Problem Set #1, 5.12 Spring 2003
Due Monday, 2/10 at 4pm

(Out of 20 points total)

1. Draw out valid Lewis structures (lines or dots) for the following formulas. Circle structures that have ionic bonds. (Show lone pairs and formal charges.)

   NaHCO₃
   \[
   \begin{array}{c}
   \text{Na}^+ \quad \text{O} \\
   \text{O} \\
   \text{O} \\
   \text{O} \\
   \text{H}
   \end{array}
   \]

   [CH₃CH₂OCH₂]⁺
   \[
   \begin{array}{c}
   \text{C} \\
   \text{H} \\
   \text{H} \\
   \text{O} \\
   \text{H}
   \end{array}
   \]

   C₂H₂
   \[
   \begin{array}{c}
   \text{H} \\
   \text{C} = \text{C} \quad \text{H}
   \end{array}
   \]

2. Draw a valid Lewis structure for AlF₃. Would you expect the aluminum atom to be electrophilic or nucleophilic? Why?

   \[
   \begin{array}{c}
   \text{F} \\
   \text{Al} \\
   \text{F} \\
   \text{F}
   \end{array}
   \]

   Aluminum, like boron, only starts with three valence electrons. This means that the aluminum atom in AlF₃ has six valence electrons and an empty p-orbital. It can accept electrons.

   \[\rightarrow\text{The aluminum atom is electrophilic.}\]
3. You learned in lecture that phenol is more acidic than cyclohexanol because its conjugate base (phenoxide ion) is stabilized by resonance. **Strong acids have stable conjugate bases.**

a) Draw the relevant resonance structures for the conjugate bases of A and B.

b) Which would you expect to be more acidic? Why?

In other words, see how much you can delocalize the negative charge.

You could double the # of resonance structures just by switching the nitro resonance, but that doesn't get you anywhere. ⇒ irrelevant.

b) B is more acidic because of the extra resonance structure that puts the negative charge on the nitro oxygen. In other words, B is more acidic because the conjugate base is more stable (more delocalization = more stabilization.)
4. Circle the following pairs of structures that do not constitute resonance structures. For the proper resonance pairs, draw curved arrows to convert the first structure to the second. Draw in all lone pairs that you move.

(a) 

(b) 

(c) 

(d) 

(e) 

(f)
5. a) Draw all of the relevant resonance structures for A, and rank them by energy (1 = lowest energy). If two or more resonance structures are similar in energy, give them the same ranking.

b) Label the electrophilic atoms in A.

\[ \text{Energy: } A < B \approx C < E \approx F < D \]

\[ \text{H}_3\text{C} \quad \text{N} \quad \text{CH}_3 \quad \text{=} \quad \text{electrophilic} \]

c) Draw all of the relevant resonance structures for B, and rank them by energy (1 = lowest energy). If two or more resonance structures are similar in energy, give them the same ranking.
d) Label the nucleophilic atoms in B.

\[ \text{Energy: } B < E < C \approx D \]

\[ \text{H}_2\text{C} \quad \text{N} \quad \text{CH}_3 \quad \text{=} \quad \text{~nucleophilic} \]

Hint: When you start with a charged molecule, don't generate any additional charge. Just move the charge around (delocalization). When you start with a neutral molecular, you usually have to generate charge to draw resonance structures.