CEM 251 (Sections 101-104)
MIDTERM #1
JUNE 4, 2010

Name: Key
PID: __________________________

Section: ________
TA: __________

This is a closed book and note examination. If boxes are provided for your answer, only what is written in the boxes will be graded. You have 50 minutes to complete the test.

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v2
1. Name or draw the structures for the following molecular compounds (2 pts each):

- 5-sec-butyl-8-ethyl-3,4,4-trimethyldecane
- (4R)-3,7-dimethyl-4-propyl nonane
- 4,4,5,6-tetraethyldodecane
- 1-cyclopropyl-3,3-dimethylecyclohexane
2. Assign formal charge to the designated atoms (assume all electrons are present) (1 pt each):

   ![Molecules]

   (4)  
   (-)  
   0    
   (-)  (4)

3. Answer the following questions regarding heroine:

   ![Heroine structure]

   a. How many sp² carbons are in this molecule (2 pts)?

   10

   b. How many stereocenters are present (2 pts)? Put a dot on each of them (5 pts).

   5
4. With two sets of electron movements to get to the next resonance structure, draw all resonance structures possible for these compounds (4 pts).

Bonuse: Draw the resonance hybrid for this compound (2 pts).

5. Indicate amount of valence electrons “owned” by the charged atoms in the following molecules (1 pt each).

\[
\begin{array}{cccc}
\text{O}^+ & \text{N}^- & \text{O}^+\text{B}^-\text{OH}^- & \text{C}^- \\
5 & 6 & 4 & 5 \\
\end{array}
\]
6. Indicate the direction of these acid/base reactions by circling the side to which the equilibrium lies (2 pts each).

\[
\begin{align*}
\text{acetate}^- & + \text{HCl} \quad \text{↔} \quad \text{acetate}^- \cdot \text{H} + \text{Cl}^- \\
pK_a = -7
\end{align*}
\]

\[
\begin{align*}
\text{H} & + \text{amine} \quad \text{↔} \quad \text{H} + \text{amine}^- \\
\end{align*}
\]

7. Identify the Lewis acids (LA) and bases (LB) in the following reactions (1 pt each).

\[
\begin{align*}
\text{LA} & + \text{Br}^- \quad \rightarrow \quad \text{Br}^- \\
\text{LB} & + \text{HBr} \quad \rightarrow \quad \text{H}^+ \quad + \text{Br}^- \\
\text{LB} & + \text{BF}_3 \quad \rightarrow \quad \text{BF}_3^- \quad + \text{La}^+ \\
\end{align*}
\]
8. Indicate the strongest intramolecular interactions in each compound. Use the appropriate abbreviation (van der Waals-V, dipole-dipole-D, hydrogen bonding-H) (1 pt each).

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9. Convert the following structures to Newman projections looking down the indicated carbons. Then draw the MOST stable conformation of the compounds (2 pts each).

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10. Convert the following structure to its chair conformations (2 pts each). Circle the MOST stable conformation (1 pt).

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11. Draw the 2D representation of this substituted cyclohexane (3 pts). Are the groups cis or trans (1 pt)?

12. Classify each reaction as an oxidation (O), reduction (R), or neither (N) (1 pt each).

   OH → O
   \[\text{N} \quad \text{R} \quad \text{N}\]
   H<br> → N

13. Indicate the relationship between each molecule and A. Diasteriomer (D), Identical (I), Constitutional isomer (C), Enantiomer (E) (1 pt each).

   \[\text{A} \quad \text{E} \quad \text{D} \quad \text{I} \quad \text{C}\]
14. Rank each of the following groups in order of DECREASING priority (1 being the highest) (1 pt each).

\[ \begin{array}{c}
\begin{array}{cccc}
\text{OH} & \text{OH} & \text{CH}_3 & \text{H} \\
3 & 4 & 2 & 1
\end{array}
\end{array} \]

15. Circle the meso compound (2 pts) and draw its diastereomers (3 pts each).

(R, R)  (S, S)
16. Draw the necessary curved arrows to show movement of electrons to form each set of products (2 pts each), then indicate what type of overall reaction it is (substitution, elimination, or addition) (1 pt each). Remember to show clearly whether you are using full or half headed arrows for full credit.

\[ \text{addition} \]

17. Draw the product of the following reaction (3 pts).

\[ \text{homolytic} \]

Bonus: What word best describes the cleavage of the x-bond (2 pts)?
18. Circle the side of the reaction that is favored (products or reactants) (2 pts each).

\[ \text{A}\text{−B} + \text{C} \rightleftharpoons \text{A} + \text{B}\text{−C} \quad K_{eq} = 0.2 \]

\[ \text{A}\text{−B} \rightleftharpoons \text{A}^+ + \text{B} \quad \Delta G^\circ = 10 \text{ kcal/mol} \]

19. The following questions are to be answered using the energy diagram.

a. How many reaction steps are there? Identify the intermediates. Enter the letter(s) and numbers in the box respectively (3 pts).

3 steps; C & E
b. Circle the rate determining step (slow step) of the reaction (1 pts).

\[ A \rightarrow C \quad C \rightarrow E \quad E \rightarrow G \]

c. Formation of C is a(n) ______ reaction. Circle your answer below (1 pts).

- a. exothermic
- b. endothermic
- c. both
- d. neither

20. Draw the energy diagram for the concerted exothermic reaction \( A \rightarrow B \) with high energy of activation. Indicate with a circle which side of the reaction is favored (5 pts).