1. Ascorbic acid, vitamin C, has one very acidic H (pK_a = 4.1), and all the others are much less acidic (pK_a = 11.8). Use your knowledge of anion stability and resonance to identify the most acidic proton, and show why it is so acidic. (5 pts)

2. Explain the following trend in acidity: (10 pts)

3. Describe (or illustrate) the structures of methyl carbanion, methyl radical and methyl carbene with regard to overall structure and hybridization of the central carbon atom of each. (10 pts)

4. The equilibrium constant for generation of acetals and ketals from carbonyl compounds is generally not favorable (K_eq < 1). However, it is possible to drive the equilibrium in the forward direction experimentally. Show a mechanism for the following acid-catalyzed ketalization, and explain how you would run the experiment so as to favor formation of product. (10 pts)

5. Use Cram’s rule to predict the stereochemistry of the product of the following reaction: (10 pts)
6. Treatment of 2-butanone with lithium diisopropylamide (LDA) in THF at –78 °C, followed by addition of isobutyraldehyde gives a mixture of syn and anti aldol products in a 5:1 ratio, respectively. The syn product predominates, because under these reaction conditions formation of the Z-enolate is preferred. Show the transition states that lead to formation of both aldol products. (20 pts)

\[
\text{O} + \text{H} = \text{O} \xrightarrow{\text{LDA, THF, } -78 \, ^\circ\text{C}} \text{O} + \text{OEt} = \text{OH} \quad \text{syn} + \text{OH} \quad \text{anti}
\]

7. Sodium borohydride (NaBH₄) reduces ketones quickly but reacts very slowly to reduce esters. How quickly would you expect an aldehyde to react with NaBH₄? Explain. (5 pts)

8. Show either a base-catalyzed (B_ac₂) or acid-catalyzed (A_ac₂) mechanism for the hydrolysis of ethyl-4-nitro benzoate. (10 pts)

\[
\text{O}_2N\text{O} + \text{H}_2\text{O} \rightarrow \text{O}_2N\text{OH}
\]

9. The following acylation of allyl alcohol proceeds to give the same allyl ester whether the reaction is catalyzed by pyridine or triethyl amine. The mechanism of each reaction, however, is different. Show the two different mechanisms of acylation. (20 pts)

\[
\text{Br} + \text{NEt}_3 \rightarrow \text{Br} \quad \text{HO} + \text{NET}_3 \rightarrow \text{Br}
\]