Worksheet #2: Minor & Major Resonance Contributors, Bronstead Acids & Bases

Supplemental Instruction
Iowa State University

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Course: Chem 331
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Date: 9/3/15

1) Which of the following are the rules given in class on 9/2/15 for determining which is the major (most stable) resonance structure (there are 4 correct answers)?

- a. Fewer charges = more stable
- ❌ 2 or more strongly electronegative atoms = more stable
- ❌ Fewer atoms = more stable
- d. Charges are on the best atoms (- on EN atom, + on EP atom)
- e. Resonance structures with atoms having complete octets preferred
- ❌ Rule d trumps rule a
- ❌ Rule e trumps rule d

2) For each of the following resonance structures, identify which is the major/minor contributor and identify the rule used in each case:

a. Formamide

![Formamide resonance structures]

- III Major/Minor
- IV Major/Minor

Rule letter (from prob. 1): a

b. Enolate ion

![Enolate ion resonance structures]

- Major/Minor
- Major/Minor

Rule letter: d

c. Hydroxymethyl

![Hydroxymethyl resonance structures]

This does not work b/c this is not a valid resonance structure. Sorry!

Rule letter: E(d-g)
3) Fill in the blanks with the correct answers:
   a. \( p\text{Ka} = -\log(K\text{a}) \)
   b. High \( K\text{a} \) value indicates a _strong_ acid.
   c. High \( p\text{Ka} \) value indicates a _weak_ acid.
   d. High \( K\text{a} \) value indicates a _weak_ base.
   e. High \( p\text{Ka} \) value indicates a _strong_ base.
   f. When using arrow pushing in an acid-base reaction, you should _NEVER_ draw an arrow starting from an \( \text{H}^+ \).

4) In each case, identify if the statement is true for weak or strong acids (Hint for b & c: consider the definition of a Bronstead acid):
   a. Equilibrium favors (i.e. a reaction will proceed towards) this side.  _Weak/Strong_
   b. The acid’s conjugate base is stable.  _Weak/Strong_
   c. The acid’s conjugate base is unstable.  _Weak/Strong_

5) Identify the Bronstead acid and base and their conjugates in the following reaction. (Hint: look at which molecules are gaining/losing electrons) Towards which side will the reaction proceed? Explain.

![Chemical Reaction Diagram]

**p\text{Ka}** values:  35  15.7  9.25  15.7

- **Identify:**  BL base  BL acid  BL acid  BL conjugate base
- **Reaction direction:**  _Left_

The \( p\text{Ka} \) of water, the 8L Bronstead—Lowry (BL) acid for this reaction, is greater than the \( p\text{Ka} \) of ammonium, the BL acid of the other side. Thus, water is a weaker acid than ammonium and the reaction will proceed in the reverse direction (towards the left). Note also that the reverse reaction is forming water, a more stable compound than hydroxide, its conjugate base.