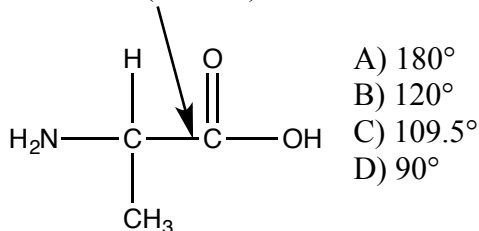CEM 251 sections 1-24 Mock exam I Fall 2017
(the actual exam will be shorter than this one – but with about the same proportion of
multiple choice and open response questions

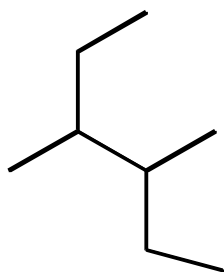1. This is the amino acid glycine. What is the closest to the bond angle indicated by the
    arrow: (C-C=O)

A) 180°
B) 120°
C) 109.5°
D) 90°

2. Which of these molecules is polar?
A) CO_2
B) CH_4
C) CCl_4
D) SO_2
E) all of them are polar

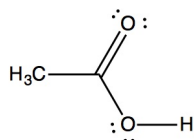3. Provide an acceptable name for the alkane shown below.

A. 2-ethyl-3-methylbutane
B. 2,3-dimethylhexane
C. 2,3-diethylbutane
D. 3,4-dimethylhexane
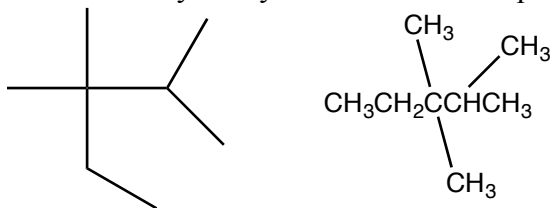
4. Which will form hydrogen bonds between its molecules?
A) $CH_3CH_2CH_2F$
B) $CH_3CH_2CH_2CH_3$
C) $(CH_3)_3N$
D) $CH_3CH_2OCH_3$
E) $CH_3NHCH_2CH_3$

5. Which functional group(s) is/are present in this compound:


A. methyl group
B. alcohol
C. carboxylic acid
D. All of them

6. What can you say about these two representations?

A. They are different compounds with different connections between the atoms
B. They are different compounds with different relative arrangements of atoms in space.
C. They are different compounds with different numbers of atoms.
D. They are the same compound in different orientations

7. This is the structure of NADH an important compound in energy metabolic processes.
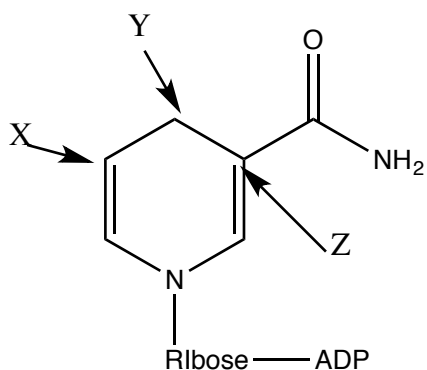
How many hydrogen atoms are bonded to C at X, Y and Z
A. 2,1,0
B. 1,2,0
C. 2,3,1
D. 0,2,0

8. Which of the following is not a conjugate acid-base pair?

A) H_2O, HO^-

B) H_2O, H_3O^+

C) HSO_4^-, H_2SO_4

D) ^-OH, O^{2-}

E) NO_3^-, NO_2^-

9a. What are the **most likely** potential products formed from the following acid-base reaction? (which side will the equilibrium lie on? Explain)
$CH_3OH + NH_3 \leftrightarrows$
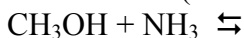
A) $CH_3O^- + {}^+NH_4$

B) $CH_2OH + {}^+NH_3$

C) $CH_3OH_2^+ + {}^-NH_2$

D) $CH_3NH_2 + H_2O$

E) $CH_4 + NH_2OH$

9b. Which side will the equilibrium lie on? A) more products B) more reactants C) in the middle

10. Which species act as bases in the following reaction?
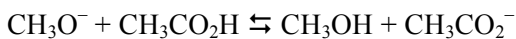
$$CH_3O^- + CH_3CO_2H \rightleftharpoons CH_3OH + CH_3CO_2^-$$
$\quad$ 1 $\qquad$ 2 $\qquad\qquad$ 3 $\qquad\qquad$ 4

A) 1 and 2
B) 3 and 4
C) 2 and 4
D) 1 and 4
E) 2 and 3

11. If H_2O has a pK_a value of 15.7 and HF has a pK_a value of 3.2, which is a stronger base, HO- or F-?

A. HO^- because water is a stronger acid than HF and therefore its conjugate base is stronger also
B. HO^- because water is a weaker acid than HF and therefore its conjugate base is stronger
C. F^- because HF is a stronger acid than H2O and therefore its conjugate base is stronger also
D. F^- because HF is a weaker acid than H2O and therefore its conjugate base is stronger

12. How many primary(P) secondary (S), tertiary (T) and quaternary (Q) carbons are in this molecule?
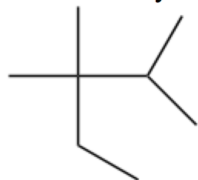
	P	S	T	Q
A.	5	1	1	1
B.	4	2	2	1
C.	3	3	1	2
D.	1	1	1	5

13. What is the product of these curved arrows?

A

B

C

D
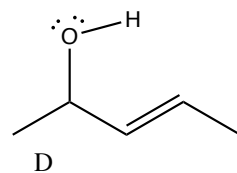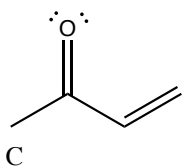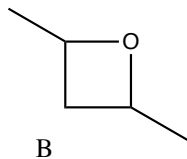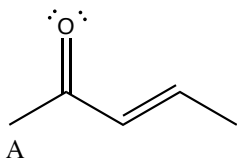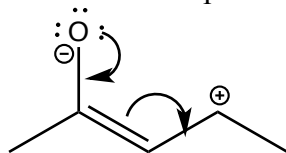
14. What properties do you predict trimethylamine, $(CH_3)_3N$ will have?

   I.   It can act as an acid
  II.   It can hydrogen bond to itself
 III.   It can act as a base
 IV.   It is non-polar

A. I and II
B. II
C. III
D. All of them

15. Which is the stronger acid CF_3CO_2H, trifluoroacetic acid? (TFA) or acetic acid CH_3CO_2H

A. TFA is the stronger acid because its conjugate base can be stabilized by resonance
B. TFA is the stronger acid because its conjugate base can be stabilized by resonance and induction
C. Acetic acid is the stronger acid because its conjugate base can be stabilized by resonance
D. Acetic acid is the stronger acid because its conjugate base can be stabilized by resonance and induction

16. Which compound is most likely to undergo nucleophilic attack upon treatment with NaI (I^-)? (explain your answer)
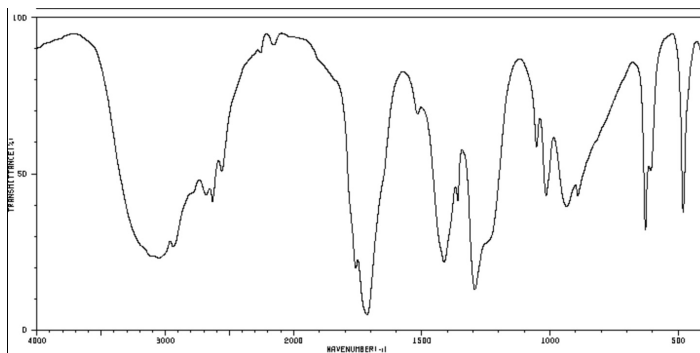A. CH_3NH_2
B. CH_3OH
C. CH_3Br
D. They are all equally likely

17. Which of these reactions are likely to give dimethyl ether (CH_3OCH_3) as the product?

   I. $CH_3I + NaOCH_3$
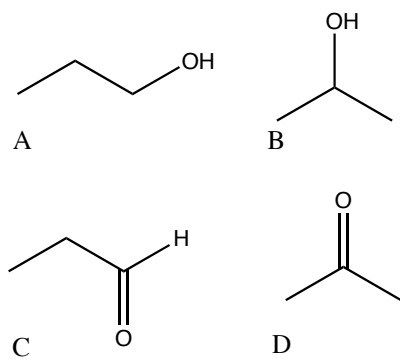 II. $CH_3OH + NaOCH_3$
 III. $CH_3OH + H_3O+$

A. I   B. I +II,   C. I and III,   D. All of them

18. Which compound is most likely to give rise to this IR spectrum?

A. CH_3COCH_3
B. CH_3CO_2H
C. CH_3CH_2CHO
D. CH_3CH_2OH
E. It could be any of them

19. Which compound is most likely to give rise to this C-13 NMR spectrum.

CDS-03-412   ppm

A   B

C   D
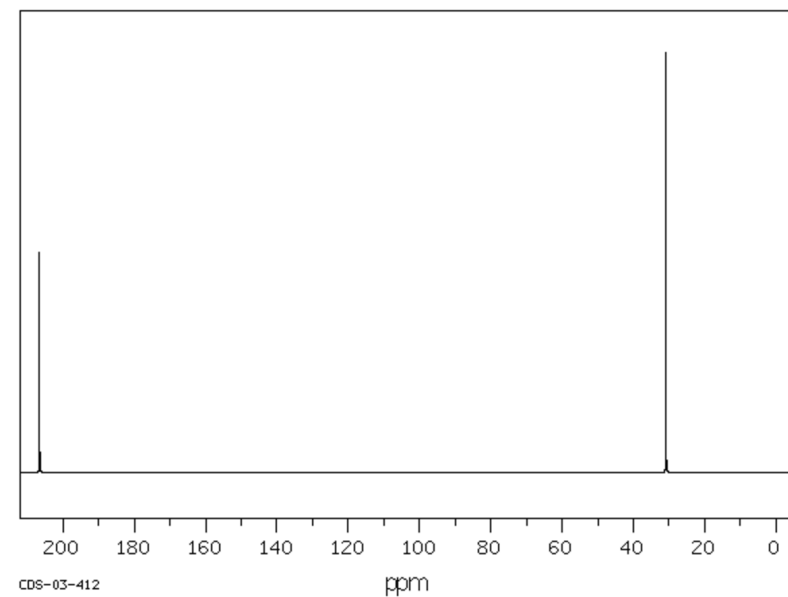
20.   How many signals do you expect to see in the C-13 NMR of this compound?
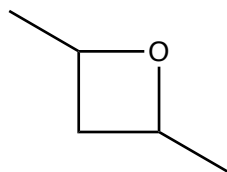
A. 3
B. 4
C. 5
D. 2

Part II Open response

1. Draw two Lewis structures for the nitrate ion NO_3^-, be sure to include all electrons, formal charges where needed and specify what the molecular shape around the central atom is.

What is the relationship between the structures? Use curved arrows to show how the changes in electron distribution can be explained.

Draw a representation that explains the electron distribution in nitrate without the need for separate structures.

2. Draw three different structures for C_3H_9N. What is the relationship between the structures? Do you expect the structures to have different physical and chemical properties? Give examples of the kinds of properties you expect for each structure
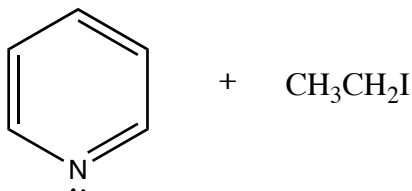
4. Predict the products of these reaction using mechanistic arrows to show the flow of electrons. Predict which side the equilibrium lies on – you may use a table of pKa values if necessary, but then also explain why in terms of structure and stability.

a. CH_3OH NH_3 ⇌

b. $CH_3C\overset{O}{\underset{OH}{}}$ CH_3OH ⇌
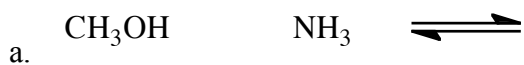
c. Predict the products of these reactions using mechanistic arrows to show the flow of electrons.

$AlCl_3$ NH_3 ⇌

d.

   + CH_3CH_2I

e.

$CH_3CH_2S^-$

Br

5. Rank these compounds in order of acidity

Explain your ranking, be sure to include the chemical principles you are basing your explanation on, and your reasoning.

CH_3CHFOH CH_2FCH_2OH CH_3CH_2OH

6. For this reaction predict the product using curved arrows, discuss **what** is happening at the molecular level , and **why** it is happening. Do you think this reaction might reverse? Why or why not.

CH_3I + CH_3CH_2ONa

7. Use these IR and NMR spectra for a compound that has a molecular weight of 100 to predict a possible structure for the compound. Be sure to indicate your reasoning. How did you determine what functional groups are present, and how many chemically different carbons are present? (You can draw on the spectra to point out important features.)