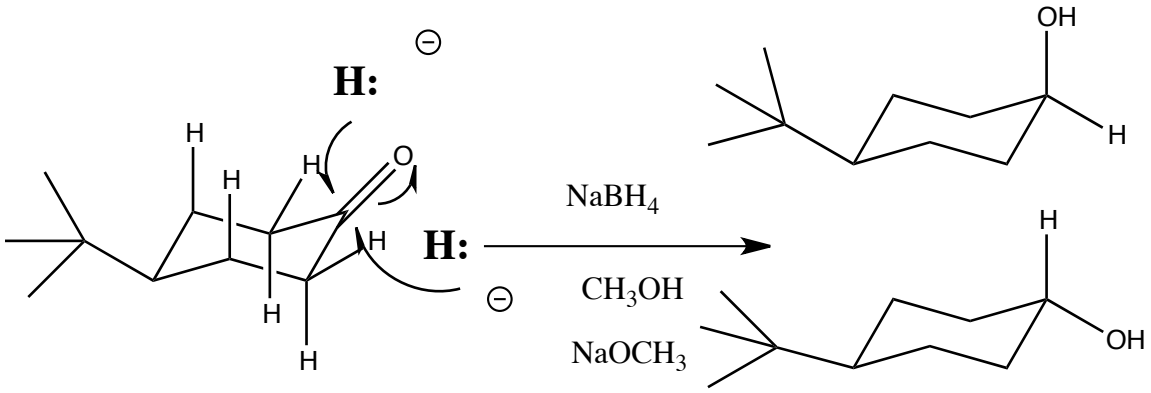
Reduction of 4-t-Butylcyclohexanone Using $NaBH_4$

In this experiment you will explore the stereochemistry of the reduction of 4-t-butyl cyclohexanone using sodium borohydride. This is the organic counterpart to hydride reduction with NADH and an enzyme which you are also carrying out at this time . As you know, t-butyl groups have an anchoring effect on cyclohexane chair conformations. This is a very interesting reaction because two possible products can form depending on the carbonyl face over which the hydride is delivered as shown below. Note, the hydride is attached to the boron at the time of attack.



One of these two diastereomeric (cis/trans) products will be preferred and it is up to you to determine which one is formed in the reaction and to explain the major product using standard theory. You should read up on lithium aluminum hydride reduction and sodium borohydride reduction in your text. Your lab write up for you will consist of completing the form that follows this text. Each student needs to complete this form, submit it to Dr. Nerz and it will count as your lab quiz. It is due after break.

To prepare for this lab, carefully write out the procedure given below in your lab note book and write out the mechanism for the reaction in your notebook. Think about the possible reasons the hydride might prefer attack from one face over the other. Be sure to have all calculations regarding the quantities of reagents completed before coming to lab.

Procedure

In a 125 mL Erlenmeyer flask combine the following:

22.5 millimole of t-butylcyclohexanone
5 mL of methanol.

In a separate small beaker, add 6 millimole of sodium borohydride to 5 mL of sodium methoxide in methanol. Carefully add the sodium borohydride in sodium methoxide solution to the t-butylcyclohexanone solution. Moderate your addition based on the level of frothing in the reaction. Swirl the reaction intermittently for five minutes.

Pour the contents and of the reaction flask into a 100 mL beaker containing 2.5 mL of 1.5 M HCl and 50 mL of ice water.

Place the resulting solution in a 125 mL separatory funnel and extract with 12.5 mL of ether. Wash the ether exract with 6.5 mL of water, followed by 6.5 mL of brine (saturated salt solution). Dry the ether over anhydrous sodium sulfate and then decant the solution into a tared 50 mL round bottom and rotavap to dryness.

Run proton NMR of the compound in two weeks. Submit a sample for GCMS analysis over the next couple weeks. Measure an IR of the sample this week (run it as a film – you need very little sample). Please take very good care of the sample. See the video on making up GCMS samples that is embedded in the website.

Name:_____ Date:_____

Chem 212 Lab
Nerz

This write up will count as your first quiz. You can use any literature, lectures, or web sites to solve the problems, but you can't ask your peers, TA or instructors. Though the lab was done as a group, this report should be done individually, submimtted to Dr. Nerz before break and it will count as your first quiz.

1. Write the mechanism for the reaction. (16 points)

2. What is the ratio of cis-4-t-butylcyclohexanol to trans—t-butylcyclohexanol. Give the ratios from both the NMR and the GCMS. How do you know which compound is which in each method. (24 points)

3. Interpret your IR spectrum of your product mixture. (16 points)(

4. Explain the major fragmentation in the Mass Spectrum of one of the alchohols you made. (24 points)

5. What does the obtained preference of attack tell you about the stereochemistry of the reaction?

Safety Issues

1.Sodium Borohydride reacts vigorously with proton sources to form hydrogen gas which is highly flammable. Exposure to water is dangerous and the reagent will deactivate. If you are exposed to this reagent, immediately flush with large amounts of cold water for fifteen minutes.

2. Methanol and ether are toxic and irritants. If your skin is exposed, please flush with water for fifteen minutes. Both are very flammable, especially ether. Ether can form epoxides and can be explosive when dry.

3. Sodium methoxide in methanol is extremely corrosive and water sensitive. If your skin is exposed to this chemical solution, please flush the area with a large volume of cold water. Do this for fifteen minutes.

Please wear, gloves, goggles, and your apron. Please inform your instructor of any chemical exposure, cuts, accidents immediately. Thank you.