



West Virginia University

**Bennett Department of Chemistry
Chemistry 233**

Exam I *February 12, 2015*

Name: _____ *Key* _____
(Last) (First)

This exam is a closed book, closed notes.
Calculators and a molecular model set are allowed.
You must show your work in order to receive partial credited.

Question I (30 points): _____

Question II (14 points): _____

Question III (12 points): _____

Question IV (13 points): _____

Question V (10 points): _____

Question VI (21 points): _____

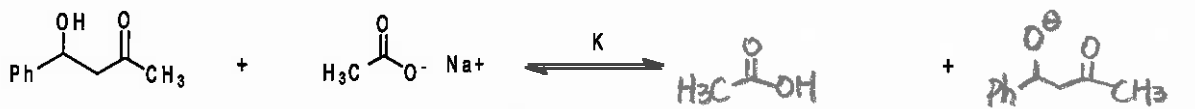
Total (out of 100): _____

Question I. Multiple Choice (1.5 point each, 30 points total)

a) Please give the pKa of the MOST ACIDIC proton in each molecule.

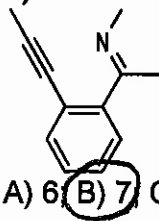
1)	2)	3)	4)	5)
<chem>NH2CH3</chem>	<chem>CC(=O)C(=O)OC</chem>	<chem>OC1=CC=C2N(C)OC=C12</chem>	<chem>[NH3+]CCC(=O)[O-]</chem>	<chem>C#CC(=O)C=C</chem>
A) 12 B) 20 C) 35 D) 40 E) 45	A) 5 B) 10 C) 12 D) 20 E) 45	A) 5 B) 10 C) 16 D) 25 E) 35	A) 10 B) 16 C) 20 D) 40 E) 45	A) 5 B) 10 C) 20 D) 40 E) 25

b) Provide the product in the box (3 points) and the Keq for the given reaction



6) Keq: A) 10^{-15} ; B) 10^{-11} ; C) 10^{-5} ; D) 10^{15} ; E) 10^{11}

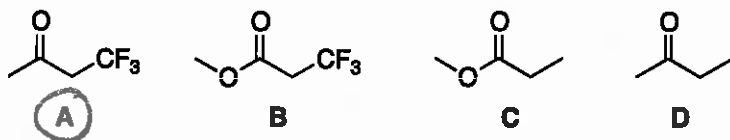
7) Number of SP² hybridized atoms in the following molecule.



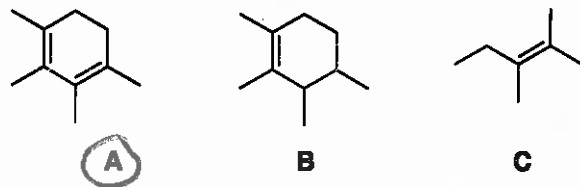
A) 6; B) 7; C) 8; D) 9; E) 10

Select the most acidic compound in the following group of molecules.

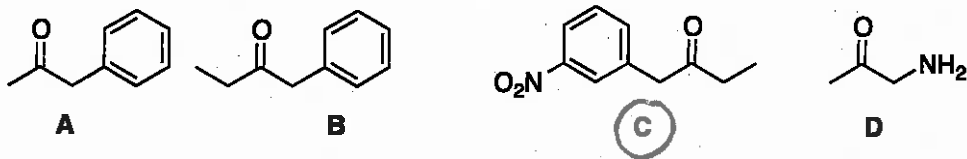
8)



9)

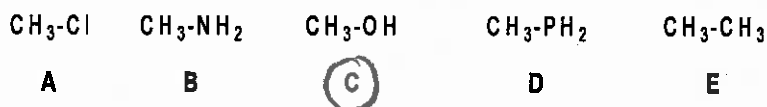


10)

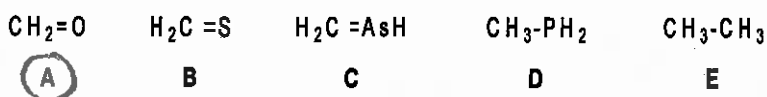


Identify the strongest labeled bond in the following group of molecules.

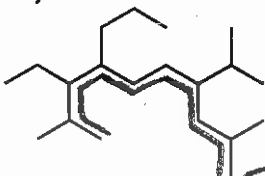
11)



12)

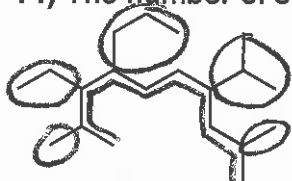


13) The number of the longest carbon chain in the following molecules.



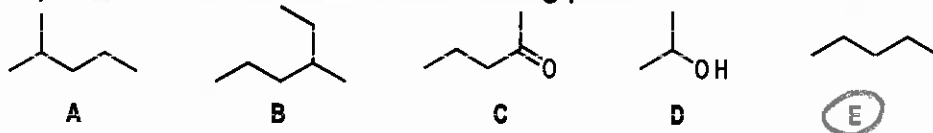
A) 12; B) 8; C) 9; D) 10; E) 11

14) The number of substituted groups on the longest carbon chain.

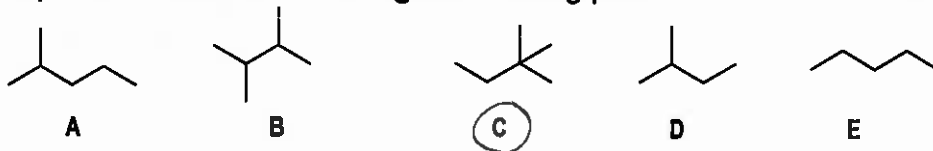


A) 4; B) 5; C) 6; D) 7; E) 8

15) The molecule with the lowest boiling point.



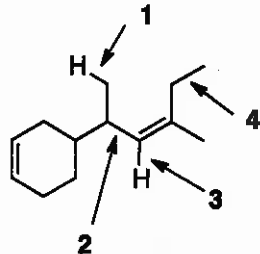
16) The molecule with the highest melting point.



17) Which atom in the following group has lowest electron negativity?

A) F; B) O; C) N; **D) H**; E) C

18) Rank the strength of the indicated bonds in the following molecule.

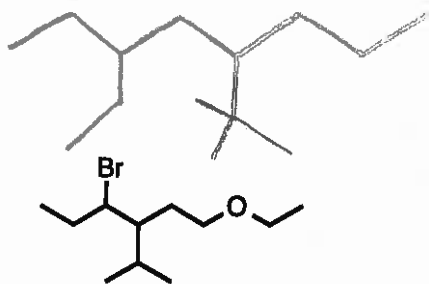


A) 1>2>3>4; B) 4>3>2>1; C) 3>1>4>2; D) 2>4>3>1; **E) 3>1>2>4**

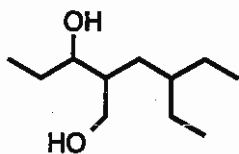
Question II. Nomenclature, Lewis structures and isomers (18 points):

2a) Name the following molecules (2 points each, 14 points total).

5-(1,1-dimethylethyl)-3-ethyloctane

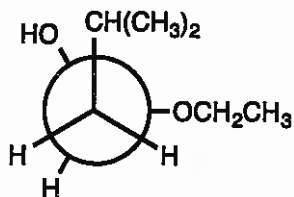


4-bromo-1-ethoxy-3-(1-methylethyl)hexane



2-(2-ethylbutyl)-1,3-pentanediol

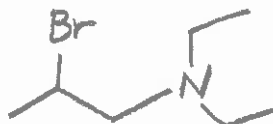
OR 2-(2-ethylbutyl)pentane-1,3-diol



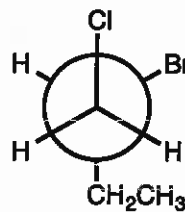
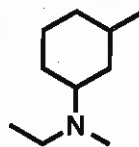
1-ethoxy-3-methyl-1-butanol

OR 1-ethoxy-3-methylbutan-1-ol

2-bromo-N,N-diethyl-1-propanamine

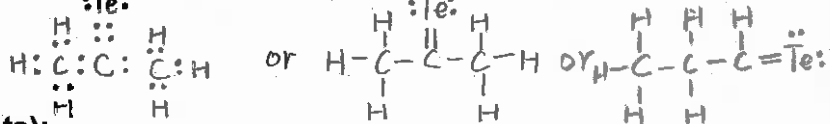
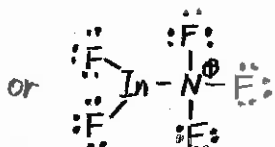
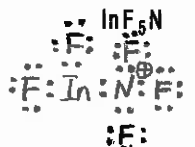
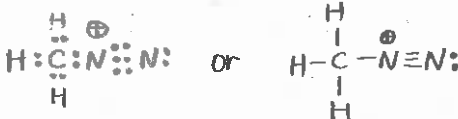
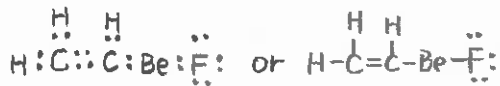
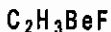


N-ethyl-N,3-dimethylcyclohexanamine



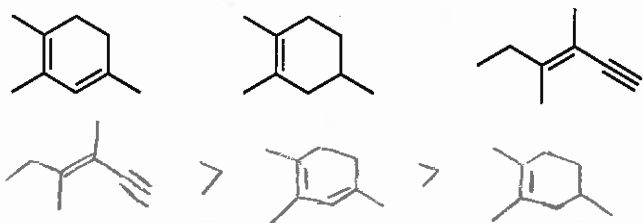
2-bromo-1-chlorobutane

2b) Draw the Lewis structure of the following molecules (4 points).



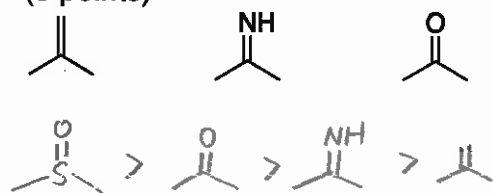
Question III. Rank and explain (12 points):

3a) Rank the acidity of the following molecules and explain why you expect this rank. (3 points)



In the most acidic H is sp^2-H , its Pka is 25. In the most acidic H is sp^2-H its Pka is 40. In the most acidic H is sp^3-H , its Pka is 45. Since the higher Pka , the weaker acid, so is the most acidic one and is the least acidic one.

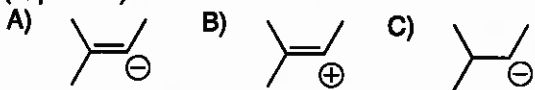
3b) Rank the polarity of the following molecules and explain why you expect this rank. (3 points)



In the structure of based on octet rule, the favored structure is The separated charge makes this molecule highest polarity. Since O has a higher electronegativity than N and N has a higher electronegativity than C, therefore, the $C=O$ is more polar than $C=N$ than $C=C$. So the polarity order is



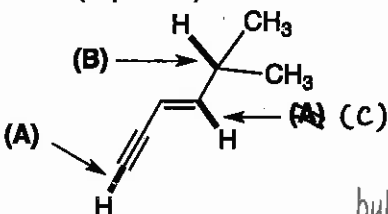
3c) Rank the stability of the following molecules and explain why you expect this rank. (3 points)



$A > C > B$

Between A and C, A is sp^2 hybridization, C is sp^3 hybridization. Since S character can stabilize negative charge, therefore A is more stable than C. And S character will unstabilize positive charge, therefore B is least stable.

3d) Rank the length of the following labeled bonds and explain why you expect this rank. (3 points)

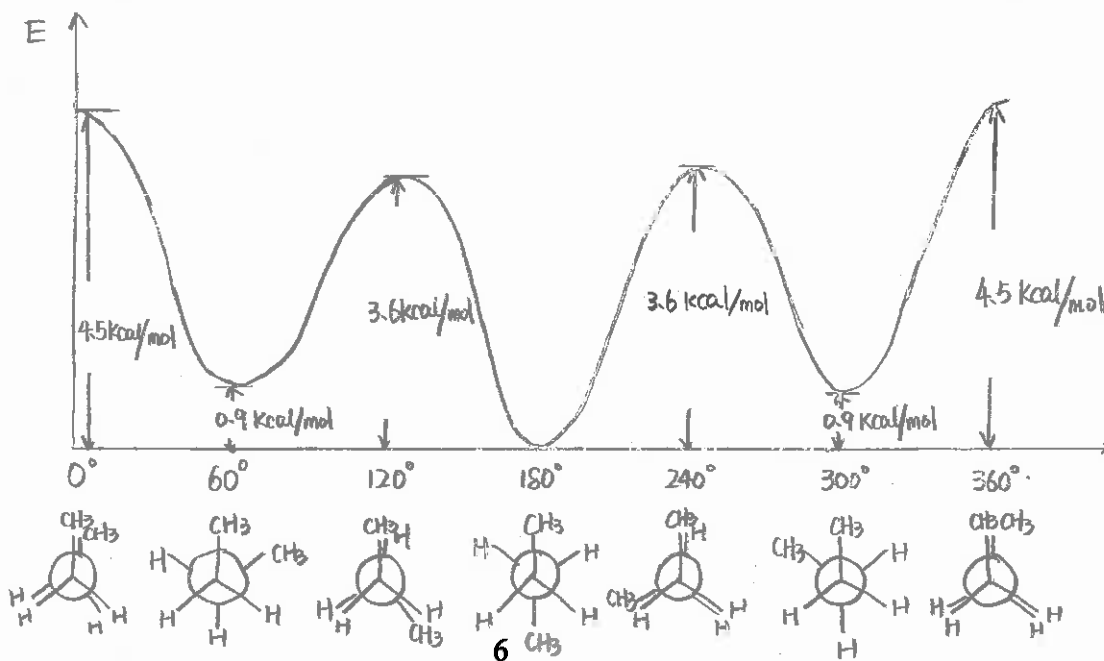


$B > C > A$

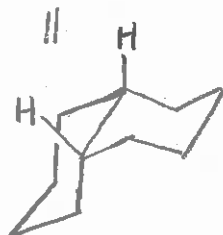
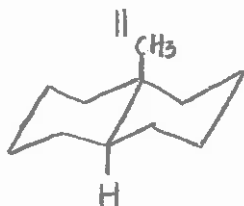
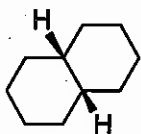
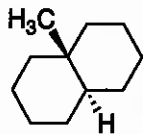
The length and strength of a C-H bond both depend on the hybridization of the carbon to which the H is attached. The more S character, the shorter and stronger is the bond because an S orbital is closer to the nucleus than is a p orbital. Therefore B (sp^3) is longer than C (sp^2) and C (sp^2) is longer than A (sp)

Question IV. Questions XMS said going to be on the exam (13 points):

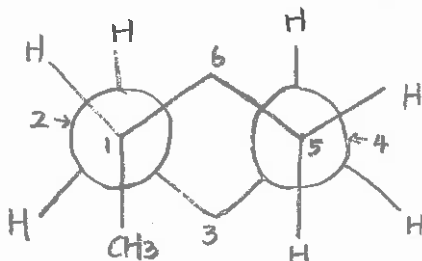
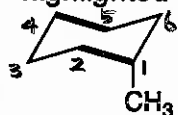
4a) Draw energetic profile of butane C2-C3 bond rotation with clear identification of energy value (4 points)



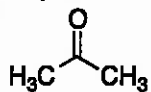
4b) Draw the most stable chair structure of the following two molecules (3 points)



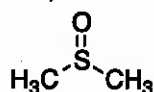
4c) Draw the double-Newman projection of the following molecule through the two highlighted bonds. Make sure pay good attention to the a and e bonds (3 points)



4d) DMSO and acetone are both commonly used solvents. The oxygen has electro negativity 3.8 while O is 2.5 and S is 2.5. Based on this number, the C-O and S=O should have similar polarity. However, DMSO is much more polar than acetone. Explain why? (3 points)

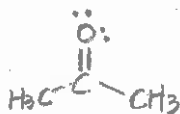


acetone

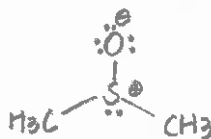


DMSO

The lewis structure of acetone :



The lewis structure of DMSO :

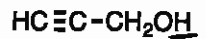


base on octet rule

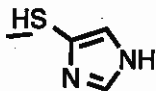
Therefore although they have similar electronegativity difference. the separated charge makes DMSO more polar.

Question V. Acid and base questions (10 points):

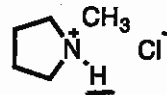
5a) Identify the most acidic proton of the following molecules and estimate the pKa (1 point, 6 points total)



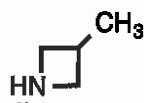
16



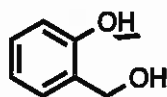
11



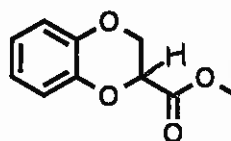
10



35



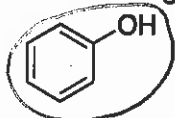
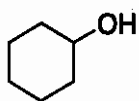
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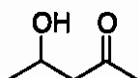
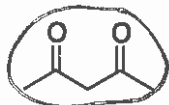
5b) Which one of the following molecule is more acidic and why (2 points, 4 points total)

A)



→ The conjugated base [O-]c1ccccc1 can form the resonance structure to stabilize the negative charge therefore [O-]c1ccccc1 is more acidic

B)

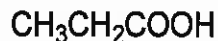


The conjugated base has more resonance structures, making it more stable, therefore CC(=O)CC(=O)C is more acidic.

Question VI. Identical question from homework (21 points):

6a) Which is a stronger acid? Circle the stronger acid. (1 point each, 2 points total)

A)



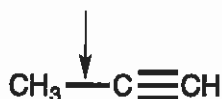
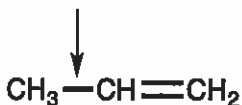
Chapter 2 Q 64a

B)



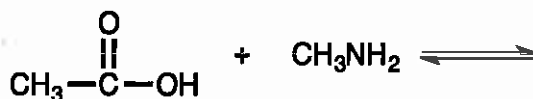
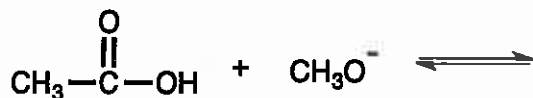
Chapter 2 Q 53

6b) A single bond between two carbons with different hybridizations has a small dipole. What is the direction of the dipole in the indicated bonds?(1 point each, 2 points total)



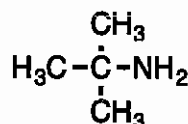
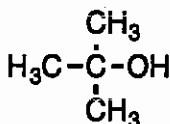
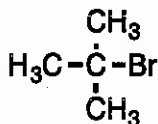
Chapter 2 Q59

6c) Give the products of the following acid-base reactions and indicate whether reactants or products are favored at equilibrium.(2 points, 8 points total)



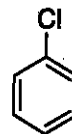
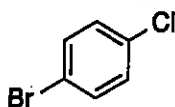
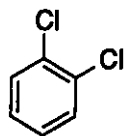
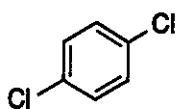
Chapter 2 Q55

6d) Are the following compounds primary, secondary, or tertiary? (1 point each, 3 points total)



Chapter 3 Q25

6e) Rank the following compounds from highest dipole moment to lowest dipole moment. (2 points)



Chapter 1 Q 63

6f) Predict the approximate bond angles. (1 point each, 4 points total)

the C-N-C bond angle in $(\text{CH}_3)_2\text{NH}_2^+$

the C-N-H bond angle in $(\text{CH}_3)_2\text{NH}$

the C-O-H bond angle in CH_3OH

the C-N-C bond angle in $(\text{CH}_3)_2\text{NH}$

Chapter 1 Q 50

The end!