

Massachusetts Institute of Technology

Chemistry 5.43

February 28th, 2007

Professor M. Movassaghi

Exam #1

Question 1a	————/4 points	Question 2b	————/10 points
Question 1b	————/2 points	Question 2c	————/6 points
Question 1c	————/1 points	Question 2d	————/5 points
Question 1d	————/2 points	Question 3a	————/10 points
Question 1e	————/3 points	Question 3b	————/3 points
Question 1f	————/5 points	Question 3c	————/2 points
Question 1g	————/4 points	Question 3d	————/5 points
Question 1h	————/4 points	Question 4a	————/5 points
Question 1i	————/4 points	Question 4b	————/5 points
Question 1j	————/6 points		
Question 1k	————/6 points	Total	————/100 points
Question 2a	————/8 points		

NAME: _____

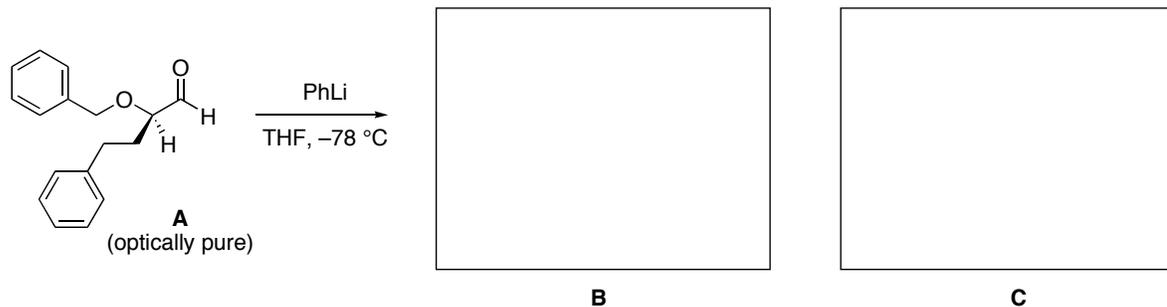
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T.A.: _____

There are 6 pages (2-7) of questions in this exam.

Question 1.

Consider the addition of phenyl lithium to the aldehyde **A** in tetrahydrofuran. Assume no epimerization or loss of optical activity in the starting aldehyde **A** under the reaction conditions.



1a) Provide the structure of the two principal addition products, clearly indicating stereochemistry, and assign the Cahn-Ingold-Prelog configuration to each stereocenter of the starting material **A** and products **B** and **C**.

1b) Indicate whether each product is chiral or achiral.

B **C**

1c) What is the isomeric relationship between the products **B** and **C** (i.e. constitutional isomers, enantiomers, or diastereomers):

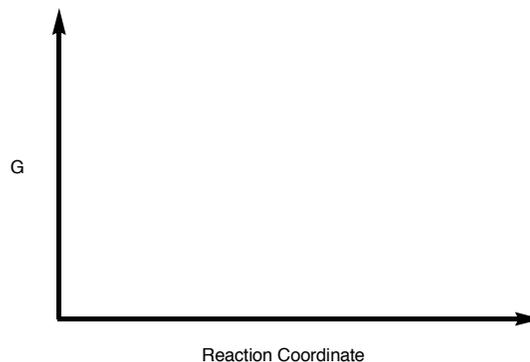
1d) Do you expect the products to be formed in equal or unequal amounts:

1e) Based on your drawings of **B** and **C**, which do you expect to be the major product of this reaction.

1f) Explain your answer to 1d using clear and informative models/drawings.



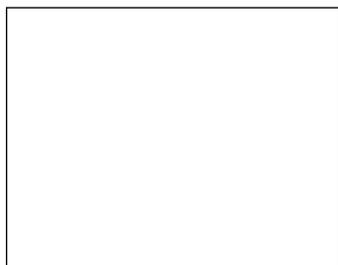
1g) Provide an energy diagram that is consistent with your answers to questions 1d and 1e. Identify and label all important features of the diagram.



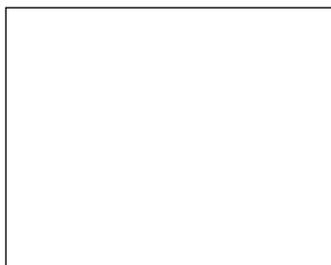
Question 1 (continued).

1h) Consider an experiment similar to that described in question 1a with the exception that an enantiomerically enriched sample of aldehyde **A** is used (instead of an optically pure sample). This new sample of aldehyde **A** (as shown in 1a) was measured to be of 80% ee (enantiomeric excess). Again, assume no loss in optical activity of aldehyde **A** during the reaction.

In addition to products **B** and **C**, what two other products do you expect to isolate; provide the structure of these compounds, clearly indicating stereochemistry, and assign the Cahn-Ingold-Prelog configuration to each stereocenter.



D



E

1i) What is the isomeric relationship between the following pair of compounds (be consistent with your answers to questions 1a and 1h):

D and B =

D and C =

E and B =

E and C =

1j) Given the enantiomeric excess of the aldehyde used in question 1h, describe the expected ratio in the following pair of compounds (be consistent with your answers to questions 1a and 1h):

D:E =

(B+C):(D+E) =

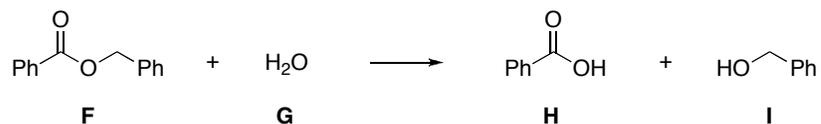
B:C =

1k) Describe three methods you could use to verify the enantiomeric excess of the product **B** in your answer to question 1h. In this scenario, what do you expect the enantiomeric excess of **B** to be?



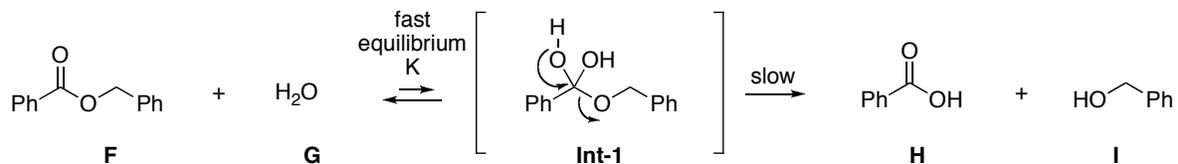
Question 2.

Consider the following hydrolysis reaction:

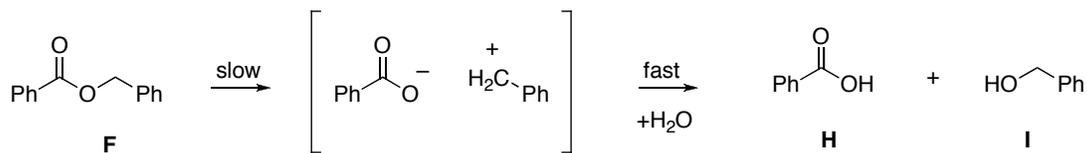


The following are two possible mechanisms:

Mechanism 1:



Mechanism 2:



2a) Propose a rate law for each possible mechanism:

Mechanism 1:

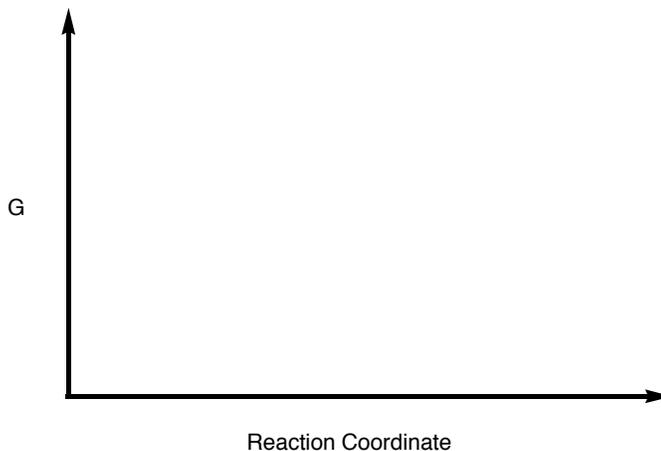
Mechanism 2:

2b) Describe an experiment that could distinguish between the two mechanism shown above based on the KIE. Be specific and provide your interpretation of expected experimental results.

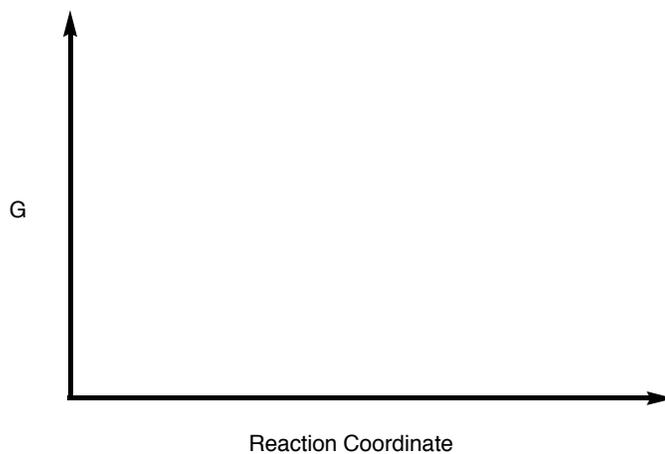
Question 2 (continued).

2c) Provide a detailed reaction coordinate diagram for each of the two possible mechanisms illustrated above. Clearly identify and label any important feature.

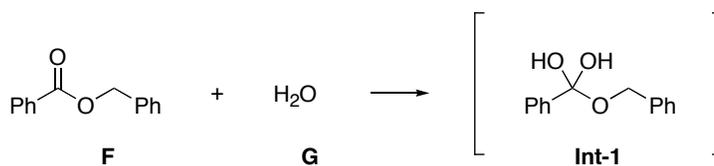
Mechanism 1:



Mechanism 2:



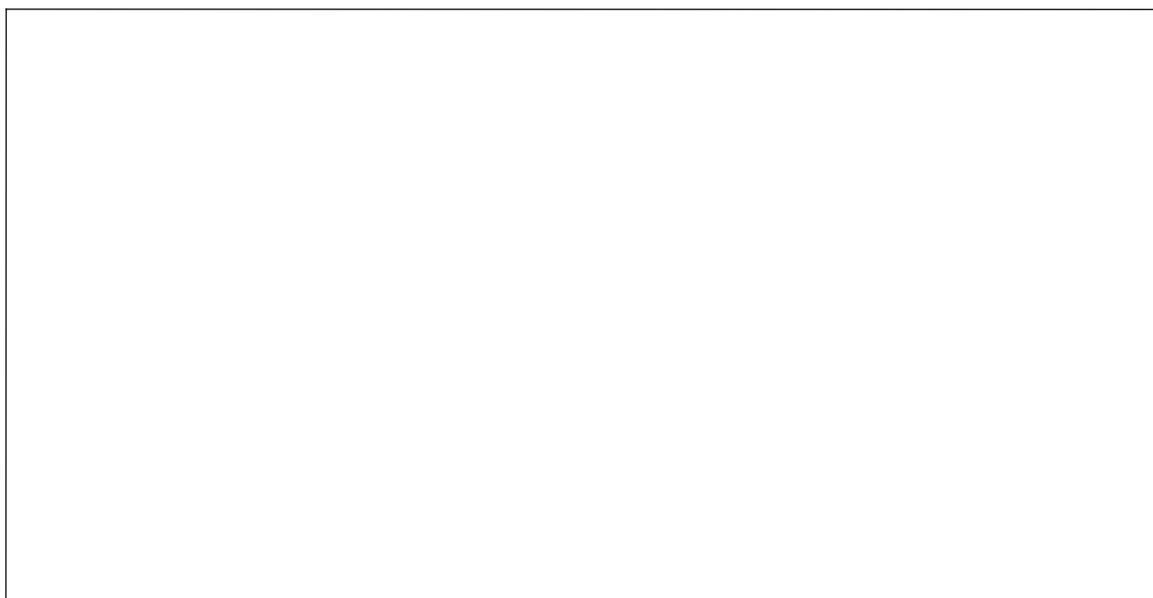
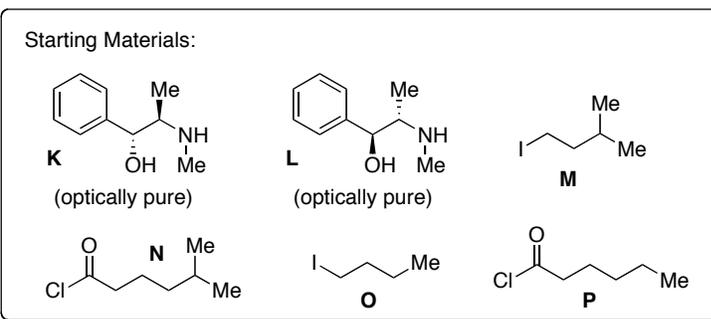
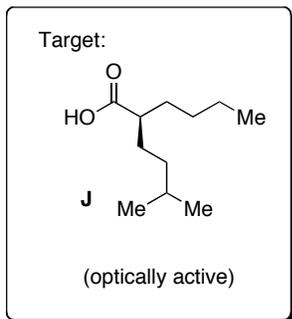
The formation of the intermediate-1 (**Int-1, Mechanism 1**) involves addition of the water (**G**) to the starting ester **F**.



2d) Assuming a late transition state for this addition reaction, provide a drawing and a detailed description of the transition state structure based on the Hammond Postulate.

Question 3.

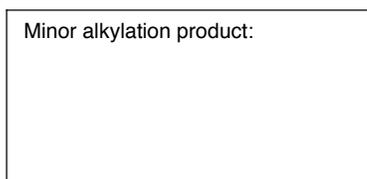
3a) The compound **J** is a compound you need to access in enantiomerically enriched form. You may use as many of the starting materials **K-P** along with any other necessary reagents for asymmetric alkylation. In the space below, indicate how you would prepare the target compound **J** from starting materials **K-P**. You only need to draw the major isomer of intermediates.



3b) Consistent with your answer above, clearly draw the structure of the enolate.



3c) Consistent with your answers above, draw the structure of the minor asymmetric alkylation product.



3d) Describe how you would determine the enantiomeric excess of the product **J** using the Mosher's ester analysis technique.



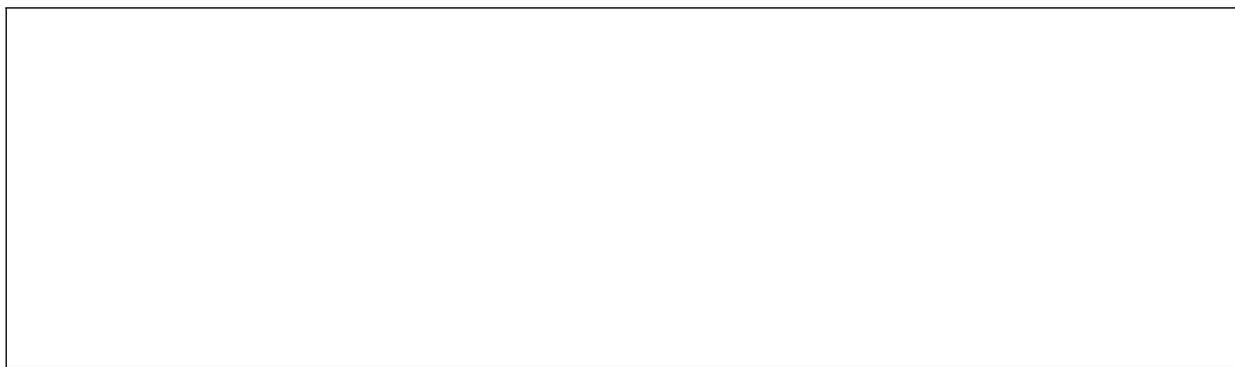
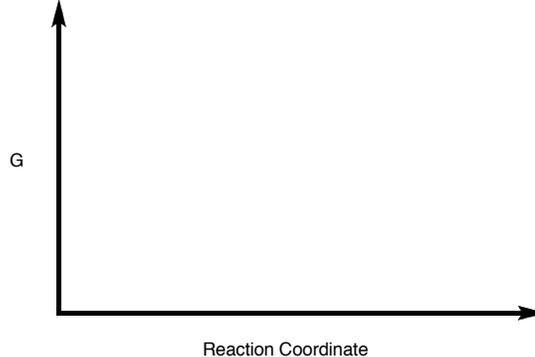
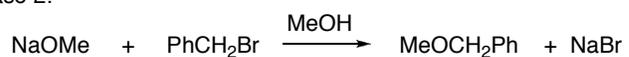
Question 4.

4a) Consider the following two reactions in dimethylformamide (DMF) and methanol (MeOH). Which reaction will be faster? Explain your answer and provide an energy diagram consistent with your answer.

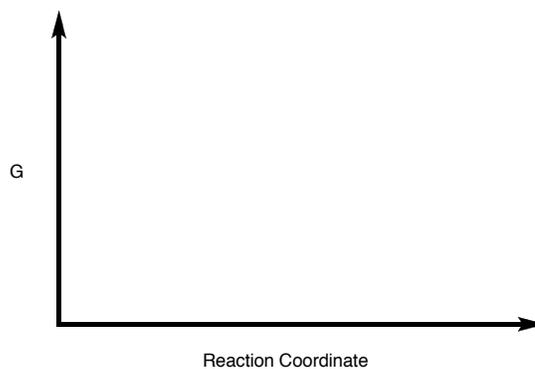
Case 1:



Case 2:



4b) Using a free energy diagram, show the fundamental issue(s) that the Curtin-Hammett principle deals with. Briefly explain your answer in the space provided.



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