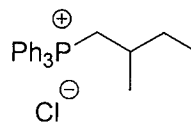
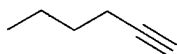


Name: \_\_\_\_\_ TA: \_\_\_\_\_

1. **Extremely short answer.** Provide the requested information for each transformation. (10 pts)

a) Write the formulas of **three bases** that are used for quantitative deprotonations of each of these compounds.



1. NaH      2. n-BuLi      3. NaNH<sub>2</sub>

b) Give ONE set of conditions (reagents, solvents, workup) that can be used to make an alcohol from a ketone.

1. LAH      or      NaBH<sub>4</sub>      or      H<sub>2</sub> / Raney Ni  
2. H<sub>3</sub>O<sup>+</sup>      or      MeOH

c) Write two specific methods/approaches that can be used to remove water from a reaction.

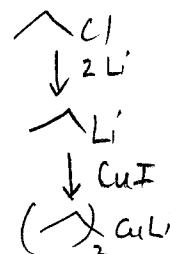
azeotropic distillation      or      molecular sieves

d) State the purpose of using an acetal protecting group in a multi-step synthesis. One sentence only, not an essay. Use only the lines.

To protect a ketone or aldehyde from  
basic conditions that would otherwise affect it

e) What kind of organic molecule is an organocuprate made from? (Two possible reasonable answers. Write only ONE)

alkyl halide or organolithium reagent

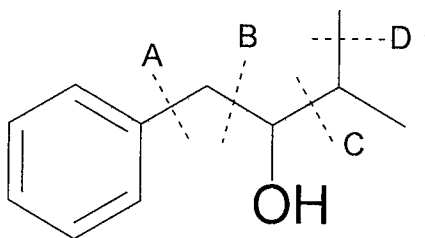


f) What type of product results when you react an unstabilized phosphorous ylide with an aldehyde?

Z alkene

Name: \_\_\_\_\_ TA: \_\_\_\_\_

2. **Retrosynthesis.** (24 pts) Here is an alcohol with four different bond disconnections labeled (A, B, C and D).

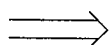


For each disconnection, indicate whether the alcohol could be made as the major product of one synthetic step (plus appropriate aqueous workup, which you should explicitly write where necessary).

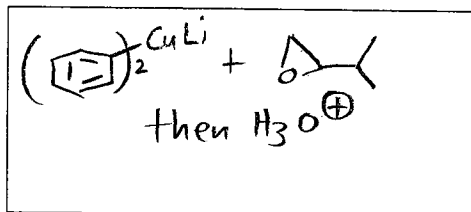
Can alcohol be made successfully by making the indicated bond?

If "yes", draw reagents and precursor(s) here. If "no", explain why not.

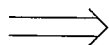
A



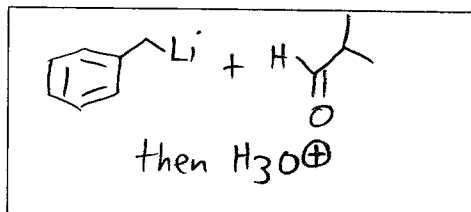
Yes  No



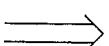
B



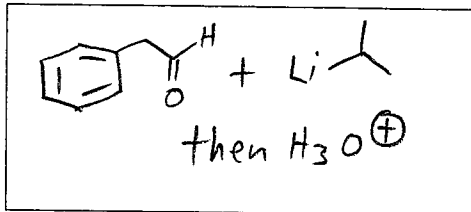
Yes  No



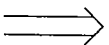
C



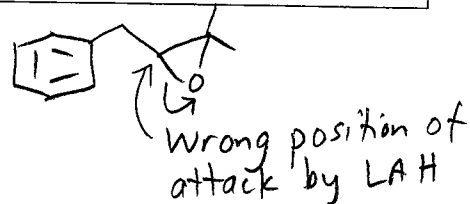
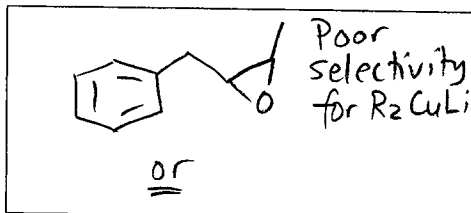
Yes  No



D

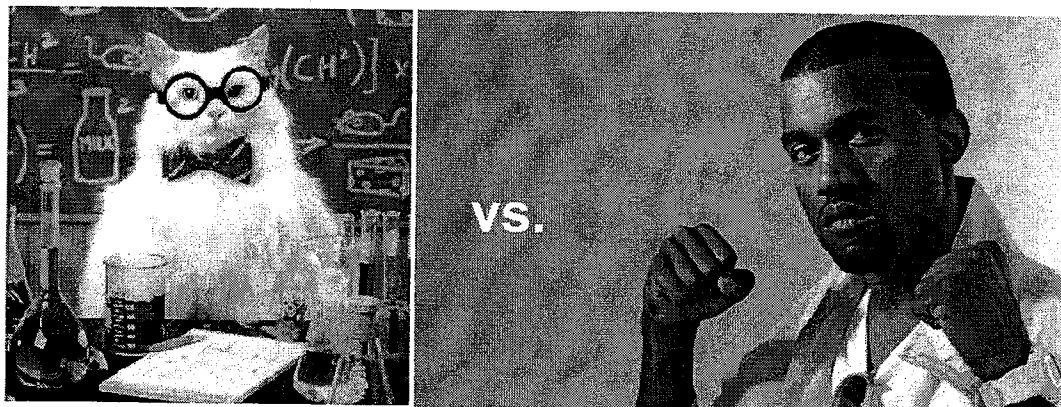


Yes  No

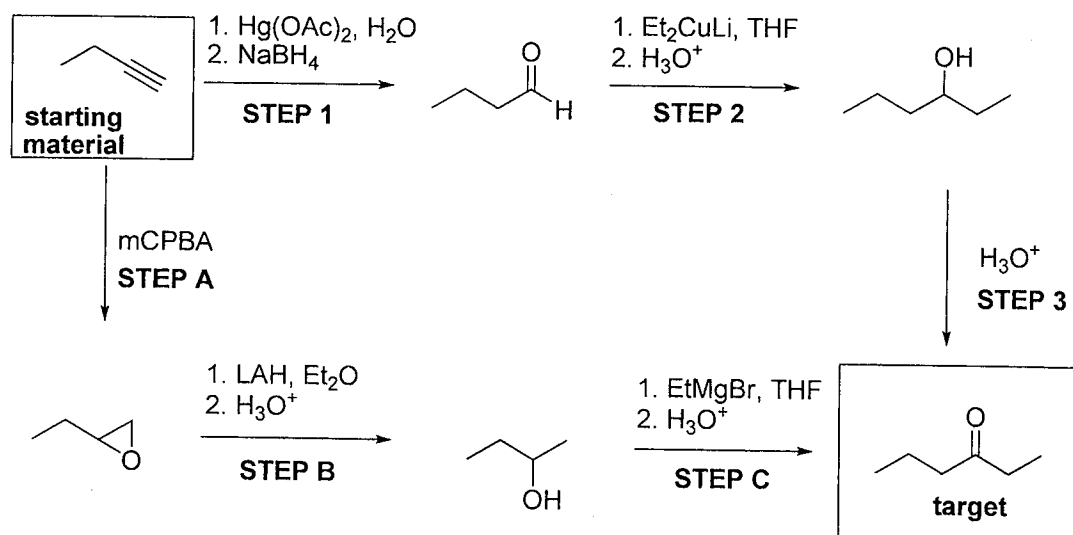


Name: \_\_\_\_\_ TA: \_\_\_\_\_

3. **Synthesis Showdown.** (18 pts) For the last few years, Kanye West has lost decisively to the Chemistry Cat in the world-famous Synthesis Showdown.



This year, determined to finally vanquish the Cat, Kanye outlined two different 3-step syntheses (Steps 1-3, and Steps A-C) in the hope that at least one of them would win. The starting material for each synthesis is 1-butyne (upper left) and the target is 3-hexanone (lower right).



Question continues on the next page.

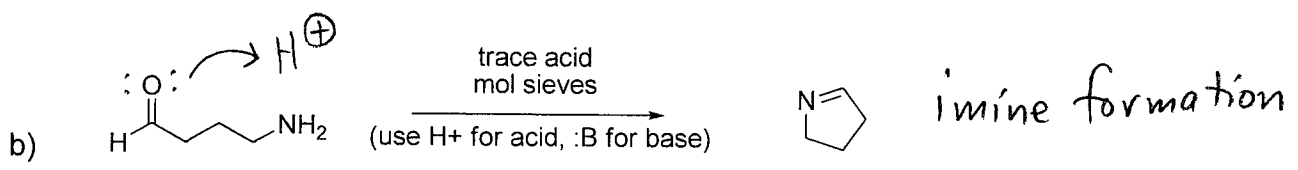
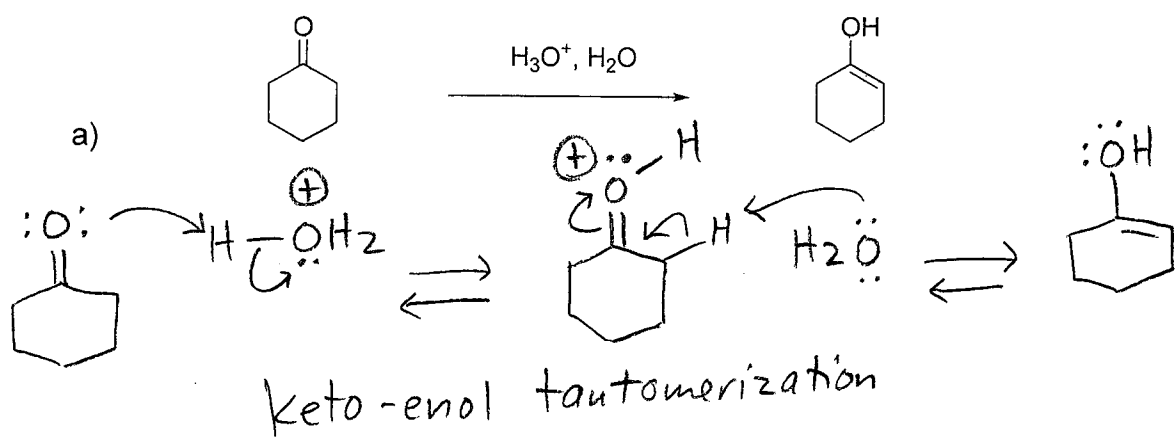
Name: \_\_\_\_\_ TA: \_\_\_\_\_

Analyze each of Kanye's two proposals (Steps 1 through 3, and Steps A through C). State whether each synthetic step, as proposed, would work. If not, indicate the reagents Kanye should use instead of the ones he has listed. Treat each step independently of the others; e.g., if the first step in a sequence doesn't work, just pretend it did when you examine the second step. If a particular step is impossible to do in ONE synthetic operation (i.e. ONE reaction, plus appropriate workup), just write "Not possible" in the third column.

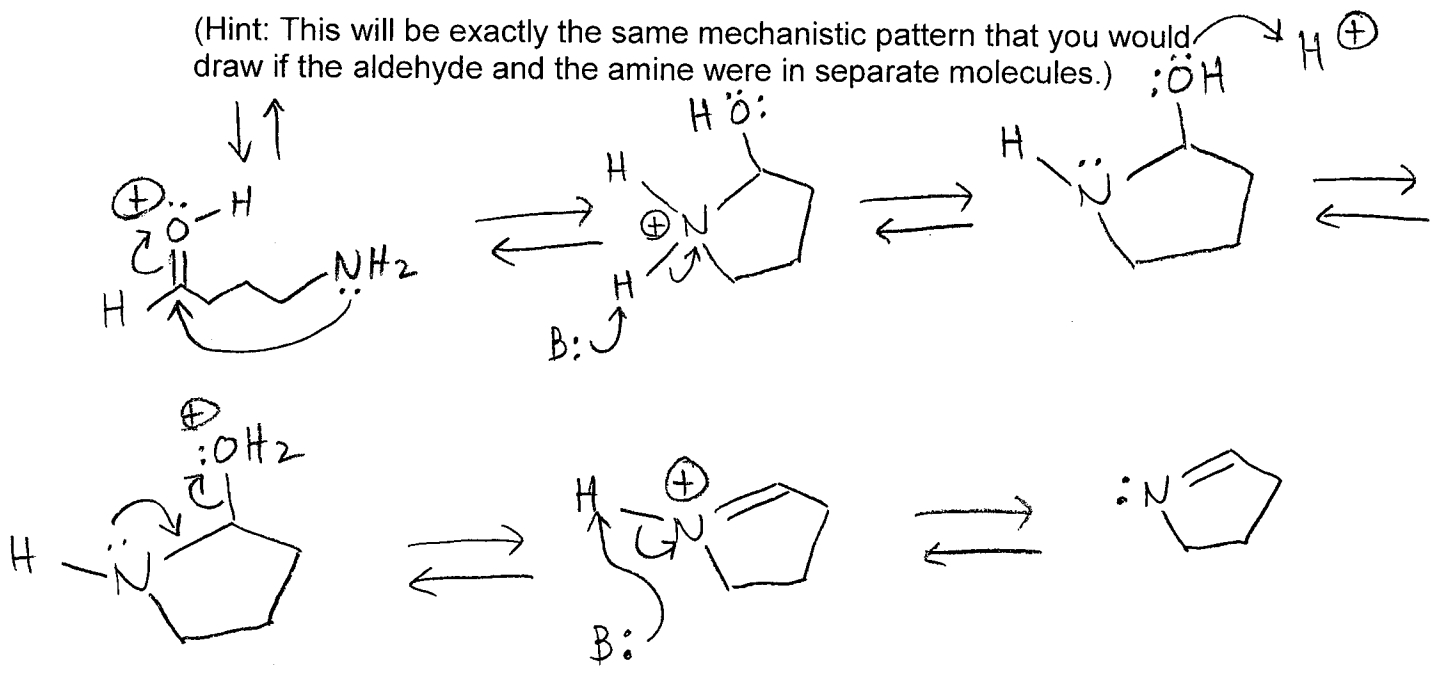
Step	Would it work as proposed? Circle Yes or No	If "No", what reagents should Kanye use? OR write "Not possible"
Step 1	Yes <input checked="" type="radio"/> No	1. $\text{SiO}_2 \text{BH}$ 2. $\text{H}_2\text{O}_2, \text{HO}^\ominus, \text{H}_2\text{O}$
Step 2	Yes <input checked="" type="radio"/> No	1. $\text{EtLi}$ or $\text{EtMgBr}$ 2. $\text{H}_3\text{O}^\oplus$
Step 3	Yes <input checked="" type="radio"/> No	PCC or Jones
Step A	Yes <input checked="" type="radio"/> No	Not possible (need 2 steps)
Step B	<input checked="" type="radio"/> Yes No	(Shocking!)
Step C	Yes <input checked="" type="radio"/> No	Not possible

Name: \_\_\_\_\_ TA: \_\_\_\_\_

4. **Mechanism.** Draw a mechanism for each of the following transformations. Include all necessary curved arrows, lone pairs of electrons, and nonzero formal charges for full credit. If your drawings are unclear or ambiguous, you will lose points, so draw carefully! (24 pts)

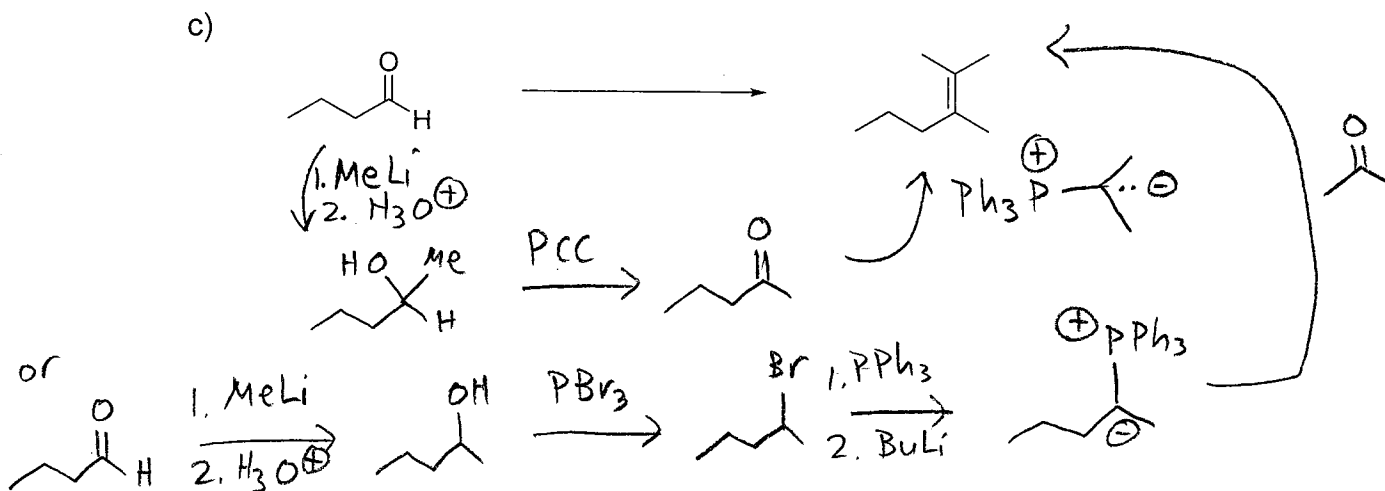
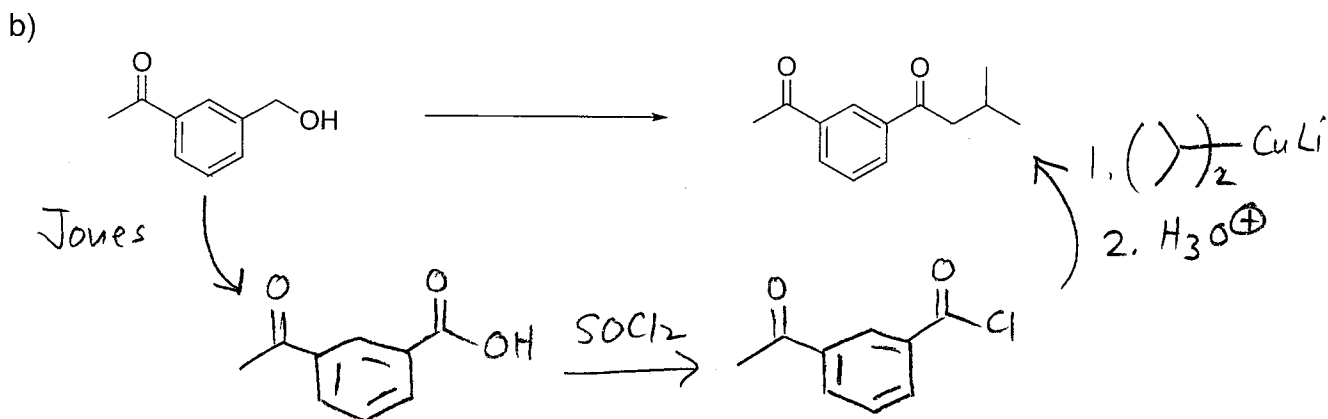
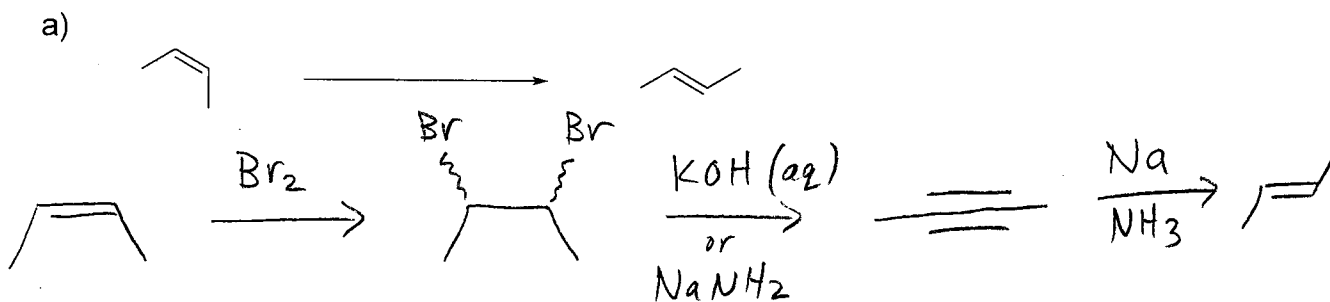


(Hint: This will be exactly the same mechanistic pattern that you would draw if the aldehyde and the amine were in separate molecules.)



Name: \_\_\_\_\_ TA: \_\_\_\_\_

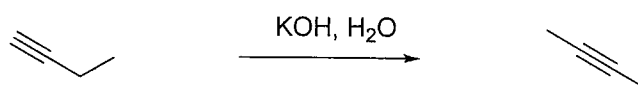
5. **Multi-step synthesis.** Propose a multi-step synthesis for each of the following transformations. Show the reagents needed for each step and the product of each step. Do not show any mechanisms. Do not just show a list of reagents without showing products or you will lose credit. If you use an organometallic reagent, you do not need to show how you made it. (27 pts)



Name: \_\_\_\_\_ TA: \_\_\_\_\_

6. **Extra credit.** (10 pts max) Do one or the other, but not both. No extra extra credit for doing both. Write your answer at the bottom of the page.

- a) Draw a mechanism to show the isomerization of the terminal alkyne to the internal alkyne using KOH as the base and water as the proton source. Include all lone pairs, curved arrows, and nonzero formal charges.



- b) Design two different multi-step syntheses of the target from the given starting material. Show the reagents needed for each step and the product of each step. Do not draw any mechanisms. Conditions: One synthesis must have an alkene as an intermediate. The other must have a carboxylic acid as an intermediate.

