrightarrow (CH_3)_4P^+Br^-$

P more polarizable, better NU.

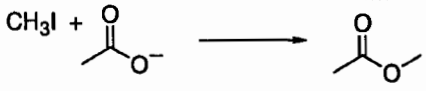
e. $CH_3CH_2Br + SCN^- \xrightarrow{EtOH} CH_3CH_2SCN + Br^-$

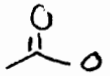
$CH_3CH_2Br + SCN^- \xrightarrow{EtOH} CH_3CH_2NCS + Br^-$

$SCN^- = {}^-S-C\equiv N: \longleftrightarrow S=C=N^{\ominus}$

S better NU than N.

f. $CH_3I + OH^- \longrightarrow CH_3OH + I^-$



^-OH stronger Nu than 

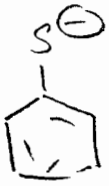
these are SN2 conditions (CH_3-I).

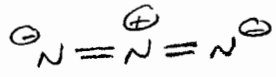
g. $(CH_3)_2CHCH_2Br + N_3^- \xrightarrow{EtOH} (CH_3)_2CHCH_2N_3 + Br^-$

$(CH_3)_2CHCH_2Br + C_6H_5S^- \xrightarrow{EtOH} (CH_3)_2CHCH_2SC_6H_5 + Br^-$

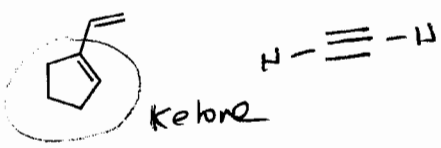
$pKa\ (HN_3) \approx pKa\ (C_6H_5SH)$

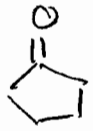
S better Nu than N.



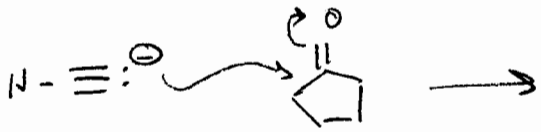


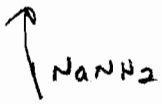
11. Design a synthesis of the following compound from acetylene and a ketone. (Hint- use your answer from problem set 5 # 4 to help)

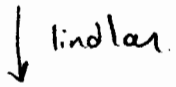


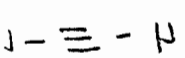


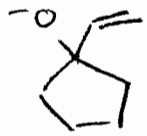
See PS 5 #4

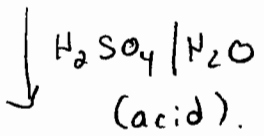


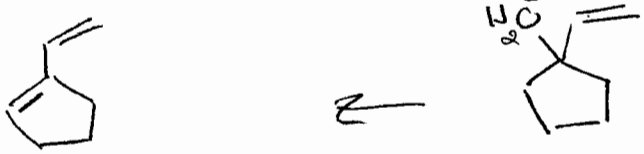












elimination!