Exam 1 Spring 2014

Name Key _____ Room _____

Student ID _____ Seat Number _____

The exam consists of 10 questions on a total of 10 pages, including periodic table.

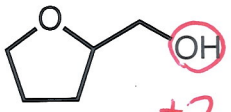
1. _____/10
2. _____/10
3. _____/10
4. _____/10
5. _____/10
6. _____/10
7. _____/10
8. _____/10
9. _____/10
10. _____/10

Regrading: All requests for regrades must be submitted in writing within 48 hours of the return of the exam. You must explicitly state what has been misgraded and why it is an error. The entire exam will be regraded, which could result in points being added or deducted overall.

1. (10 points)

a) (4 points) For the compound illustrated below indicate the most acidic hydrogen and indicate its pKa.

-1 for incorrect statement



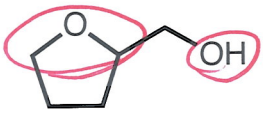
+2

pKa = 16-18

+2

b) (2 points) Identify all of the functional groups found in the molecule illustrated below.

-1 for incorrect statement

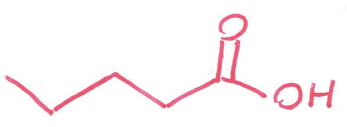


alcohol +1

ether

+1

c) (4 points) For the compound illustrated above, draw a constitutional isomer that is ***more*** acidic. Please indicate the identity of all functional groups.

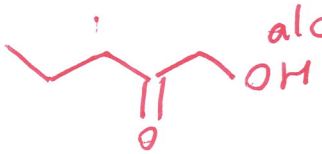


carboxylic acid

+2

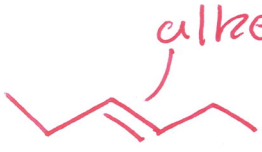
+2

also acceptable (several possibilities of many)



alcohol +1

ketone +1

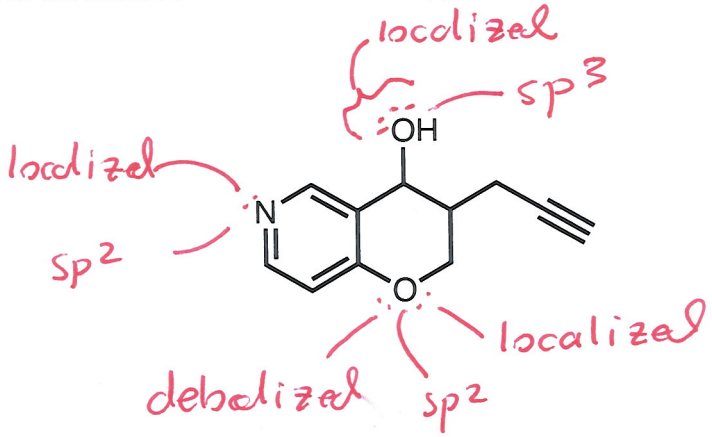


alkene +1

peroxide

+1

2. (10 points) For the molecule illustrated below, please answer the following questions:



a) (4 points) How many carbon atoms are present? How many hydrogen atoms are present?

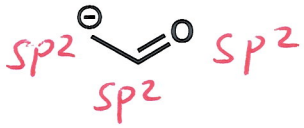
Carbons: 11 +2 Hydrogens: 11 +2

b) (3 points) Indicate on the above structure the hybridization of each heteroatom. +1 For each

c) (3 points) Indicate on the above structure whether each lone pair is delocalized or localized. +1 For each

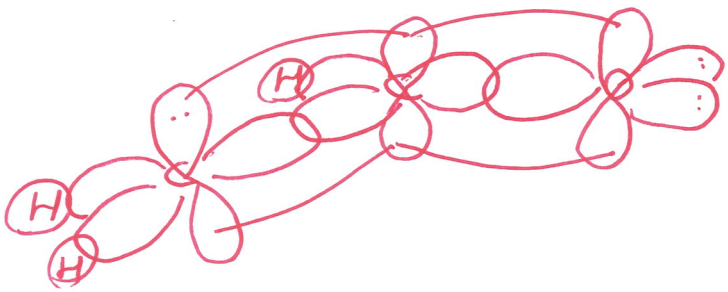
3. (10 points)

(3 points) Indicate the hybridization of each atom.



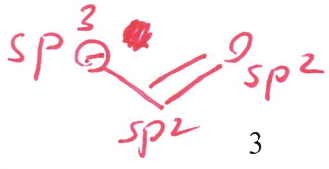
+1 for each

(7 points) Draw an orbital overlap picture for the molecule illustrated directly above.



-1 for each error

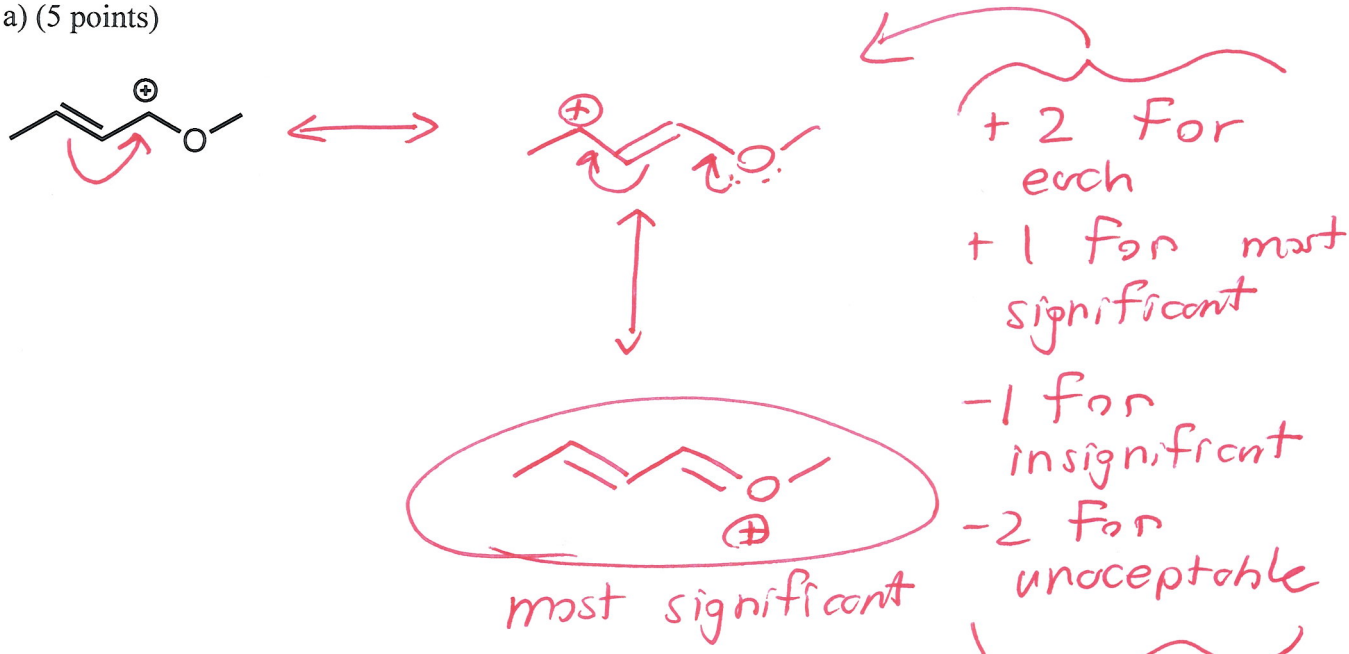
+6 For



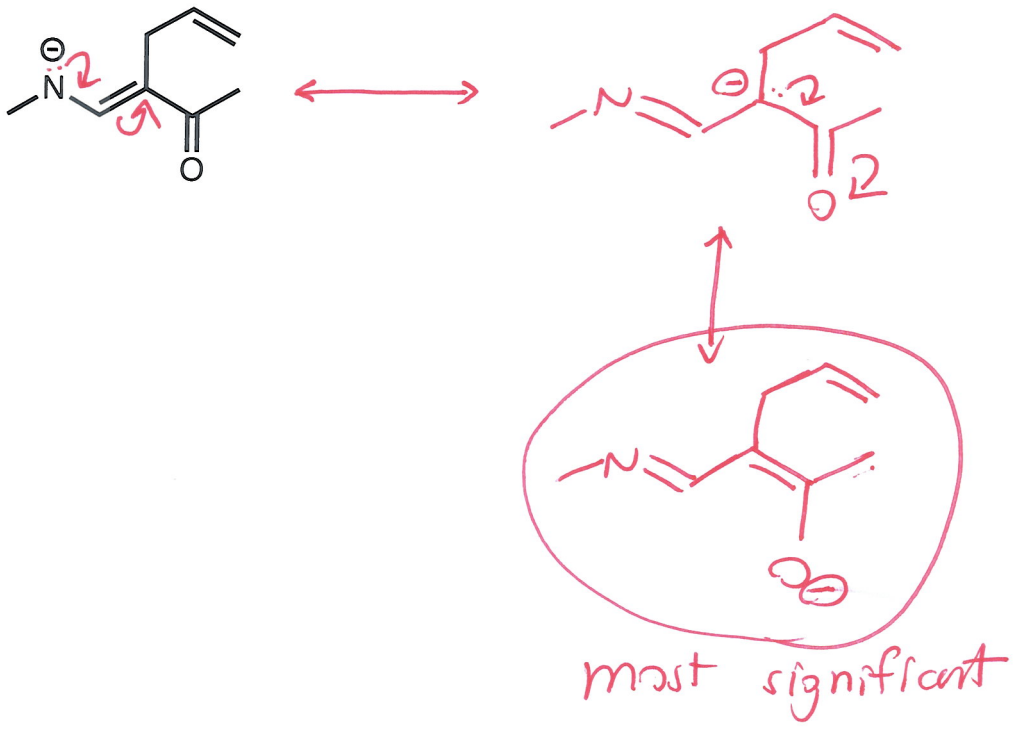
drawn correctly

4. (10 points) Draw all ***significant*** resonance structures for the compounds illustrated below. Circle the most significant contributor in each case.

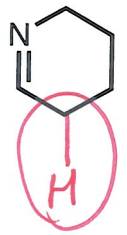
a) (5 points)

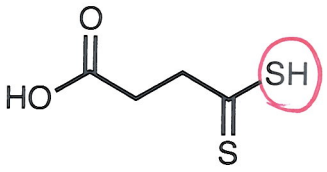


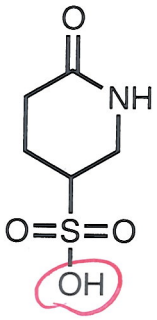
b) (5 points)



5. (6 points) Indicate the most acidic proton on each compound illustrated below.







+2 For each correct answer need to have circled the proton.

b) (4 points) In which direction does the equilibrium lie? What is K_{eq} for the following process?

Right

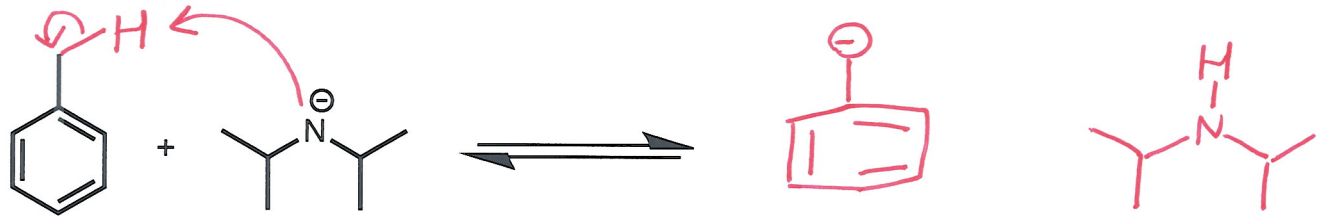
+2 For direction

+2 For correct value

$K_{eq} = 10^6$

6. (10 points)

a) (4 points) For the acid/base reaction illustrated below, predict the products. Show the mechanism with clearly drawn arrows (only consider left to right).



+2 for correct products

+2 For correct arrows

+2 if aryl proton is deprotonated with correct arrows

b) (4 points) In what direction does the equilibrium lie? Briefly support your answer using base stability principles.

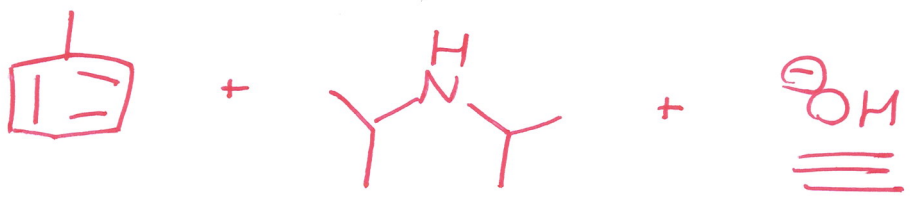
Left +1

ARIO

negative charge is more stable on more electronegative atom. (Nitrogen is more electronegative than Carbon)

+1 - +3 For explanation

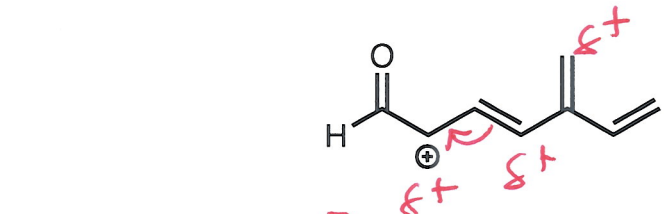
c) (2 points) If the above reaction is carried out in H_2O as solvent, what would you expect the products to be?



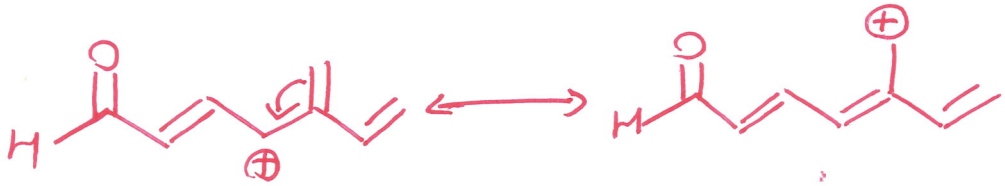
+2 for correct answer

7. (10 points)

a) (5 points) For the structure illustrated below, use resonance structures to identify all carbons that are electron deficient. Mark the appropriate carbons in the figure below with a δ^+.

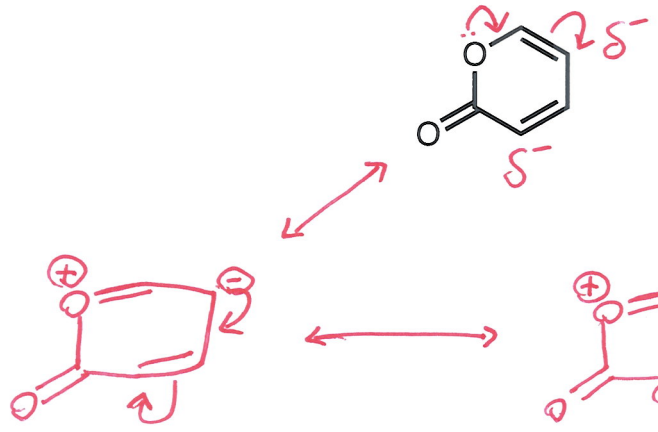


+ 1 for each correct δ+
-1 For incorrect δ−



+2 For a correct resonance structure

b) (5 points) For the structure illustrated below, use resonance structures to identify all carbons that are electron rich. Mark the appropriate carbons in the figure below with a δ^-.

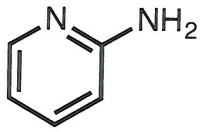


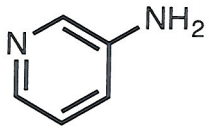
+2 for each δ+
-1 For incorrect δ−

+1 For a correct structure

8. (10 points)

a) (5 points) Draw the conjugate base of the following two molecules illustrated below.





+2 For one correct

+5 For both correct

b) (5 points) Which of the two molecules is more acidic? Briefly support your answer with appropriate figures and/or text.

← more acidic

negative charge can delocalize to both nitrogens

+3 For correct molecule

+1-2 For correct explanation

9. (10 points)

a) (6 points) Hydroxide is not a suitable base for deprotonating an alkyne, why? Use pKa values to support your answer.

pKa = 25

pKa = 15.7

+2 For wrong pKa's but correct direction based on pKa

Reaction favors weaker acid (left side)

+2 For each pKa, +2 For answer

b) (4 points) Propose a base that would be suitable to deprotonate the alkyne.

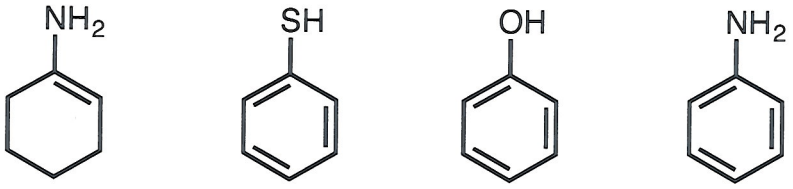
$^{\ominus}NH_2$ or deprotonated amine

also acceptable

+4 For correct answer

10. (10 points)

a) (5 points) Please rank the following compounds in order of their acidity, with 1 being the most acidic and 4 being the least acidic.



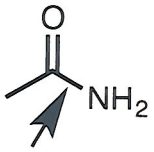
4 1 2 3

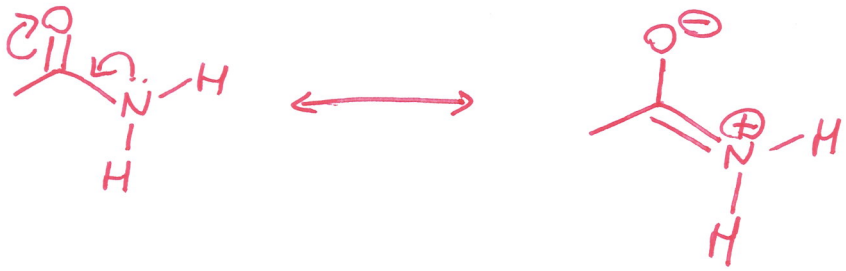
+2 For strongest

+2 For weakest

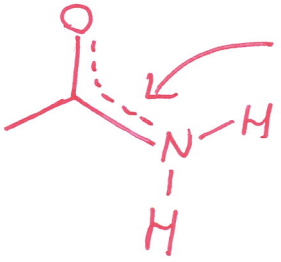
+1 For middle two

b) (5 points) The barrier to rotation of the indicated bond of an amide is significantly higher than a typical C-N bond, why?





resonance hybrid



partial double bond = hindered rotation

+5 For correct answer

PERIODIC TABLE OF THE ELEMENTS

1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)															

1 H 1.008 — Atomic Number, Symbol, Atomic Weight

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Scratch work: