

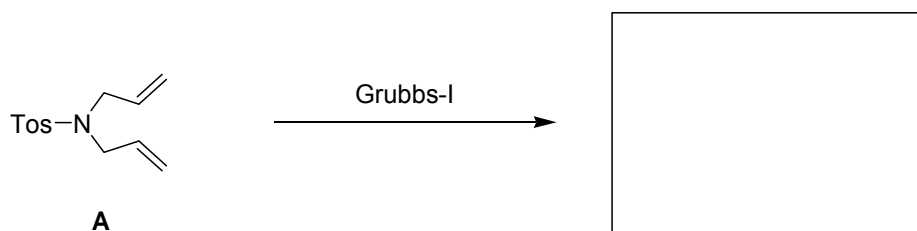


1. The following questions concern carbene complexes as reagents or intermediates.

a) Grubbs-I catalyst has the following structure!



The ring closing metathesis of substrate **A** provides a five-membered ring! Complete the reaction equation!

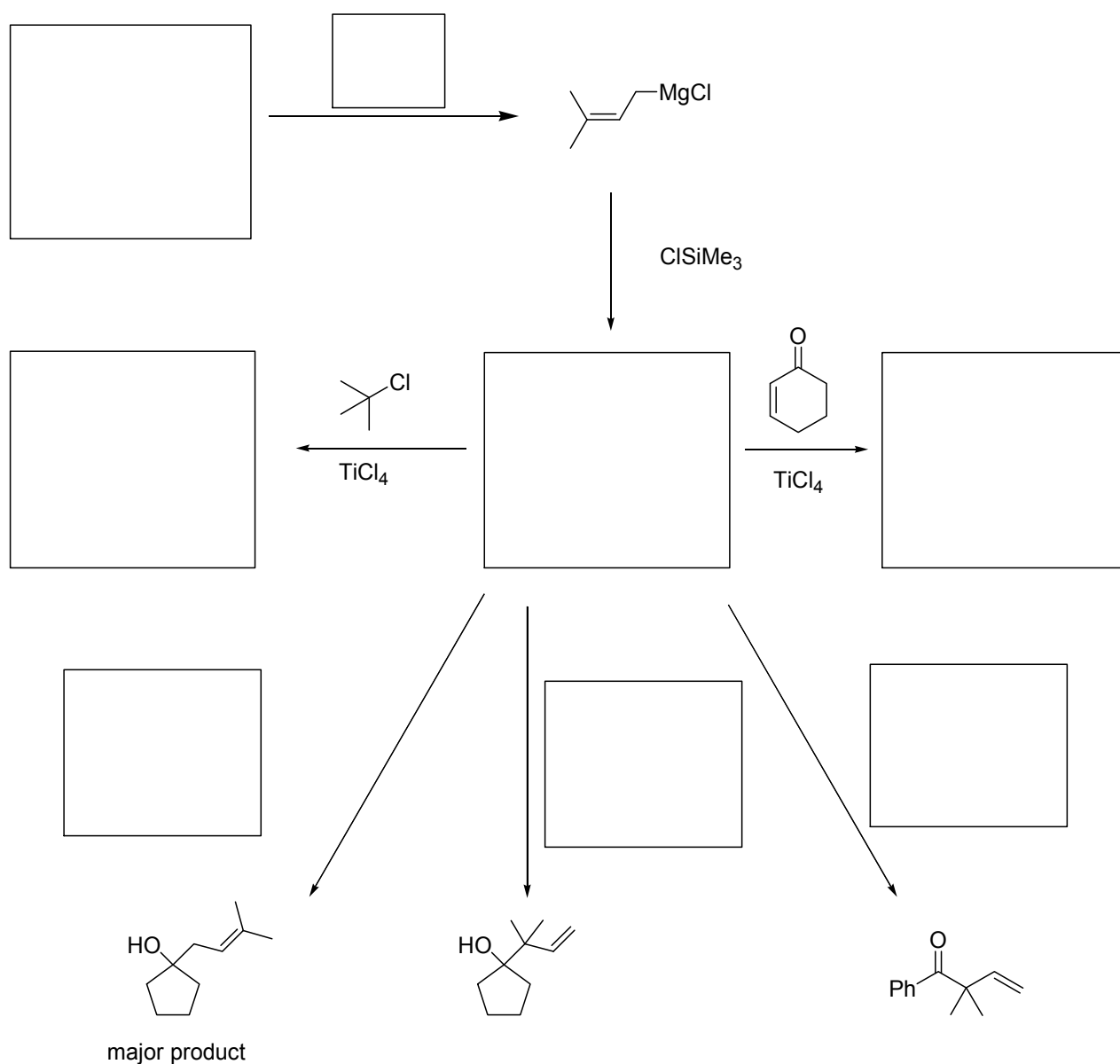


Suggest a mechanism for this metathesis process!

b) Give an example of a cross-metathesis with allyl acetate using **A**!

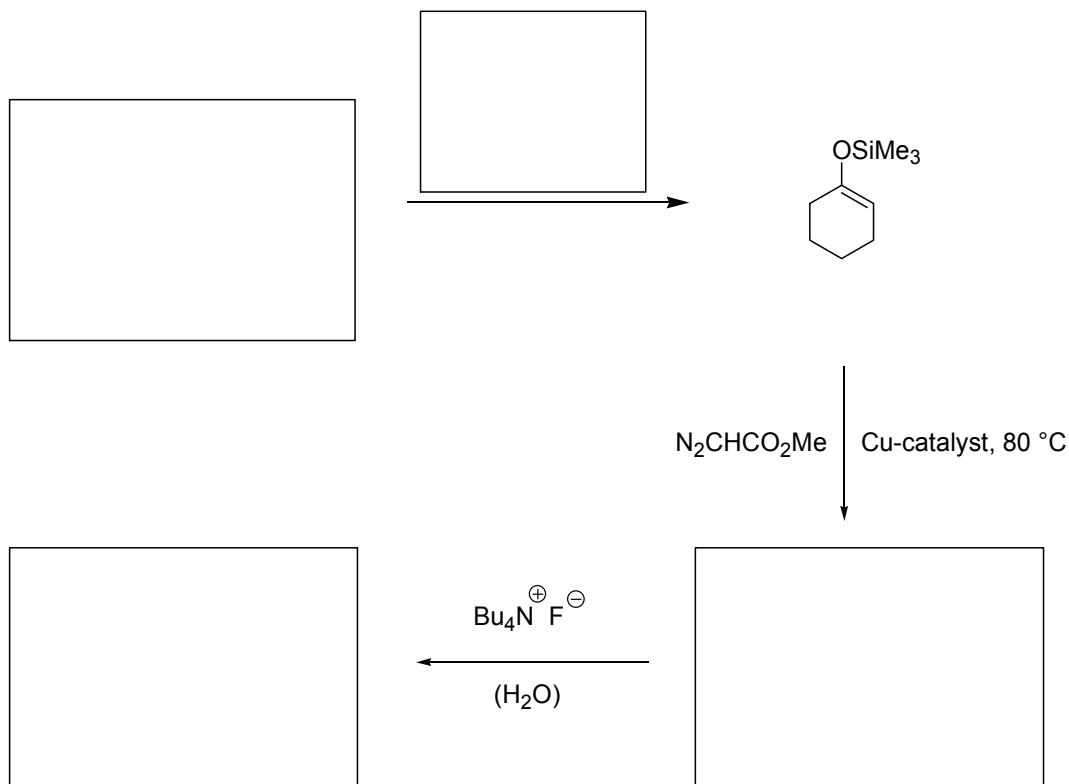
c) Give an example for the synthesis of a Fischer carbene complex with a  $\text{C}(\text{OCH}_3)\text{CH}_3$  ligand! Treat the resulting product with benzaldehyde, triethylamine and  $\text{ClSiMe}_3$  and react the condensation product with methyl diazoacetate! Give a brief explanation of the regiochemistry of the cycloadduct.

2. a) Supplement the following schemes dealing with **silyl compounds** with starting materials, reagents or products (no mechanism!!)



b) Give a brief explanation of the  $\beta$ -effect operation in reactions of allyl silanes!

c) Supplement the scheme employing a silyl enol ether as precursor!

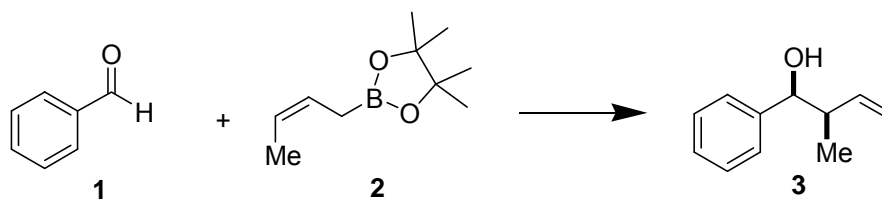


3. a) Give examples of **four different** 1,3-dipoles (different classes, not just different substituents!) and draw two mesomeric formulas for each species! React two of these 1,3-dipoles with diphenylacetylene to the corresponding heterocyclic product! Give the name of the resulting **class** of heterocycles!

4. The reaction of 1-azidohexane with phenylacetylene in the presence of copper(I) regioselectively provides a heterocyclic product. What is the name of the resulting product class? Suggest a mechanism for this reaction and explain the observed regiochemistry!

5. The addition of (*Z*)-crotylboronate **2** to benzaldehyde **1** leads to the formation of product **3** in racemic form.

a) Why is **3** the preferred isomer? Provide a suitable drawing (transition state model) which is rationalizing this result.



Compound **3** is equivalent to an aldol addition product. How can you achieve this goal!