Midterm Exam 2
CHEM 181: Introduction to Chemical Principles
October 13, 2015

Directions:

Do all three problems.

Show all of your work neatly and clearly. Do not skip steps. Partial credit will be awarded for all problems. Correct answers will not receive credit if your work is not shown.

If you are not sure exactly what a question means, ask!

Not all problems are of equal difficulty, but all are worth the same fraction of the overall grade.
1. Draw Lewis structures for the isomers with the molecular formula C$_3$H$_3$NO$_2$ that are shown on the following pages. For each isomer shown, do the following:

- Label non-zero formal charges.
- Include all resonance structures that follow the octet rule.
- Label each resonance structure as either **major**, **minor**, **very minor**, or **not valid** (i.e., should not be considered).
- **Rank** the resonance structures in numerical order (1=best, 2=next best, etc.) If two structures are exactly equivalent, give them the same number.

(a) Methyl cyanoformate is an isomer of C$_3$H$_3$NO$_2$, with the connectivity shown below:

![Lewis structure of methyl cyanoformate](image)

Provide a Lewis structure for methyl cyanoformate.
(b) Acetyl isocyanate is an isomer of C$_3$H$_3$NO$_2$, with the connectivity shown below:

![Lewis structure for acetyl isocyanate](image)

Provide a Lewis structure for acetyl isocyanate.
(c) Oxazolone is an isomer of $\text{C}_3\text{H}_3\text{NO}_2$, with the connectivity shown below:

Provide a Lewis structure for oxazolone.
2. Here is the best single electron-dot structure for acetyl azide (C₂H₃N₃O):

Consider the following proposed (but not necessarily correct) resonance structures, labeled A through E. Categorize each one according to the following. (You will *not* receive credit for categorizing a structure if you do not provide an explanation.)

(a) Which structures (if any) *must be included* as resonance structures because they tell you something new about the molecule? Identify each structure by its label, and explain (one sentence each) what is important about its inclusion (i.e., its effect on bond order, formal charge, and/or hybridization).
(b) Which structures (if any) *could be included*, but are very minor and their inclusion would not change bond order, formal charge, or hybridization in any significant way. Identify each structure by its label, and explain (one sentence each) what makes the structure unimportant.

(c) Which structures (if any), are *bad structures that can not be included*. Identify each structure by its label, and explain (once sentence each) the problem or problems with it.
3. Draw 4 isomers that have the molecular formula $\text{C}_2\text{H}_3\text{NO}$. Do not use rings.

(a) For each isomer, provide a Lewis structure with major and minor resonance structures and non-zero formal charges (if present).
(b) Label which of the four isomers you expect to be the most stable compound ("most" or "most stable") and explain (1 sentence):

(c) Label which of the four isomers you expect to be the second most stable compound ("second most" or "second") and explain (1 sentence):

(d) Label which of the four isomers you expect to be the third most stable compound ("third most" or "third") and explain (1 sentence):

(e) Label which of the four isomers you expect to be the least stable compound ("least" or "least stable") and explain (1 sentence):
Electronegativity:

<table>
<thead>
<tr>
<th>Atom</th>
<th>$\chi$</th>
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<tbody>
<tr>
<td>F</td>
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<tr>
<td>C</td>
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<tr>
<td>H</td>
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</tr>
</tbody>
</table>

Equations:
Bond order $= \frac{1}{2} (\# \text{ bonding electrons} - \# \text{ antibonding electrons})$.
Formal charge $= \# \text{ valence electrons} - (\# \text{ lone pair electrons} + \frac{1}{2} \# \text{ bonding electrons})$.