

Key

CHM 2120B - MIDTERM #1

Date: October 2, 2019

Duration: 75 minutes

Professeur : Claudia El Nachef

First name: _____

Last name: _____

Student #: _____

- Total number of points : 74
- Molecular model is allowed.
- Faculty-approved calculator is permitted.
- Scratch papers to be submitted with the exam copy.
- A simplified pKa table is provided on the last page.

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

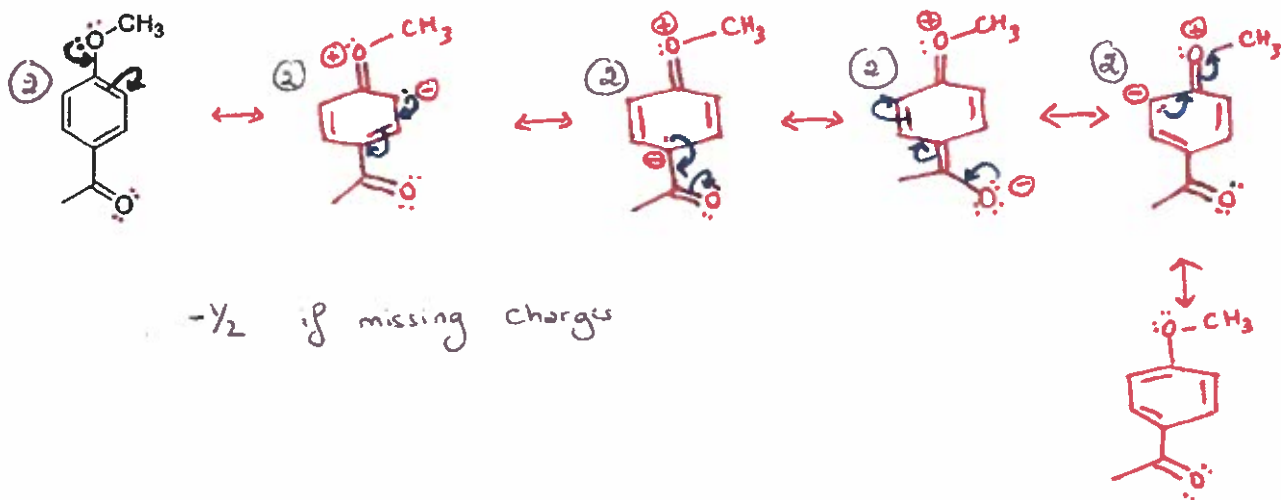
58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Th	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Cellular phones, unauthorized electronic devices or course notes (unless an open-book exam) are not allowed during this exam. Phones and devices must be turned off and put away in your bag. Do not keep them in your possession, such as in your pockets. If caught with such a device or document, the following may occur: academic fraud allegations will be filed which may result in your obtaining a 0 (zero) for the exam.

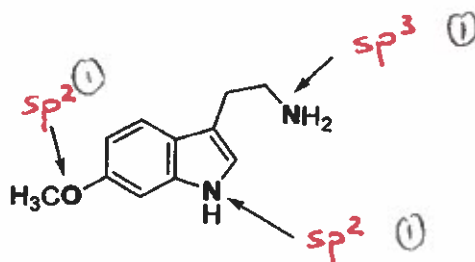
By signing below, you acknowledge that you have read and ensured that you are complying with the above statement.

GOOD LUCK!

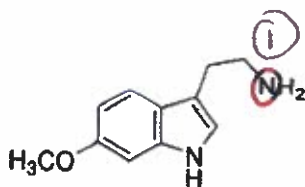
1. Draw the resonance structures of the following molecule, using curved arrows to show electron movement and appropriate arrows to show the relationship between the structures. All lone pairs and charges must be clearly shown. (10 points)



2. a) Determine the hybridization state of the oxygen and both nitrogen atoms indicated with an arrow in the following structure. (3 points)



- b) Circle the most basic atom on the structure and explain briefly your choice. (4 points)



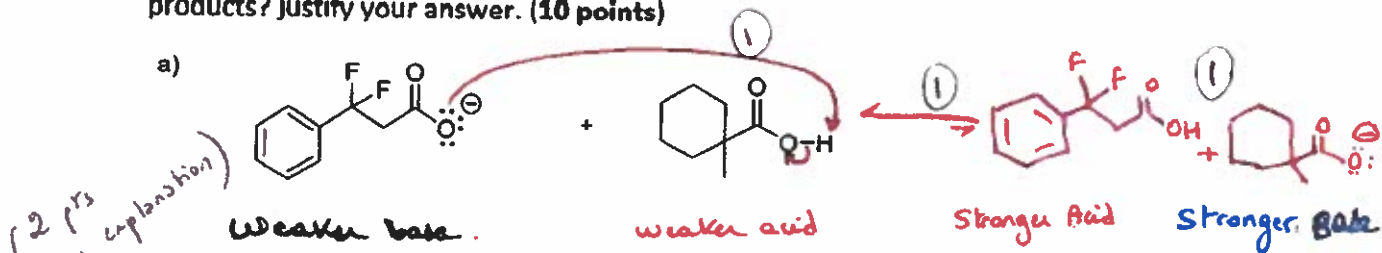
This nitrogen has the most electron density:

- It is sp^3 (less s-character)
- lone pair available localized.

- Nitrogen is also less electronegative than "O"

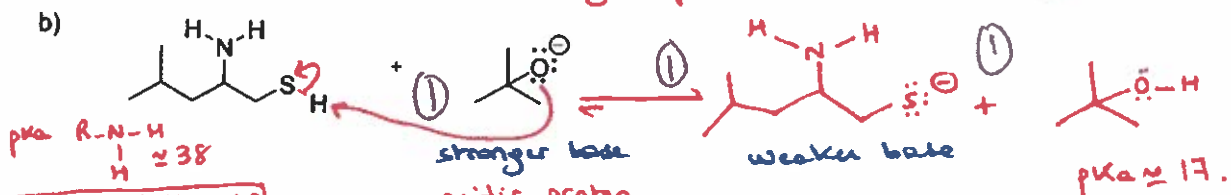
(3)
(full mark if 2 explanations)

3. Complete each of the following reversible reactions. Use curved arrows to show the mechanism. Once products are established, show by using uneven equilibrium arrows, in each of the following cases, what side does the equilibrium favor, the starting materials or the products? justify your answer. (10 points)



* Relative Stability of the bases: In the presence of the electronegative atom F, the anion is more stabilized by inductive effect (electron shared between multiple atoms).

* Acidity: F is an electronegative atom, decreasing by inductive effect the electron density around the oxygen, weakening therefore the O-H bond making proton more acidic.

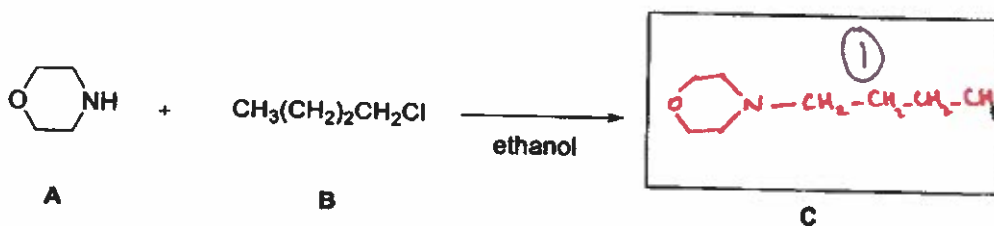


* pK_a R-S-H \approx 10 ← more acidic proton
Stronger Acid

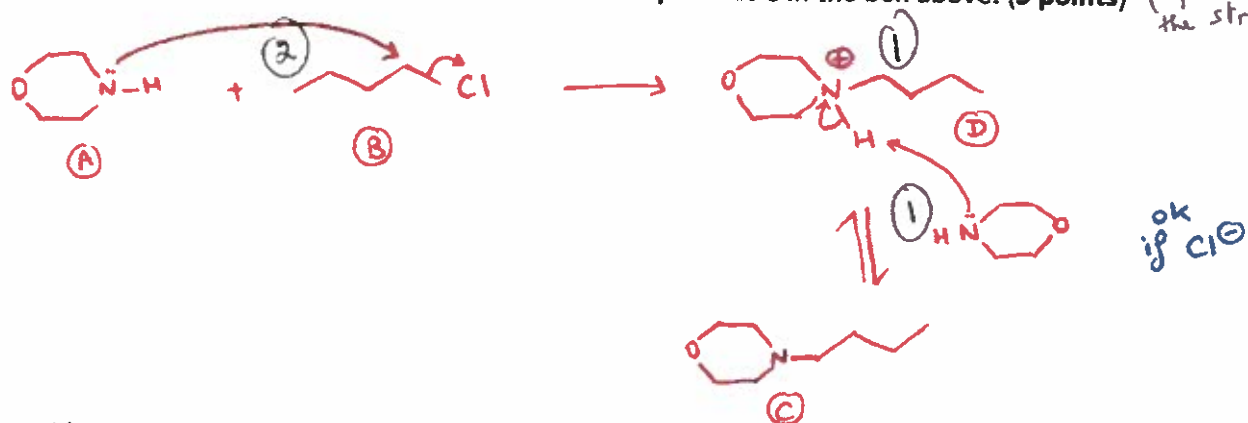
Weaker acid (lower pK_a)

* Relative stability: $R\ddot{S}^-$ vs $R\ddot{O}^-$
Sulfur is a bigger atom than oxygen; it would stabilize the negative charge more \Rightarrow more stable anion therefore weaker base.

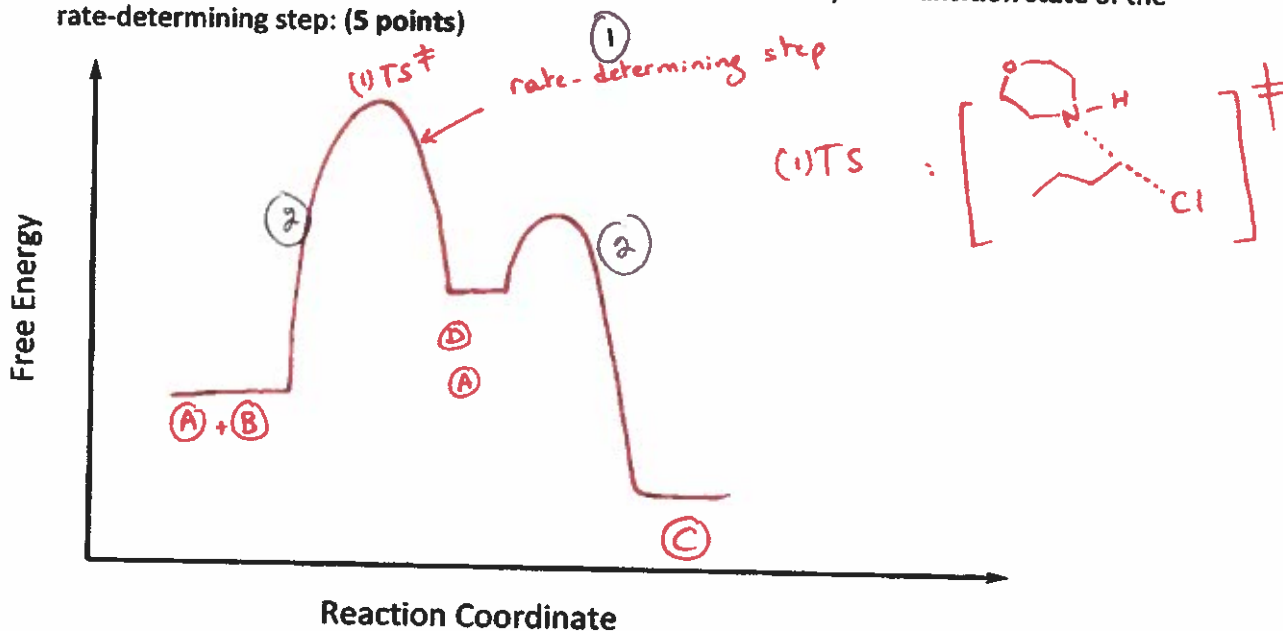
4. Morpholine A reacted with 1-chlorobutane B to give product C. The reaction rate observed was $3 \cdot 10^{-5} M \cdot s^{-1}$ when the concentrations of A and B were 0.2 M and 0.1 M respectively.



a) Show the reaction mechanism and draw the product C in the box above. (5 points) (1 pt on the structure)



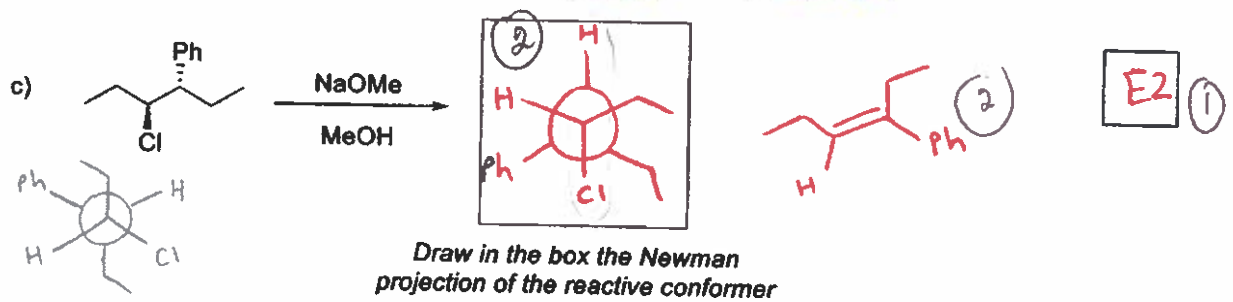
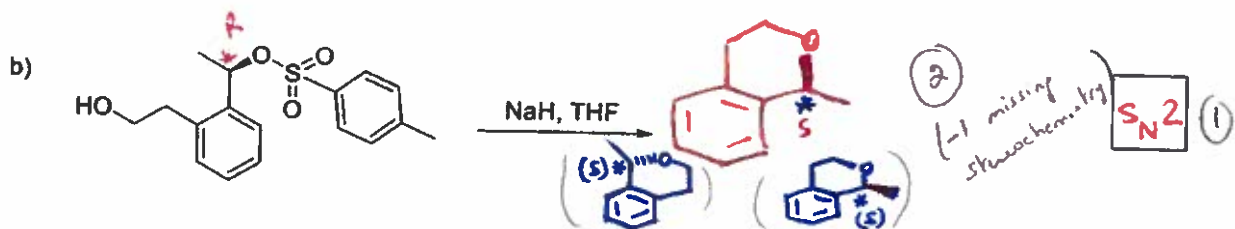
b) Draw the energy diagram of the reaction. Please indicate clearly the transition state of the rate-determining step: (5 points)



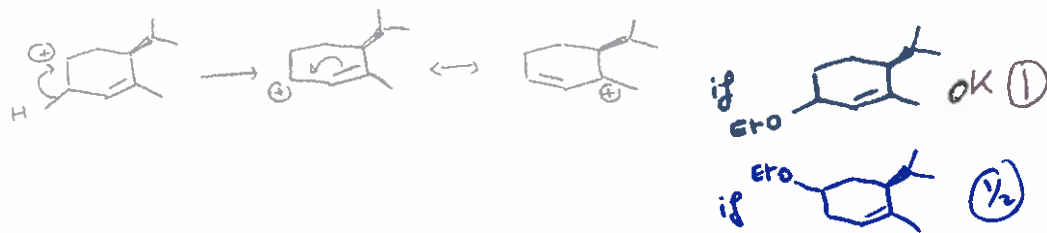
c) Now that you have identified how the reaction is proceeding, determine from the list below the rate of this reaction when the concentration of A is 0.3 M and of B is 0.02 M.: (Circle the correct answer) (3 points)

- i) $v = 4,5 \times 10^{-5} \text{ M}\cdot\text{s}^{-1}$
- ii) $v = 6,0 \times 10^{-6} \text{ M}\cdot\text{s}^{-1}$
- iii) $k = 4,5 \times 10^{-3} \text{ M}^{-1}\text{s}^{-1}$
- ③ iv) $v = 9,0 \times 10^{-6} \text{ M}\cdot\text{s}^{-1}$

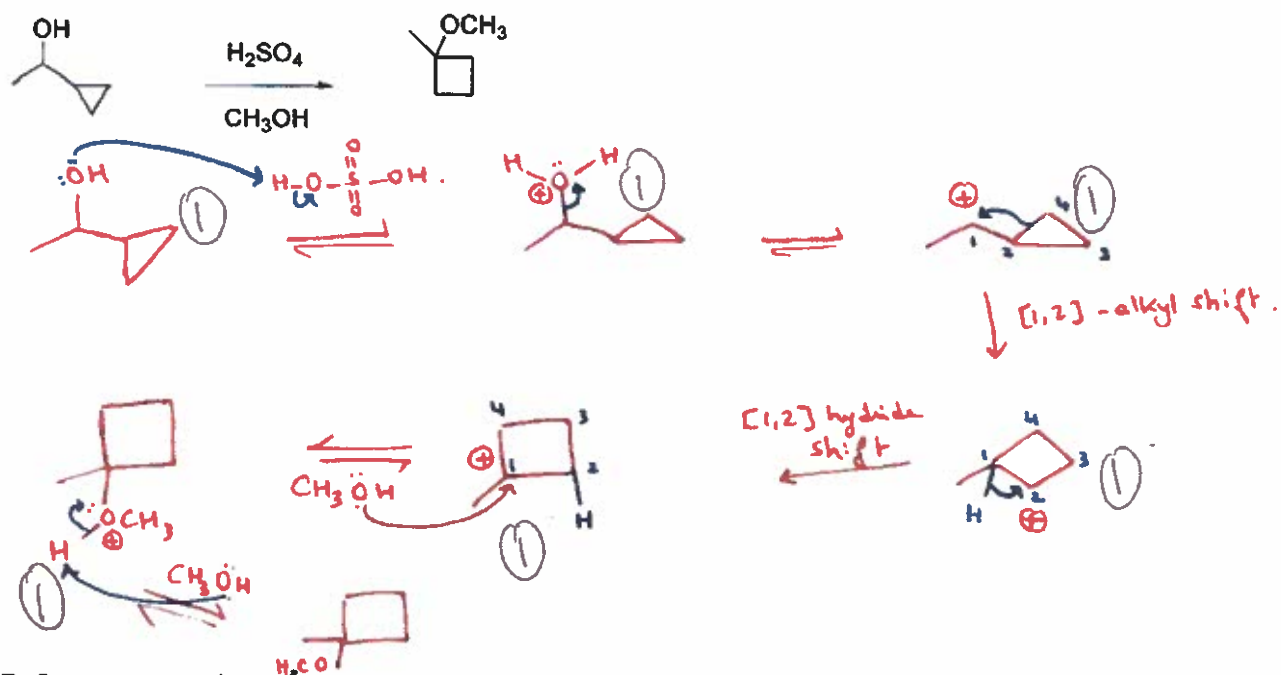
5. Draw the major product of the following reactions. Indicate in the boxes whether the reaction proceeded via S_N1 , S_N2 or E2. (19 points)



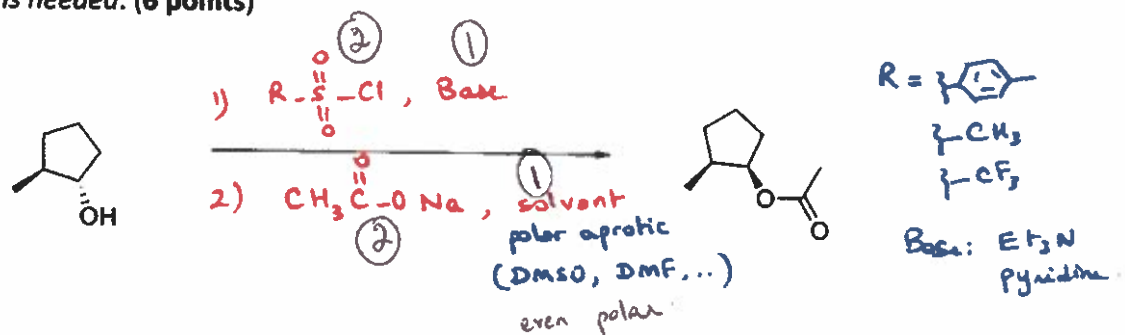
② (if absolute configuration is correct) (2R,3S)-3-methoxy-2-methylbutanenitrile
Name the product following IUPAC



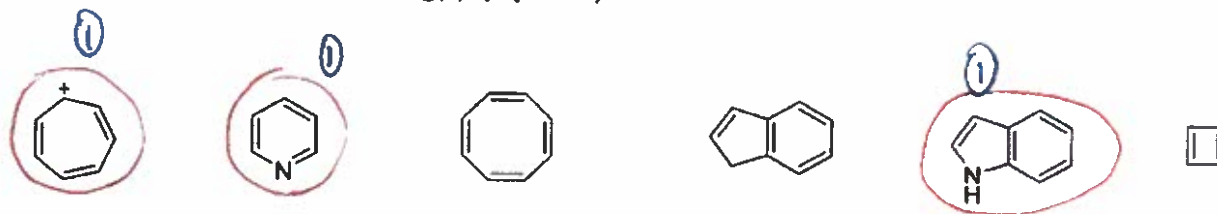
6. Provide a detailed mechanism for this following reaction: (6 points)

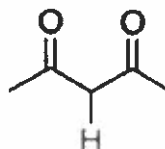
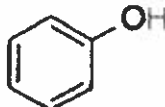
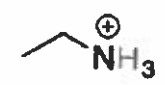
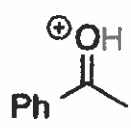
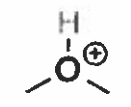
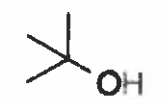
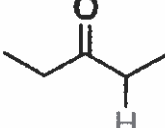




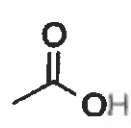


7. Propose a synthesis of the following compounds. Show all required reagents/solvents. No mechanism is needed. (6 points)



8. Circle only the aromatic ring(s). (3 points)



Acid	pK _a value (H ₂ O solvent)	Acid	pK _a value (H ₂ O solvent)
HI	-10		9
HBr	-9		9.9
HCl	-8		10.6
	-6.2	H ₂ O	15.7
	-3.8		17
H ₂ SO ₄	-3		20
	-2.6		24
CH ₃ OH ₂ ⁺	-2.2	H ₂	36
H ₃ O ⁺	-1.7	NH ₃	38
HNO ₃	-1.3		50
HF	3.17		51
	4.76	BuSH	10-11
H ₂ S	7.00	PhSH	≈7