

Sign Name Key Print Name _____
 (2 pt name above print & sign, 1 pts scantron name) (100 pts, 9 pages + scantron sheet)

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper – If you want me to grade something not in the space for the answer, clearly specify in writing. Telling me during the exam where to find the answer does not qualify because I will just vaguely remember someone telling me something during the exam not which one of 200 students told me what to grade on what page of the exam.)

Please READ and FOLLOW directions. (ex: don't give me 5 structures if I only ask for one or you will lose points on this exam by **RUNNING OUT OF TIME**)

Circle answer on this form for backup to the scantron for the multiple choice. R=alkyl, not hydrogen on all parts of this exam.

NA = not attempted NW = NO WORK

I. Multiple Choice (2 pts each, 24 pts) Choose the **one** best statement in each question.

BA = bad attempt

1. Alkanes are characterized by: Choose the one **incorrect** statement.

- a) Alkanes are saturated hydrocarbons
- b) Alkanes have a general formula of C_nH_{2n+2}
- c) Alkanes have multiple bonds.
- d) A normal alkanes are straight chair alkanes.

No partial credit for MC

2. Choose the **best** statement.

- a) $CH_3CH_2CH_2CH_2CH_3$ and $CH_3\overset{CH_3}{CH}CH_2CH_3$ are structural isomers
- b) CH_3CH_2-O-H and CH_3-O-CH_3 are structural isomers
- c) $CH_3-CH_2-\underset{CH_2}{CH}-CH_2-CH_3$ & $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$ are structural isomers
- d) All of the above are structural isomers.
- e) None of the above pairs of molecules are structural isomers.

3. For intermolecular forces the general progression from weakest to strongest intermolecular force is

- a) Hydrogen bonding > dipolar > van der Waals
- b) Van der Waals > hydrogen bonding > dipolar
- c) Dipolar > hydrogen bonding > van der Waals
- d) None of the above is correct.

4. Choose the best statement about intermolecular forces.

- a) CH_3NH_2 has hydrogen bonding
- b) $\text{CH}_3\text{N}(\text{CH}_3)_2$ has hydrogen bonding *dipolar*
- c) CH_2Cl_2 has hydrogen bonding *dipolar*
- d) All statements above are correct.

5. Choose the one statement below which is incorrect

- a) p subshell has a maximum of 6 electrons
- b) The most electronegative element is fluorine.
- c) Periodic table group number gives the number of valence electrons for main group elements.
- d) Each orbital can hold a maximum of ~~2~~² electrons.
- e) All statements above are correct so I am unable to choose the one incorrect statement.

6. For the element Si, circle the one incorrect statement.

- a) The atomic number is 14
- b) The atomic mass is 28.09
- c) The number of electrons for a neutral atom is 28
- d) The number of valence electrons is 4

7. Choose the most electronegative element among the elements shown.

a) P

b) O

c) Te

d) Na

8. Which ONE of the following is an ionic compound?

a) SO₂

b) CO₂

c) Li₂O

d) CH₄

9. Choose the primary alcohol from the list below

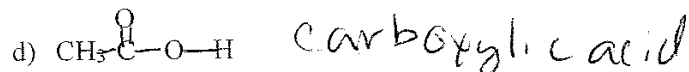
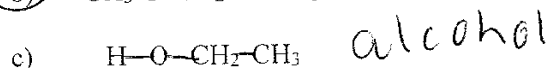
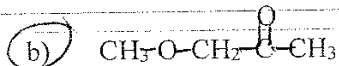
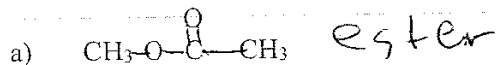
a) CH₃CH₂OH

b) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{-CH-OH} \end{array}$

c) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{-C-O-H} \\ | \\ \text{CH}_3 \end{array}$

d) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{CH}_2\text{-C-O-H} \\ | \\ \text{H} \end{array}$

10. Which of the following has a functional group ETHER in the molecule? Choose the best statement. There may be more than one functional group in the shown structure in each letter.



e) None of the above structures has an ether in the structure.

11. An alkane with 8 carbons is called: Choose the best answer.

a) Octane

b) Nonane

c) Octogenarian

d) Heptane

e) none of the above.

12. About polar bonds, choose the one best statement.

a) The C—H bond is a very polar bond.

C & H nearly same EN

b) I—I bond is a ^{not} polar bond

c) I—F bond is a polar bond

d) C—F bond is a polar bond

e) (a) and (b) are incorrect

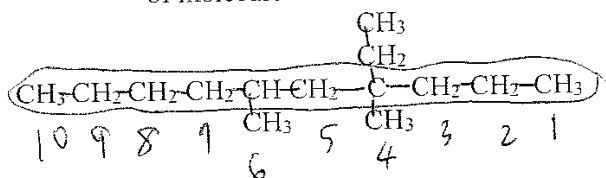
II. Short Answers (45 pts)

A. Nomenclature: (2 pts each, 4 pts)

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

a. name
of molecule

4-ethyl-4,6-dimethyldecane



-1/2 pt for wrong #C

-1/2 pt no ethyl

decane -1/2 pt no di

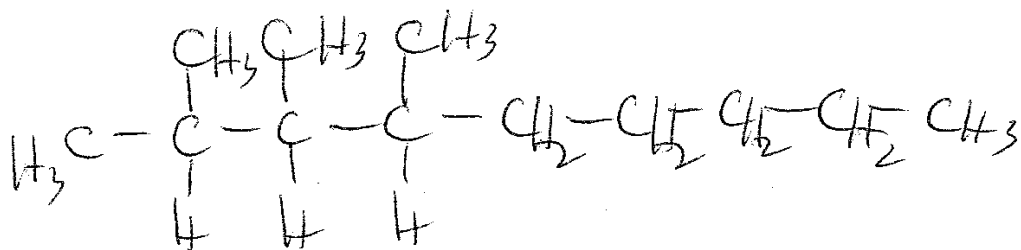
-1/2 # wrong

4,6-dimethyl
4-ethyl

BA = -1 1/2 pts

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.)

2,3,4-trimethylnonane



of H left off -1/2

-1/2 pt for same as above

B. Short Answers Part of Short Answers (41 pts)

1. Complete the following for the element Se (2 pts each, 8 pts total)

a. For the element Se show the electron configuration for all valence electrons in the format $1s^2, 2s^2, \dots$

$4s^2, 4p^4$ ← not valence - 1 pt

b. For the element Se, show the valence electron configuration orbital diagram in the format:

{ $\downarrow\uparrow$ \downarrow etc} using up and down arrows to represent electrons. (OK to write all on one line)

1s

2s

$\downarrow\uparrow$ \downarrow \downarrow \downarrow
4s 4p ← attempt - 1 pt

c. For the element Se, what is the group number? 6A

d. How many valence electrons does the element Se have? 6

2. Fill in the parenthesis with the letter of the following: (A) s block (B) p block (C) d block (D) f block (E) period (F) group (G) main group element (H) transition metal element (I) actinide lanthanide Each parenthesis has one best answer. (4 pts each, 8 pts total)

← G correct - 2 bc main group includes p block

(A)

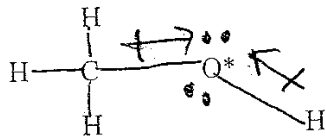
Periodic Table of the Elements

| | | | | | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | |
| H | He | | | | | | | | | | | Li | Be | B | C | N | O | F | Ne |
| Na | Mg | | | | | | | | | | | Al | Si | P | S | Cl | Ar | | |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | | |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | | |
| Cs | Ba | La | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn | | |
| Fr | Ra | Ac | Rf | Db | Sg | Bh | Hs | Mt | | | | | | | | | | | |

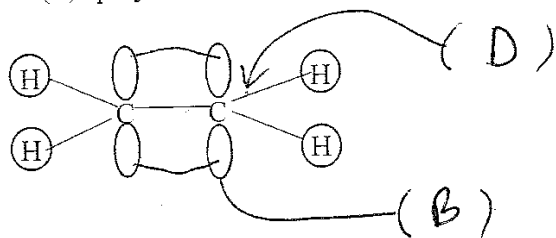
(C)
(H)

extra wrong - 2

3. For the Lewis Dot Structure shown answer the following, [1 pt per letter, 2 pts for (e), 8 pts total]

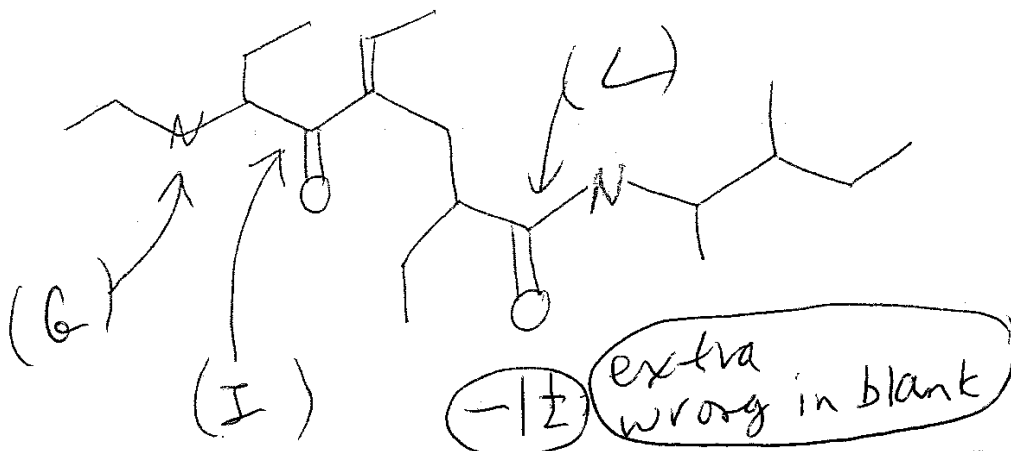


- (a) How many VSEPR electron pairs on the atom with the *? 4
- (b) How many lone pairs on the atom with the *? 2
- (c) What is the VSEPR shape of the electrons at *? tetrahedral
- (d) What is the VSEPR shape of the molecule at *? best
- (e) Draw **all non zero dipole moment arrows** on the molecule above. (2 pts this question)
- (f) Is the vector sum of the individual dipoles [(zero) or (nonzero)] (circle one)
- (g) What is the intermolecular force for the molecule? [(H bonding) (dipolar) (van der waals)] (circle one)
4. Given the following molecular orbital diagram for the alkene $H_2C=CH_2$, fill the parenthesis with a matching letter. (A) s orbital (B) p orbital (C) sp^3 hybridized orbital (D) sp^2 hybridized orbital (E) sp hybridized orbital (You may use the same letter multiple times) (4 pts each, 8 pts total)



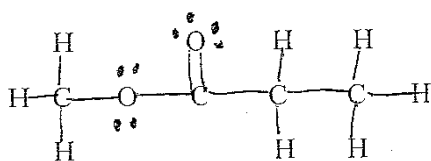
5. Given the following molecule, fill in the parenthesis with the letter of the functional group.

- (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, 9 pts total)



Part III. Long Answers (28 pts) Show work. Note that you earn partial credit for "attempt". "Attempt" is defined as not just rewriting the question but doing something towards getting the final answer.

a). Given the following Lewis Dot structure, show how you would calculate the total number of valence electrons using the periodic table and molecular formula. (DO NOT count the number of electrons in the structure or you will earn NO POINTS but show how you count up the number of valence electrons using the periodic table group numbers.) Molecular formula of the molecule is $C_4H_8O_2$ (6 pts)



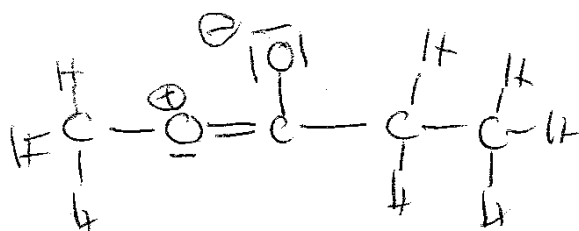
Original structure

$$\begin{array}{ccc}
 C & H & O \\
 4(4e) & + & 8(1e) & + & 2(6e) = 36e
 \end{array}$$

2 pt each

NW-3

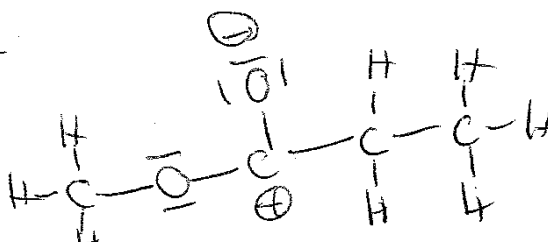
b) Draw one valid resonance structure of the above Lewis Dot Structure. (8 pts)



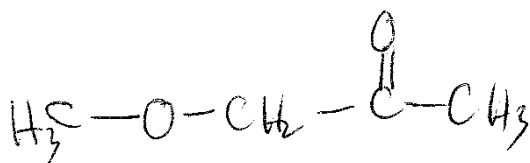
#e wrong - 2

attempt - 4

BA - 6



c) Given the above molecule, show one structural (constitutional) isomer (8 pts)



BA - 6
attempt - 4

Gave same as above or other letter - 8

d) For the above molecule written as a Lewis Dot Structure (Lewis Dot structure is a structural formula with lone pairs added in), give a skeletal formula. (6 pts)



attempt - 3
BA - 4
Condensed
Same thing as other letter - 8

Sign Name _____ Print Name _____
(2 pt name above print & sign, 1 pts scantron name) (100 pts, 9 pages + scantron sheet)

Please show work on all questions for partial credit even on questions which do not specify. Please write legibly. If I cannot read your answer, I cannot grade your answer. (use back of exam for scratch paper – If you want me to grade something not in the space for the answer, clearly specify in writing. Telling me during the exam where to find the answer does not qualify because I will just vaguely remember someone telling me something during the exam not which one of 200 students told me what to grade on what page of the exam.)

Please READ and FOLLOW directions. (ex: don't give me 5 structures if I only ask for one or you will lose points on this exam by **RUNNING OUT OF TIME**)

Circle answer on this form for backup to the scantron for the multiple choice. R=alkyl, not hydrogen on all parts of this exam.

I. Multiple Choice (2 pts each, 24 pts) Choose the **one** best statement in each question.

1. Alkanes are characterized by: Choose the one **incorrect** statement.

- a) Alkanes are saturated hydrocarbons
- b) Alkanes have a general formula of C_nH_{2n+2}
- c) Alkanes have multiple bonds.
- d) A normal alkanes are straight chair alkanes.

2. Choose the **best** statement.

- a) $CH_3CH_2CH_2CH_2CH_3$ and $CH_3\overset{CH_3}{CH}CH_2CH_3$ are structural isomers
- b) CH_3CH_2-O-H and CH_3-O-CH_3 are structural isomers
- c) $CH_3-CH_2-\underset{\begin{array}{c} CH_2 \\ CH_3 \end{array}}{CH}-CH_2-CH_3$ & $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$ are structural isomers
- d) All of the above are structural isomers.
- e) None of the above pairs of molecules are structural isomers.

3. For intermolecular forces the general progression from **weakest to strongest intermolecular force** is
- Hydrogen bonding > dipolar > van der Waals
 - Van der Waals > hydrogen bonding > dipolar
 - Dipolar > hydrogen bonding > van der Waals
 - None of the above is correct.
4. Choose the **best statement** about intermolecular forces.
- CH_3NH_2 has hydrogen bonding
 - $\text{CH}_3\text{N}(\text{CH}_3)_2$ has hydrogen bonding
 - CHCl_3 has hydrogen bonding
 - All statements above are correct.
5. Choose the one statement below which is **incorrect**
- p subshell has a maximum of 6 electrons
 - The most electronegative element is fluorine.
 - Periodic table group number gives the number of valence electrons for main group elements.
 - Each orbital can hold a maximum of 4 electrons.
 - All statements above are correct so I am unable to choose the one incorrect statement.
6. For the element **Si**, circle the one **incorrect** statement.
- The atomic number is 14
 - The atomic mass is 28.09
 - The number of electrons for a neutral atom is 28
 - The number of valence electrons is 4

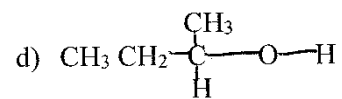
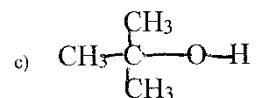
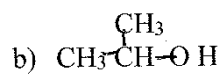
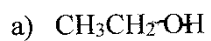
7. Choose the **most electronegative element** among the elements shown.

- a) P
- b) O
- c) Te
- d) Na

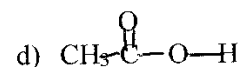
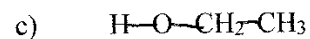
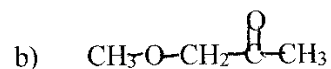
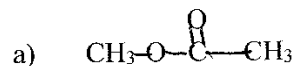
8. Which **ONE** of the following is an ionic compound?

- a) SO_2
- b) CO_2
- c) Li_2O
- d) CH_4

9. Choose the **primary alcohol** from the list below



10. Which of the following has a functional group ETHER in the molecule? **Choose the best statement.** There may be more than one functional group in the shown structure in each letter.



e) None of the above structures has an ether in the structure.

11. An alkane with 8 carbons is called: **Choose the best answer.**

- a) Octane
- b) Nonane
- c) Octogenarian
- d) Heptane
- e) none of the above.

12. About polar bonds, choose the **one best statement.**

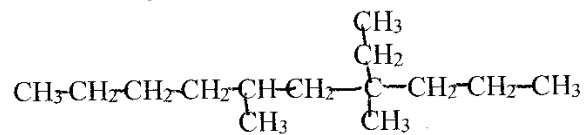
- a) The C—H bond is a very polar bond.
- b) I—I bond is a polar bond
- c) I—F bond is a polar bond
- d) C—F bond is a polar bond
- e) (a) and (b) are incorrect

II. Short Answers (45 pts)

A. Nomenclature: (2 pts each, 4 pts)

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

a. name _____
of 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.)

2,3,4-trimethylnonane

B. Short Answers Part of Short Answers (41 pts)

1. Complete the following for the element Se (2 pts each, 8 pts total)

a. For the element Se show the electron configuration for all valence electrons in the format $1s^2, 2s^2, \dots$

b. For the element Se, show the valence electron configuration orbital diagram in the format:

{ $\downarrow\uparrow$ \downarrow etc} using up and down arrows to represent electrons. (OK to write all on one line)

1s 2s

c. For the element Se, what is the group number? _____

d. How many valence electrons does the element Se have? _____

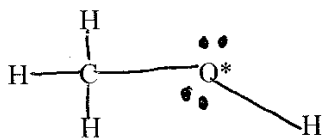
2. Fill in the parenthesis with the letter of the following: (A) s block (B) p block (C) d block (D) f block (E) period (F) group (G) main group element (H) transition metal element (I) actinide lanthanide Each parenthesis has one best answer. (4 pts each, 8 pts total)

Periodic Table of the Elements

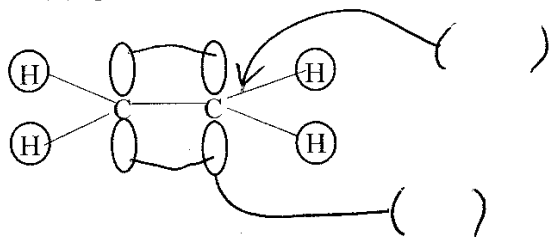
| | | | | | | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | |
| H | He | | | | | | | | | | | | | | | | | | | |
| Li | Be | B | C | N | O | F | Ne | | | | | | | | | | | | | |
| Na | Mg | Al | Si | P | S | Cl | Ar | | | | | | | | | | | | | |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | Rb | Sr | |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | Cs | Ba | |
| Cs | Ba | La | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn | | | |
| Fr | Ra | Ac | Rf | Db | Sg | Bh | Hs | Mt | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu |
| Lr | Fa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |

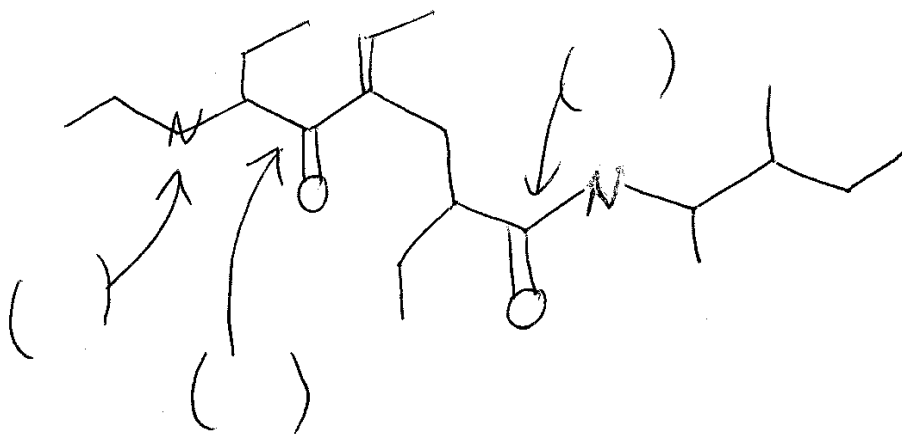
3. For the Lewis Dot Structure shown answer the following, [1 pt per letter, 2 pts for (e), 8 pts total]



- (a) How many VSEPR electron pairs on the atom with the *? _____
- (b) How many lone pairs on the atom with the *? _____
- (c) What is the VSEPR shape of the electrons at *? _____
- (d) What is the VSEPR shape of the molecule at *? _____
- (e) Draw **all non zero dipole moment arrows** on the molecule above. (2 pts this question)
- (f) Is the vector sum of the individual dipoles [(zero) or (nonzero)] (circle one)
- (g) What is the intermolecular force for the molecule? [(H bonding)(dipolar)(van der waals)] (circle one)
4. Given the following molecular orbital diagram for the alkene $H_2C=CH_2$, fill the parenthesis with a matching letter. (A) s orbital (B) p orbital (C) sp^3 hybridized orbital (D) sp^2 hybridized orbital (E) sp hybridized orbital (You may use the same letter multiple times) (4 pts each, 8 pts total)

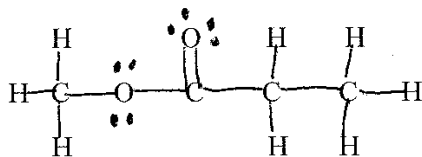


5. Given the following molecule, fill in the parenthesis with the letter of the functional group.
- (A) alkene (B) alkyne (C) arene (D) alkyl halide (E) alcohol (F) ether (G) amine
 (H) aldehyde (I) ketone (J) carboxylic acid (K) ester (L) amide (M) acid halide (N) acid anhydride (You may use the same letter multiple times) (3 pts each, 9 pts total)



Part III. Long Answers (28 pts) Show work. Note that you earn partial credit for "attempt". "Attempt" is defined as not just rewriting the question but doing something towards getting the final answer.

a). Given the following Lewis Dot structure, show how you would calculate the total number of valence electrons using the periodic table and molecular formula. (DO NOT count the number of electrons in the structure or you will earn NO POINTS but **show how you count up the number of valence electrons using the periodic table group numbers.**) Molecular formula of the molecule is $C_4H_8O_2$ (6 pts)



Original structure

b) Draw **one** valid resonance structure of the above Lewis Dot Structure. (8 pts)

c) Given the above molecule, show **one** structural (constitutional) isomer (8 pts)

d) For the above molecule written as a Lewis Dot Structure (Lewis Dot structure is a structural formula with lone pairs added in), give a **skeletal formula**. (6 pts)

Periodic Table of the Elements

| | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|---------------------------|-----------------------------|--------------------------|--------------------------|---------------------------|-----------------------------|--------------------------|-----------------------|------------------------------|------------------------|---------------------------|--------------------------|-----------------------------|---------------------------|----------------------------|-------------------------|---------------------|--------------------------|-------------------------|----------------------|---------------------|
| 1 H 1.00794 | 2A 2 He 4.002602 | | | | | | | | | | | | | | | | | 7A 7 N 14.00674 | 8A 8 O 15.9994 | | |
| 3 Li 6.941 | 4 Be 9.012182 | | | | | | | | | | | | | | | | | 5 B 10.811 | 6 C 12.0107 | 9 F 18.9984032 | 10 Ne 20.1797 |
| 11 Na 22.989770 | 12 Mg 24.3050 | 3B 21 Sc 44.955910 | 4B 22 Ti 47.867 | 5B 23 V 50.9415 | 6B 24 Cr 51.9961 | 7B 25 Mn 54.938049 | 8B 26 Fe 55.845 | | 9B 27 Co 58.9332001 | | 1B 28 Ni 58.6934 | 2B 29 Cu 63.546 | 3A 13 Al 26.981538 | 4A 14 Si 28.0855 | 5A 15 P 30.973761 | 6A 16 S 32.066 | 17 Cl 35.4527 | 18 Ar 39.948 | | | |
| 19 K 39.0983 | 20 Ca 40.078 | 39 Y 88.90585 | 40 Zr 91.224 | 41 Nb 92.90638 | 42 Mo 95.94 | 43 Tc (98) | 44 Ru 101.07 | 45 Rh 102.90550 | 46 Pd 106.42 | 47 Ag 107.8682 | 48 Cd 112.411 | 49 In 114.818 | 50 Sn 118.710 | 51 Sb 121.760 | 52 Te 127.60 | 53 I 126.90447 | 54 Xe 131.29 | 55 Cs 132.90545 | 56 Ba 137.327 | | |
| 87 Fr (223) | 88 Ra (226) | 89 Ac (227) | 92 Hf 178.49 | 93 Ta 180.9479 | 94 W 183.84 | 95 Re 186.207 | 96 Os 190.23 | 97 Ir 192.217 | 98 Pt 195.078 | 99 Au 196.966551 | 100 Hg 200.59 | 81 Tl 204.3833 | 82 Pb 207.2 | 83 Bi 208.98038 | 84 Po (209) | 85 At (210) | 86 Rn (222) | 87 Fr (223) | 88 Ra (226) | | |

| | | | | | | | | | | | | | |
|----------------------|-----------------------|---------------------|-------------------|--------------------|---------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|---------------------|
| 58 Ce 140.116 | 59 Pr 140.90765 | 60 Nd 144.24 | 61 Pm (145) | 62 Sm 150.36 | 63 Eu 151.964 | 64 Gd 157.25 | 65 Tb 158.92534 | 66 Dy 162.50 | 67 Ho 164.93032 | 68 Er 167.26 | 69 Tm 168.93421 | 70 Yb 173.04 | 71 Lu 174.967 |
| 90 Th 232.0381 | 91 Pa 231.03588 | 92 U 238.0289 | 93 Np (237) | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (262) |