

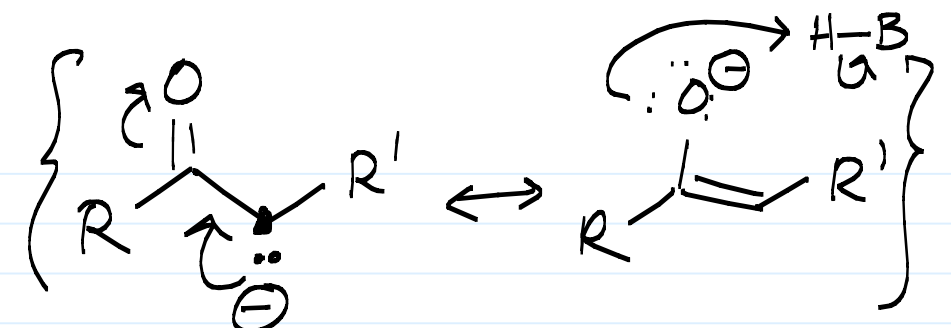
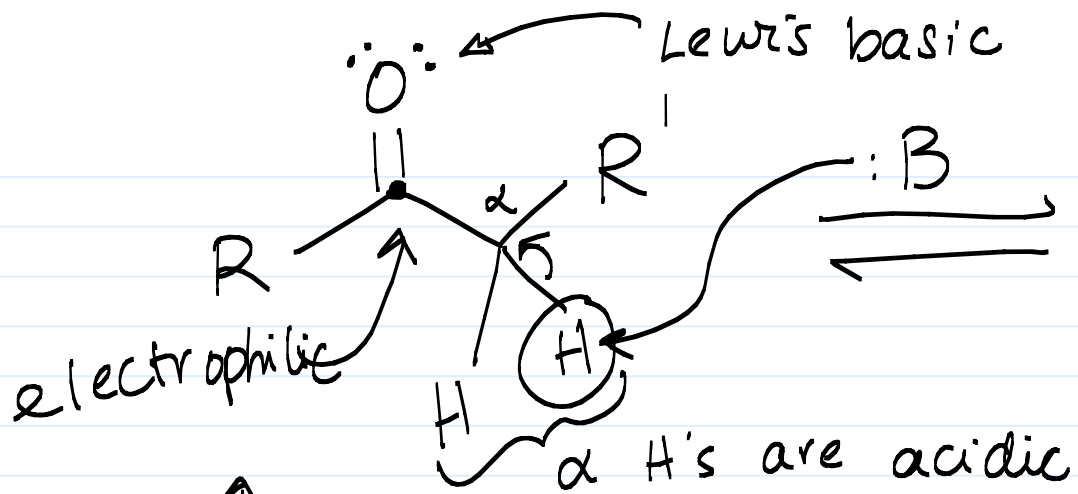
# Carbonyl Chemistry II (Enolates) - Chapter 19

Note Title

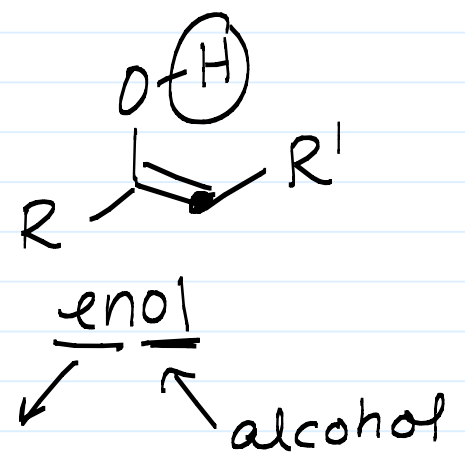
4/29/2014

## Announcements:

- (1) Midterm 3: Sat, May 3, 10am-12pm, KRB 100  
- Material through Chapter 18 (nothing from Chapter 19)
- (2) Review Session: Fri, 6-8 pm, 206 BRL
- (3) Discussion Sections: Carboxylic Acid Derivatives
- (4) Final Exam: Wed, May 28, 7-10 pm
- (5) Music Videos due this Friday, 5/2.

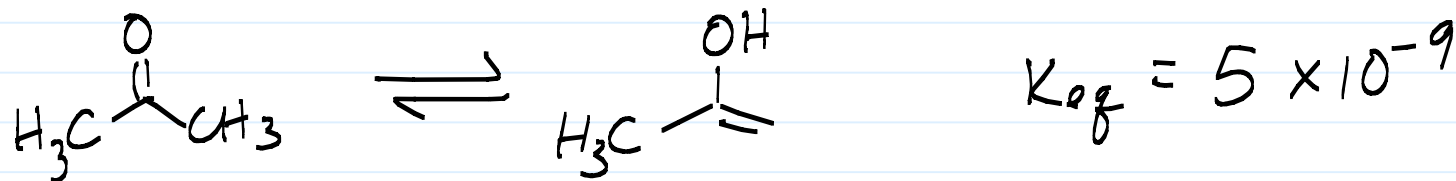
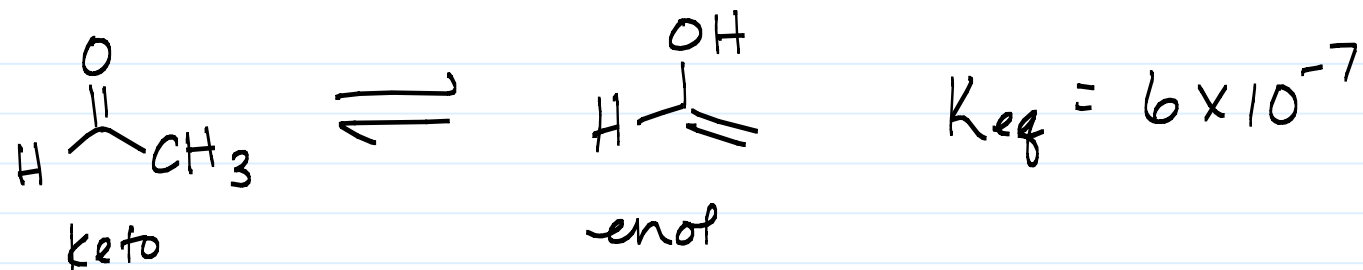


enolate  
 resonance stabilized

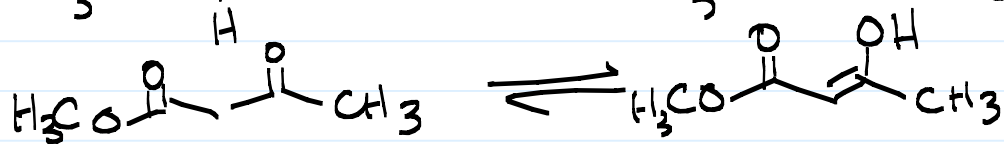
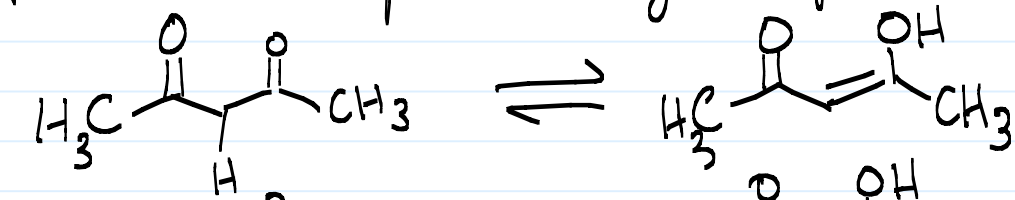


Tautomers interconverted by tautomerization. "keto-enol tautomerization"  
 Nucleophilic!! (with arrow pointing to the enolate)

For most aldehydes + ketones, keto is favored:



Special cases:  $\beta$ -carbonyl compounds



$$K_{\text{eq}} = 3.2$$

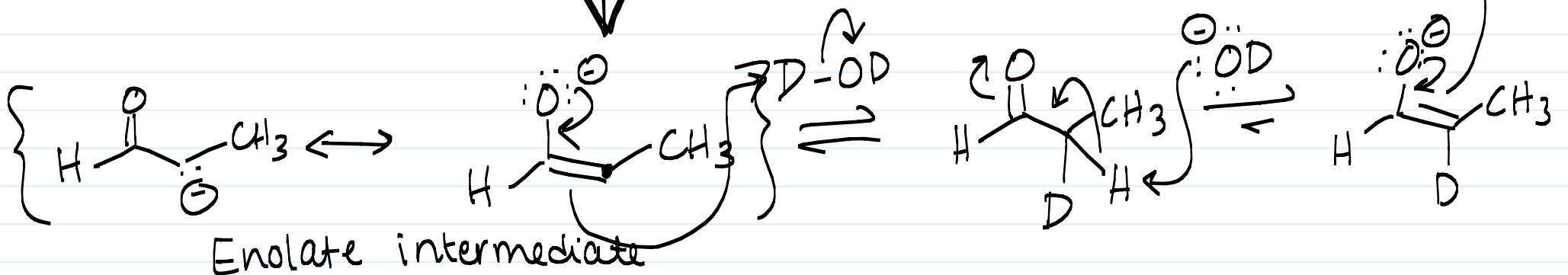
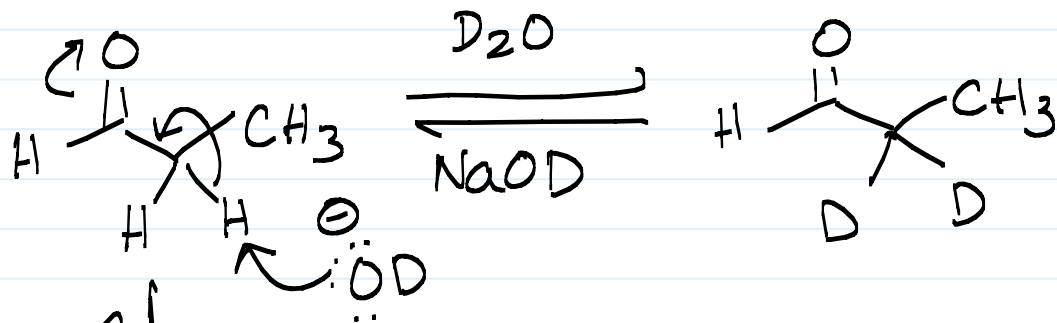
$$K_{\text{eq}} = 0.1$$

} Conjugation stabilizes enol form.

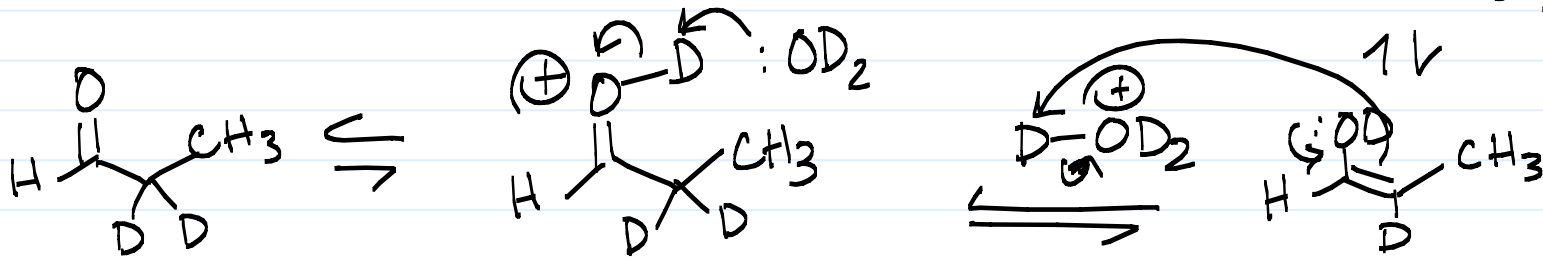
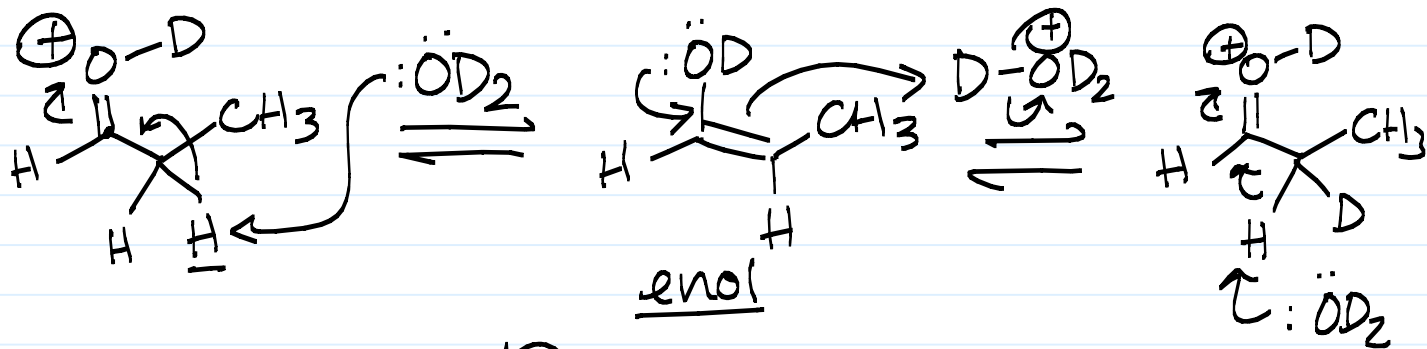
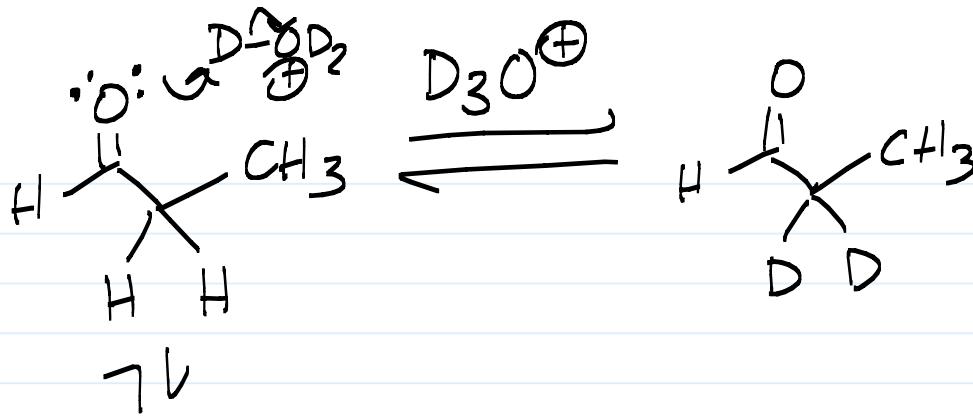
Just b/c Keq favors keto form doesn't mean enol isn't important...  
 ↑ or enolate.

H/D exchange

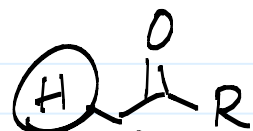
BASE CATALYZED



ACID-CATALYZED



Enols & Enolates possible w/ any carbonyl compound w/  $\alpha$ -H's:



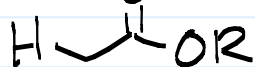
pKa

~17-19

\*  $\alpha$ -H's are mildly acidic \*

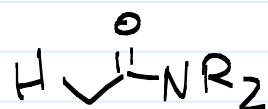


15-20



24

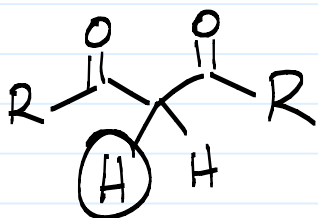
Practice Problems:



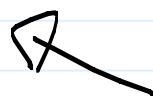
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(1) Explain why ketones are more acidic than esters & amides.

(Conjugate base...)



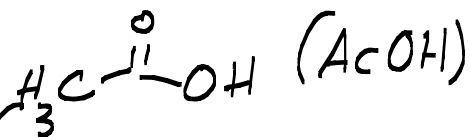
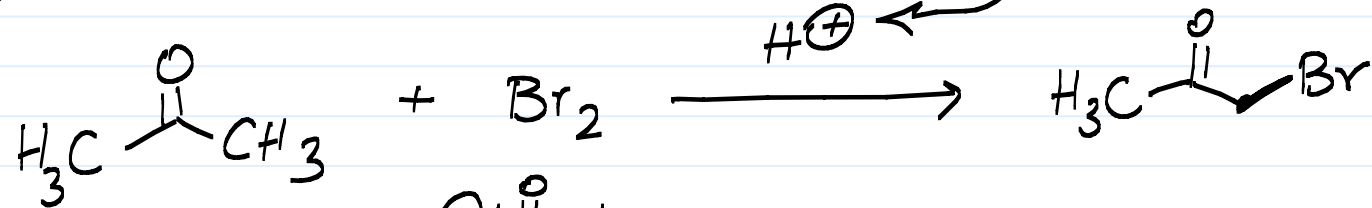
~9



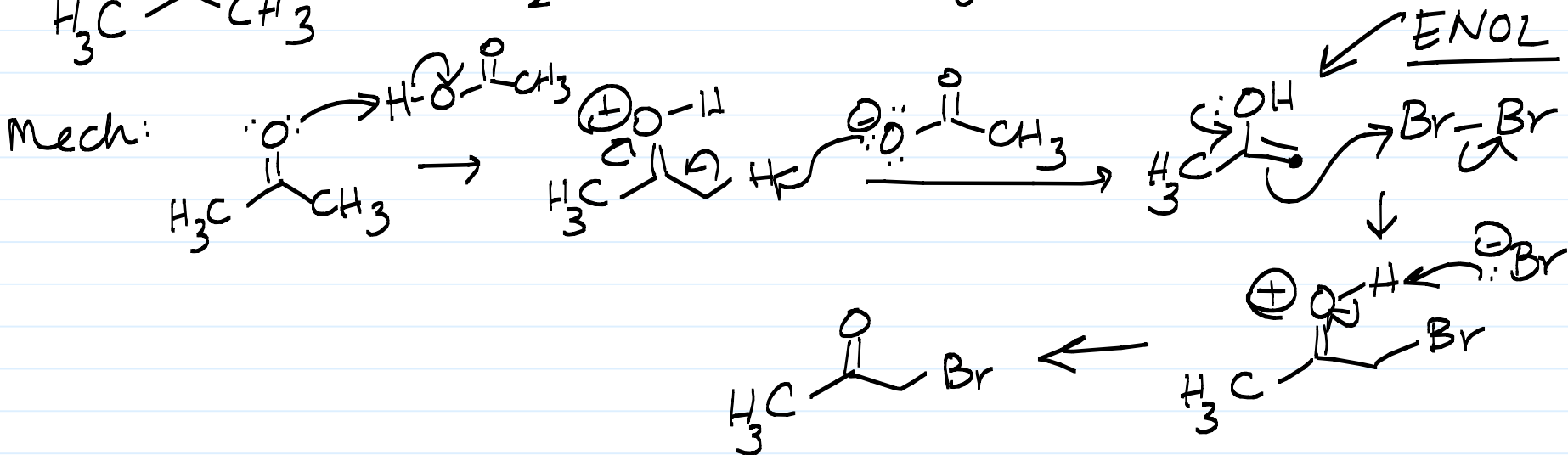
(2) Explain why  $\beta$ -keto carbonyls are so acidic.

# Reactions @ the $\alpha$ -Carbon

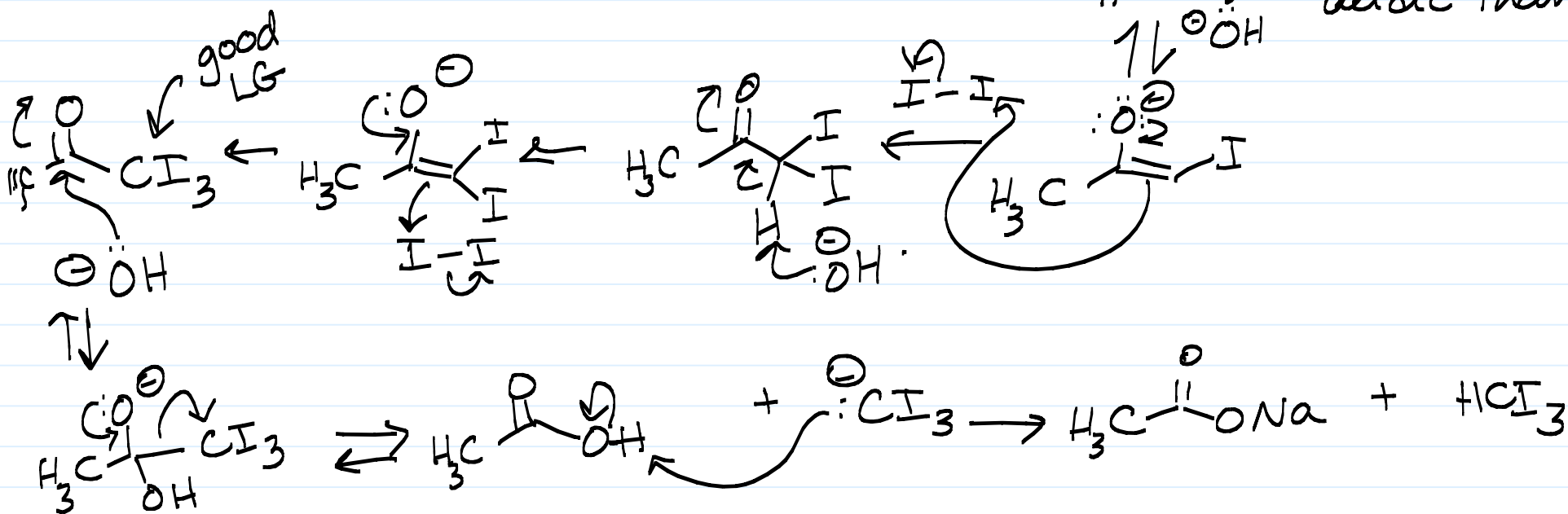
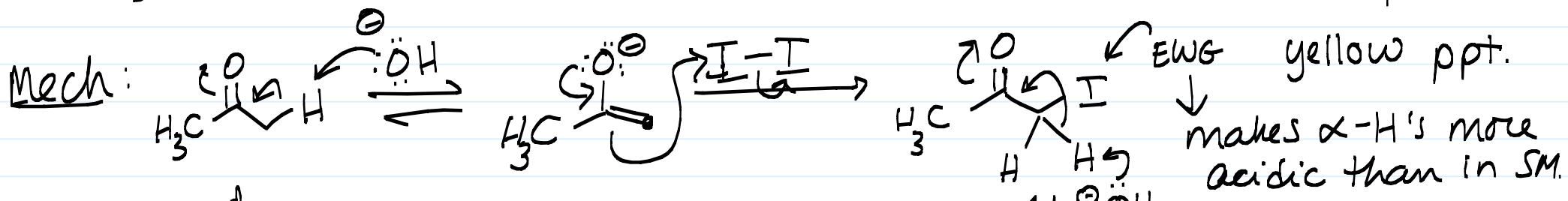
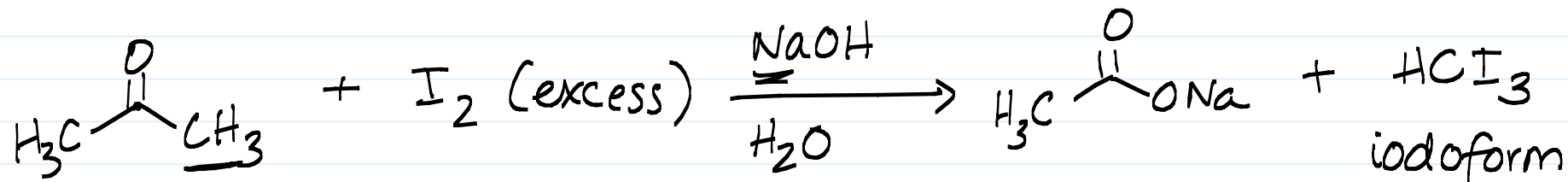
## ① Acid-catalyzed halogenation



Also works w/  
 $\text{Cl}_2$  or  $\text{I}_2$

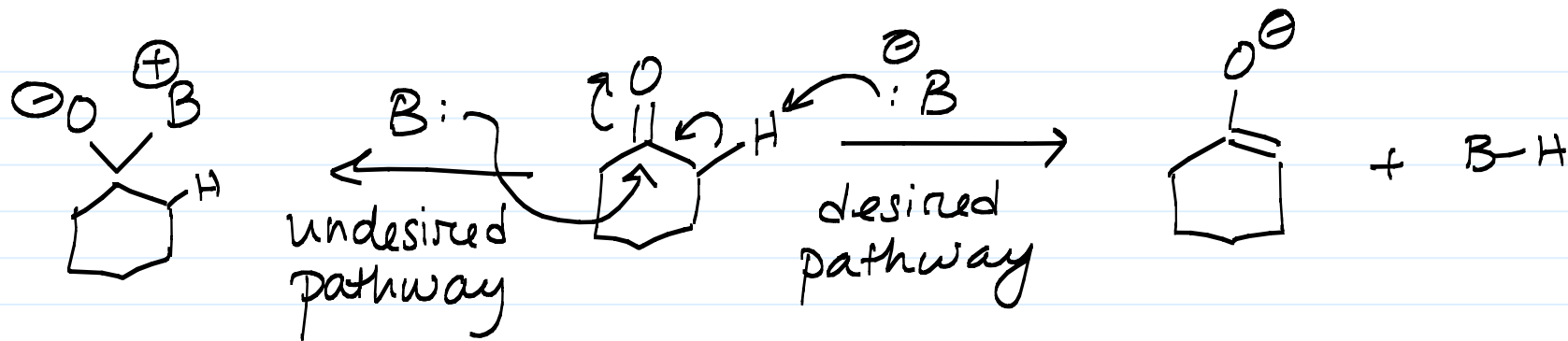


② Base-catalyzed halogenation → Haloform Reaction w/ methyl Carbonyls.





A closer look @ enolate form'n:



To control this: strong base + a bad nucleophile.

Common Bases:

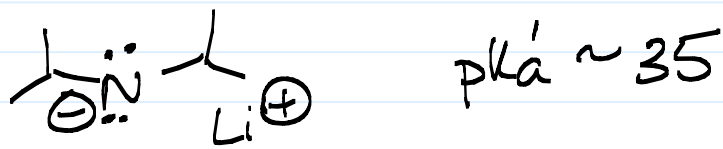
$\leftarrow$   $pK_a$  of conjugate acid  $\rightarrow H_2$

①  $NaH$  or  $KH$   $pK_a' \sim 35$

②  $pK_a' \sim 17$

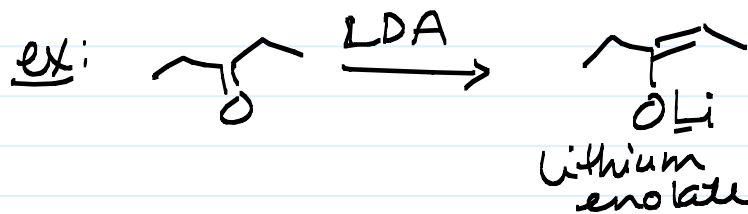
$\leftarrow$  ketones + aldehydes only  
not great for esters or amides

③ Lithium diisopropyl amide (LDA)

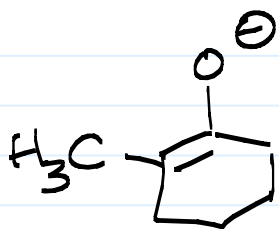


$pK_a' \sim 35$

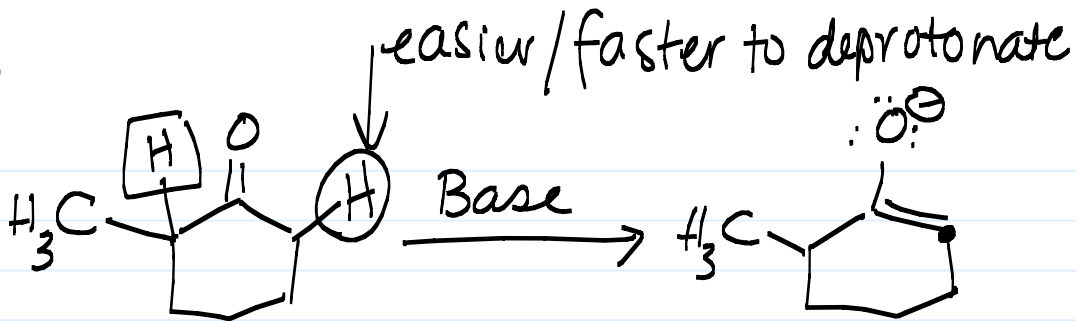
④  $Et_3N$   $pK_a' \sim 9$



# Stability of Enolates...



Base ←



more subst'd double bond

↓  
more stable

↓  
thermodynamically favored

↓  
"THERMODYNAMIC ENOLATE"

H's are less sterically hindered

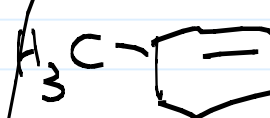
↓  
easier to deprotonate

↳ FASTER

↓  
kinetically favored

"KINETIC ENOLATE"

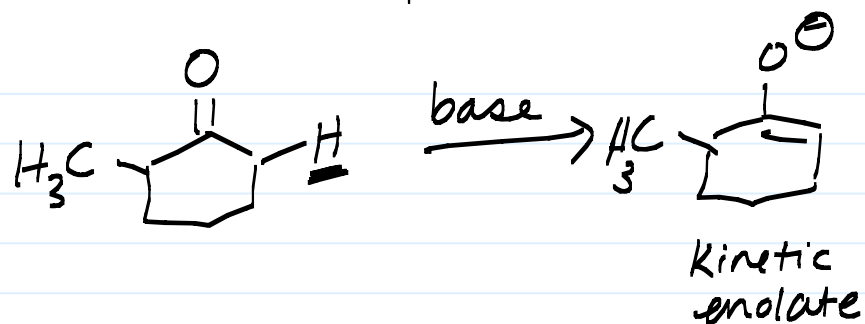
formed first



more stable

↓  
more substituted

Kinetic Enolate forms 1st.

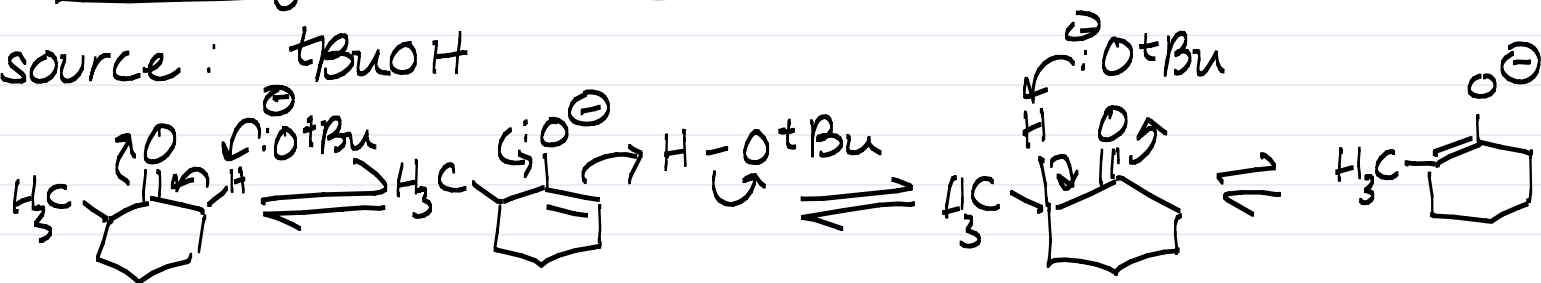


Order of addition:

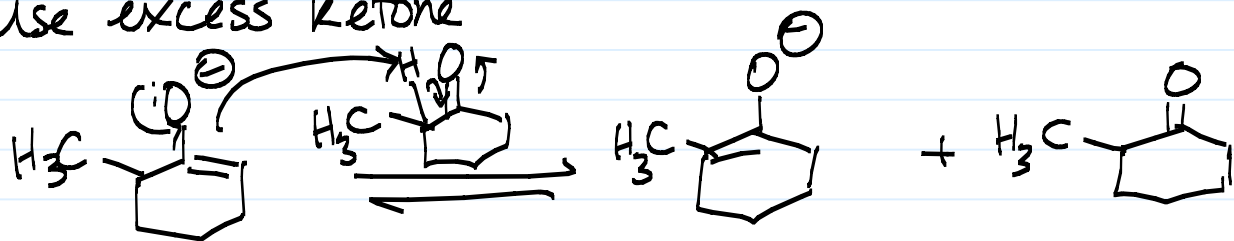
Add ketone to base.

How do we make thermodynamic enolate? ALLOW EQUILIBRATION

① Add proton source: *t*BuOH



② Use excess ketone



- Add base slowly to ketone

- or use a "slow" base  
↓  
NaH

## Conditions

### Kinetic

vs.

### Thermodynamic

- Rapid deprotonation
- Quantitative deprotonation
- low temp ( $< 0^{\circ}\text{C}$ )
- strong base
- irreversible deprotonation

Ideal: LDA,  $< 0^{\circ}\text{C}$

- slow deprotonation
- excess ketone
- reversible deprotonation
- higher temp ( $> 0^{\circ}\text{C}$ )
- allow equilibration

Ideal:  $\text{Et}_3\text{N}$  or  $\text{tBuO}^-/\text{tBuOH}$   
@ room temp

