



Faculté des sciences | Faculty of Science
Département de chimie et sciences biomoléculaires | Department of Chemistry and Biomolecular Sciences
Complexe STEM complex (342)
150 Louis Pasteur Pvt Ottawa ON Canada K1N 6N5
§ 613-562-5728 ◀ 613-562-5193 chminfo@uOttawa.ca

ANSWERS

CHM 2120A
Final exam – Part 1 (Individual)
December 16, 2021, Length: 2 hours

First Name: _____ Last Name: _____

Student Number: _____

Approximate total number of marks: 63

The marks are given as a guide and are subject to minor changes.

Instructions:

1. You can write the exam digitally, on blank paper, or on a printed copy.
2. When finished, submit your exam to the assignment space in PDF format. If you are scanning papers, please use a scanner or app that scans to PDF. The Dropbox app and CamScanner apps are options.
3. Important! **Part 1 needs to be submitted BEFORE you begin Part 2.**

Academic integrity rules for the exam, Part 1:

1. Work individually, without consulting or working with anyone else
2. Open book: you may consult text or internet sources, except where answers are explicitly posted (e.g., Discord, Chegg)
3. You may not post questions/answers or ask for answers

Important! **If you become aware of academic dishonesty** during the exam, report it to Dr. Flynn by [email](#) or [anonymously](#). Please sign below to attest that you have read and agree to the academic integrity rules for this exam:

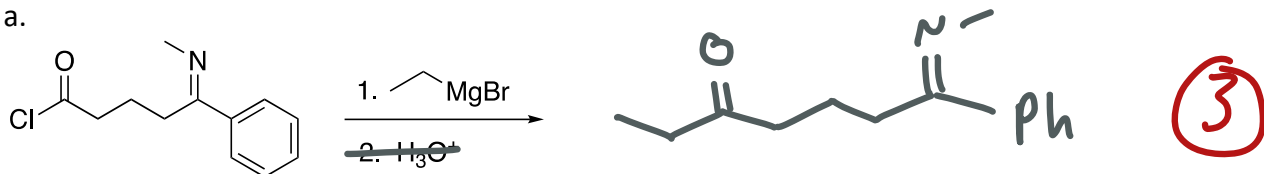
Signature: _____

- Have questions during the exam? You can:
 - Post your question on Slack
 - Contact Dr. Flynn via Zoom (link in Brightspace)
 - [Email](#) Dr. Flynn (confidential messages only)

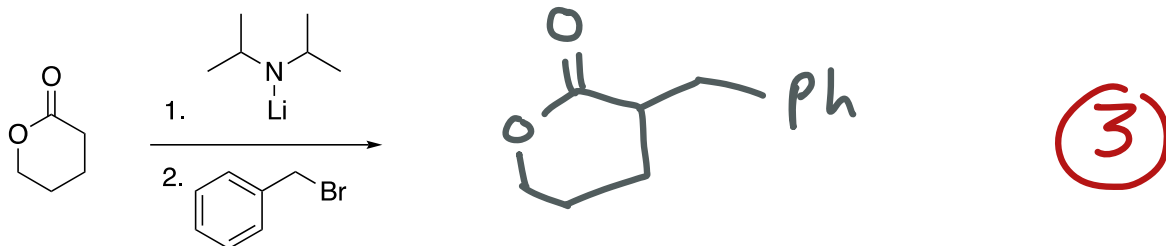
-1 per error (eg reaction at incorrect electrophilic atom, wrong # Cs)

1. Draw the products for each of the following reactions (3 points each; total 12)

a.



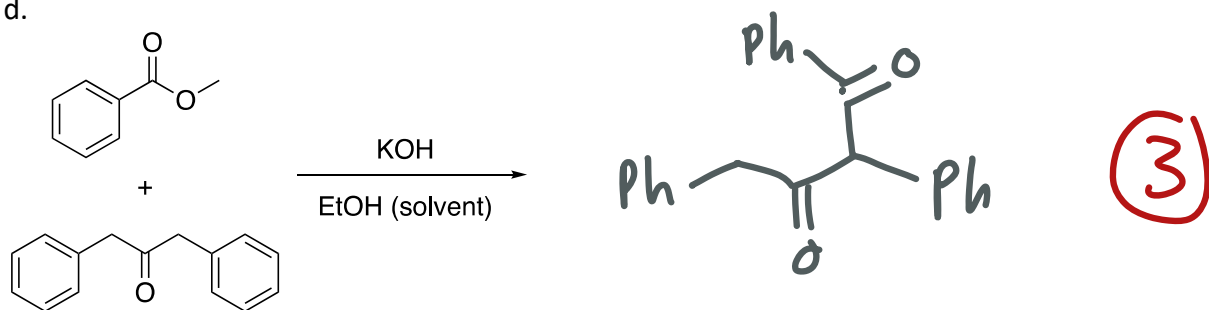
b.



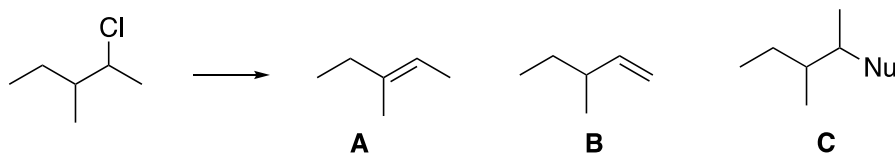
c.



d.



2. Consider the reaction below:



Possible reactants



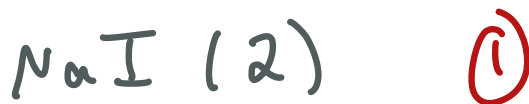
a. Which reactant that will give alkene **A** as the major product? (1 point)



b. Which reactant will give alkene **B** as the major product? (1 point)



c. Which reactant will give **C** as the major product? (1 point)



d. Justify your answer in part **b** (alkene formation), using causal reasoning; be sure to make a comparison to **A** and **C**. (5 points)

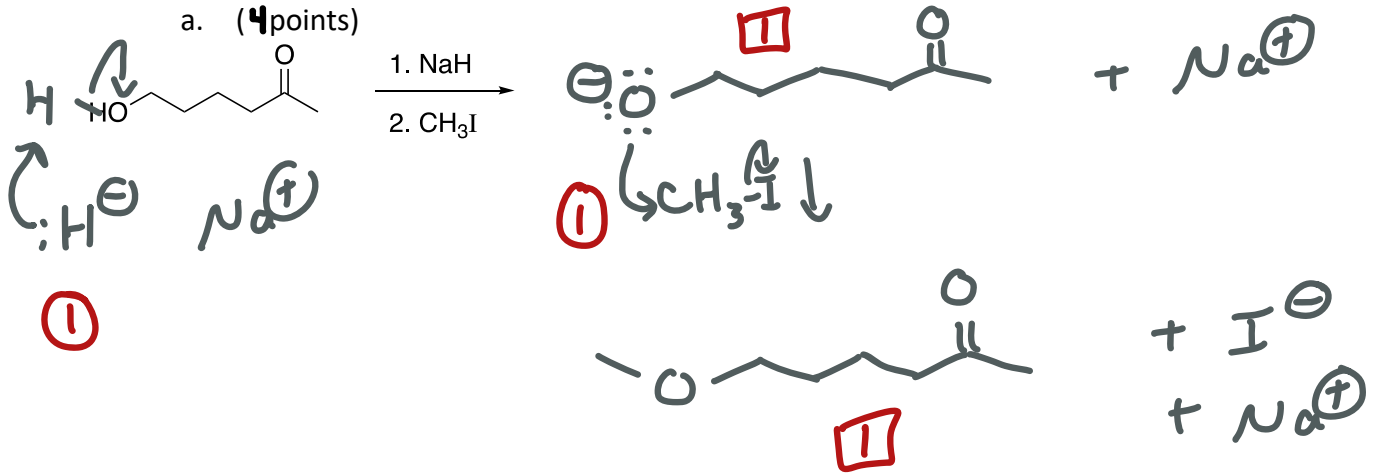
KO^+Bu is too sterically hindered to access the α carbon in **C** (E_a too high).

For elimination, the E_a is lower for the reaction between the base and the most sterically accessible proton, despite not leading to the most stable alkene (**A**).

① Arrows
 ② Structure

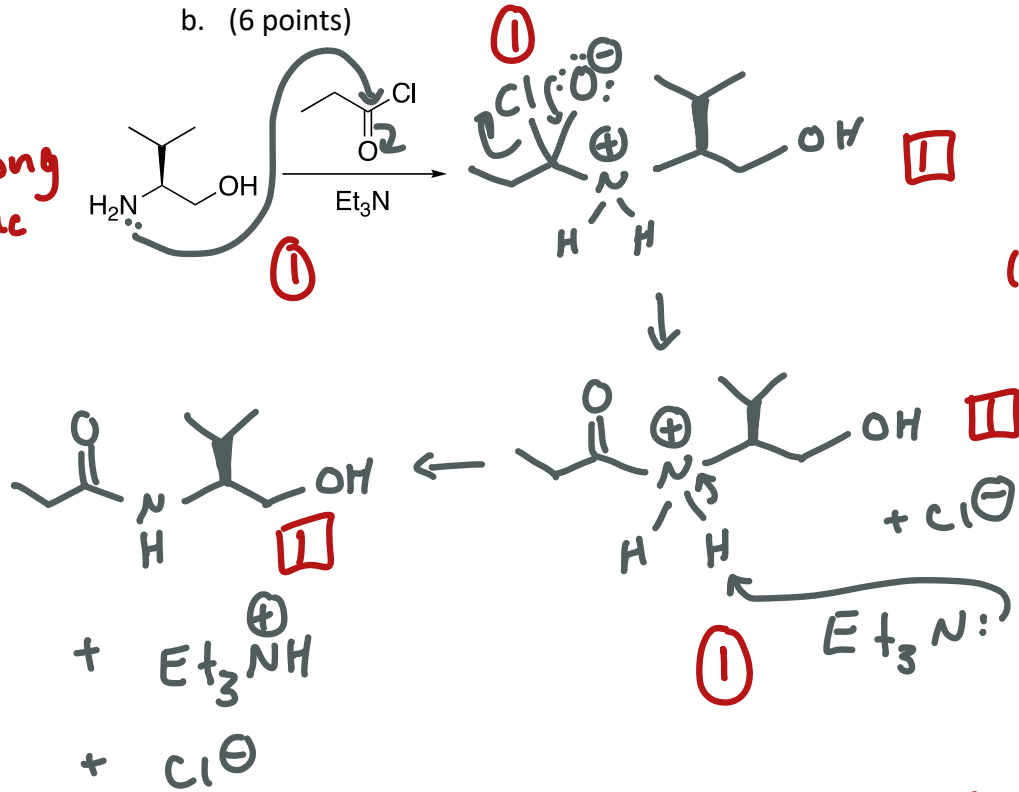
3. Provide the mechanism and products for each reaction below. All steps should be balanced.

a. (4 points)



b. (6 points)

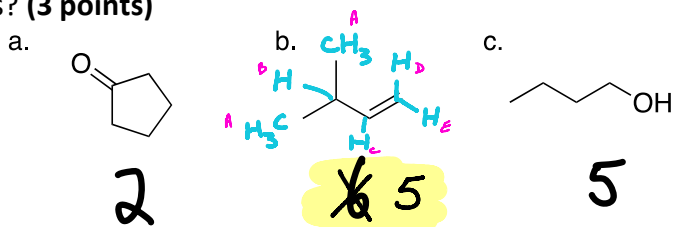
-1 wrong
 *Nuc



either order ok.
 (TI collapse or
 A/B as the
 middle step)

-1 wrong base*
 * mark the rest
 accordingly

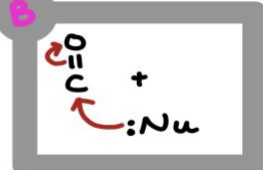
4. How many unique proton signals would be expected in the ^1H NMR spectrum of each of the following molecules? (3 points)

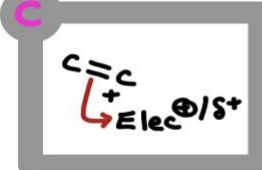



① point each

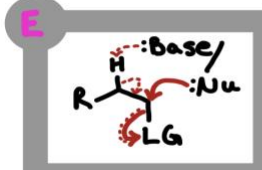
5. Categorize each of the following reactions by the main mechanism involved, using the categories below. Only select "A" if it is the only reaction. (4 points)

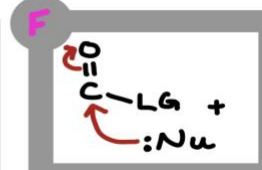
A Acid-Base


B 

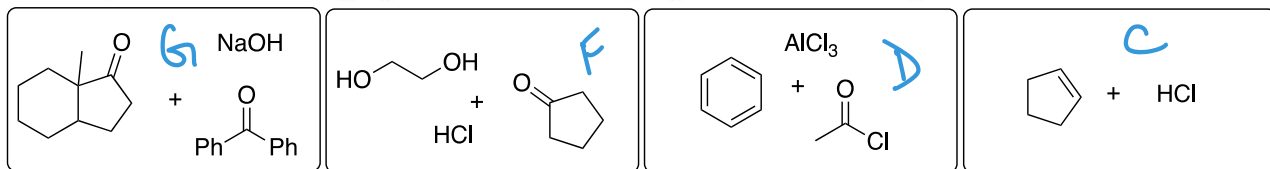
C 

D 

E 

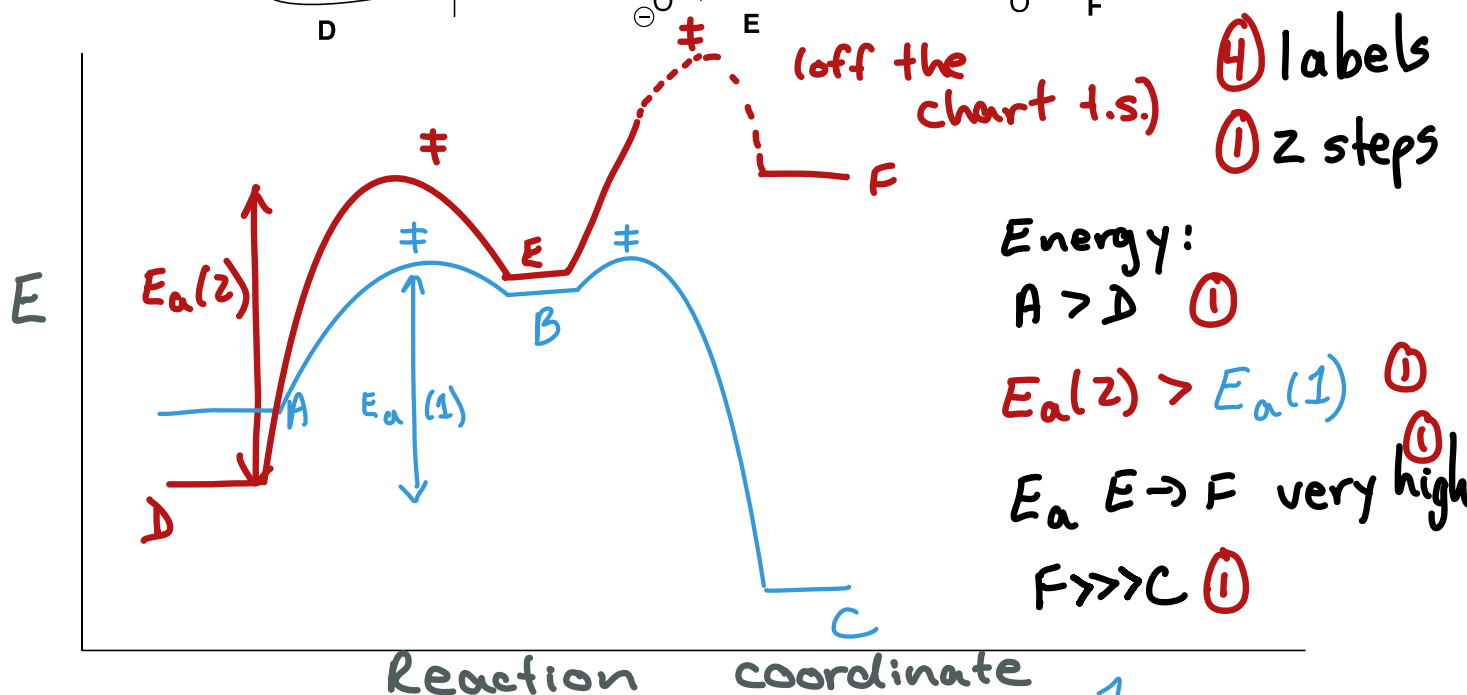
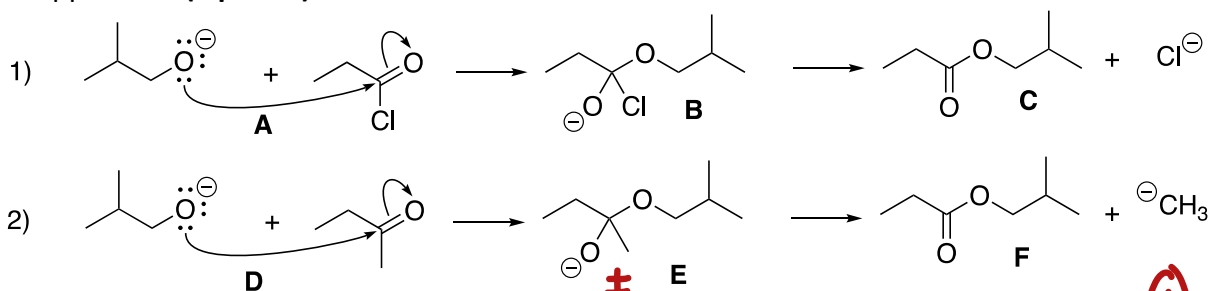
F 

G 



① point each

6. a. Draw and label the reaction coordinate diagram for reaction steps below, including for each reaction: the transition states, activation energy, reactants, intermediates, products, and axes, as applicable. (9 points)



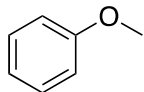
- b. Which reaction is most likely to proceed by the mechanism shown? 1 (1 point)
- c. Justify your answer in part b (causal explanation), using your reaction coordinate diagram as part of your explanation. (3 points)

The rate-determining step for each reaction is step 1. ⁺¹

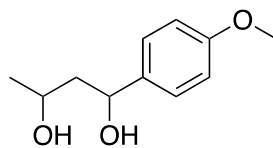
The carbonyl in A is more electrophilic because of Cl's greater electronegativity compared to C. Reaction 1 therefore has a lower E_a than Reaction 2. (1)

7. Propose a synthesis of the diol below from the reagents shown plus any other reactants that you require. You do not have to include a retrosynthetic analysis. (6 points)

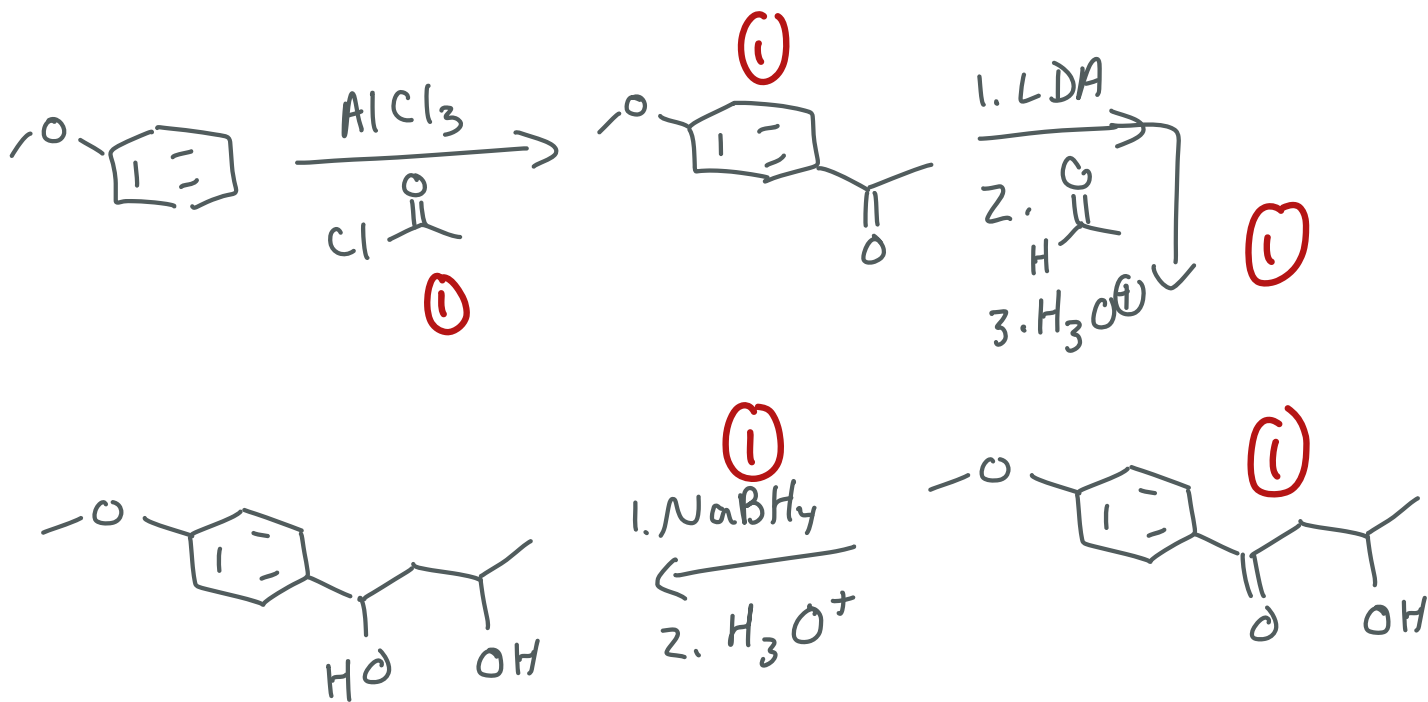
Reactants that need to be used at some point



and anything else

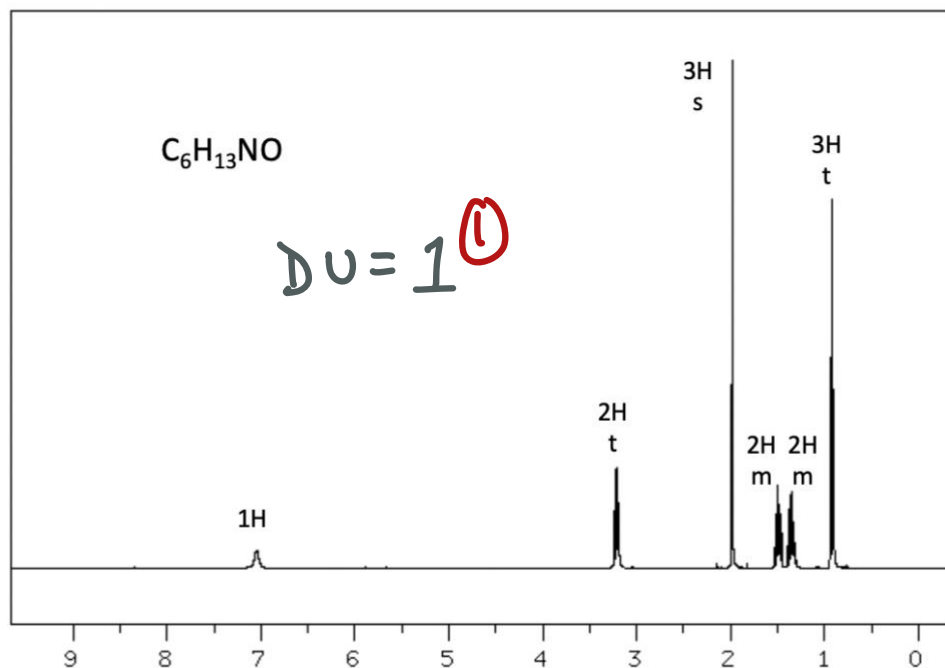


product

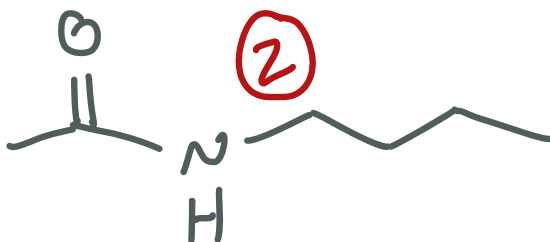


overall strategy (eg order) (1)

8. Determine the structure of the molecule with molecular formula $C_6H_{13}NO$. The 1H NMR spectrum is given below. (6 points)



| Peak | Chemical shift | Integration | Multiplicity | Comments/Ideas |
|------|----------------|-------------|--------------|--|
| A | 7 | 1 | Broad s | (1) NH (CH) |
| B | 3.2 | 2 | t | -CH ₂ - next to CH ₃ |
| C | 2 | 3 | s | -CH ₃ |
| D | 1.5 | 2 | m | -CH ₂ -) (1) |
| E | 1.3 | 2 | m | -CH ₂ - |
| F | 0.9 | 3 | t | -CH ₃ next to CH ₂ (1) |

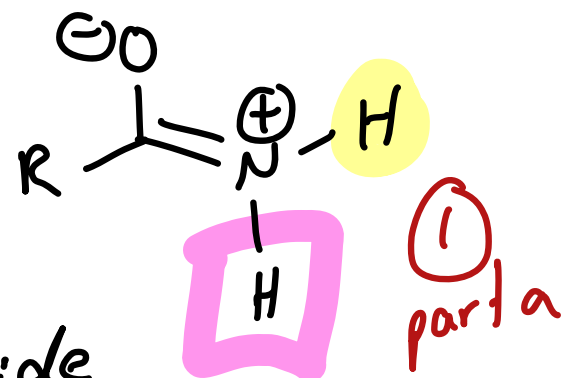
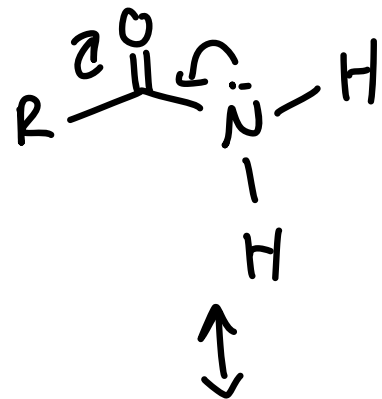
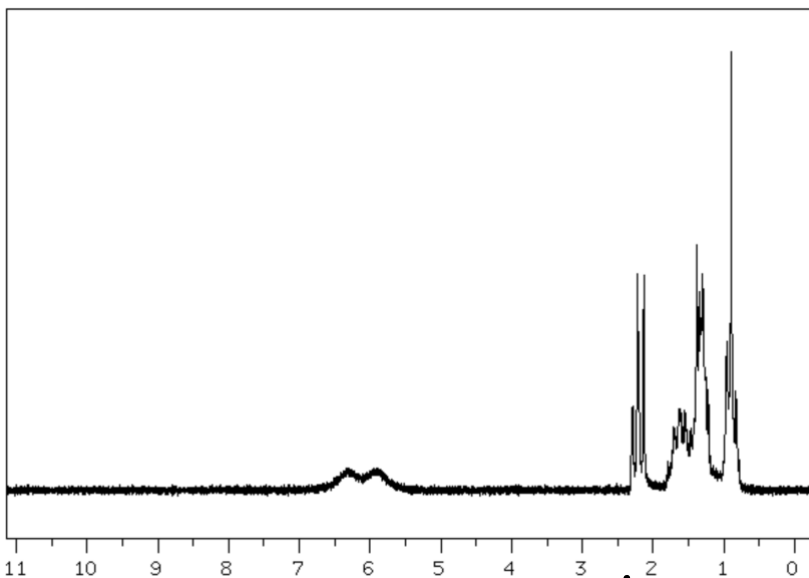
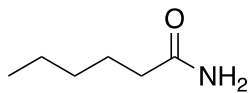


9. Provide an example of a SMART goal (specific, measurable, accountable, reachable, time-defined/specific). It does not have to be personal. (2 points)

marked according to criteria

BONUS!

- a. What do the peaks at ~6 ppm represent in the ^1H NMR spectrum for hexanamide? (1 point)
- b. Why are there two signals at that chemical shift? Justify your answer using a structure. (2 points)



① Resonance in the amide results in restricted rotation around the $\text{C}=\text{N}$ (partial double bond). As a result, N's Hs are "locked" in different chemical environments