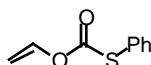


September 2002 Organic Cume

Please note that short, correct answers are preferred to long, incoherent and incorrect answers. Use words carefully, use structures and equations to illustrate your points as often as you can. Be neat and complete

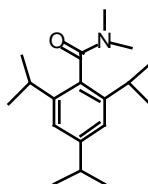
1. (10 pts) Organolithiums often exist as aggregates in solution (dimers, trimers, etc.). Let's say you have a 1 M solution of n-butyllithium in hexane. How could you get information about its aggregation state without using spectroscopy? Here is a hint: You learned about this stuff in freshman chemistry.

2. (10 pts) Alkyl lithium reagents are reactive, and sometimes they react with solvent. One typical solvent for organolithium reactions is THF. Allowing n-BuLi in THF to stand for several hours at room temperature followed by quenching with phenylthio chloroformate gives the product shown in good yield. Provide a mechanistic explanation for the formation of this

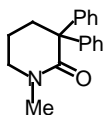


product.

3. (15 pts) Treatment of the amide (C=O) 1650 cm^{-1} shown below with n-BuLi results in the formation of a species **A** (C=O) 1625 cm^{-1} . A new species **B** is then eventually formed (C=O) 1588 cm^{-1} . Quenching with electrophiles gives a product **C** as a single stereoisomer, because rotation about the C-N bond is slow. Assuming the quenching is done with TMSCl,



give structures for **A**, **B** and **C**.

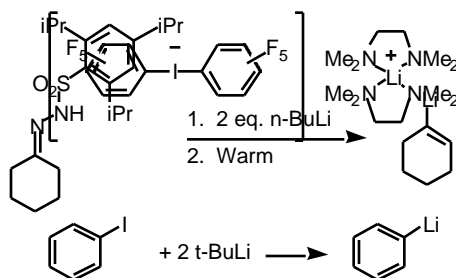


4. (10 pts) Complex-induced proximity effects as in problem 3 appear to be common in organolithium chemistry. Treating the amide shown below with LiTMP followed by quenching with TMSCl gives a single product. What is it? Interestingly, NaTMP and KTMP do not deprotonate the amide. Why?

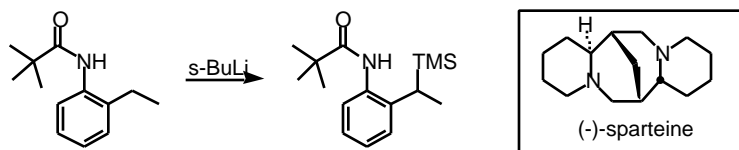
5. (10 pts) Lithiation next to an oxygen atom is generally unfavorable (but not impossible). Oxygen is electronegative. Why should lithiation be disfavored?

6. (10 pts) Give a complete, yes I said complete mechanism (electron-pushing with arrows) for the following reaction:

7. (10 pts) Reaction of pentafluorophenyl iodide with pentafluorophenyl lithium followed by addition of TMEDA affords a stable, crystalline “ate” complex shown below. Given this fact, draw a complete mechanism for the lithiation of phenyl iodide with t-butyllithium. Be sure your mechanism explains why two equivalents of t-butyllithium must be used for this reaction.



8. (25 pts) Deprotonation of the anilide shown at $-25\text{ }^{\circ}\text{C}$ followed by treatment with (-)-sparteine at $-25\text{ }^{\circ}\text{C}$, followed by cooling to $-78\text{ }^{\circ}\text{C}$ and quenching with TMSCl gave the silylated product shown in 82% ee. The reaction occurs with retention of configuration with respect to the organolithium species.



If the organolithium produced in the first operation is first cooled to $-78\text{ }^{\circ}\text{C}$ and then treated with (-)-sparteine, and then quenched, the product is obtained in only 21% ee. However, in the latter case, if only 0.1 equivalent of TMSCl is used, the ee of the product obtained is 82%. If you run the reactions through cycles of quenching with small amounts of TMSCl, followed by warming, recooling and quenching again, high yields of product can be obtained in high (>90%) ee.

Two enantiomeric organolithium species are available from the deprotonation of the anilide. Draw them.

When these complex to sparteine, new species are created. What is their stereochemical relationship? Is it conceivable that they might react with achiral electrophiles at different rates?

If these species interconvert rapidly with respect to reaction with TMSCl , what principle should apply which determines the product ratio (i.e., ratio of enantiomers, ee)?

Draw a potential energy diagram which illustrates this. The energy diagram is one that we would use to represent a dynamic kinetic resolution.

Do the data suggest that this is taking place here? If not, develop an explanation for what is going on here. A well-labeled potential energy diagram will suffice for an answer here. If you get it right, you will have explained what Peter Beak calls a dynamic thermodynamic resolution.