CHEM 301 A

HOMEWORK SET 1

NAME: _____ SIGNATURE_____

Please staple and hand in H/W sets IN CLASS on due date.

1. Draw complete Lewis Structures showing **all bonds, lone pairs** for the following molecules. Label the Functional groups and Type of Compounds by looking up Table 3.1 3.2 and 3.3 in textbook. Remember all carbons must have a total of four bonds, oxygen 2 bonds and nitrogen 3 bonds. Provide answers in the space provided. Do not attach sheets to any of the HW Sets.

   a. C_2H_2

   b. $HCONH_2$

   c. CH_3CHO

   d. CH_3COCH_3

   e. CH_3OH

   f. CH_3COOH

   g. CH_3NH_2

   h. CH_3COOCH_3

2. Draw 2-3 Lewis structures for each of the following formula as indicated, and identify the functional groups in each of the structures. All structures must be neutral. What is the hybridization of the hetero atom (non C, H atom). What are the bond angles of the hetero atom?

(i) C_2H_6O (2 structure)

(a) **(b)**

Functional groups: (a)_____ (b)_____

Hybridization: (a)_____ (b)_____

Bond Angles: (a)_____ (b)_____

(ii) C_2H_4O (3 structures)

(a) **(b)** **(c)**

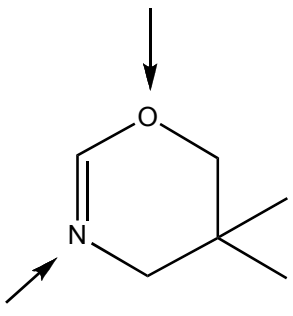
Functional groups: (a)_____ (b)_____ (c)_____

Hybridization: (a)_____ (b)_____ (c)_____

Bond Angles: (a)_____(b)_____(c)_____

3. What is the **hybridization** of the lone pair orbitals on the oxygen and nitrogen atoms pointed to in the molecule? What is **angle** between the lone pair and the bond?

4.



5. Draw 4 Constitutional isomers possible for each of the molecular formulae a-c below (don't forget the cyclic structures). Draw them in the line diagram format.

   a. C_3H_6O

   b. C_4H_6O

   c. C_3H_4O

3. Draw the **Expanded Lewis structures for one of the resonance structures with lines for bonds and .. dots for lone pair electrons.** Calculate the **formal charges** on the atoms in **bold type.** (Hint: take off a valence electron for positive charge and add a valence e- for negative charge). FC=?

1. $\mathbf{C}H_2\mathbf{N}_2$

2. $(CH_5\mathbf{O})^+$

3. $(\mathbf{C}_2H_5)^+$

4. $(\mathbf{C}_2\ H_5)^-$

5. $(CH_3\mathbf{O})^-$

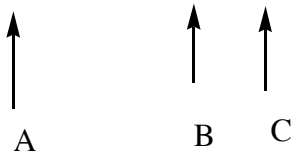
6. $(C_2H_5\mathbf{NH})^-$

7. $\mathbf{(}CH_6\mathbf{N)}^+$

8. $CH_2\mathbf{O}$

4.A. Draw the **Expanded Lewis structures with lines for all bonds and .. dots for lone pair electrons.** Predict the **geometry** (tetrahedral=Th, trigonal planar=TP, linear), bond angles 109.5° or 120° or 180°, and the **hybridization** of the **BOLDED** atoms. All atoms MUST have octets. (Hint: CO can be single or double bond). Draw the expanded structure next to the condensed structure.

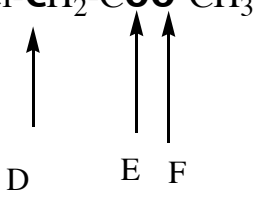
(a) 1. HC≡**C-**CH2-CH=**C**H-C**O-**CH3



Put an X in the correct box below to indicate the answer

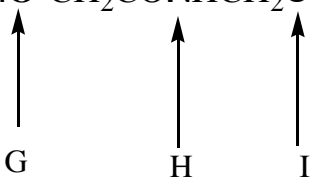
	Geometry (Th, TP, Linear)			Hybridization (sp^3, sp^2, sp)			Bond Angle (°) (109.5, 120, 180)		
A									
B									
C									

(b) 2. Cl-**C**H_2-C**OO-**CH_3



	Geometry (Th, TP, Linear)			Hybridization (sp^3, sp^2, sp)			Bond Angle (°) (109.5, 120, 180)		
D									
E									
F									

c. 3.H**O**-CH_2CO**N**HCH_2**O**CH_3



	Geometry (Th, TP, Linear)			Hybridization (sp^3, sp^2, sp)			Bond Angle (°) (109.5, 120, 180)		
G									
H									
I									

B. Draw the orbital diagrams showing the hybridized orbitals and the pi orbitals for the molecules given below. Show all hybridized sigma and lone pair orbitals plus the pi orbitals.

a. Ethylene (**CH_2CH_2**),

b. acetylene (**C_2H_2**)

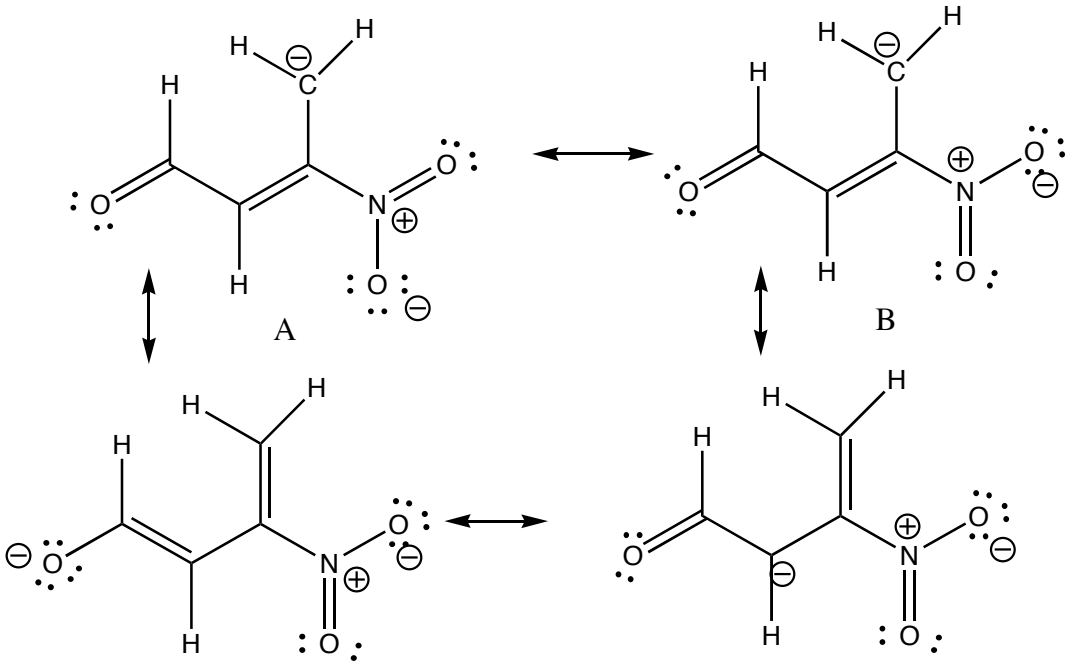
c. formaldehyde (HCHO)

d. (**-**OH)

e. (**NH_4^+**)

f**. (CH_3^+)**

5.A. Draw arrows to show the movement of non-bonding and pi electrons during resonance between the structures below, going from A to B to C to D and back to A.

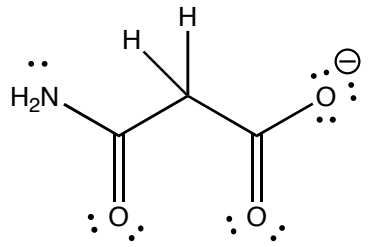


A B D C

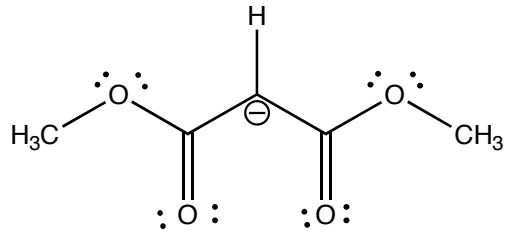
B. Draw at least 2 Resonance structures each for the following anions. All structures must be correct expanded Lewis Structures showing lone pairs and/or charges. **Show the curved arrows leading to the resonance structures**.

1. $^{-}CH_2$-CH=CH-CHO

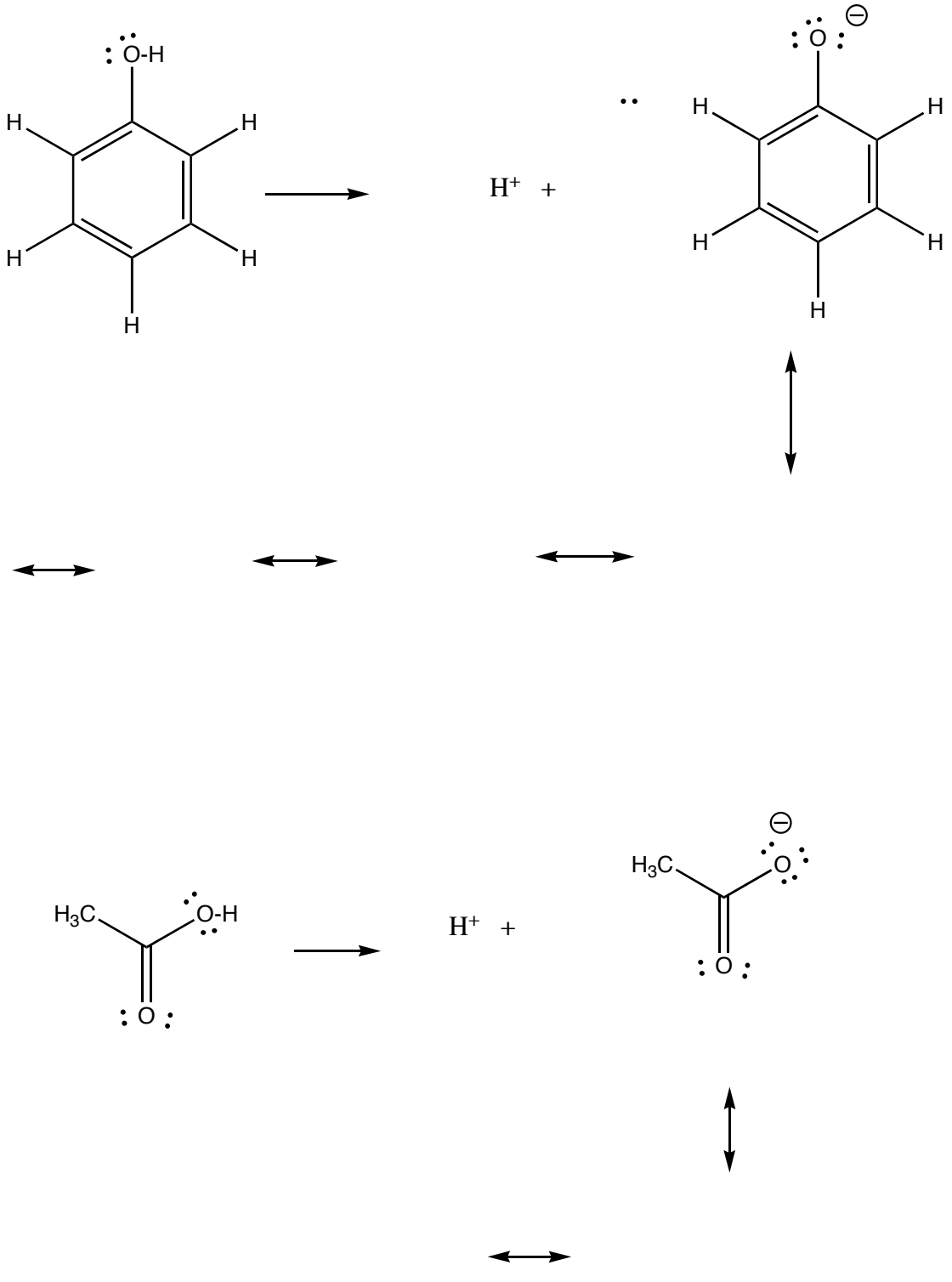
2.



3.



6. **Acidity is directly proportional the stability of the conjugate base.** The conjugate bases (A^-) of acetic acid and phenol are given below. Write the resonance structures for them.



Why is acetic acid which has a pKa of 5, more acidic than phenol, pKa = 10 even though the conjugate base of phenol has more resonance structures?

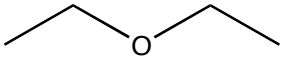
7. Rank the following according to their polarity from **lowest to highest**. Show direction of net dipole for each molecule. Rationalize your answer briefly.

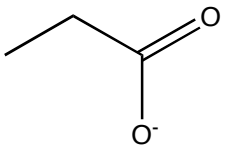
(1) CH_3Cl (2) CH_3F (3) CF_4 (4) CH_2F_2

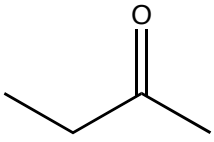
(2) CH_3CH_2OH (2) CH_3F (3) CH_3NH_2

3. CH_3CH_2COOH (2) CH_3OH (3) CH_3OCH_3

4.

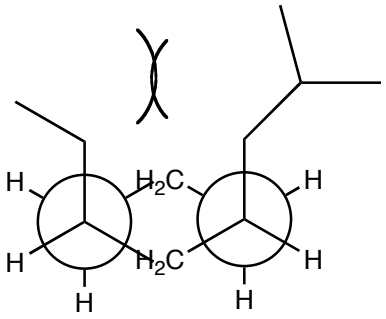
1 

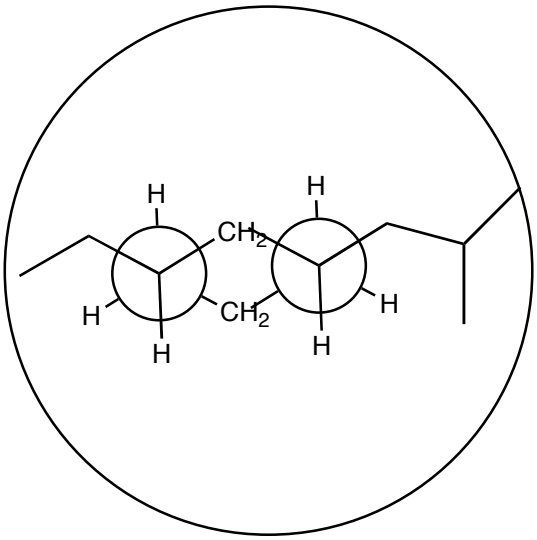
2 

3 

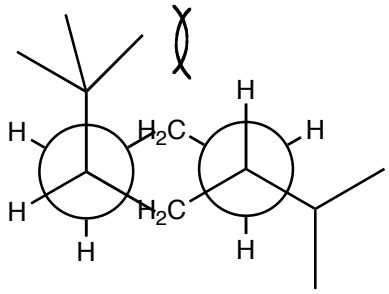
Q8.a. Draw the Newman projections for the cis and trans 1,3 substiruted cyclohexanes and circle the most stable conformer. Provide reasons for your choice.

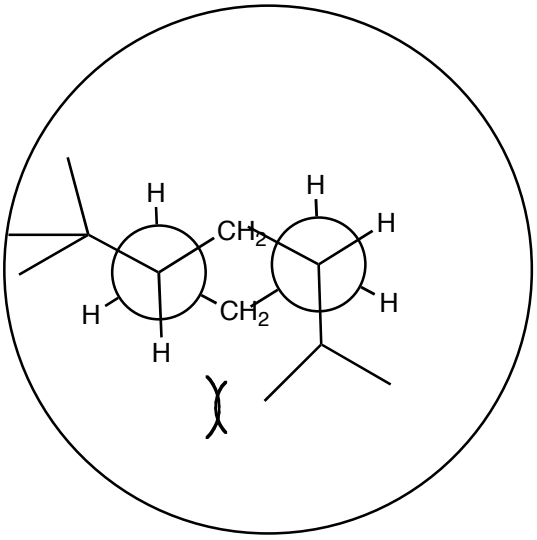
Large 1,3-diaxial steric





Both group equatorial has less 1,3-diaxial steric





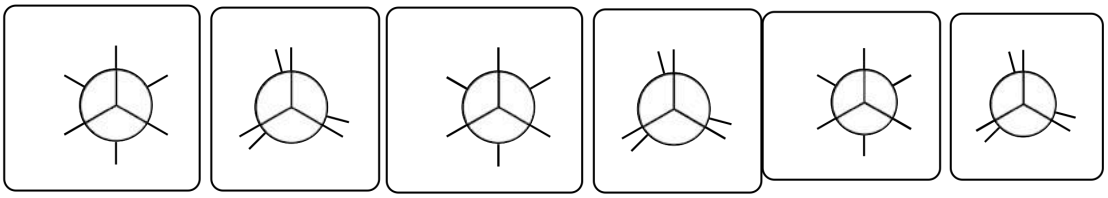
Larger group equatorial has less 1,3-diaxial steric

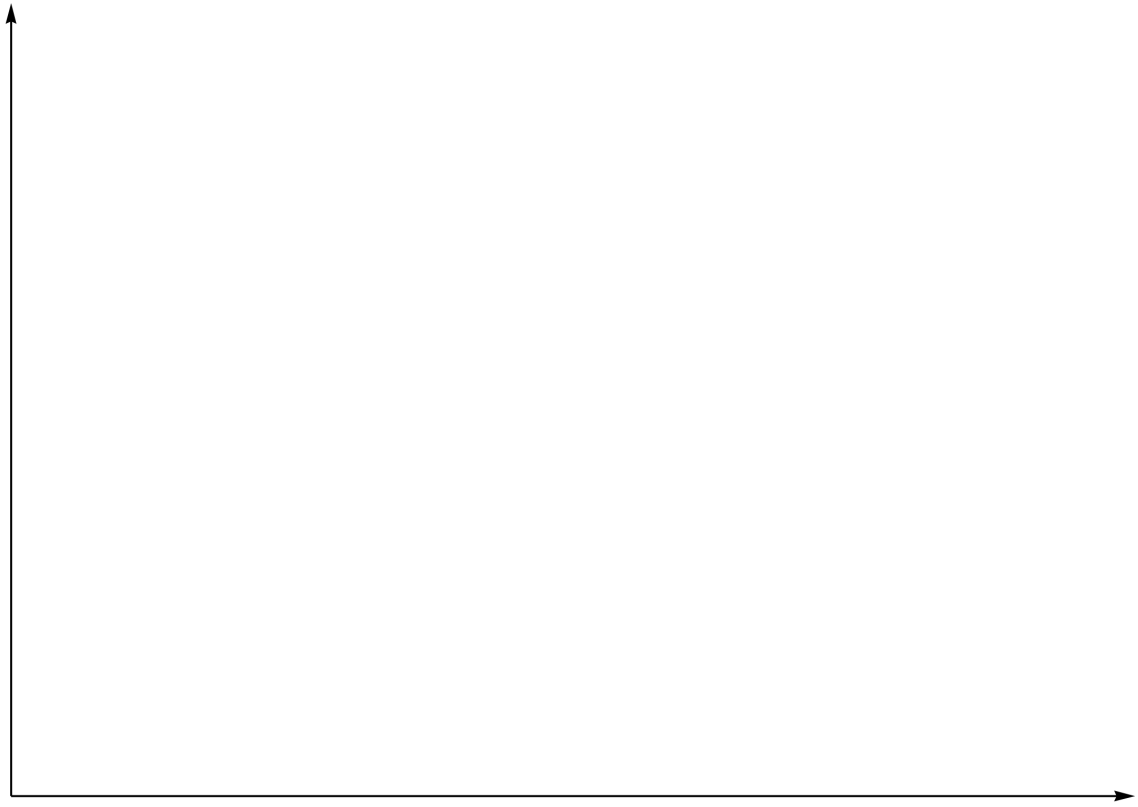
Practice

b. Draw the Newman projections for the cis and trans 1,2 substiruted cyclohexanes and circle the most stable conformer. Provide reasons for your choice.

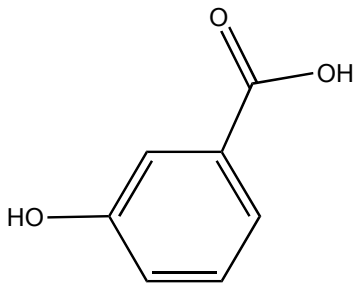
c. Draw the Newman projections for the cis and trans 1,4 substiruted cyclohexanes and circle the most stable conformer. Provide reasons for your choice.

a. Q9. . Draw the Newman projections for **2-methylbutane** , **$CH_3CH_2CH(CH_3)_2$** for rotation about the **C2-C3 bond**, (C2 carbon must be the front carbon) for every 60° rotation. On templates provided below.
Draw the corresponding energy graph of the dihedral angle (x axis) vs the increased steric energy (y axis) for the rotation around this middle carbon-carbon bond of 2-methylbutane below. You must calculate the energy of the conformers from values provided in the chart.





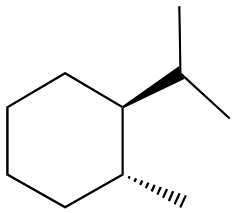
b. Draw the conjugate bases for the following molecule in order of deprotonation.



conjugate base 1

conjugate base 2

c A. Draw the two chair conformations for the compounds below. Circle the higher energy structure. Give one reason for your answer.



Total Points _____/15_____ Good Luck!