UCSC, Binder Name_____

SID or UCSC Email Address _____

CHEM 8B Organic Chemistry II
FINAL EXAM (*400 points*)

In each of the following problems, use your knowledge of organic chemistry conventions to answer the questions in the proper manner. **Be sure to read each question carefully.** You have 3 hours to complete the exam, but hopefully you won't need it! You are welcome to use pre-built models. **Complete every problem on Pages 1-8. Pages 9 & 10 (multi-step synthesis) are the only pages where you can skip problems.**

Keep your eyes on your own paper. Electronic devices, study guides, and cheat sheets of any kind are not allowed, including cell phones and calculators. If you agree that cheaters never prosper, draw a picture of a cheetah in trouble on the back of the exam (page 11). Any student found using any of the above devices or found examining another student's exam will be promptly removed from the room and will receive a zero on this exam. Such an incident may also be reported to the UCSC Judiciary Affairs Committee.

1. Nomenclature (50)	
2. Lipids (40)	
3. Amino Acids (30)	
4. Peptides (40)	
5. Single Step, MC (40)	
6. Mini Puzzles (50)	
7. Reaction Puzzle (50)	
8. Mechanisms (50)	
9. Multi-Step (30)	
10. Multi-Step Challenge (20)	
Total (400)	
	%

1. Nomenclature

(a) (*20 points*) **Provide IUPAC names** for the following compounds.

(2*R*,3*E*)-2-methoxy-5-oxo-3-hexenoic acid

meta-bromoacetophenone

(2*R*,6*R*)-2-*tert*-butyl-6-hydroxycyclohexanone

Isopropyl cyclohexane carboxylate

(b) (*30 points*) Complete the following Fischer, Haworth projections and chair conformations…

α-D-Glucopyranose

FISCHER: **HAWORTH** **CHAIR**

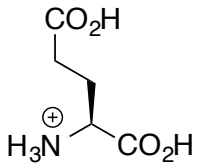
β-D-Galactopyranose (the C4 epimer of D-Glucose)

FISCHER: **HAWORTH** **CHAIR**

2. Amino Acids

Draw the dominant ionic species of the amino acids at each of the indicated pH ranges based on the given pKa's. Indicate all charged atoms. Circle the charges as shown below.

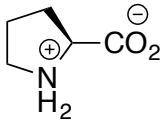
(a) (*10 points*) **Titration of Glutamic Acid** - pKa_1 2.10; pKa_2 9.47; pKa_R 4.07



L-Glutamic Acid
(fully protonated)

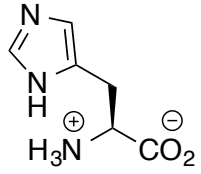
pH < 2.10	2.10 < pH < 4.07	4.07 < pH < 9.47	pH > 9.47
Charge:			

(b) (*10 points*) **Titration of Proline** – pKa_1 2.28; pKa_2 9.21



pH < 2.0	2.0 < pH < 10.6	pH > 10.6
Net Charge:		

(c) (*10 points*) **Titration of Histidine** - pKa_1 1.8; pKa_2 9.2; pKa_R 6.0



pH < 1.8	1.8 < pH < 6.0	6.0 < pH < 9.2	pH > 9.2
Net Charge:			

3. Peptide Primary Structure

Use the structures on page 2 to draw tripeptides containing L-Proline, L-Glutamic Acid, and L-Histidine at each of the following pH conditions.

Pro – Glu – His

(a) *(15 points)* Draw the structure of the **tripeptide at pH 3** and indicate its **net charge**.

_____ Net Charge

(b) *(10 points)* Draw the structure of the **tripeptide at pH 5** and indicate its **net charge**.

_____ Net Charge

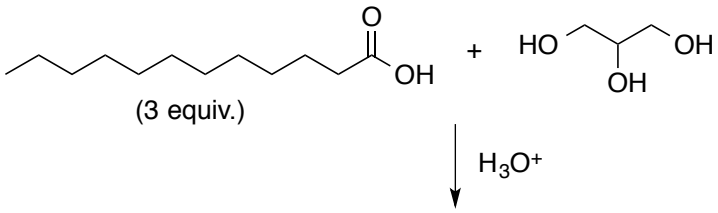
(c) *(10 points)* Draw the structure of the **tripeptide at pH 7** and indicate its **net charge**.

_____ Net Charge

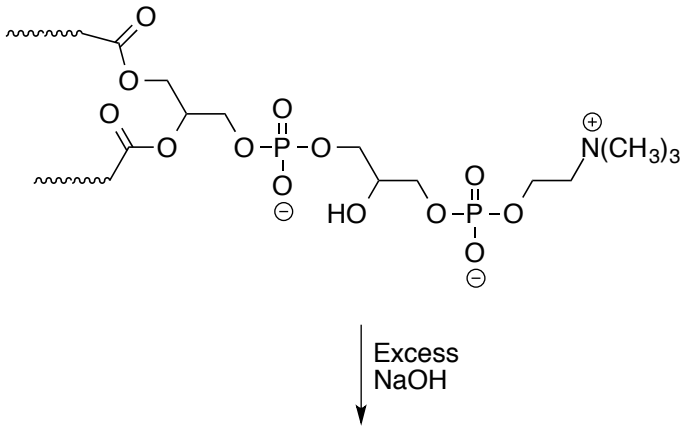
(d) *(5 points)* What is the **isoelectric point (pI)** of the Pro-Glu-His tripeptide? Show your work. You should not need a calculator for this!!

4. Lipids

(a) (*20 points*) Draw the **triacylglycerol** product of the following reaction.



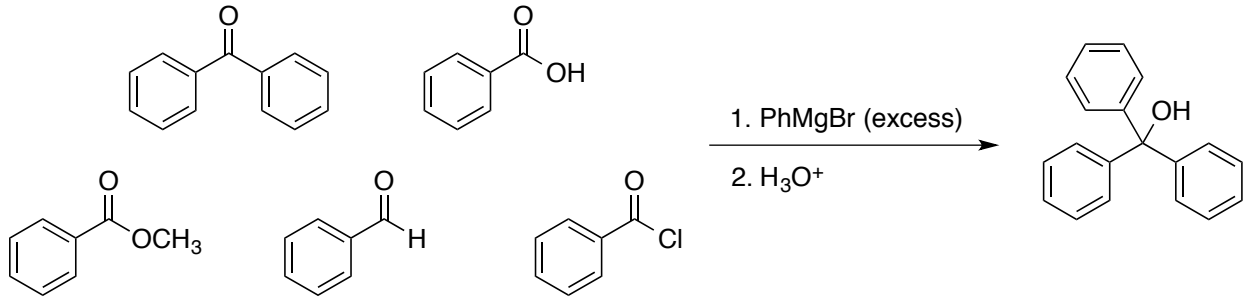
(b) (*20 points*) The following **phospholipid** was subjected to **saponification** (basic hydrolysis). Draw the many **products of the reaction**.



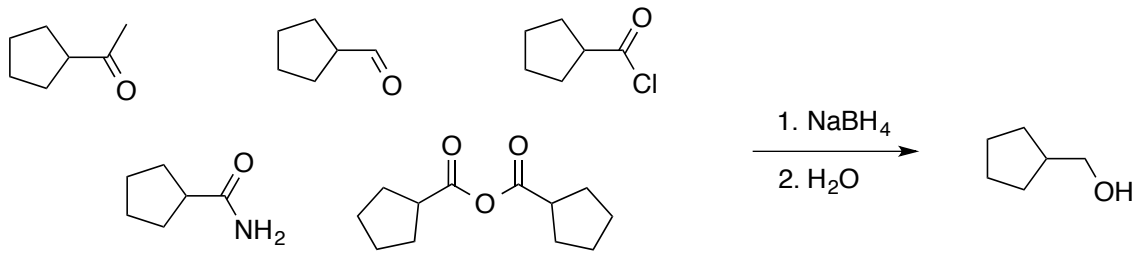
5. (*40 points*) **Single Step Reactions – <u>Multiple Choice</u>**

Circle the starting material(s) that would give the indicated product. More than one answer may be possible for each.

(a)

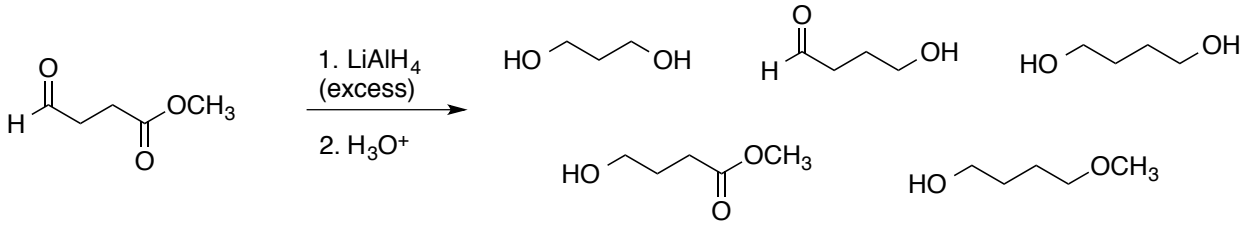


(b)

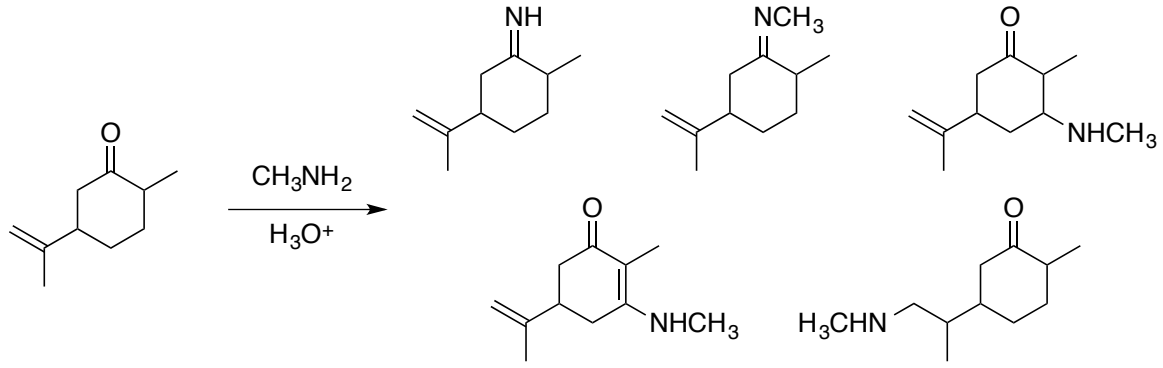


Circle the correct product in each reaction.

(c)

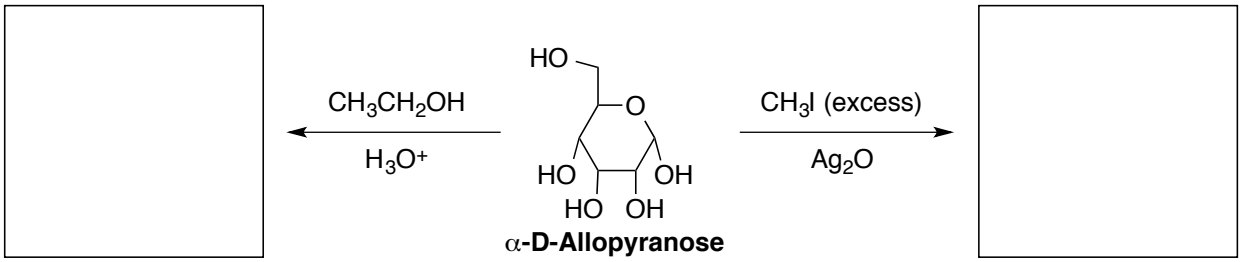


(d)

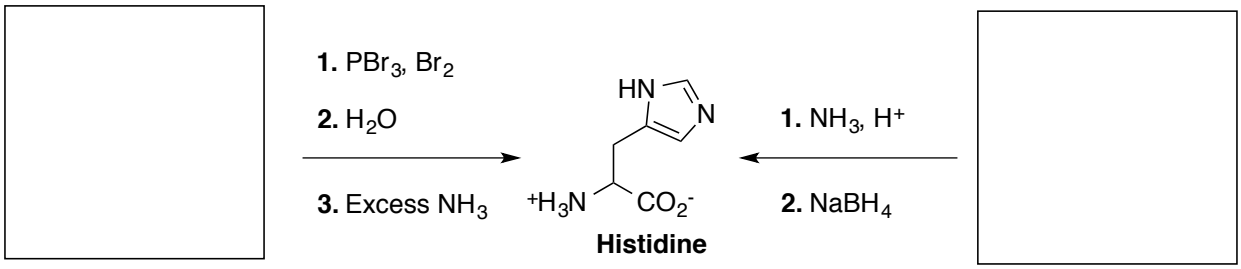


6. (*50 points*) **Mini-Puzzles**

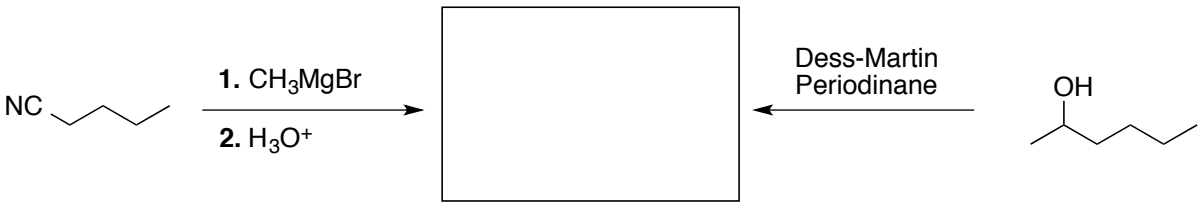
(a) Show the **products** of two different reactions of **α–D-allopyranose.**



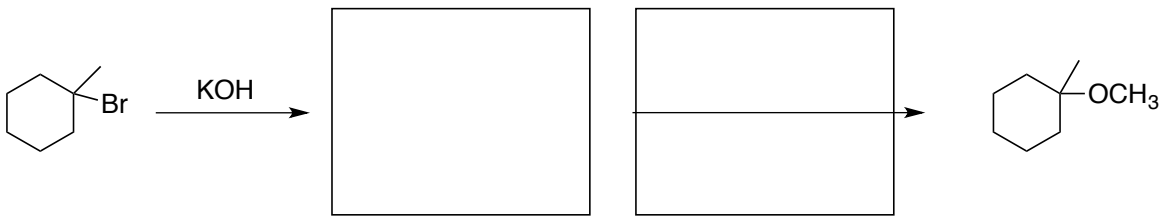
(b) Show the **starting materials** for two different methods for synthesizing **Histidine.**



(c) The two reactions below give the same product. Draw that **product**.

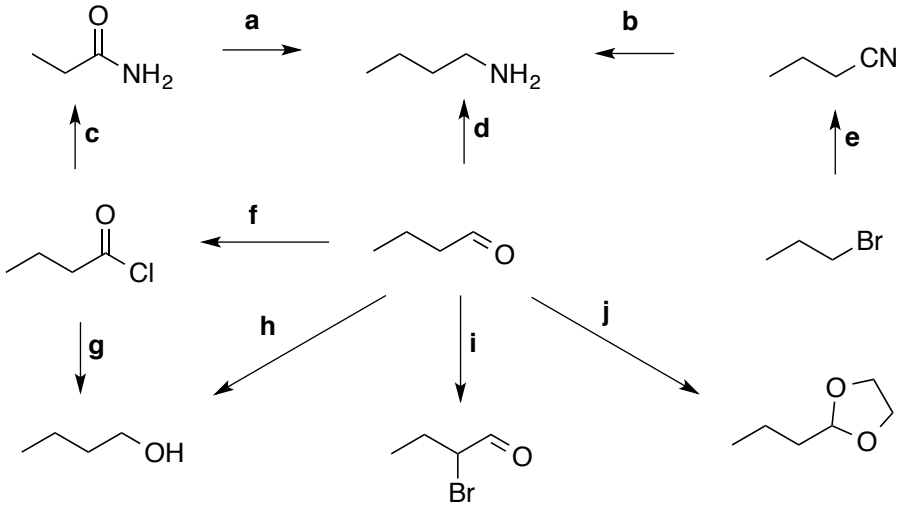


(d) Show the synthetic **intermediate** and **reagents** needed to synthesize the following ether.



7. (*50 points*) **Reaction Puzzle**

(a) Fill in the missing reagents. More than one set of reagents may be required in each step (letter) and the same set of reagents may be used more than once.
Pro-tip: take it one reaction at a time!



(a) _____ **(b)** _____

(c) _____ **(d)** _____

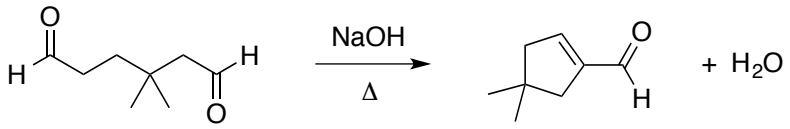
(e) _____ **(f)** _____

(g)_____ **(h)** _____

(i)_____ **(j)**_____

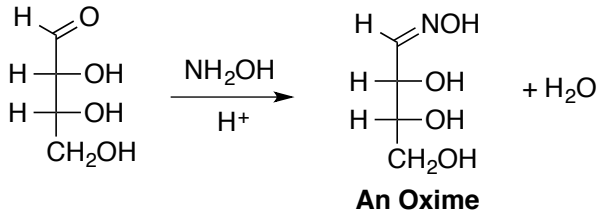
8. Mechanisms – Draw the full arrow-pushing mechanism for **both reactions** below, including all arrows for acid-base reactions. Include all intermediates with proper charges circled for each step.

(a) (*25 points*) 4,4-Dimethyl-1-cyclopentene carbaldehyde is made through a **base-promoted intramolecular aldol cyclization** of the dialdehyde below. Show this mechanism. Yes, this is similar to the second exam!
Pro tip: consistently number the carbons in the starting material & product.



(b) (*25 points*) The first step in the **Wohl degradation** is the reaction of an aldopentose with **hydroxylamine** to form an **oxime**, which is closely related to an imine. Draw the **full arrow-pushing mechanism** for the formation of the oxime, including reaction **intermediates** and **charges** clearly indicated, in the space below. It is recommended, though not required, to make a list of all bonds broken and formed.

bonds broken

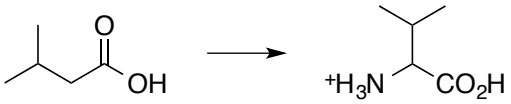


An Oxime

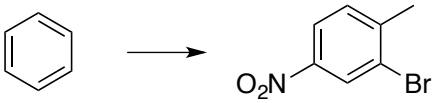
bonds formed

9. (*30 points*) **Multi-Step Synthesis – CHOOSE TWO**
Carry out the syntheses of the indicated target molecules using the starting material provided and any other reagents or carbon sources needed. Draw the **product after each synthetic step. No mechanisms.**

(a)



(b)

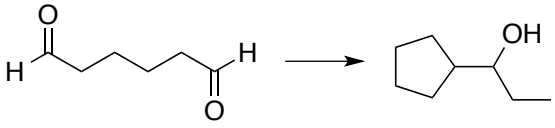


(c)

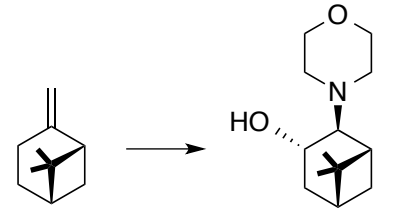
PUT A LARGE "X" OVER THE ENTIRE REACTION & SPACE YOU ARE SKIPPING AND DO NOT WANT GRADED.
OTHERWISE THE TOP TWO REACTIONS WILL BE GRADED, EVEN IF THEY ARE BLANK!

10. (*20 points*) **Multi-Step Synthesis – CHOOSE ONE**
Carry out the syntheses of the indicated target molecules using the starting material provided and any other reagents or carbon sources needed. **Draw the product after each synthetic step. No mechanisms.**

(a) Show the synthesis of the following cyclopentane derivative. It would be wise to revisit page 8 for assistance!



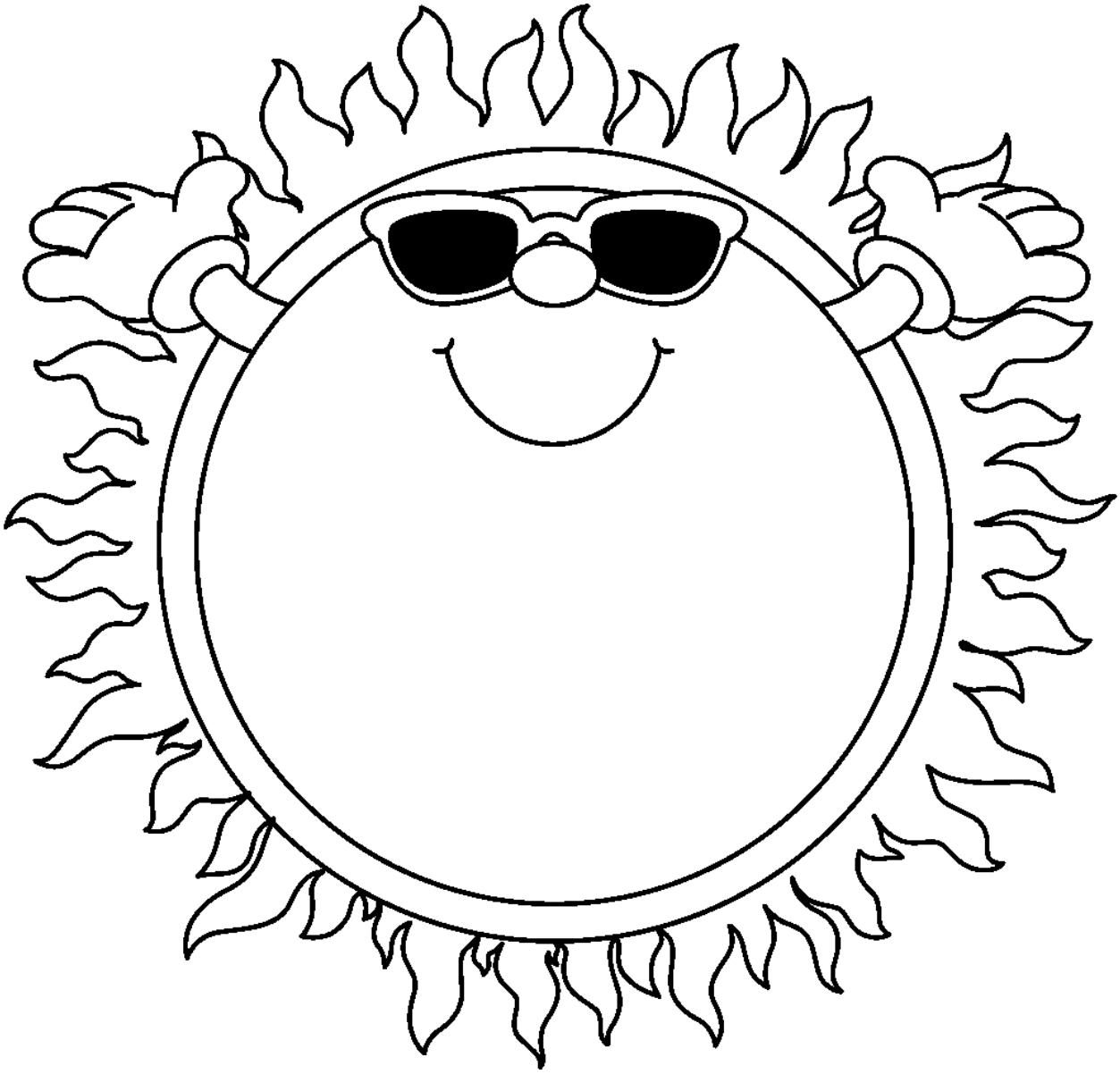
(b) Dr. B's Ph.D. dissertation focused on the synthesis of amino alcohols for use as chiral catalysts in alkylation reactions. The synthesis of the compound below was accomplished using creative understanding of the reactions from CHEM 108A&B. Impress me with your knowledge and complete the synthesis of *trans*-2-morpholino apopinol (***trans*-2-MAP**) from ***β*-pinene**!



***β*-Pinene** ***trans*-2-MAP**

PUT A LARGE "X" OVER THE ENTIRE REACTION & SPACE YOU ARE SKIPPING AND DO NOT WANT GRADED.
OTHERWISE THE FIRST REACTION WILL BE GRADED, EVEN IF IT IS BLANK!

STARTED FROM CHEM 8A AND NOW YOU’RE HERE!



HAVE A GREAT BREAK!!