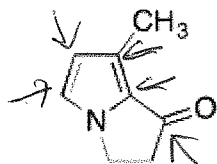


Name Key (print) Name \_\_\_\_\_ (sign)

Please show work for partial credit and full credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If you run out of space, please continue on the empty back pages but clearly label where the remaining answer can be found. (If I can't find your answer or cannot read it, I obviously cannot grade it). Return your entire exam including the periodic table. (Please count your exam pages and make sure there are 8 real pages + periodic table)

**MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts each, 30 pts total)**

- 1) Shown below is one of the sex pheromones from the butterfly family. How many  $sp^2$  hybridized carbon atoms are present in this molecule? 1) E



- A) 1                      B) 2                      C) 3                      D) 4                      E) 5

- 2) If an acyclic alkane hydrocarbon contains  $n$  carbon atoms, how many hydrogen atoms must it also contain? 2) B

- A)  $2n$                       B)  $2n + 2$                       C)  $n - 2$                       D)  $n$                       E)  $n + 2$

- 3) Which of the class of organic compound below contains a carbonyl group as a part of its structure? 3) E

- A) ester  
B) aldehyde  
C) ketone  
D) carboxylic acid  
E) all of the above

- 4) Which of the following statements is correct? 4) C

- A) Polar solutes tend to be more soluble in nonpolar solvents  
B) Induced dipole interactions are usually stronger than dipole-dipole interactions  
C) The polarity of a molecule is dependent on its three-dimensional structure  
D) Higher molecular dipole values ( $\mu$ ) are associated with nonpolar molecules  
E) All polar molecules are capable of hydrogen bond formation

- 5) A carbon-hydrogen bond in ethane ( $\text{CH}_3\text{CH}_3$ ) is best described a \_\_\_\_\_. 5) B

- A) a multiple bond  
B) essentially nonpolar  
C) resonance stabilized  
D) ionic  
E) highly polar

6) How many  $\pi$  bonds are present in the molecule shown?

6) C



A) 0

B) 1

C) 2

D) 4

E) 6

7) The electronegativity of elements on the periodic table increases going \_\_\_\_\_ a column and to the \_\_\_\_\_ in each row. (hint: where is F)

7) C

A) down; left

B) down; right

C) up; right

D) up; left

8) The atomic number of boron is 5. The correct electronic configuration of boron is:

8) C

A)  $1s^2 2p^3$

B)  $2s^2 2p^3$

C)  $1s^2 2s^2 2p^1$

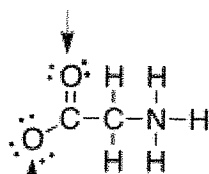
D)  $1s^2 2s^2 3s^1$

E)  $1s^2 2s^3$

9) The formal charge on the oxygens in the compound below are \_\_\_\_\_.

9) A

Oxygen 2



$$\text{Oxygen 1} - 6 - \frac{2}{2} - 6 = -1$$

A) Oxygen 1: -1, Oxygen 2: 0

B) Oxygen 1: 0, Oxygen 2: -1

C) Oxygen 1: +1, Oxygen 2: 0

D) Oxygen 1: -1, Oxygen 2: -1

E) Oxygen 1: 0, Oxygen 2: 0

*nothing sign*

10) Which atomic orbital combination would result in a molecular sigma bond?

10) B

A)

B)

C)

D)

11) Which of the following terms comes closest to describing an electrophile?

11) D

A) nucleophile

B) nonpolar

C) anion

D) Lewis acid

E) Lewis base

12) The compound methylamine,  $\text{CH}_3\text{NH}_2$ , contains a C-N bond. In this bond, which of the following best describes the charge on the carbon atom?

12) B

A) +1

B) slightly positive

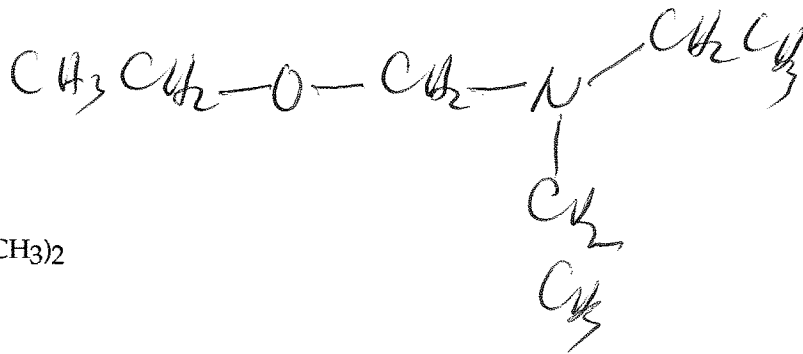
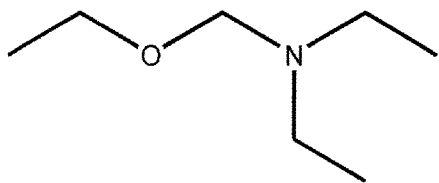
C) neutral

D) slightly negative

E) -1

13) Which of the following condensed formulas represents the same compound as the line-angle structure shown?

13) C



- A)  $\text{CH}_3\text{ON}(\text{CH}_3)_2$
- B)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_2\text{N}(\text{CH}_2\text{CH}_2\text{CH}_3)_2$
- C)  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{N}(\text{CH}_2\text{CH}_3)_2$
- D)  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{N}(\text{CH}_2\text{CH}_2\text{CH}_3)_2$
- E)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2\text{N}(\text{CH}_2\text{CH}_3)_2$

14) In the structure below, the hybridization of the oxygen is \_\_\_\_\_ and the C-O-C bond angle is \_\_\_\_\_

14) D



- A)  $sp^2$ ;  $120^\circ$
- B)  $sp^3$ ;  $120^\circ$
- C)  $sp^2$ ;  $<109.5^\circ$
- D)  $sp^3$ ;  $<109.5^\circ$
- E)  $sp$ ;  $120^\circ$

15) Which of the following molecules contains a polar covalent bond?

15) B

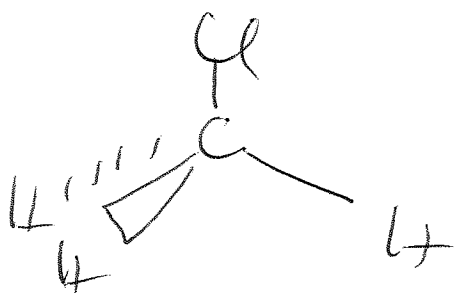
A)  $\text{H}_2$

B)  $\text{CH}_3\text{Cl}$

C) He

D) NaCl

E)  $\text{F}_2$



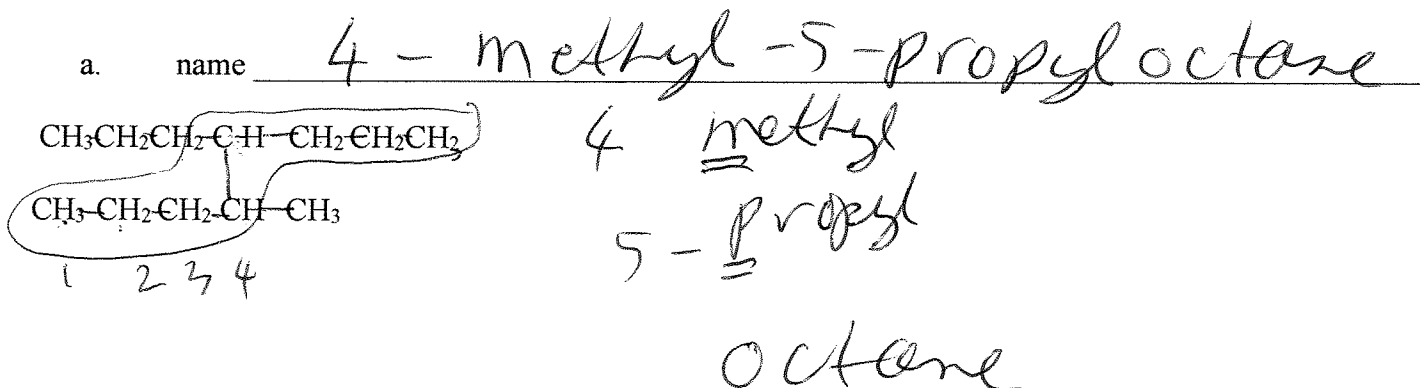
ionic

nonpolar  
covalent

**Part II: Short Answers (39 pts)**

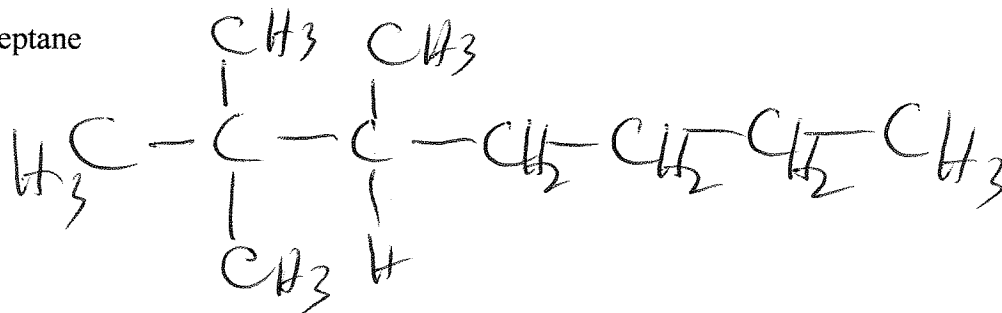
A. Nomenclature: (3 pts each, 6 pts)

1. Given the structural formula shown below, give the IUPAC name of the molecule.



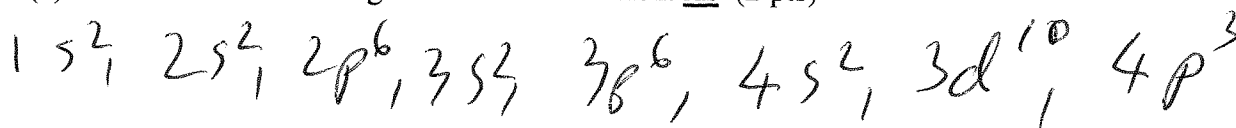
2. Given the following IUPAC name, draw a structural formula of the molecule (skeletal formula acceptable, condensed structure, Lewis Dot structure acceptable, molecular formula not acceptable - don't forget to show the hydrogens in your formula unless you are using the skeletal structure.)

2,2,3-trimethylheptane

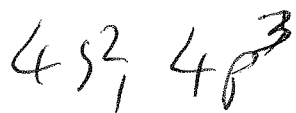


B. Short Answer Part of Short Answer:

1. (a) Give the electron configuration for the element As (2 pts)



(b) Give the valence electron configuration for the element As (2 pts)



(c) How many valence electrons is in the element As (2 pts)

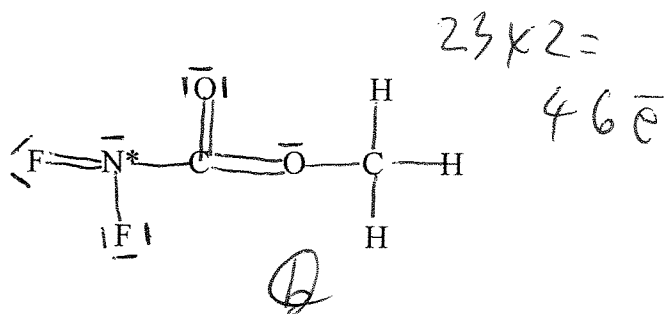
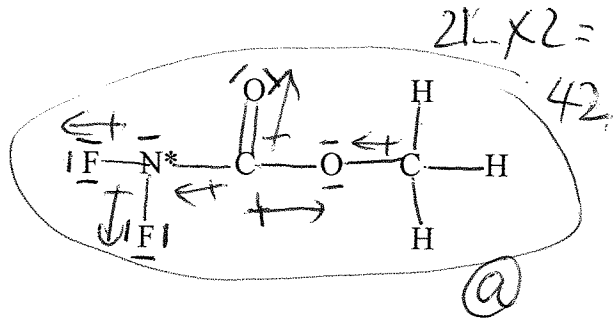


2. (a) Given the following formula, calculate the number of valence electrons for the molecule. Show work.  $C_2 O_2 N F_2 H_3$  (2 pts)

$$2(4e^-) + 2(6e^-) + (5e^-) + (7e^-)2 + 3(1e^-) = 42e^-$$

$C$ 
 $O$ 
 $N$ 
 $F$ 
 $H$

- (b) Given the following 2 Lewis Dot structures (for the formula above), circle the correct one. (2 pts)



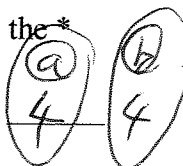
- (c) Give at least one reason why the structure which you did NOT choose above is the incorrect structure. (2 pts)

(1)  $N, C$  cannot expand octet

(2) (b) has wrong #  $e^-$  for # valence  $e^-$

3. VSEPR: Given the Lewis Dot structure which you chose above in (2b), for the atom with the \*

- a) What is the number of electron domains (VSEPR electron pairs) around the atom with the \* (1 pts each, 6 pts total)



- b) How many lone pairs on the atom with the \*

- c) What is the structure of the electron pairs at the atom with the \* (a) tetrahedral (b) "

- d) What is the structure of the molecule at the \* (a) trigonal pyramidal (b) "

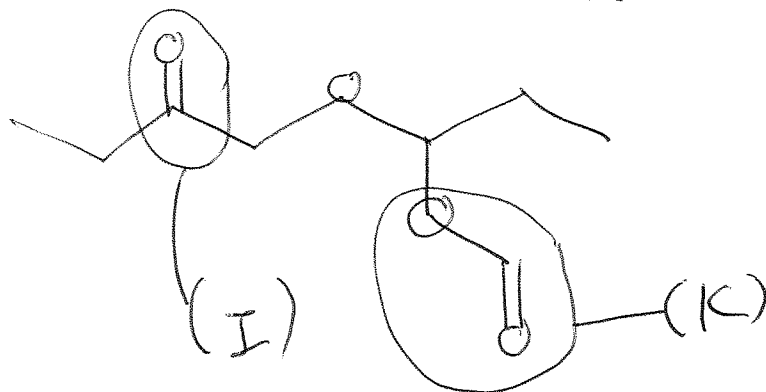
- e) Draw in dipole moment arrows in the Lewis Dot structure which you chose above in (2b).

- (f) What is the intermolecular force in the molecule above ?

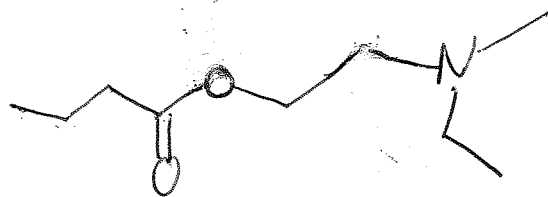
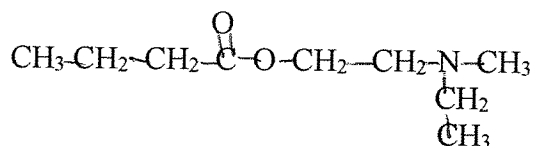
(a) dipole-dipole

(b) "

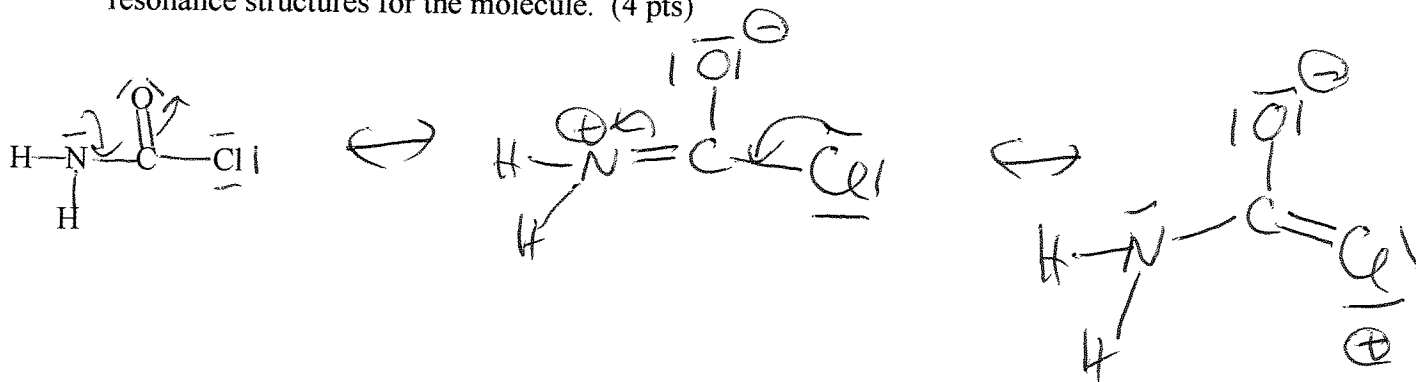
4. Given the following molecule, fill in the parenthesis with the letter of the functional group.  
 (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine  
 (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid  
 anhydride (You may use the same letter multiple times) (3 pts each, 6 pts total)



5. For the following **condensed molecular formula**, write out the **skeletal** molecular formula. (5 pts)



6. Draw **one resonance structure** for the molecule shown below. There are several potential resonance structures for the molecule. (4 pts)

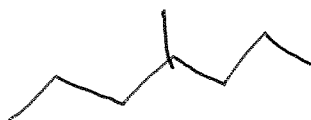


Part III: Long Answers (31 pts)

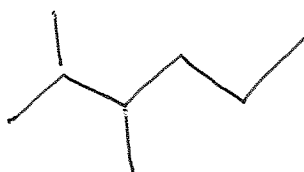
1. Given the following molecule shown, give at least 3 constitutional isomers (also called structural isomers) of the molecule. (15 pts)



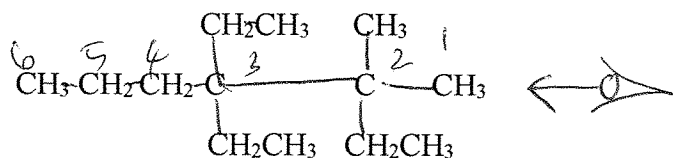
8C



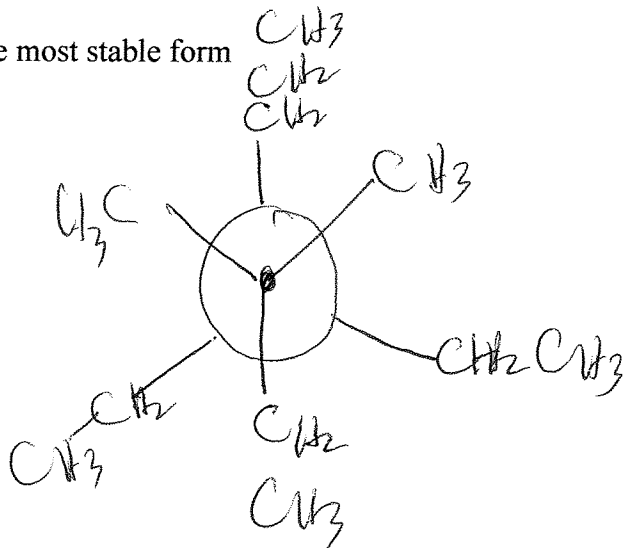
many more



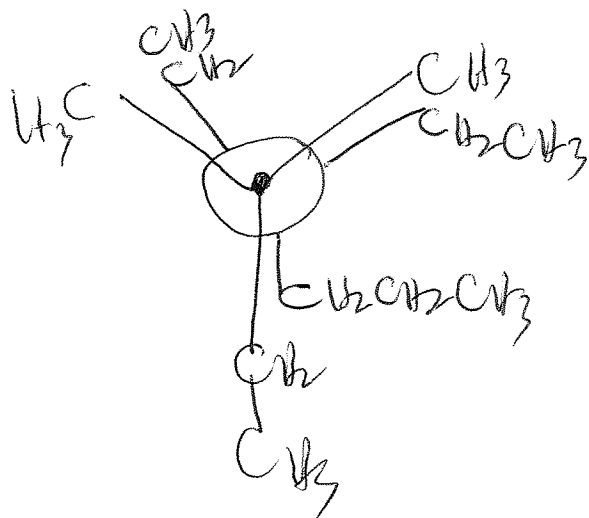
2. For the following molecule give the Newman Projection formula of (a) the most stable and the (b) the most unstable form of the molecule shown. Draw the Newman Projection formula between carbon 2 and carbon 3 with carbon 2 drawn in front. Please note the eye (shown in the normal organic chemist's notation). (16 pts, 8 pts each letter)



- a) The most stable form



- b) The most unstable form



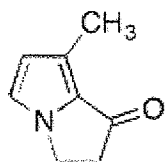


Name \_\_\_\_\_ (print) Name \_\_\_\_\_ (sign)

Please show work for partial credit and full credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If you run out of space, please continue on the empty back pages but clearly label where the remaining answer can be found. (If I can't find your answer or cannot read it, I obviously cannot grade it). Return your entire exam including the periodic table. (Please count your exam pages and make sure there are 8 real pages + periodic table)

**MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts each, 30 pts total)**

- 1) Shown below is one of the sex pheromones from the butterfly family. How many  $sp^2$  hybridized carbon atoms are present in this molecule? 1) \_\_\_\_\_



- A) 1                      B) 2                      C) 3                      D) 4                      E) 5
- 2) If an acyclic alkane hydrocarbon contains  $n$  carbon atoms, how many hydrogen atoms must it also contain? 2) \_\_\_\_\_  
 A)  $2n$                       B)  $2n + 2$                       C)  $n - 2$                       D)  $n$                       E)  $n + 2$
- 3) Which of the class of organic compound below contains a carbonyl group as a part of its structure? 3) \_\_\_\_\_  
 A) ester  
 B) aldehyde  
 C) ketone  
 D) carboxylic acid  
 E) all of the above
- 4) Which of the following statements is correct? 4) \_\_\_\_\_  
 A) Polar solutes tend to be more soluble in nonpolar solvents  
 B) Induced dipole interactions are usually stronger than dipole-dipole interactions  
 C) The polarity of a molecule is dependent on its three-dimensional structure  
 D) Higher molecular dipole values ( $\mu$ ) are associated with nonpolar molecules  
 E) All polar molecules are capable of hydrogen bond formation
- 5) A carbon-hydrogen bond in ethane ( $CH_3CH_3$ ) is best described a \_\_\_\_\_. 5) \_\_\_\_\_  
 A) a multiple bond  
 B) essentially nonpolar  
 C) resonance stabilized  
 D) ionic  
 E) highly polar

6) How many  $\pi$  bonds are present in the molecule shown?

6) \_\_\_\_\_



A) 0

B) 1

C) 2

D) 4

E) 6

7) The electronegativity of elements on the periodic table increases going \_\_\_\_\_ a column and to the \_\_\_\_\_ in each row. (hint: where is F)

7) \_\_\_\_\_

A) down; left

B) down; right

C) up; right

D) up; left

8) The atomic number of boron is 5. The correct electronic configuration of boron is:

8) \_\_\_\_\_

A)  $1s^2 2p^3$

B)  $2s^2 2p^3$

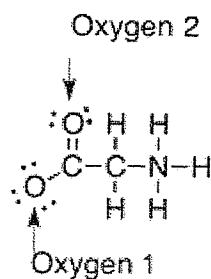
C)  $1s^2 2s^2 2p^1$

D)  $1s^2 2s^2 3s^1$

E)  $1s^2 2s^3$

9) The formal charge on the oxygens in the compound below are \_\_\_\_\_.

9) \_\_\_\_\_



A) Oxygen 1: -1, Oxygen 2: 0

B) Oxygen 1: 0, Oxygen 2: -1

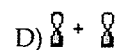
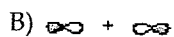
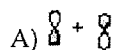
C) Oxygen 1: +1, Oxygen 2: 0

D) Oxygen 1: -1, Oxygen 2: -1

E) Oxygen 1: 0, Oxygen 2: 0

10) Which atomic orbital combination would result in a molecular sigma bond?

10) \_\_\_\_\_



11) Which of the following terms comes closest to describing an electrophile?

11) \_\_\_\_\_

A) nucleophile

B) nonpolar

C) anion

D) Lewis acid

E) Lewis base

12) The compound methylamine,  $\text{CH}_3\text{NH}_2$ , contains a C-N bond. In this bond, which of the following best describes the charge on the carbon atom?

12) \_\_\_\_\_

A) +1

B) slightly positive

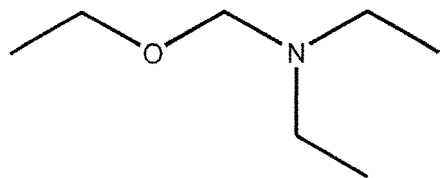
C) neutral

D) slightly negative

E) -1

13) Which of the following condensed formulas represents the same compound as the line-angle structure shown?

13) \_\_\_\_\_



- A)  $\text{CH}_3\text{ON}(\text{CH}_3)_2$
- B)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_2\text{N}(\text{CH}_2\text{CH}_2\text{CH}_3)_2$
- C)  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{N}(\text{CH}_2\text{CH}_3)_2$
- D)  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{N}(\text{CH}_2\text{CH}_2\text{CH}_3)_2$
- E)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2\text{N}(\text{CH}_2\text{CH}_3)_2$

14) In the structure below, the hybridization of the oxygen is \_\_\_\_\_ and the C-O-C bond angle is \_\_\_\_\_

14) \_\_\_\_\_



- A)  $sp^2$ ;  $120^\circ$
- B)  $sp^3$ ;  $120^\circ$
- C)  $sp^2$ ;  $<109.5^\circ$
- D)  $sp^3$ ;  $<109.5^\circ$
- E)  $sp$ ;  $120^\circ$

15) Which of the following molecules contains a polar covalent bond?

15) \_\_\_\_\_

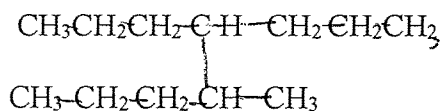
- A)  $\text{H}_2$
- B)  $\text{CH}_3\text{Cl}$
- C) He
- D) NaCl
- E)  $\text{F}_2$

**Part II: Short Answers (39 pts)**

A. Nomenclature: (3 pts each, 6 pts)

1. Given the structural formula shown below, give the IUPAC name of the molecule.

a. name \_\_\_\_\_



2. Given the following IUPAC name, draw a structural formula of the molecule (skeletal formula acceptable, condensed structure, Lewis Dot structure acceptable, molecular formula not acceptable - don't forget to show the hydrogens in your formula unless you are using the skeletal structure.)

2,2,3-trimethylheptane

B. Short Answer Part of Short Answer:

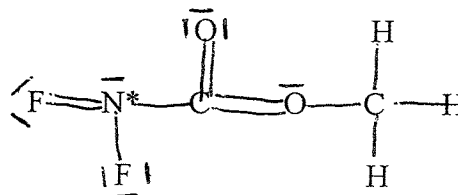
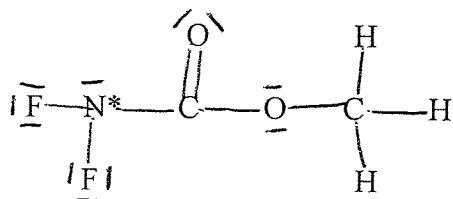
1. (a) Give the electron configuration for the element As (2 pts)

(b) Give the valence electron configuration for the element As (2 pts)

(c) How many valence electrons is in the element As (2 pts)

2. (a) Given the following formula, calculate the number of valence electrons for the molecule. Show work.  $C_2 O_2 N F_2 H_3$  (2 pts)

(b) Given the following 2 Lewis Dot structures (for the formula above), circle the correct one. (2 pts)



(c) Give at least one reason why the structure which you did NOT choose above is the incorrect structure. (2 pts)

3. VSEPR: Given the Lewis Dot structure which you chose above in (2b), for the atom with the \*

a) What is the number of electron domains (VSEPR electron pairs) around the atom with the \* \_\_\_\_\_ (1 pts each, 6 pts total)

b) How many lone pairs on the atom with the \* \_\_\_\_\_

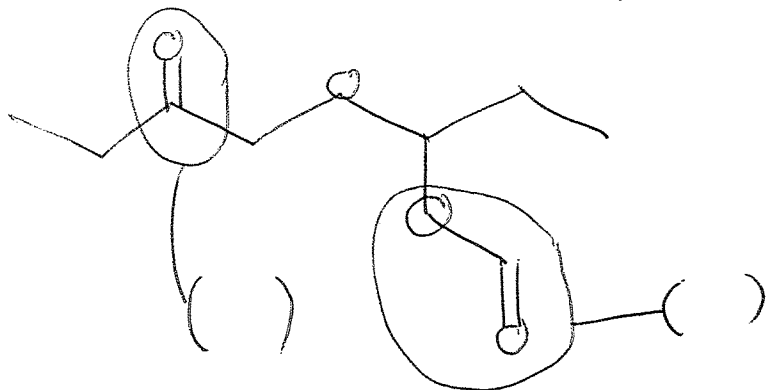
c) What is the structure of the electron pairs at the atom with the \* \_\_\_\_\_

d) What is the structure of the molecule at the \* \_\_\_\_\_

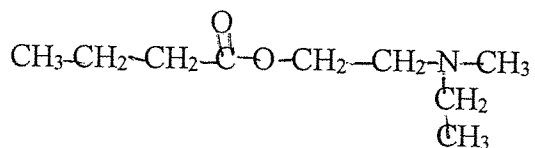
e) Draw in dipole moment arrows in the Lewis Dot structure which you chose above in (2b).

(f) What is the intermolecular force in the molecule above ?

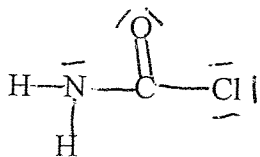
4. Given the following molecule, fill in the parenthesis with the letter of the functional group.  
 (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine  
 (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid  
 anhydride (You may use the same letter multiple times) (3 pts each, 6 pts total)



5. For the following condensed molecular formula, write out the skeletal molecular formula. (5 pts)

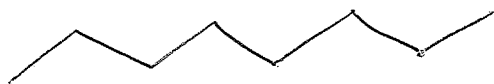


6. Draw one resonance structure for the molecule shown below. There are several potential resonance structures for the molecule. (4 pts)

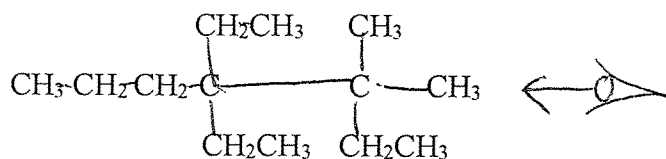


Part III: Long Answers (31 pts)

1. Given the following molecule shown, give at least 3 constitutional isomers (also called structural isomers) of the molecule. (15 pts)



2. For the following molecule give the Newman Projection formula of (a) the most stable and the (b) the most unstable form of the molecule shown. Draw the Newman Projection formula between carbon 2 and carbon 3 with carbon 2 drawn in front. Please note the eye (shown in the normal organic chemist's notation). (16 pts, 8 pts each letter)



a) The most stable form

b) The most unstable form