

Name: Answer Key  
 Last First MI

## Chemistry 233 Exam 1

Fall 2016

Dr. J. Osbourn

**Instructions:** The first 13 questions of this exam should be answered on the provided Scantron. You must use a pencil for filling in the Scantron sheet. Ensure all erasures are complete. Any questions left blank will be marked incorrect. Any question with multiple answers selected will be marked incorrect. Answer the remaining questions on the exam itself. Show all work and provide complete explanations.

**Please write your name on:**

- The Exam Cover Page
- The Second(Grading)Page
- The Scantron Sheet

**Please bubble in your WVU Student ID Number on your Scantron sheet.**

### The Periodic Table

1 IA	2											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA		
1 <b>H</b> 1.01	2 <b>He</b> 4.00											5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18		
3 <b>Li</b> 6.94	4 <b>Be</b> 9.01											11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31	13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.07	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
19 <b>K</b> 39.1	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.39	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.61	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80		
37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.91	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.29		
55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La*</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.9	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)		
87 <b>Fr</b> (223)	88 <b>Ra</b> (226)	89 <b>Ac^</b> (227)	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (264)	108 <b>Hs</b> (265)	109 <b>Mt</b> (268)	110 <b>Ds</b> (271)	111 <b>Rg</b> (272)									

*	58 <b>Ce</b> 140.1	59 <b>Pr</b> 140.9	60 <b>Nd</b> 144.2	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.4	63 <b>Eu</b> 152.0	64 <b>Gd</b> 157.3	65 <b>Tb</b> 158.9	66 <b>Dy</b> 162.5	67 <b>Ho</b> 164.9	68 <b>Er</b> 167.3	69 <b>Tm</b> 168.9	70 <b>Yb</b> 173.0	71 <b>Lu</b> 175.0
^	90 <b>Th</b> 232.0	91 <b>Pa</b> (231)	92 <b>U</b> 238.0	93 <b>Np</b> (237)	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (260)

Exams will be returned by placing them alphabetically on the table at the front of Clark 101. Your grade will not be visible as it is on the second page. If, however, you have a privacy concern, check the box below and your exams will be held back so that you can pick them up privately.

**Hold Back My Exams**

Name: \_\_\_\_\_  
Last First MI

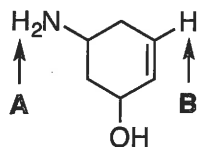
Grading Page (Exam 1):

Page	Points Possible	Points Earned
Multiple Choice (3-5)	26	
6	18	
7	18	
8	21	
9	17	
<b>TOTAL</b>	<b>100</b>	

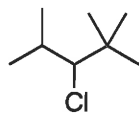
### Multiple Choice

Choose the one best answer for each of the following questions. Using a pencil, record this answer on the Scantron provided. (2 points each)

1. The approximate  $pK_a$  values for protons **A** and **B** are 35 and 44, respectively.



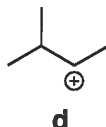
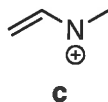
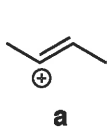
- a. 10, 44  
b. 25, 50  
**c. 35, 44**  
d. 10, 25  
e. 35, 50
2. What is the condensed formula for the structure below?



- a.  $(CH_3)_2CHCHClCH(CH_3)_2$   
b.  $CH_3CH(CH_3)CHClCH(CH_3)_2$   
**c.  $(CH_3)_2CHCHClC(CH_3)_3$**   
d.  $(CH_3)_3CCHClCH(CH_3)_3$
3. What is the formal charge on the oxygen atom in the structure below?

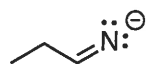


- a. -1  
b. 0  
**c. +1**  
d. +2
4. The H-C-H bond angle in methane is closest to
- a.  $90^\circ$   
**b.  $109.5^\circ$**   
c.  $120^\circ$   
d.  $180^\circ$
5. Which structure below is classified as an allylic carbocation?



both b & c  
**e.**

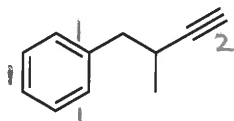
6. What is the hybridization of the nitrogen atom in the molecule below?



1 bond 2 lone pairs = 3 groups =  $sp^2$   
(db)

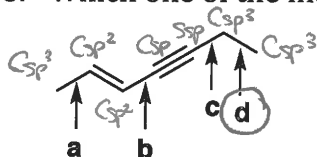
- a. s
- b. sp
- c.  $sp^3$
- d.  $sp^2$
- e. p

7. How many  $\pi$ -bonds are present in the structure below?

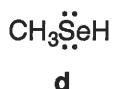
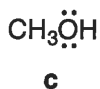
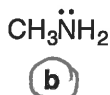


- a. One
- b. Three
- c. Four
- d. Five
- e. Six

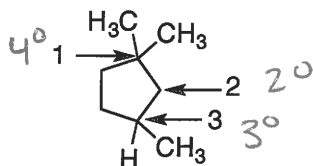
8. Which one of the indicated C-C single bonds is the longest?



9. Which species below would you expect to be the strongest base? *Hint: Think about the acidity of the conjugate acids.*

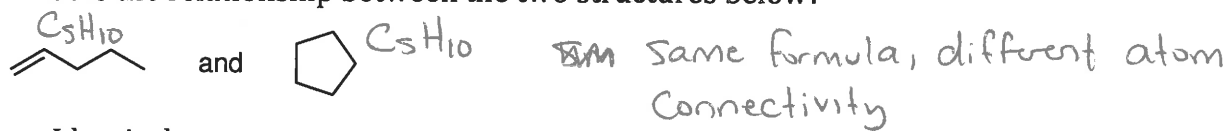


10. Carbons 1, 2, and 3 in the following structure are classified, respectively, as:



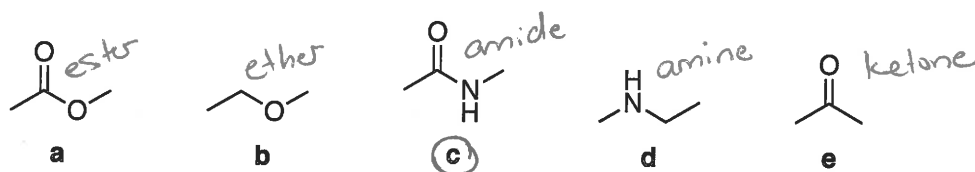
- a. tertiary, primary, secondary
- b. quaternary, primary, secondary
- c. quaternary, secondary, quaternary
- d. quaternary, primary, tertiary
- e. quaternary, secondary, tertiary

11. What is the relationship between the two structures below?

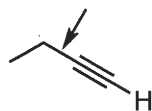


- a. Identical structures
- b. Resonance forms
- c. Constitutional isomers
- d. None of the above

12. Which species below contains an amide functional group?



13. What type of orbital overlap is involved in the indicated bond?

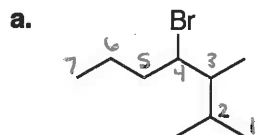


- a.  $C_{sp}-C_{sp}$
- b.  $C_{sp^3}-C_{sp}$
- c.  $C_{sp^3}-C_p$
- d.  $C_{sp^2}-C_{sp}$
- e. None of the above

### Completion Section

Answer the remaining questions in the spaces provided. Show all work and provide complete explanations.

(9) 14. Provide IUPAC systematic names for each of the following compounds. (3 points each)



4-bromo-2,3-dimethylheptane

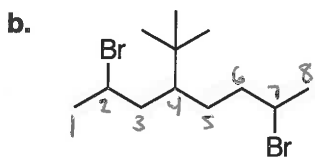
(+3)

Naming

-1 wrong parent Chain

-1 wrong #

-1 wrong abc order of Substituents



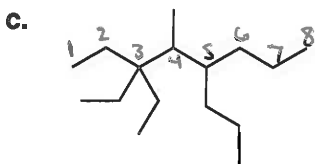
2,7-dibromo-4-tertbutyl octane

(+3)

or  
4-*t*-butyl  
or

4-(1,1-dimethylethyl)

-1 wrong Substituent names

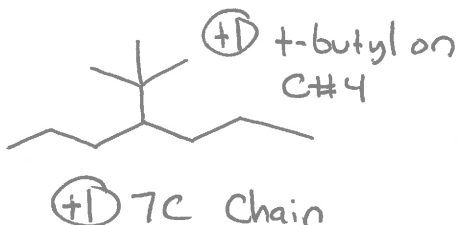


3,3-diethyl-4-methyl-5-propyloctane

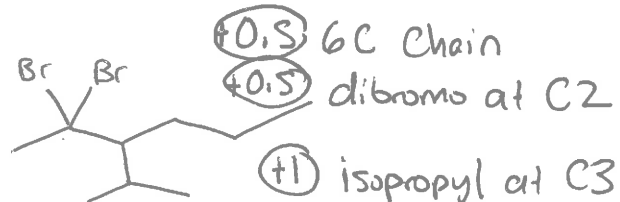
(+3)

(4) 15. Convert the following IUPAC Names into skeletal structures. (2 points each)

a. 4-(1,1-dimethylethyl)heptane

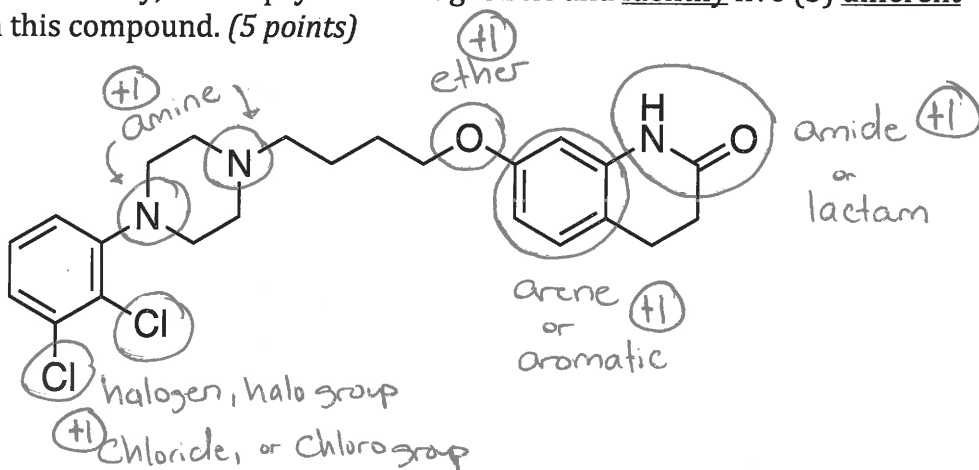


b. 2,2-dibromo-3-isopropylhexane

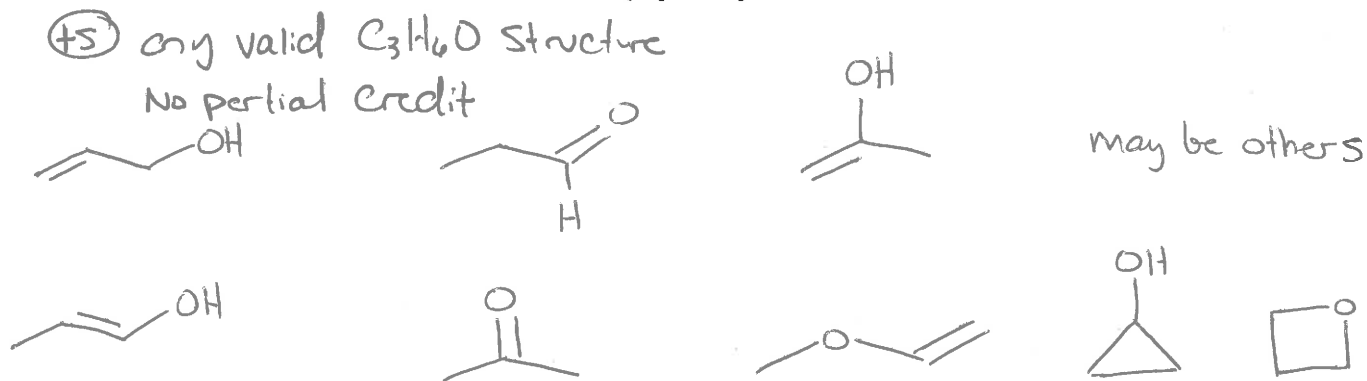


(5) 16. Below is the structure of abilify, an antipsychotic drug. Circle and identify five (5) different functional groups in this compound. (5 points)

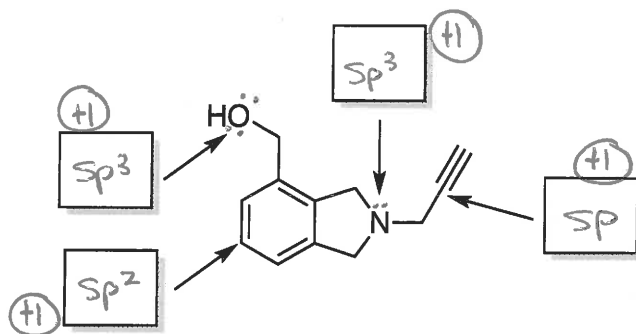
For amine and Chloride, only one needs to be circled.



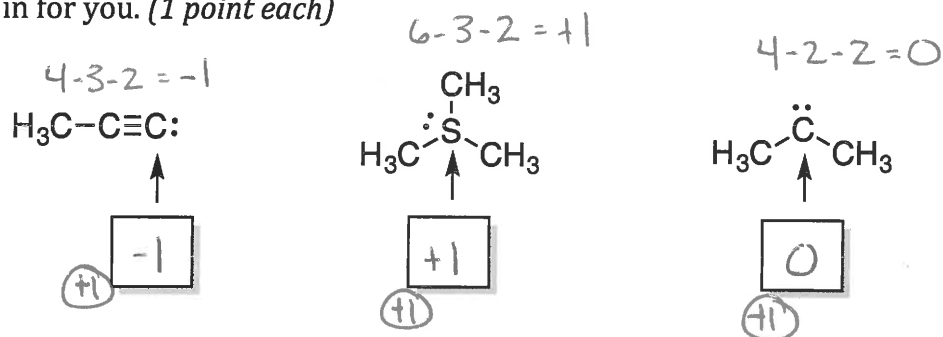
- (5) 17. Draw a valid uncharged Lewis structure or skeletal structure for a compound with the molecular formula  $C_3H_6O$ . Hint: Check octets! (5 points)



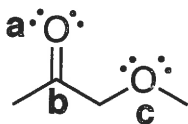
- (4) 18. For the compound below, predict the hybridization for each of the indicated atoms. (4 points)



- (3) 19. Determine the formal charge for each of the indicated atoms below. All atoms and lone pairs are already drawn in for you. (1 point each)



- (6) 20. Consider the molecule below and answer the following questions.



- a. In what type of orbital do the lone pairs in oxygen a reside? (2 points)

$sp^2$  (+2)

- b. What is the geometry at carbon b? (2 points)

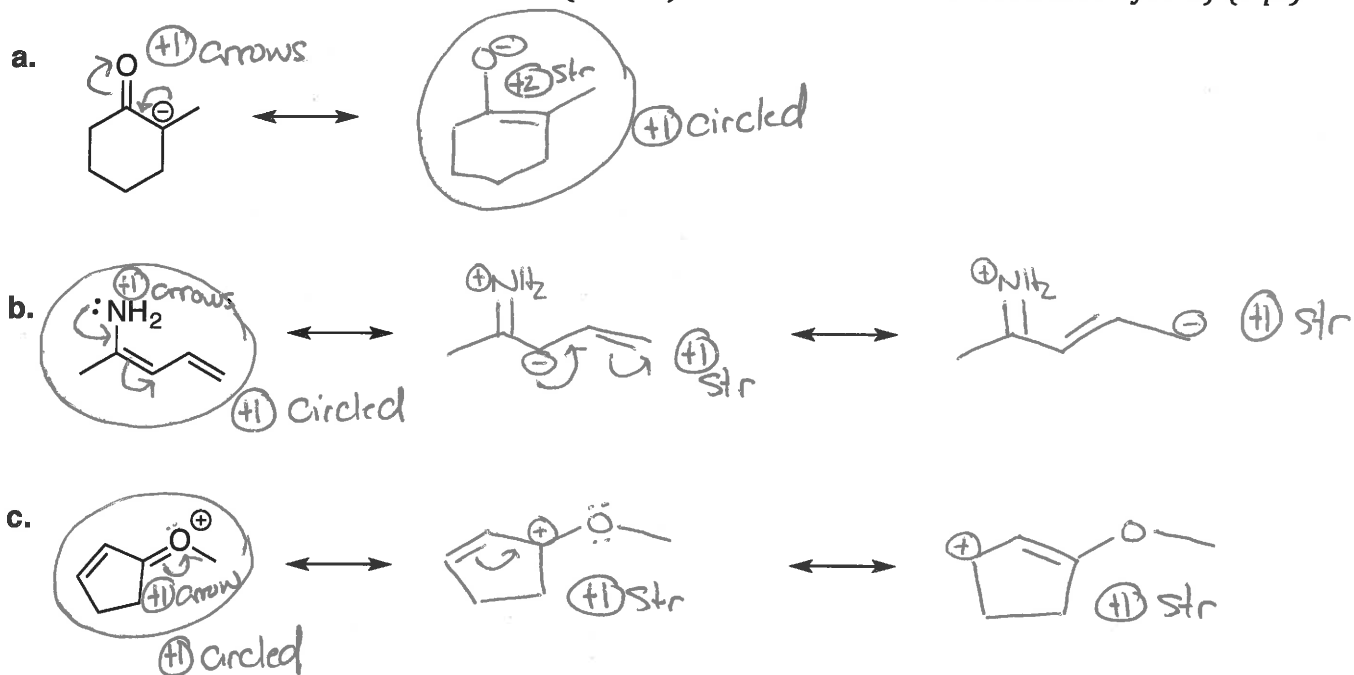
trigonal planar (+2)

- c. What is the bond angle around oxygen c? (2 points)

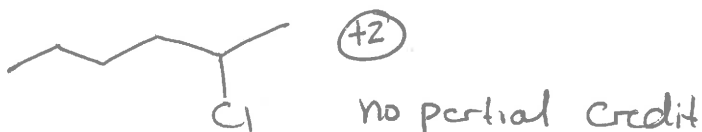
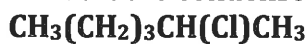
$\sim 109.5^\circ$  (+2)

(12) 21. For each structure shown below, complete the following: (12 points)

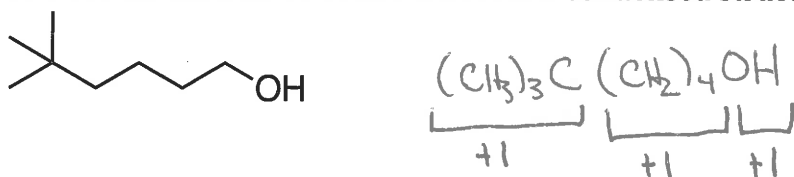
- Draw all resonance structures. (2 pts)
- Use curved arrows to show electron flow. (1 pt)
- Circle the "best" resonance structure (the major contributor to the resonance hybrid). (1 pt)



(2) 22. Convert the condensed structure below to a skeletal structure. (2 points)

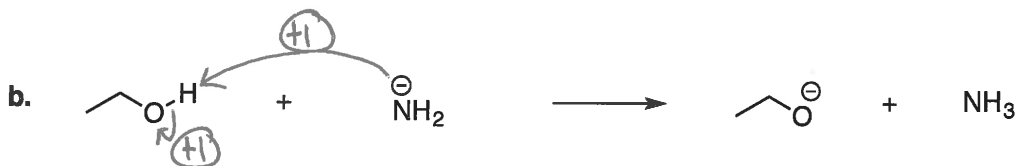
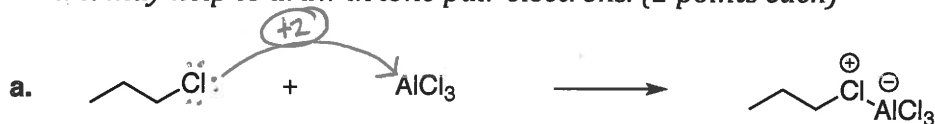


(3) 23. Convert the skeletal structure below to a condensed structure. (3 points)



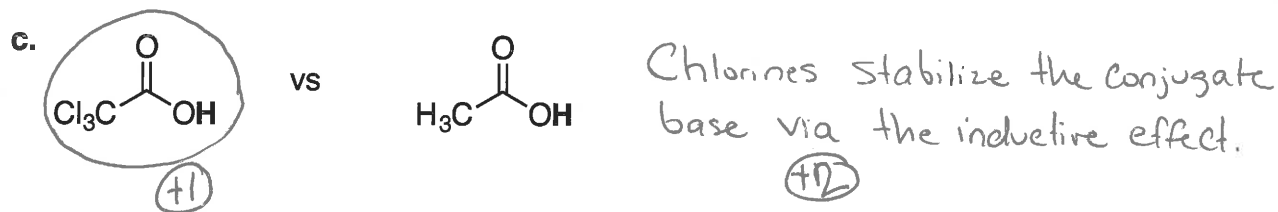
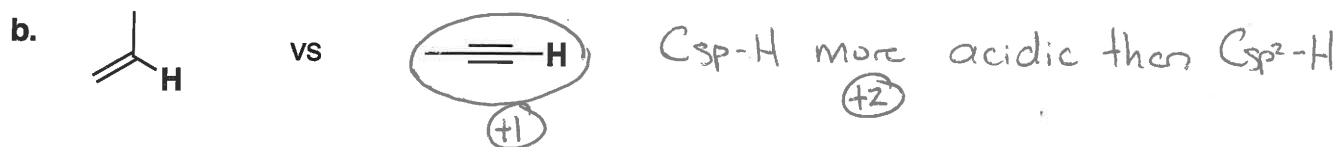
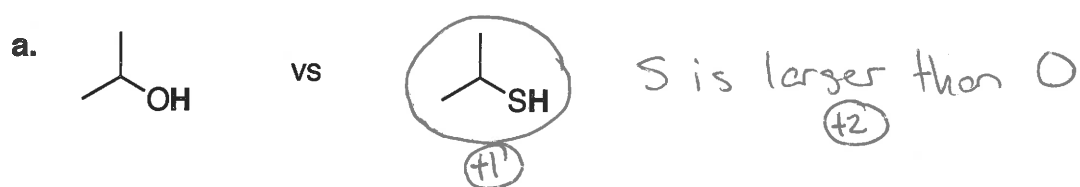
(4) 24. For each reaction shown below, add in curved arrows to the reactants to show electron flow.

Hint: it may help to draw in lone pair electrons. (2 points each)





(9) 25. For each pair, circle the compound that is most acidic. Include a brief (one sentence or less) explanation for each choice. (3 points each)



(9) 26. For each acid/base reaction below: 1. Draw the correct products; 2. Label the acid (A), base (B), conjugate acid (CA), and conjugate base (CB); 3. Circle the set of equilibrium arrows that best represents the direction in which the reaction lies. (4 points each)

