## Final Exam Chem 3045x Wednesday, Dec. 23, 1998

**Instructions:** This is an open book examination. You may use the course text and the solution manual during the course of the examination. Please **print** your name and social security number on the front page of the examination. <u>Be sure to allot your time in a manner that is</u> related to the point value of the question. <u>Be sure to show your reasoning wherever possible for partial credit.</u>

All material to be graded must be on one of the pages of the exam with your name and social security number on the front page. If you need more space than is available on the page with the questions, use the back page of the previous page and label the number of the question on that page.

## Correlation tables for IR, <sup>1</sup>H NMR and <sup>13</sup>C NMR are attached on the last page of the exam.

Your Name: \_\_\_\_\_

Your Soc. Sec. Number: \_\_\_\_\_

## **Time for the exam:** three hours.

Question 1:	10 points	
Question 2:	20 points	
Question 3:	20 points	
Question 4:	20 points	
Question 5:	20 points	
Question 6:	30 Points	
Question 7:	20 Points	
Question 8:	20 Points	
Question 9:	20 Points	
Question 10:	20 Points	
Question 11:	20 Points	
Question 12:	20 Points	
Question 13:	20 Points	
Question 14:	20 Points	
Question 15:	20 Points	

Total: 300 Points

1. (10 Points). What are the formal charges (0, 1 or -1) on each of the atoms of the indicated Lewis structure? Place the formal charge next to each atom.



2. (20 Points). Imagine the photochemical chlorination of each of the isomers possessing the composition  $C_5H_{12}$  to produce monochlorides of composition  $C_5H_{11}Cl$ . Draw the Lewis structure of the isomer of composition  $C_5H_{12}$  that produces:

(a) a single monochloride

(b) three isomeric monochlorides

(c) four isomeric monochlorides

3. (20 Points) Menthol and neomenthol are constitutional isomers both of which produce the Lewis structure A. Menthol is the most stable stereoisomer possessing the constitution A.



(a) Draw a structure which clearly shows the axial and equitorial positions of the substituents in menthol. (Hint: A hydroxy group is a smaller group than a methyl group.)

(b) Are the hydroxy and methyl groups cis or trans to each other in menthol?

(c) Draw a structure which clearly shows the axial and equitorial positions of the substituents in neomenthol.

d) Are the hydroxy and methyl groups cis or trans to each other in neomenthol?

4. (20 Points) Which, if any, of the following structures are chiral? Indicate your reasoning for full credit.



5. (10 Points) Treatment of either of the 1,2-bromoalcohols A or B with HCl results in formation of the 1-bromo-2-chloro cyclopentane C, but the rate of reaction of A to form C is much faster than the rate of reaction of B to form C. Suggest a plausible mechanistic interpretation of these results.



6. (30 Points) Predict the products of each of the following reactions. Give an indication of your thinking for full credit.



7. (20 Points). Use Hückel theory to explain why the following hydrocarbon possesses an unusually large dipole moment for a hydrocarbon. Which ring possesses the negative dipole and which possesses the positive dipole?



8. (20 Points). Suggest structures of the diene and dienophile you would employ to synthesis the following products by a Diels Alder reaction.





9. (<u>20 Points</u>) Suggest a plausible synthesis for the indicated compounds employing the indicated starting material and any inorganic or organic reagents you need in addition to the starting material. More than one step may be required for a plausible synthesis.





10. (20 Points) Suggest a plausible structure for  $C_4H_8$  (A) and  $C_{10}H_{16}$  (B) based on the indicated reactions. Be sure to indicate pertinent stereochemistry in the structures you suggest.





11. (<u>20 Points</u>) Under certain conditions, the nitration of benzene follows the rate law: rate =  $k[HNO_3]$ . Which, if any, of the following is a plausible rate determining step under these conditions? Explain your reasoning.



12. (20 Points) Three different dibromobenzenes (A, B and C) are known. Each is further brominated with  $Br_2/FeBr_3$ . Deduce the structures of A, B and C from the following information and explain your reasoning.

(1) A yields 2, and only 2, tribromobenzenes.

The structure of A is:

(2) B yields 3, and only 3, tribromobenzenes.

The structure of B is:

(3) C yields 1, and only a single, tribromobenzene.

The structure of C is:

13. (20 points) Imagine molecules that existed in "Flatland", that is, in a two dimensional space. Translating the ideas of chirality in three dimensional space to two dimensional space, which, if any, of the following molecules are chiral in "Flatland"? Explain your reasoning.



14. (20 Points) Consider that the infrared carbonyl stretching frequencies of the three compounds A, B, and C are quite different. Based on your knowledge of resonance theory and infrared spectroscopy, predict which will have the highest carbonyl stretching frequency and which will have the lowest carbonyl stretching frequency. Explain your reasoning.



15. (20 Points. 10 Points for each spectrum) Suggest a structure that is consistent with the IR, 1H NMR and 13C NMR spectra shown on the following pages for the molecular compositions  $A = C_5H_{10}O$ ,  $B = C_6H_{10}O$ . Indicate briefly how each structure is consistent with each spectra. The number of protons responsible for each signal is indicated under or next to the signal on the spectrum.

The suggested structure for A is



My reasoning for suggesting the structure for A:

The suggested structure for B is



My reasoning for suggesting the structure of B is