ANSWERS.

CHM 2120A
Midterm #1
October 2, 2013

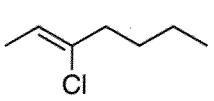
First Name: _____ Last Name: _____

Student Number: _____ Seat number: _____

Approximate total number of marks: 72
The marks are given as a guide and are subject to change.
You can write in pen or in pencil.
The use of molecular models is permitted but they cannot be shared.
The use of calculators or other electronic devices is not permitted.
There is a pK_a table on the last page.

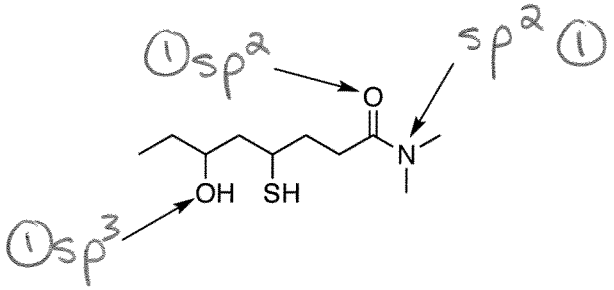
1a	2a	3b	4b	5b	6b	7b		8			1b	2b	3a	4a	5a	6a	7a	0
1 H																		2 He
3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn		31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd		49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg		81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Ha	106 106													

1. Name the following molecule. **(3 points)**

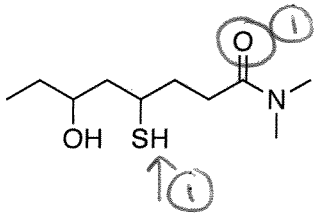


(1) (1) (1)
(Z)-3-chlorohept-2-ene
(Z)-3-chloro-2-heptene

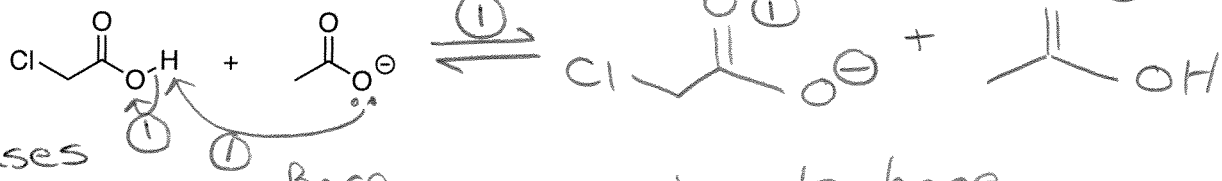
2. What is the hybridization of each of the indicated atoms? **(3 points)**



3. Point to the most acidic proton (→) and circle the most basic atom. **(2 points)**



4. For the following reaction:
   a. Draw the mechanism and products. **(5 points)**
   b. Determine the direction of the equilibrium. **(1 point)** → (1)
   c. Justify your answer in part b. **(3 points)**



compare bases

Base (B)

conjugate base (CB)

~~CB more stable than B~~

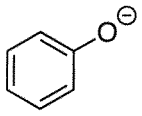
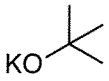
The CB is more stable than the B (1)

because of the inductive (1) effect – the electronegative Cl withdraws e⁻ density from the O⁻, decreasing its negative charge.

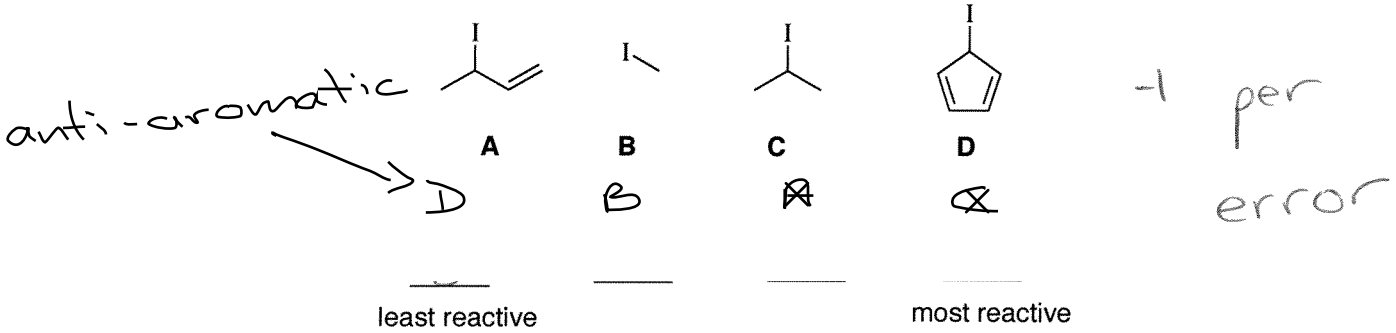
∴ equilibrium goes to the right

5.

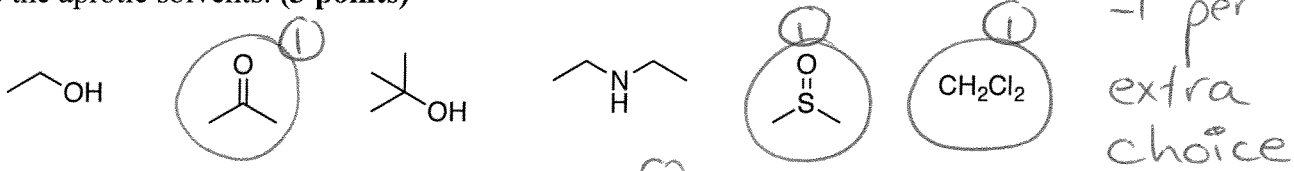
a. Draw the conjugate acid of each of the bases shown below. **(4 points)**
b. Circle the base that would deprotonate 1-butyne with an equilibrium that favours the products. **(1 point)**

Base	Conjugate acid
H_2O	$H_3O^{\oplus}$ (1)
	PhOH (1)
(1) $NaNH_2$	NH_3 (1)
	HO^tBu (1)

6. Rank the electrophiles in increasing order of reactivity in an S_N1 reaction. **(3 points)**

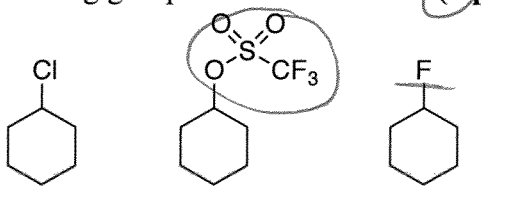


7. Circle the aprotic solvents. **(3 points)**

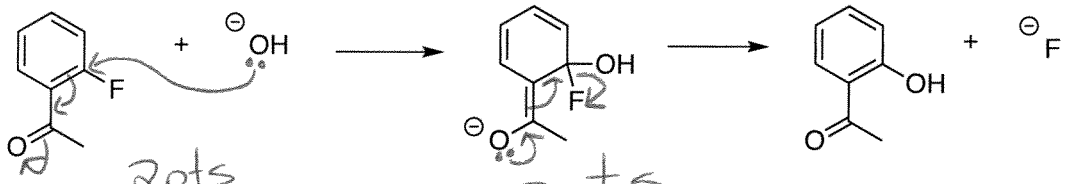


8.

a. Circle the best leaving group for an E1 reaction. **(1 point)**
b. Underline the worst leaving group for an E1 reaction. **(1 point)**

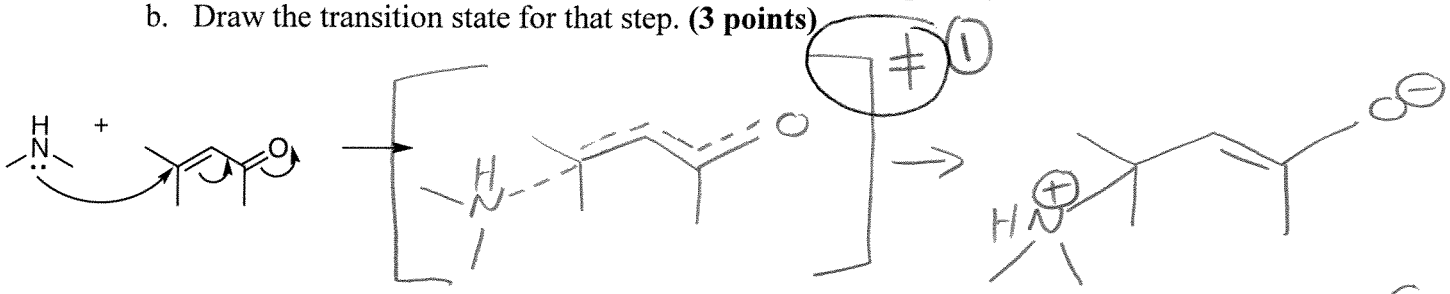


9. Add curved arrows to describe the mechanism for the following reaction. All reagents and intermediates have already been shown. **(4 points)**



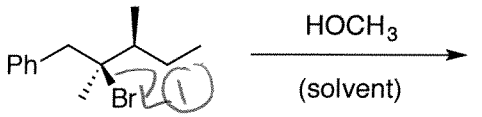
10.

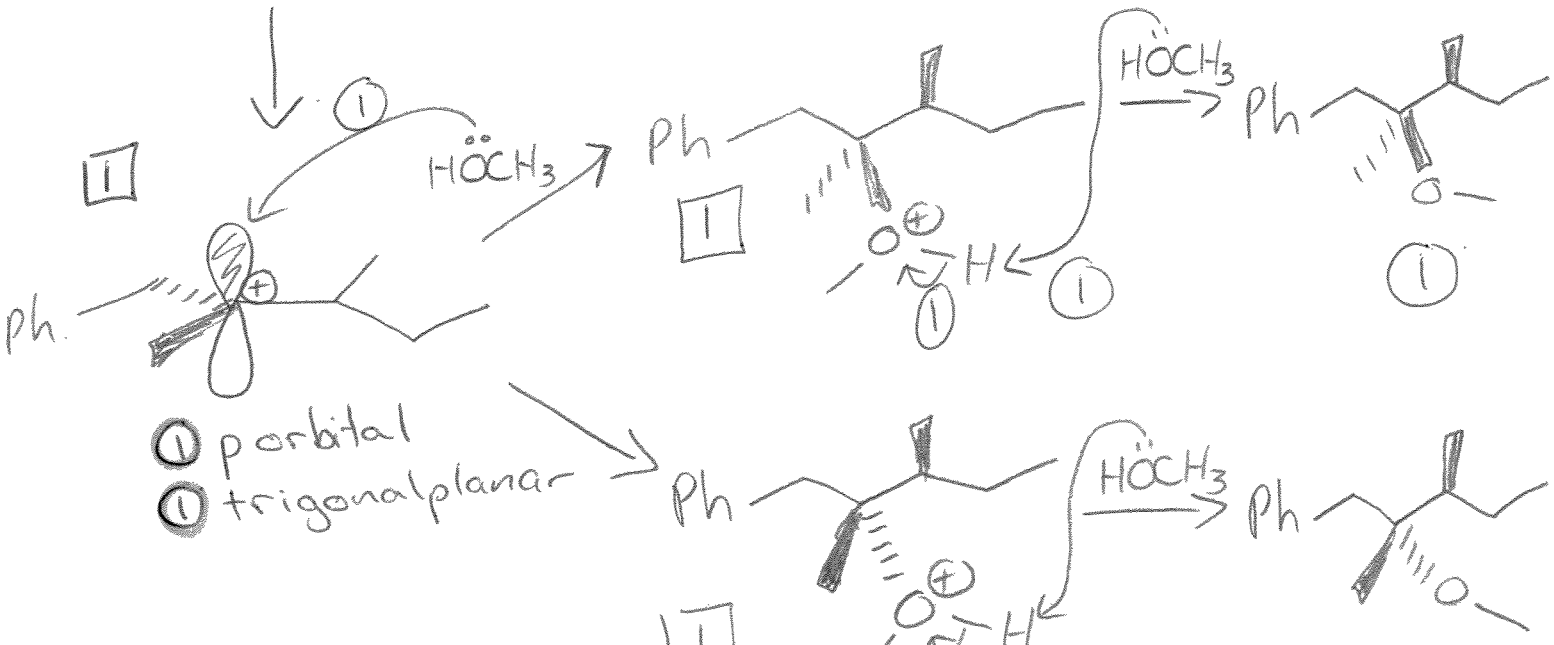
a. Draw the product of the reaction step shown below. **(2 points)**
b. Draw the transition state for that step. **(3 points)**



11.

a. Draw the mechanism and substitution products for this reaction. **(8 points)**
b. Draw the reactive orbital on the carbocation intermediate. **(2 points)** → p orbital(1) sp^2 geometry(1)

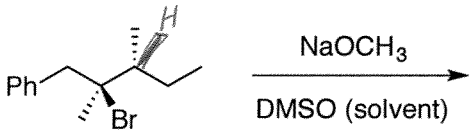


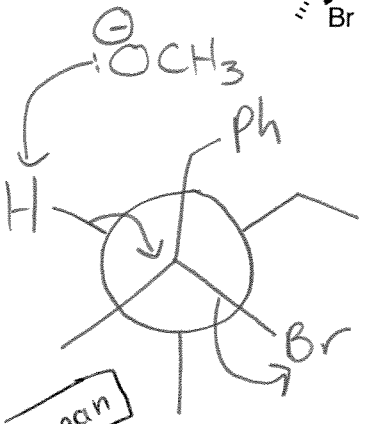


arrows = (1)
structure = (1)

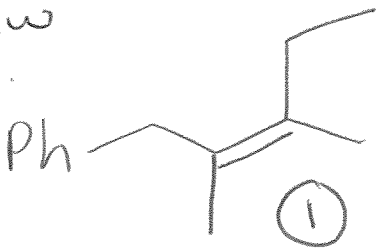
12.

a. What is the major mechanism for the reaction below? **(1 point)** E2.
b. Draw a Newman projection of the starting material in the reactive conformation. **(3 points)**
c. Draw the mechanism and the major organic product. **(3 points)**





Arrows (2) (ok to draw on ~)



(1)

(+ HOCH3 + Br)

(based on Newman).

Newman

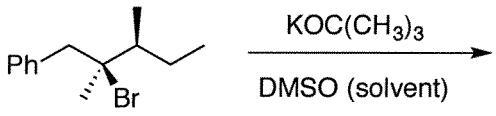
Correct constitutional isomer (1)

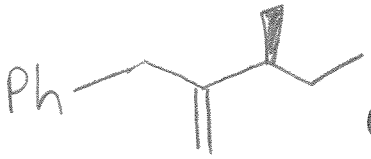
" stereoisomer (1)

H + Br APP (1)

13. Draw the missing reagent(s) OR the major organic product for the following reactions. **(3 points each; total 9 points)**

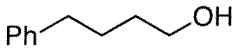
a.





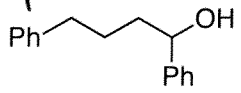
(1) regioisom
(1) stereoisom
(1) structure

b.

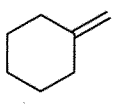


1. PCC (2)
2. PhMgBr (1)
3. H_3O^+

(1 pt if Jones' reagent).

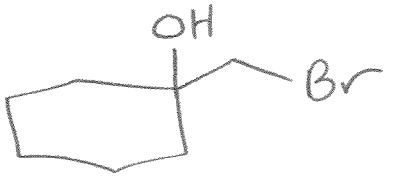


c.

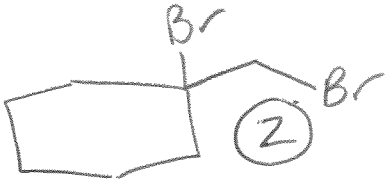


Br_2

H_2O (excess)



(3)

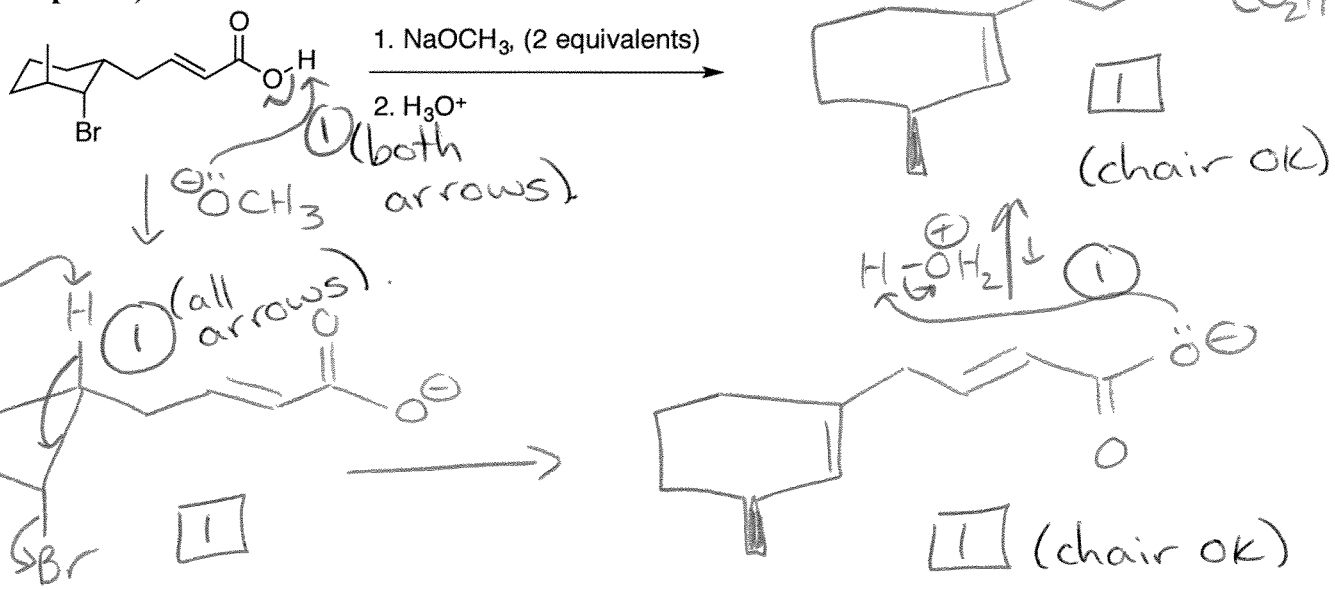


(2)

A/B 1st (1)
correct H (1)
(APP to Br)

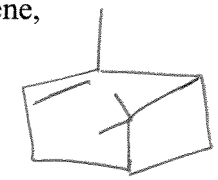
arrows = (1)
structure = [1]

14. Draw the mechanism and major organic product for the following reaction. (8 points)

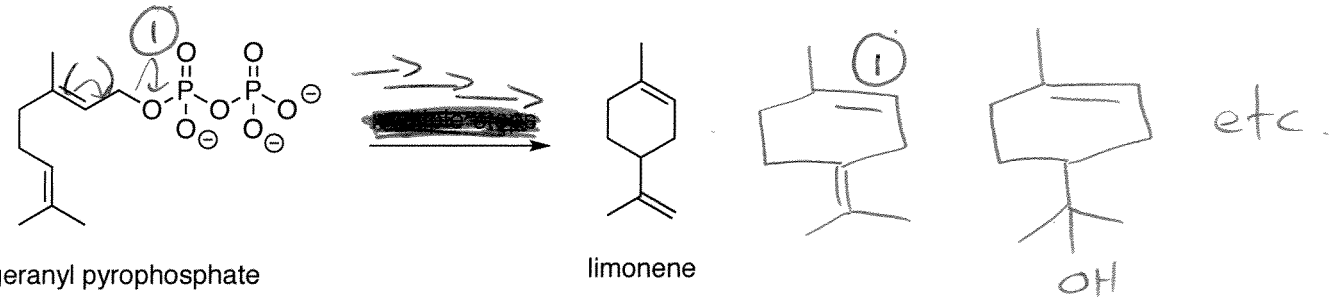


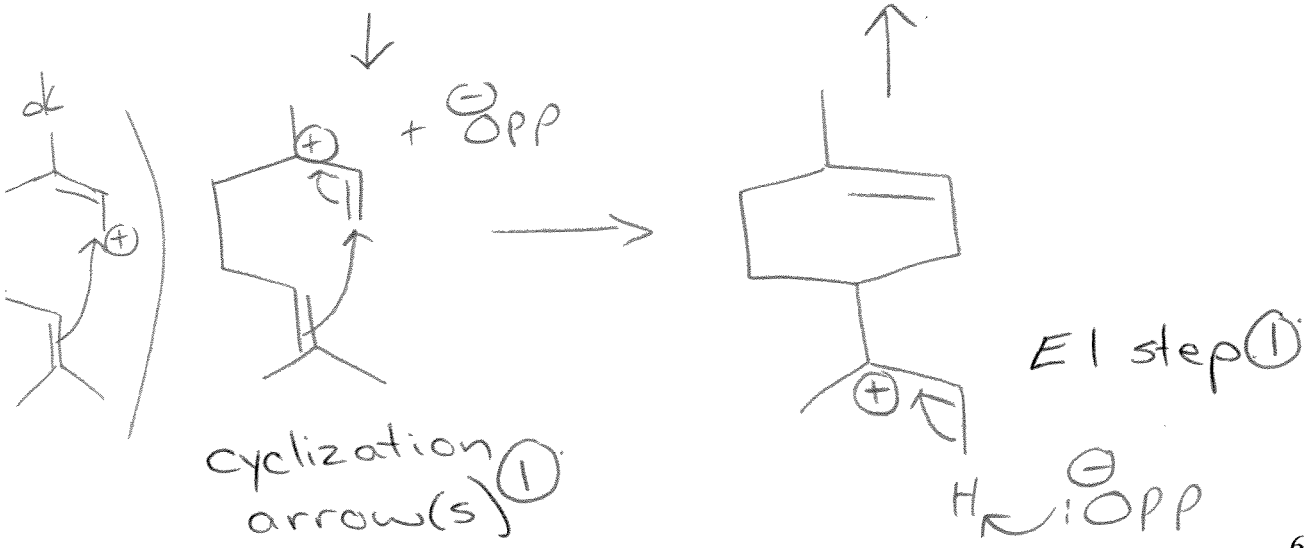
BONUS! (6 points) 4

Reactions of the following monoterpene natural product, called geranyl pyrophosphate (GPP), can generate MANY different products. One of those products is limonene, shown below, which contributes to the smell of oranges and lemons.



a) Draw a mechanism to explain the formation of limonene.
b) Draw one other possible product.





	Acid	Approximate pK_a	Conjugate Base	
Strongest acid	$HSbF_6$	<-12	SbF_6^-	Weakest base
	HI	-10	I^-	
	H_2SO_4	-9	HSO_4^-	
	HBr	-9	Br^-	
	HCl	-7	Cl^-	
	$C_6H_5SO_3H$	-6.5	$C_6H_5SO_3^-$	
	$(CH_3)_2\overset{+}{O}H$	-3.8	$(CH_3)_2O$	
	$(CH_3)_2C{=}\overset{+}{O}H$	-2.9	$(CH_3)_2C{=}O$	
	$CH_3\overset{+}{O}H_2$	-2.5	CH_3OH	
	H_3O^+	-1.74	H_2O	
	HNO_3	-1.4	NO_3^-	
	CF_3CO_2H	0.18	$CF_3CO_2^-$	
	HF	3.2	F^-	
	$C_6H_5CO_2H$	4.21	$C_6H_5CO_2^-$	
	$C_6H_5NH_3^+$	4.63	$C_6H_5NH_2$	
	CH_3CO_2H	4.75	$CH_3CO_2^-$	
	H_2CO_3	6.35	HCO_3^-	
	$CH_3COCH_2COCH_3$	9.0	$CH_3COHCOCH_3$	
	NH_4^+	9.2	NH_3	
	C_6H_5OH	9.9	$C_6H_5O^-$	
	HCO_3^-	10.2	CO_3^{2-}	
	$CH_3NH_3^+$	10.6	CH_3NH_2	
	H_2O	15.7	OH^-	
	CH_3CH_2OH	16	$CH_3CH_2O^-$	
	$(CH_3)_3COH$	18	$(CH_3)_3CO^-$	
	CH_3COCH_3	19.2	$^-CH_2COCH_3$	
	$HC{\equiv}CH$	25	$HC{\equiv}C^-$	
	H_2	35	H^-	
	NH_3	38	NH_2^-	
	$CH_2{=}CH_2$	44	$CH_2{=}CH^-$	
Weakest acid	CH_3CH_3	50	$CH_3CH_2^-$	Strongest base

Increasing acid strength

Increasing base strength