NAME _____

ID # _____

ORGANIC CHEMISTRY I (2301)

9:30 – 10:20 am, June 27, 2011

Exam 1

**Form A**

If you want to pick this exam up on Tuesday in class (in public), please check the box on the right: ☐

If you do not check the box, I will not bring your exam to class on Tuesday, and you will need to pick up your exam in private from Chemistry department staff in 115 Smith beginning Wednesday, June 29th. Exams that are not picked up within two weeks will be disposed of.

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A periodic table is attached to the back of this exam as an aid. Otherwise, you are not permitted to use any other materials (including notes, books, or electronic devices of any kind).

Right now, write your name at the top of this page, and fill in the bubbles on the back of the multiple-choice answer sheet for your name and your 7-digit student ID number. When the exam begins, please write your name at the top of the next page.

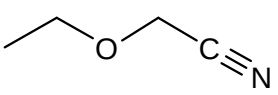
You may use pen or pencil. However, re-grades will be considered only for exams completed in pen.

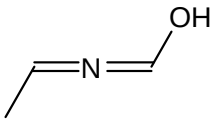
Please write your answers in the boxes/spaces provided. If your answer is not in the appropriate space (say, for example, it's on the back of the page), draw us an arrow and/or note telling us where to look.

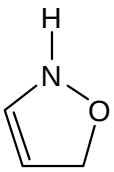
## Multiple-Choice Section

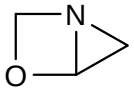
Please answer these problems on the bubble sheet.

1. (3 pts) Which of the structures below is NOT a valid line-angle structure for $C_3H_5NO$?

a. 

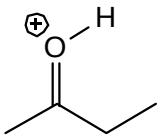

b. 

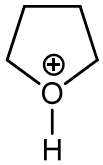

c. 

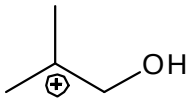

d. 

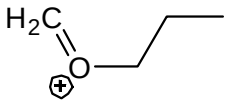

e. All of the structures (a-d) above are valid.

2. (3 pts) Which of the structures below is NOT a valid Lewis dash-bond structure for $C_4H_9O^+$?

a. 

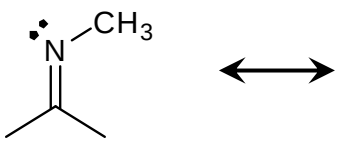

b. 


c. 

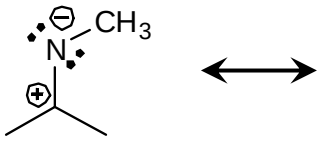

d. 


e. All of the structures (a-d) above are valid.

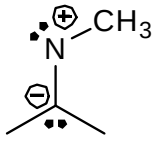
(3 pts each) For each of the resonance structures below, indicate whether the structure is a major contributor, a minor contributor, or a non-contributor to the overall electronic distribution in the molecule.

3. 


a. major contributor
b. minor contributor
c. non-contributor

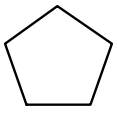
4. 

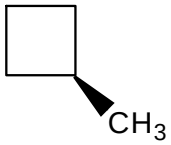

a. major contributor
b. minor contributor
c. non-contributor

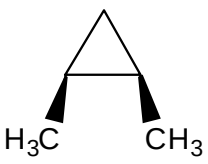
5. 

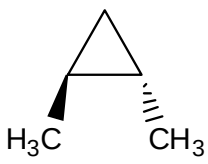

a. major contributor
b. minor contributor
c. non-contributor

6. (3 pts) Each of the $C_5H_{10}$ cycloalkanes below combusts in $O_2$ exothermically (with $\Delta H_{comb} << 0$) to $CO_2$ and $H_2O$. **Which one combusts the most exothermically?**

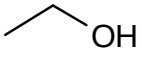
a. 

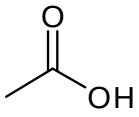
b. 

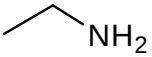

c. 

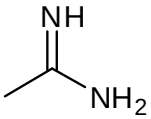

d. 

Of the molecules listed below,

a. 


b. 

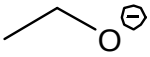

c. 

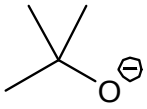

d. 

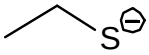

7. (3 pts) Which would be the most acidic?

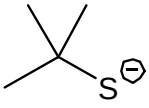
8. (3 pts) Which would be the least acidic?

Of the molecules listed below,

a. 


b. 


c. 


d. 

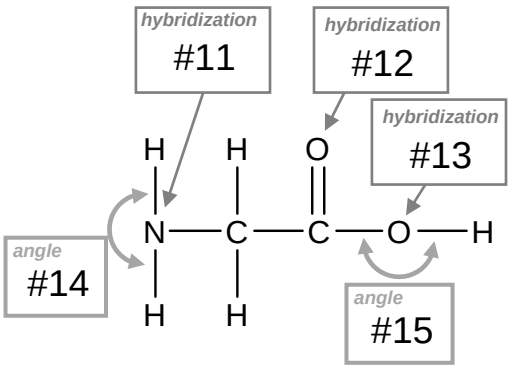

9. (3 pts) Which would be the most basic?

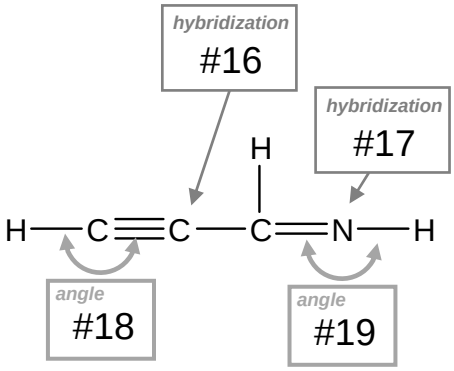
10. (3 pts) Which would be the least basic?

(2 pts each) In the each of the Lewis structures drawn below:

- For each atom marked "hybridization", indicate whether the atom is hybridized (a) *sp*, (b) $sp^2$, (c) $sp^3$, or (d) none of these.
- For each bond angle marked "angle", indicate whether the angle is closest to (a) 109.5°, (b) 120°, or (c) 180°.

Mark each answer on the bubble sheet, with the problem number indicated inside each box.



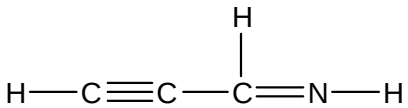
NAME _____

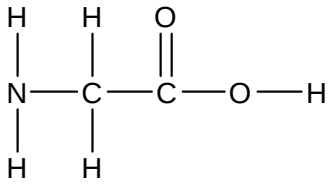
Scoring: 19. _____ / 6 21. _____ / 15

20. _____ / 9 22. _____ / 22

**Score for this section: _____ / 52**

19. (6 pts) On the previous page (in the multiple-choice section), you assigned atom hybridizations and bond-angle values to the two molecules shown below. In the empty boxes below each molecule, draw Lewis wedge/dashed-bond structures that illustrate the most stable three-dimensional structure of the molecule. Draw all atoms, but feel free to omit lone pairs.

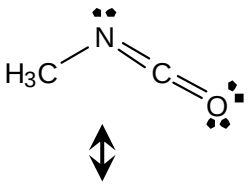




*wedge/dashed-bond (3D) structure*

*wedge/dashed-bond (3D) structure*

20. (9 pts) Draw two more valid resonance structures for methyl isocyanate (at right). Include lone pairs in your resonance structures. Then, draw a consensus structure that illustrates partial charges and bond order in the molecule.



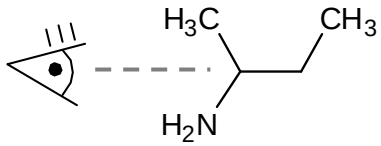
*consensus structure*

*resonance structure*

*resonance structure*

21. (15 pts)

a. For 2-aminobutane (shown at right), draw Newman projections that show the most stable, second-most stable, least stable, and second-least stable conformations of the molecule. Draw your projections looking down the C2-C3 bond, using the perspective I've shown in the drawing.




| *Newman projection for* ***most stable*** *conformation* | *Newman projection for* ***second-most stable*** *conformation* |
|---|---|
| *Newman projection for* ***least stable*** *conformation* | *Newman projection for* ***second-least stable*** *conformation* |

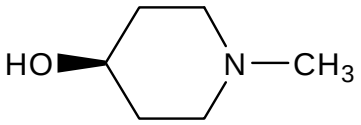
b. Next, draw a Lewis wedge/dashed-bond structure for the **most stable** conformation. Abbreviate carbon atoms as vertices, don't draw hydrogen atoms bound to carbon, and omit lone pairs.

| *wedge/dashed-bond structure for* ***most stable*** *conformation* |
|---|

22. (XX pts) 4-hydroxy-1-methyl piperidine (**1**) is a base, and it reacts with hydrochloric acid to form two conjugate acid stereoisomers as products. In one of the products, the -OH and -$CH_3$ groups are *cis*, and in the other product, they are *trans*.

a. Using "electron pushing" (with double-barbed arrows), show how the molecules on the left of the diagram below would react in an acid-base reaction to transfer a proton from one to the other. Draw your arrows directly on my structures.

b. In the boxes on the right, draw the two products as wedge/dashed-bond structures.




**1**

+ H—Cl

*cis-disubstituted conjugate acid*

+ $Cl^{\ominus}$

*and*

*trans-disubstituted conjugate acid*

+ $Cl^{\ominus}$

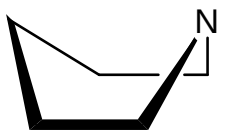
c. For both of these products, the most stable conformation is a chair. In the boxes below, draw the most stable chair conformation of each product. Feel free to omit C-H's and lone pairs, and abbreviate -$CH_3$ as I have, but draw all other atoms.

*most stable chair conformer for **cis**-product*

*most stable chair conformer for **trans**-product*

d. Ordinarily, the boat conformation of a six-membered ring is much less stable than its chair conformation. In the case of the *trans*-disubstituted product on the previous page, this is still true, but the *trans*-boat conformation does have a stabilizing interaction that the *cis*-isomer doesn't. On my incomplete structure on the right,

***trans**-disubstituted boat conformation*




- Add an -OH, a -$CH_3$, and a proton to illustrate the *trans*-product in its most stable boat conformation;
- Then, illustrate and label (with a name) the stabilizing interaction that makes this particular boat most stable.

Periodic Table of the Elements

# Chemistry Reference Sheet

California Standards Test

| | 1 1A | | | | | | | | | | | | 13 3A | 14 4A | 15 5A | 16 6A | 17 7A | 18 8A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 **H** Hydrogen 1.01 | 2 2A | | | | | | | | | | | | | | | | 2 **He** Helium 4.00 |
| 2 | 3 **Li** Lithium 6.94 | 4 **Be** Beryllium 9.01 | | | | | | | | | | | 5 **B** Boron 10.81 | 6 **C** Carbon 12.01 | 7 **N** Nitrogen 14.01 | 8 **O** Oxygen 16.00 | 9 **F** Fluorine 19.00 | 10 **Ne** Neon 20.18 |
| 3 | 11 **Na** Sodium 22.99 | 12 **Mg** Magnesium 24.31 | 3 3B | 4 4B | 5 5B | 6 6B | 7 7B | 8 | 9 8B | 10 | 11 1B | 12 2B | 13 **Al** Aluminum 26.98 | 14 **Si** Silicon 28.09 | 15 **P** Phosphorus 30.97 | 16 **S** Sulfur 32.07 | 17 **Cl** Chlorine 35.45 | 18 **Ar** Argon 39.95 |
| 4 | 19 **K** Potassium 39.10 | 20 **Ca** Calcium 40.08 | 21 **Sc** Scandium 44.96 | 22 **Ti** Titanium 47.87 | 23 **V** Vanadium 50.94 | 24 **Cr** Chromium 52.00 | 25 **Mn** Manganese 54.94 | 26 **Fe** Iron 55.85 | 27 **Co** Cobalt 58.93 | 28 **Ni** Nickel 58.69 | 29 **Cu** Copper 63.55 | 30 **Zn** Zinc 65.39 | 31 **Ga** Gallium 69.72 | 32 **Ge** Germanium 72.61 | 33 **As** Arsenic 74.92 | 34 **Se** Selenium 78.96 | 35 **Br** Bromine 79.90 | 36 **Kr** Krypton 83.80 |
| 5 | 37 **Rb** Rubidium 85.47 | 38 **Sr** Strontium 87.62 | 39 **Y** Yttrium 88.91 | 40 **Zr** Zirconium 91.22 | 41 **Nb** Niobium 92.91 | 42 **Mo** Molybdenum 95.94 | 43 **Tc** Technetium (98) | 44 **Ru** Ruthenium 101.07 | 45 **Rh** Rhodium 102.91 | 46 **Pd** Palladium 106.42 | 47 **Ag** Silver 107.87 | 48 **Cd** Cadmium 112.41 | 49 **In** Indium 114.82 | 50 **Sn** Tin 118.71 | 51 **Sb** Antimony 121.76 | 52 **Te** Tellurium 127.60 | 53 **I** Iodine 126.90 | 54 **Xe** Xenon 131.29 |
| 6 | 55 **Cs** Cesium 132.91 | 56 **Ba** Barium 137.33 | 57 **La** Lanthanum 138.91 | 72 **Hf** Hafnium 178.49 | 73 **Ta** Tantalum 180.95 | 74 **W** Tungsten 183.84 | 75 **Re** Rhenium 186.21 | 76 **Os** Osmium 190.23 | 77 **Ir** Iridium 192.22 | 78 **Pt** Platinum 195.08 | 79 **Au** Gold 196.97 | 80 **Hg** Mercury 200.59 | 81 **Tl** Thallium 204.38 | 82 **Pb** Lead 207.2 | 83 **Bi** Bismuth 208.98 | 84 **Po** Polonium (209) | 85 **At** Astatine (210) | 86 **Rn** Radon (222) |
| 7 | 87 **Fr** Francium (223) | 88 **Ra** Radium (226) | 89 **Ac** Actinium (227) | 104 **Rf** Rutherfordium (261) | 105 **Db** Dubnium (262) | 106 **Sg** Seaborgium (266) | 107 **Bh** Bohrium (264) | 108 **Hs** Hassium (269) | 109 **Mt** Meitnerium (268) | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58 **Ce** Cerium 140.12 | 59 **Pr** Praseodymium 140.91 | 60 **Nd** Neodymium 144.24 | 61 **Pm** Promethium (145) | 62 **Sm** Samarium 150.36 | 63 **Eu** Europium 151.96 | 64 **Gd** Gadolinium 157.25 | 65 **Tb** Terbium 158.93 | 66 **Dy** Dysprosium 162.50 | 67 **Ho** Holmium 164.93 | 68 **Er** Erbium 167.26 | 69 **Tm** Thulium 168.93 | 70 **Yb** Ytterbium 173.04 | 71 **Lu** Lutetium 174.97 |
| 90 **Th** Thorium 232.04 | 91 **Pa** Protactinium 231.04 | 92 **U** Uranium 238.03 | 93 **Np** Neptunium (237) | 94 **Pu** Plutonium (244) | 95 **Am** Americium (243) | 96 **Cm** Curium (247) | 97 **Bk** Berkelium (247) | 98 **Cf** Californium (251) | 99 **Es** Einsteinium (252) | 100 **Fm** Fermium (257) | 101 **Md** Mendelevium (258) | 102 **No** Nobelium (259) | 103 **Lr** Lawrencium (262) |

**Key**

11 — Atomic number
**Na** — Element symbol
Sodium — Element name
22.99 — Average atomic mass*

* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.