EXAMINATION 2

Chemistry 3A  
Professor Carolyn Bertozzi  
Professor Peter Vollhardt  
November 5, 1996

Name: _____________________________  
(PRINT First name first, then Last name. Use capital letters!)  

Please check the name of your TA and corresponding section number. Complete the remaining information if applicable.

161  Baryza, Jeremy  
111  Goon, Scarlett  
121  Yeston, Jake  
131  Gruneich, Jeffrey  
141  Richards, Steven  
151  Berglund, Timna  
211  Thornton, Joel  
221  Moore, Jennifer  
361  Paisner, Sara  
371  Tellers, David  
311  Adronov, Alex  
321  Mullins, Sarah  
331  Esker, Todd  
341  Shaffer, Wendy  
351  Loftus, Christine  
411  Lemieux, George  
421  Essy, Blair  
511  Staunton, Joanna  
521  Magliery, Thomas  
531  Marcordes, Belinda

Making up an I-grade
(If you are, please indicate the semester during which you took Chem 3A previously_______.)

Please write the answers you want graded in the spaces provided. Do scratch work on the back of the pages. This test should have 14 numbered pages. Check to make sure that you have received a complete exam. A good piece of advice: read carefully over the questions at least twice; make sure that you understand exactly what is being asked; avoid sloppy structures or phrases. It is better to be pedantic in accuracy! Good Luck!

DO NOT WRITE IN THIS SPACE

I. _______(15)  
II. _______(10)  
III. _______(60)  
IV. _______(35)  
V. _______(40)  
VI. _______(40)  
Vla. _______  
Vlb. _______  
Vic. _______  
Vld. _______  
Vle. _______  
Total _______

Total _______(200)
I. [15 Points]

Name or draw, as appropriate, the following molecules according to the IUPAC rules. Indicate stereochemistry where necessary (cis, trans, R, S, or meso).

a. 

(2R,3S)-2-chloro-3-iodobutane

b. 

c. 

OH
II. [10 points]

a. The reduction of (+)-galactose with NaBH₄ gives a product A and the reduction of (-)-galactose gives a product B. Draw the structures of A and B in the boxes provided. Are these products optically active or inactive (circle one)?

![Diagram of (+)-galactose and its reduction with NaBH₄]

A

![Diagram of (-)-galactose and its reduction with NaBH₄]

B

active inactive

active inactive

b. What is the relationship between A and B? (Circle one answer)

enantiomers diastereomers constitutional isomers identical
III. [60 points]

Add the missing starting materials, reagents, or products (aqueous work-up is assumed where necessary). Don't forget stereochemistry!

a. CH₃CH₂CH₂CH₂OH

b. CH₃S⁻ (1 equiv) Acetone

c. HO-CH₂-CH₂Br NaH

d. 1. Na₂Cr₂O₇, H₂O, H₂SO₄
   2. CH₃MgBr

Circle one: optically active? yes no
e. \[ \text{Br} \quad \text{OH} \]

f. 

\[ \text{MgBr} \quad \text{OH} \quad \text{C}_6\text{H}_{10}\text{O} \]

\[ \text{H}_2\text{O}, \text{H}_2\text{SO}_4 \]

h. 

\[ \text{H}_2\text{SO}_4, \Delta \]

a tertiary alcohol
I. \[
\begin{align*}
&\text{Br} \\
&\text{Cyclopentane} \\
&\rightarrow \\
&\text{OH} \\
&\text{Cyclopentanol}
\end{align*}
\]

II. \[
\begin{align*}
&\text{H}_2\text{C} = \text{CH}_2 \\
&\text{Cyclopropene} \\
&\rightarrow \\
&\text{CH}_3\text{OH, } H^+ \\
&\text{Optically active?} \\
&\text{Yes} \\
&\text{No}
\end{align*}
\]
IV. [35 points]

For each pair of reactions shown below, mark the box on the right with an "X" indicating which will go faster and circle the mechanism by which it proceeds (e.g., S_N2, S_N1, E2, E1). Below, circle the letter corresponding to the statement that best explains your choice. No credit will be given for a correct answer in the first part of the question with an incorrect reason in the last part.

a. 

\[ \text{Br} \quad \text{CH}_3\text{O}^- \quad \text{CH}_3\text{OH} \quad \text{OCH}_3 \quad [\square] \]

\[ \text{Br} \quad \text{CH}_3\text{S}^- \quad \text{CH}_3\text{OH} \quad \text{SCH}_3 \quad [\square] \]

S_N2 \quad S_N1 \quad E2 \quad E1

a. CH_3O^- is a stronger base than CH_3S^-.

b. CH_3S^- is less solvated and more polarizable than CH_3O^-.

c. The S-H bond is weaker than the O-H bond.

b. 

\[ \text{I} \quad \text{CH}_3\text{CH}_2\text{OH} \quad \text{OCH}_2\text{CH}_3 \quad + \quad \text{HI} \quad [\square] \]

\[ \text{Cl} \quad \text{CH}_3\text{CH}_2\text{OH} \quad \text{OCH}_2\text{CH}_3 \quad + \quad \text{HCl} \quad [\square] \]

S_N2 \quad S_N1 \quad E2 \quad E1

a. I^- is a weaker base than Cl^-.

b. I^- is a better nucleophile than Cl^-.

c. Ethanol is a better nucleophile than I^-.
c.

\[
\begin{align*}
\text{SN2} & \quad \text{SN1} & \quad \text{E2} & \quad \text{E1} \\
\end{align*}
\]

a. \(\text{CH}_3\text{CH}_2\text{O}^-\) is a better nucleophile than \(\text{CF}_3\text{CH}_2\text{O}^-\).

b. \(\text{CH}_3\text{CH}_2\text{O}^-\) is a stronger base than \(\text{CF}_3\text{CH}_2\text{O}^-\).

c. \(\text{CH}_3\text{CH}_2\text{O}^-\) is a weaker base than \(\text{CF}_3\text{CH}_2\text{O}^-\).

d.

\[
\begin{align*}
\text{SN2} & \quad \text{SN1} & \quad \text{E2} & \quad \text{E1} \\
\end{align*}
\]

a. Carbocations are more stable in polar solvents.

b. \(\text{CH}_3\text{OH}\) is a weak base.

c. Anions are encumbered by solvation in protic solvents.
a. The E1 reaction proceeds through a planar carbocation.
b. The nucleophile in the $S_N2$ reaction attacks from the backside.
c. The base in the E2 reaction attacks the proton anti to the leaving group.

Hint: Draw the chair conformers of the starting materials.
V. [40 points]

Explain the following observations by a detailed mechanism (i.e., write a scheme with structures, use arrow-pushing to illustrate the flow of electrons, etc.).

a.

\[
\text{Br} + \text{HO} \xrightarrow{\text{NaOH, H}_2\text{O}} \text{HO} + \text{NaBr}
\]

b.

\[
\text{H}_2\text{SO}_4, \text{H}_2\text{O}, \Delta \xrightarrow{} \text{HO}
\]
VI. [40 points]

Provide a viable synthetic route from starting material to product. You may use any additional organic or inorganic compounds in your scheme.

a.

\[
\text{Br} \quad \rightarrow \quad \text{O} - \text{CH}_3
\]
d.

\[ \text{HO-CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{Br} \rightarrow \text{HO-CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{OH} \]
"It's time we face reality, my friends. ... We're not exactly rocket scientists."

"THE END"