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Points by question

1_____________/14
2_____________/21
3_____________/12
4_____________/36
5_____________/18
6_____________/20
7_____________/30
8_____________/24

Points Removed for cover errors ____/2

Extra Credit_____/5

Total (incl Extra)________/175+5

"YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM"
Question 1 (14 pts.) Give the IUPAC name for the following structure, include all stereochemistry as appropriate.

\[ \text{Structure Image} \]

Question 2 (21 pts) For the proton nmr spectrum of the provided structure, circle the hydrogen atom or atoms that would have the smallest chemical shift, and also the hydrogen atom or atoms that would have the largest chemical shift, clearly indicate which is which. Give a BRIEF EXPLANATION that includes the term DESHIELDING.

To determine which proton has the largest chemical shift you will need to draw a minor resonance contributor, draw this minor contributor as part of your answer, be sure to include all curved arrow pushing, resonance arrows and resonance brackets.

\[ \text{Structure Image} \]

Question 3 (12 pts.) For each of the following 2 structures, indicate how many signals would you expect to see in a $^{13}$Carbon nmr spectrum.

\[ \text{Structure Image} \]
Question 4 (36 pts) Give the curved-arrow pushing for the following reaction. For each INTERMOLECULAR, indicate the Lewis acid/base (LA/LB) and Bronsted acid/base (BA/BB) where appropriate.

\[
\begin{align*}
\text{HBr} & \quad \text{CCl}_4 \\
\text{inert solvent} & \\
\text{Cyclopentene} & \quad \text{Br} \\
\rightarrow & \\
\text{Product} & 
\end{align*}
\]

b) How many steps are there in your mechanism? 

c) How many transition states are associated with your mechanism? 

d) Draw a reaction energy diagram for your mechanism, label the axes, indicate the positions of the reactants, products and any intermediates (don't redraw the structures, you can circle the items on the mechanism and use arrows, or use symbols such as I1 for intermediates 1 etc.). Indicate the ACTIVATION ENERGY FOR EACH STEP, the REACTION EXOTHERMICITY and the RATE DETERMINING STEP.

e) Draw below the TRANSITION STATE for the rate determining step (only)
Question 5 (18 pts.) Give the missing major organic products OR reagents/conditions as appropriate for each of the following reactions, include all non-bonding electrons.

a) 

b) 

2. -OH/H₂O₂

HBr

CCl₄ (inert solvent)

Extra Credit (5 pts) Dr. Gould had a conversation with his daughter about which topic?

cis- and saturated acids Markovnikov and
and unsaturated and bases Anti-Markovnikov
Question 6 (20 pts.) For the structures A and B, draw the conjugate base anion formed upon deprotonation of the hydrogen atoms bonded to nitrogen, indicated, be sure to include ALL resonance structures where appropriate. Indicate which would be the stronger Bronsted acid, A or B, and give a BRIEF explanation for your choice.

\[ \text{A} \quad \text{B} \]

Question 7 (30 pts.) For the following Bronsted acid/base equilibrium:
1. Give the curved arrow-pushing and indicate the stronger and weaker acid and base on each side and indicate which acid has the larger and smaller pKa values.
2. Draw a reaction energy diagram, indicate which reaction would be faster and on which side the equilibrium would lie, give a BRIEF explanation that includes drawing of resonance contributor as appropriate.
3. Give a drawing of the transition state.

\[ \text{H}_3\text{C} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \]
Question 8 (24 pts) Provided are spectra for a compound with molecular formula $C_{10}H_{14}$.

a) Give the degrees of unsaturation

b) On the infrared spectrum, indicate which peaks correspond to which functional groups (including C(sp$^3$)-H). Indicate BOTH the functional group, and where appropriate, the specific BOND in the functional group that corresponds to the peak.

c) draw the structure and clearly indicate which hydrogens correspond to which signals in the proton nmr spectrum