Chemistry 230 (Fall 2009)
Midterm Exam 1
75 minutes, 100 points

Tear off the ANSWER PAGE at the back of the exam. FILL IN YOUR NAME AND ID#.

Please mark your answers clearly ON THE ANSWER PAGE. It is this page ONLY that will be graded!

Make sure you read the questions carefully and answer all parts. A periodic table is attached at the back of the exam, along with a page of scratch paper.

No electronic devices are allowed.
Have your ID visible on the table.

GOOD LUCK!
1) (8 points) Draw Lewis structures for each of the following molecules (include lone pairs and formal charges). Draw resonance structures where appropriate. Label the major and minor contributors:

A) CO  
B) HCONH₂

2) (8 points) Draw all the isomers with the formula C₄H₈.
3) (10 points). Indicate whether equilibrium lies to the **LEFT** or to the **RIGHT** for the following reactions.

A) CH$_3$CH$_2$OH + CH$_3$S$^-$ $\rightleftharpoons$ CH$_3$CH$_2$O$^-$ + CH$_3$SH

B) NH$_3$ + CH$_3$S$^-$ $\rightleftharpoons$ NH$_2$ + CH$_3$SH

C) CN$^-$ + CH$_3$CH$_2$OH $\rightleftharpoons$ HCN + CH$_3$CH$_2$O$^-$

D) The pKa of NH$_3$ = ____.

E) The pKa of CH$_3$CH$_2$OH = ____.

4) (12 points) The marked hydrogen is very acidic. Why? (Hint: you will have to draw all relevant structures to support your explanation.)
5) (15 points) Consider the following two molecules. Draw all resonance structures (no more than 5) for the CONJUGATE BASE OF THE LESS ACIDIC molecule.

A) \[
\begin{align*}
\text{OH} & \\
\text{NO}_2 & 
\end{align*}
\]

B) \[
\begin{align*}
\text{OH} & \\
\text{NO}_2 & 
\end{align*}
\]

6) (10 points) DMAP (4-dimethylaminopyridine) is an important molecule used in many reactions. The different N atoms have been labeled as “N1” and “N2”. For your answer, write “N1” or “N2”.

A) Which N is more basic?

B) Which N is more nucleophilic?
7) (12 points) Name the following functional groups. Identify the hybridization of the indicated carbons.

A) \[ \text{ester} \]  
B) \[ \text{cyano} \]  
C) \[ \text{aldehyde} \]  
D) \[ \text{cyclic ketone} \]

8) (8 points) The important antioxidant molecule glutathione is shown below. Name the functional groups indicated by the arrows (and circle).

A) \[ \text{carboxyl} \]  
B) \[ \text{primary amine} \]  
C) \[ \text{thiol} \] (Functional group within the circle)  
D) \[ \text{carboxyl} \]
9) (9 points) The following molecule is nicotine, an important pharmacophore in tobacco.

![Nicotine molecule](image)

a) Redraw nicotine, and label the hybridization of each N atom.
b) Label the geometry of each N atom.
c) Identify the type of orbital that the lone pair resides in for each N atom.

10) (8 points) For each of the following molecules, provide the following information:
Is the molecule polar or nonpolar?
What are the PRIMARy intermolecular forces present in each compound?

A) ![Molecule A](image)  
B) ![Molecule B](image)  
C) ![Molecule C](image)  
D) ![Molecule D](image)
The Periodic Table of Elements
1) A) Left  Right  
    B) Major  Minor

2)...

3) (Please circle the appropriate answer for A, B, and C.)
   A) Left  Right  
   B) Left  Right  
   C) Left  Right  
   D) pKa = 35-38  
   E) pKa = 16

4) pKa = 9. 2 carbonyl groups make this position very acidic as the resulting enolate ion delocalizes it charge over two carbonyl groups (3 resonance forms)
6) N1 or N2?  
A) N1  
B) N1

7) A) Ester, sp²  
B) Nitrile, sp³  
C) alkyne, sp²  
D) ketone/enolate, sp²

8) A) Carboxylic acid  
B) Amine  
C) Amide  
D) Thiol

9) 

10) A) polar, dipole-dipole  
B) polar, H-bond  
C) nonpolar, van der Waals  
D) nonpolar, van der Waals