NAME (Print): ______________________________

SIGNATURE: ______________________________

Chemistry 310N
Dr. Brent Iverson
3rd Midterm
April 23, 2009

Please print the first three letters of your last name in the three boxes

Please Note: This test may be a bit long, but there is a reason. I would like to give you a lot of little questions, so you can find ones you can answer and show me what you know, rather than just a few questions that may be testing the one thing you forgot. **I recommend you look the exam over and answer the questions you are sure of first**, then go back and try to figure out the rest. Also make sure to **look at the point totals** on the questions as a guide to help budget your time.

For synthesis problems GO FOR PARTIAL CREDIT EVEN IF YOU DO NOT KNOW THE ENTIRE ANSWER!!!WRITE DOWN WHAT YOU DO KNOW IS IN THE REACTION SEQUENCE SOMEWHERE. YOU WILL GET PARTIAL CREDIT IF IT IS CORRECT

Note: You must have your answers written in pen if you want a regrade!!!!

Page	Points	
1		(29)
2	deleted	(-)
3		(29)
4		(17)
5		(24)
6		(20)
7		(23)
8		(26)
9		(21)
10		(22)
11		(17)
12		(7)
13		(16)
14		(22)
15		(28)
16		(23)
Total		(324)
%		
T Score		
HW		
(HW score + Exam Grade) ⟹ Total Grade		

Honor Code

The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

____

(Your signature)

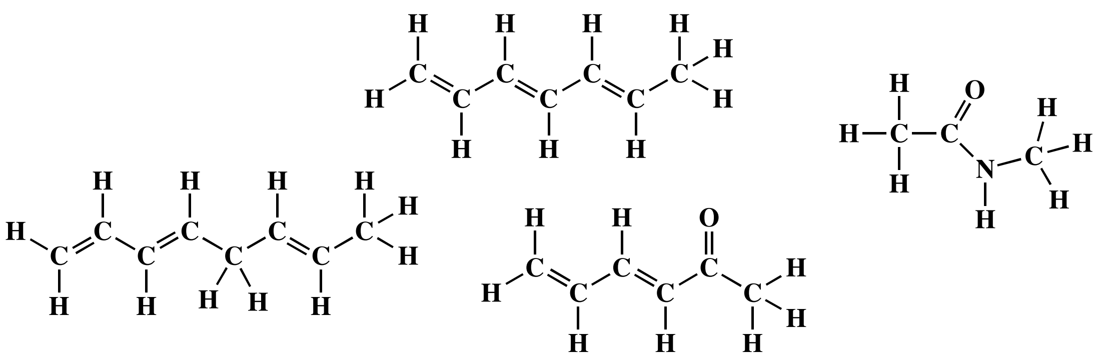
Compound		pK_a
Hydrochloric acid	$\underline{H}$-Cl	-7
Protonated alcohol	$RCH_2O\underline{H}_2^{\oplus}$	-2
Hydronium ion	$\underline{H}_3O^{\oplus}$	-1.7
Carboxylic acids	$R-\overset{O}{\overset{\|}{C}}O-\underline{H}$	3-5
Ammonium ion	$\underline{H}_4N^{\oplus}$	9.2
β-Dicarbonyls	$R\overset{O}{\overset{\|}{C}}-C\underline{H_2}-\overset{O}{\overset{\|}{C}}R'$	10
β-Ketoesters	$R\overset{O}{\overset{\|}{C}}-C\underline{H_2}-\overset{O}{\overset{\|}{C}}OR'$	11
β-Diesters	$RO\overset{O}{\overset{\|}{C}}-C\underline{H_2}-\overset{O}{\overset{\|}{C}}OR'$	13
Water	$HO\underline{H}$	15.7
Alcohols	$RCH_2O\underline{H}$	15-19
Acid chlorides	$RC\underline{H_2}-\overset{O}{\overset{\|}{C}}Cl$	16
Aldehydes	$RC\underline{H_2}-\overset{O}{\overset{\|}{C}}H$	18-20
Ketones	$RC\underline{H_2}-\overset{O}{\overset{\|}{C}}R'$	18-20
Esters	$RC\underline{H_2}-\overset{O}{\overset{\|}{C}}OR'$	23-25
Terminal alkynes	$RC\equiv C-\underline{H}$	25
LDA	$\underline{H}\text{-}N(i\text{-}C_3H_7)_2$	40
Terminal alkenes	$R_2C=\underset{H}{C}-\underline{H}$	44
Alkanes	$CH_3CH_2\text{-}\underline{H}$	51

Signature__________________________ Pg 1 _____________(28)

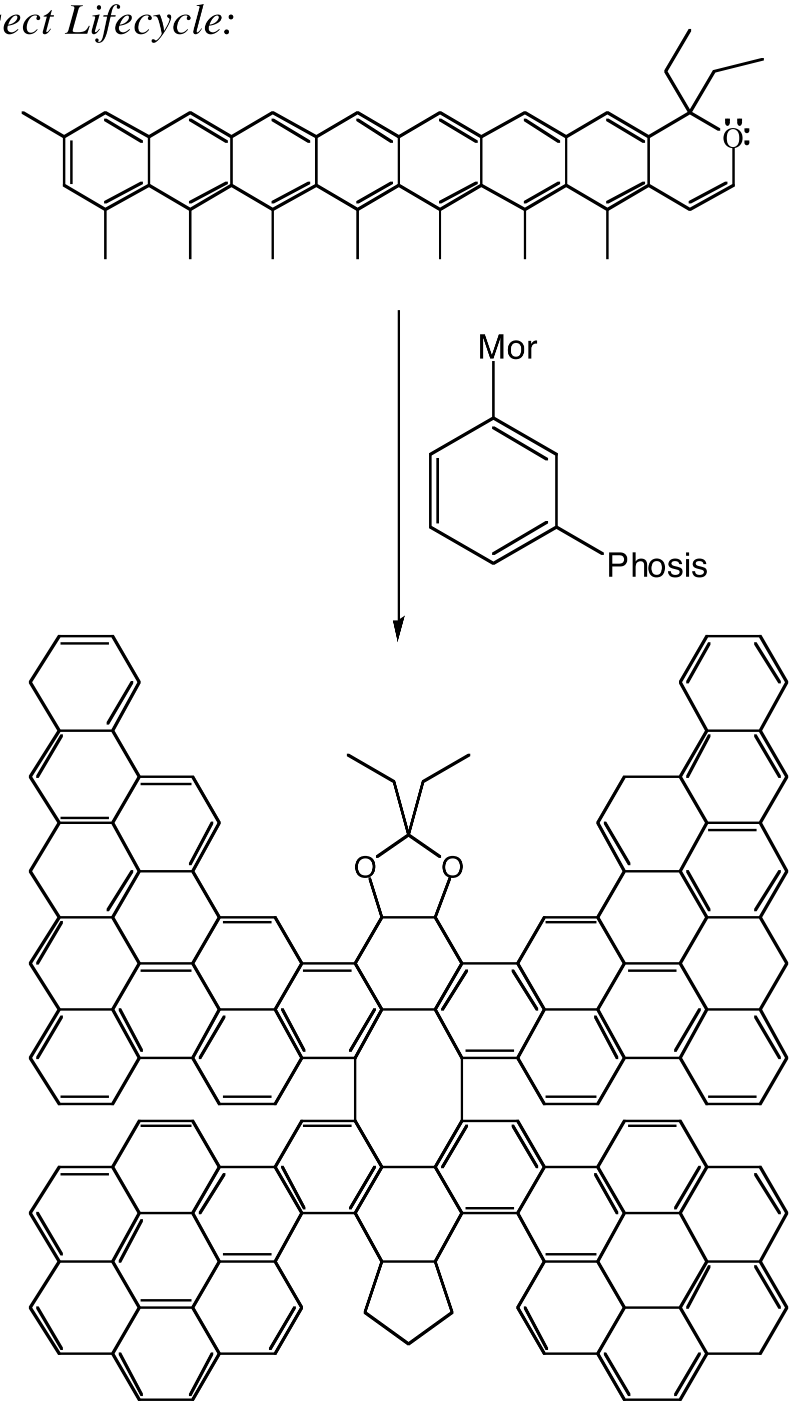
1. (14 points) Suppose a relative of yours is having an MRI. In no more than four sentences, explain to them what is happening when they have the MRI scan. We will be looking for a minumum of 7 key points here.

2. (8 points) Aromaticity is a term that refers to molecules with characteristic pi systems. A theorist named Hückel helped to derive several criteria that can be used to determine if a molecule is aromatic. List all four of these criteria:

3. (7 points) We have now run into cases in which bonds that look like normal sigma single bonds in a Lewis structure, actually have partial double bond character in the molecule. **In the following set of molecules, circle the single bonds that have double bond character** (i.e. hindered bond rotation at room tempterature). NOTE: You DO NOT have to circle any bonds WITHIN an aromatic ring.

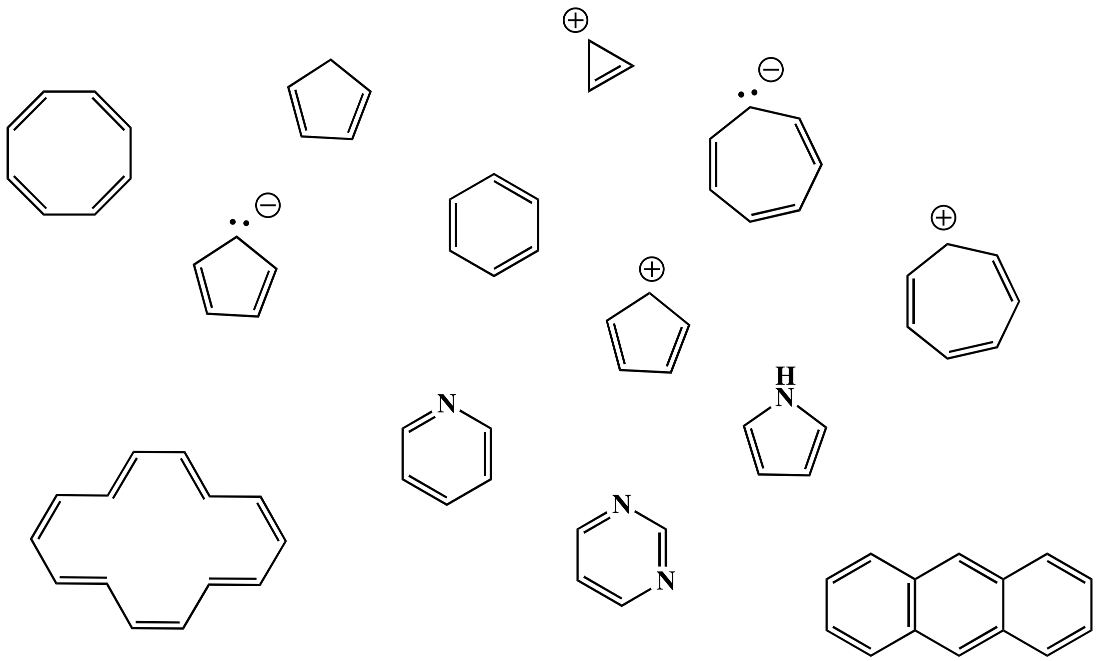


Aromatic Insect Lifecycle:

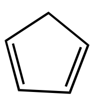
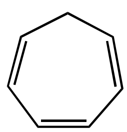


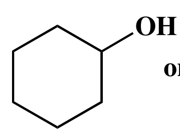
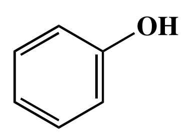
I put this here to help you relax. You will do better on the exam in a relaxed frame of mind. (If the above equation made you laugh or even smile, you may be a chem nerd, but nobody has to find out.)

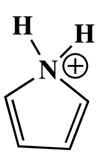
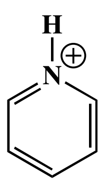
5. (13 points) **Draw a circle around** all of the molecules below that **can be considered aromatic.**

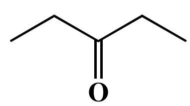
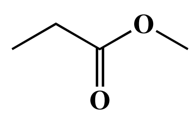


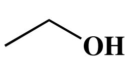
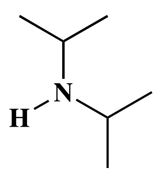
6. (16 points) **For each pair of molecules, circle the one that is more acidic.**

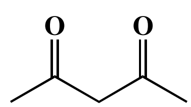
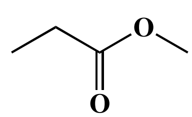
A.  or 

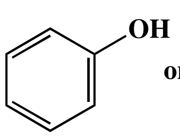
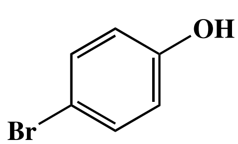
B.  or 

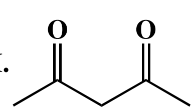
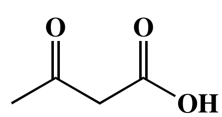
C.  or 

D.  or 

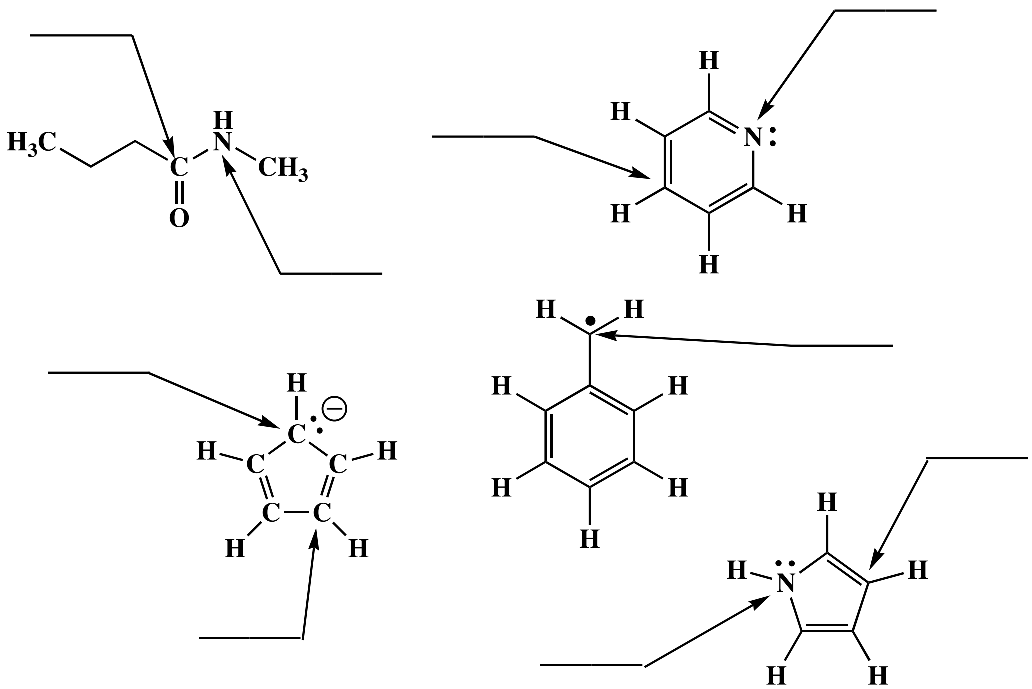
E.  or 

F.  or 

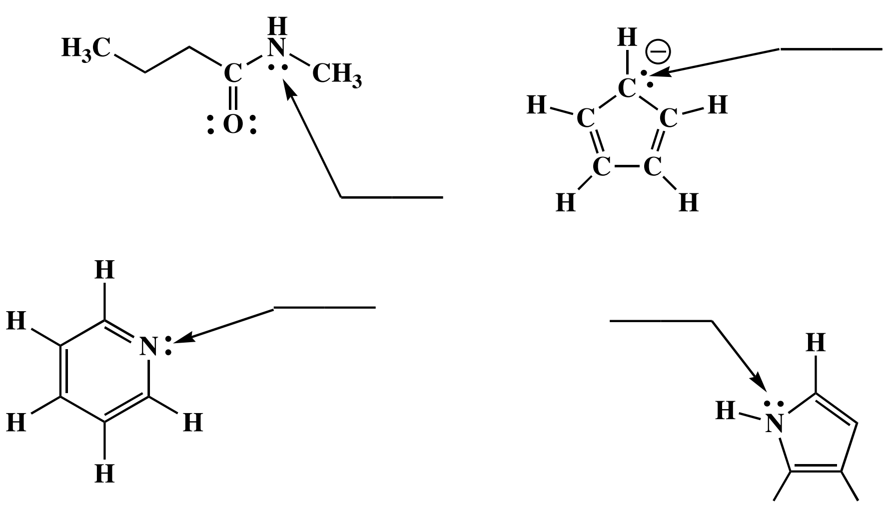
G.  or 

H.  or 

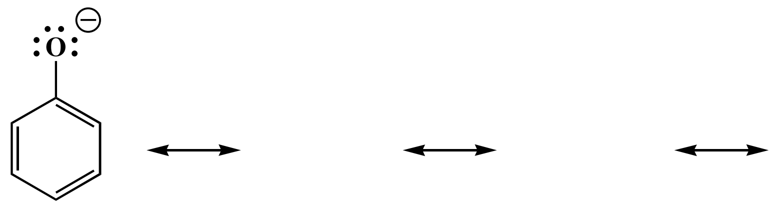
7. (9 points) On the lines provided, state the **hybridization state of the atom** indicated by the arrow.

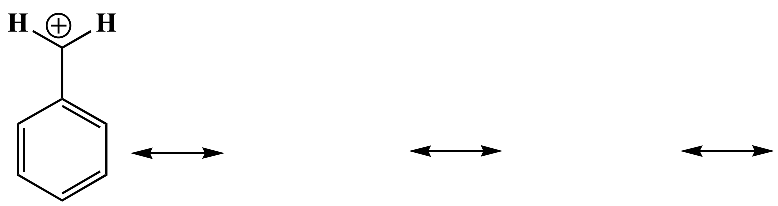


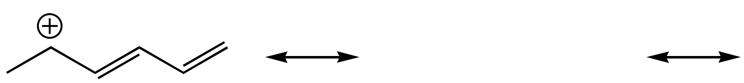
8. (8 points) On the lines provided, state the **atomic orbital that contains the lone pair** of electrons indicated by the arrow.

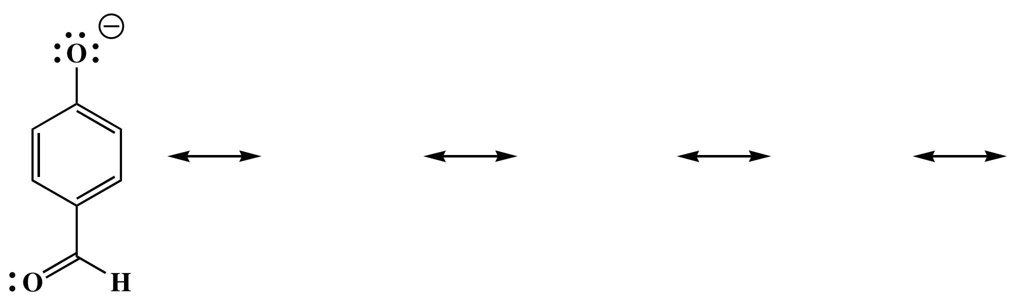


9. (24 points) An important theme that you have encountered throughout organic chemistry is that charge delocalization through resonance is stabilizing. For the following ions, draw the indicated number of most important resonance contributing structures. For each contributing structure, **you must show all formal charges and all lone pairs of electrons. In addition, you must use arrows to show movement of electrons leading to the structure immediately to the right.** This means the right most structures will be the only ones without arrows.





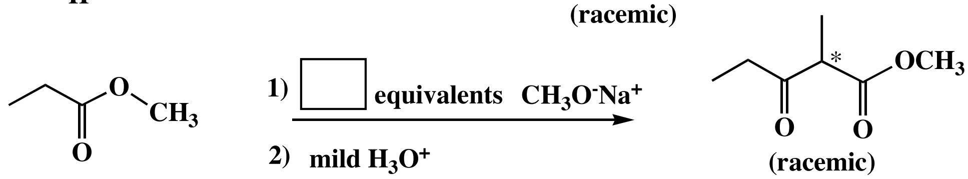




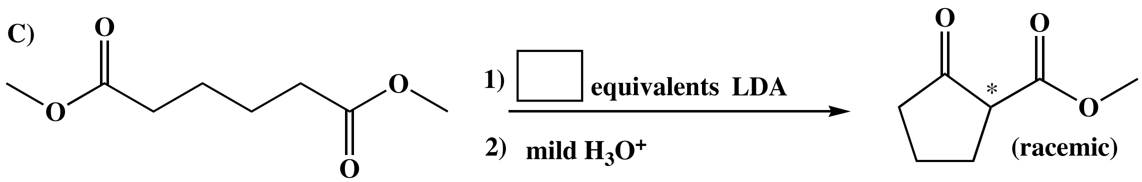
11. (2 pts each) In each of the boxes over an arrow, **write the minimum number of equivalents** of the specified reagent required to carry out the reaction shown **to completion**. If only a catalytic amount is needed, write **"CAT"**. Note: **You must assume the carbonyl compound starting material is initially present in an amount of 1.0 equivalent.**

A)

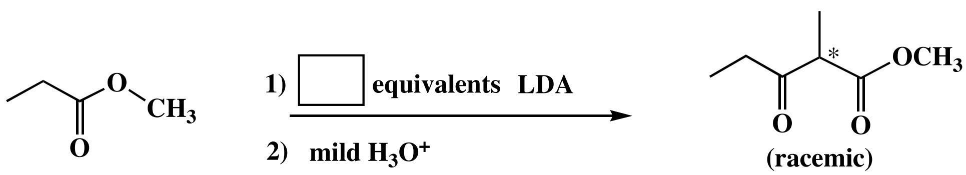
B)



C)

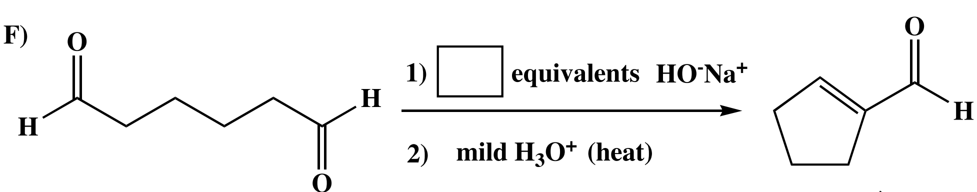


D)

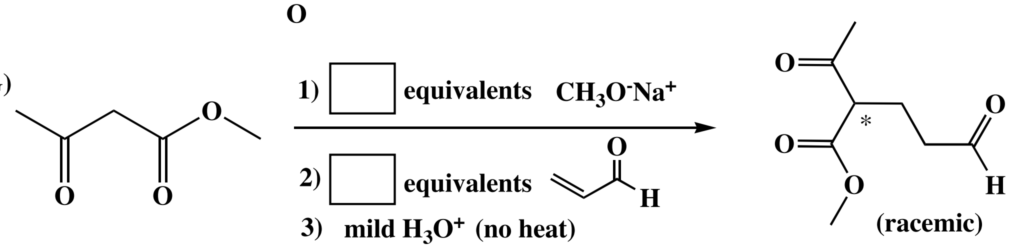


E)

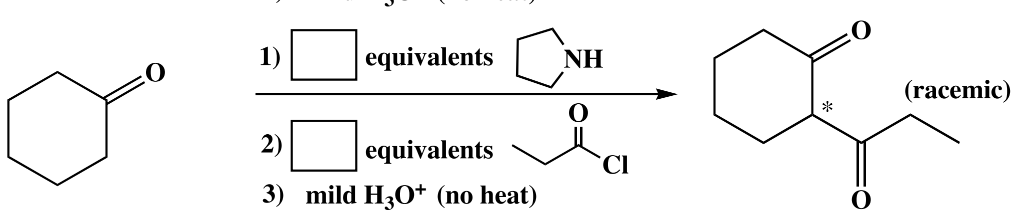
F)



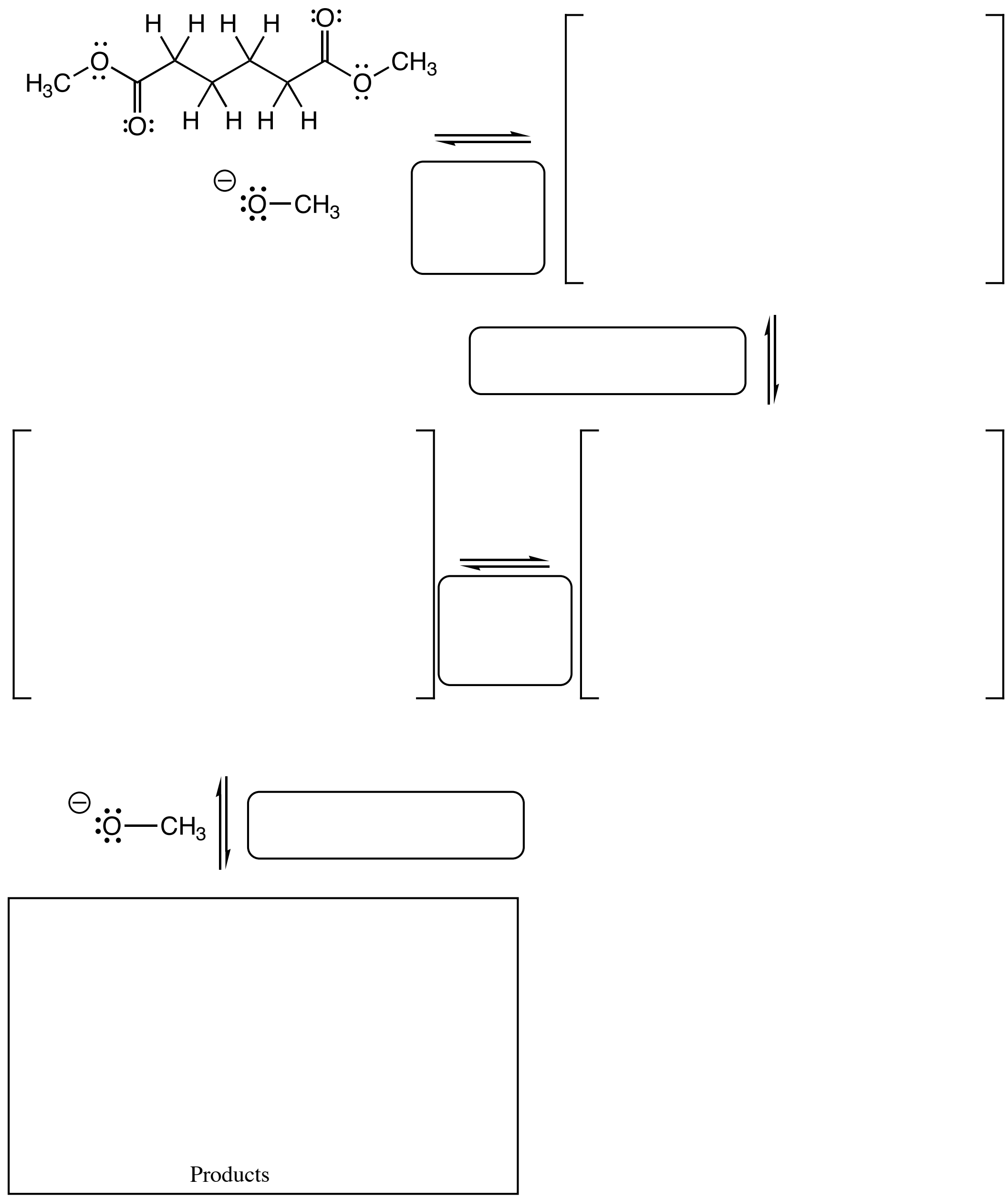
G)



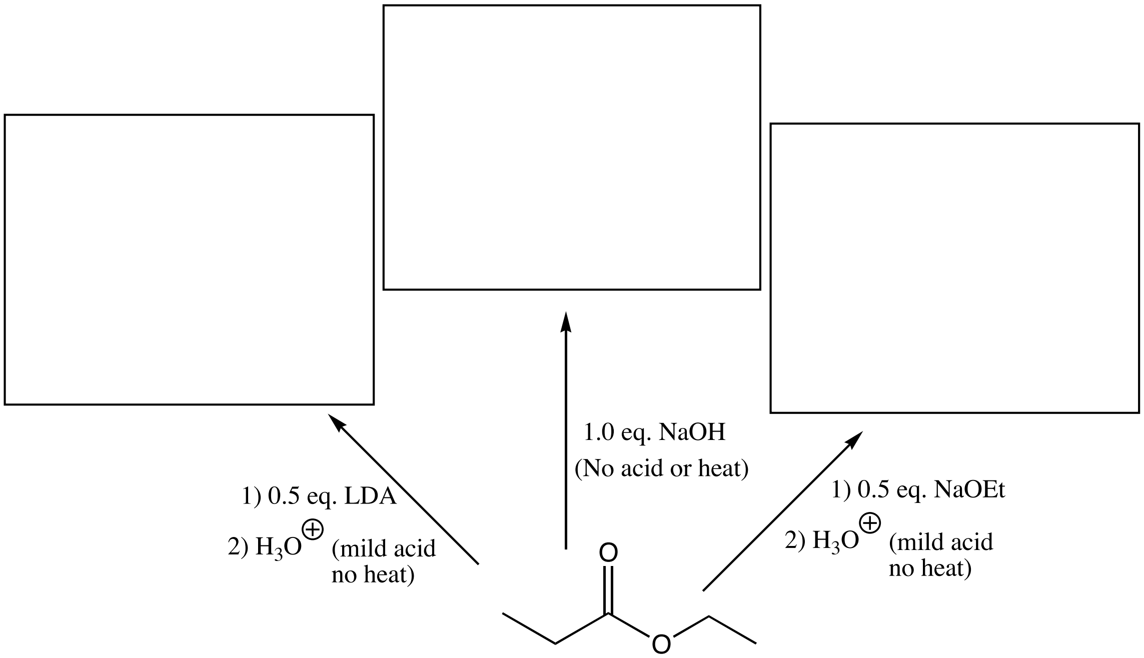
H)

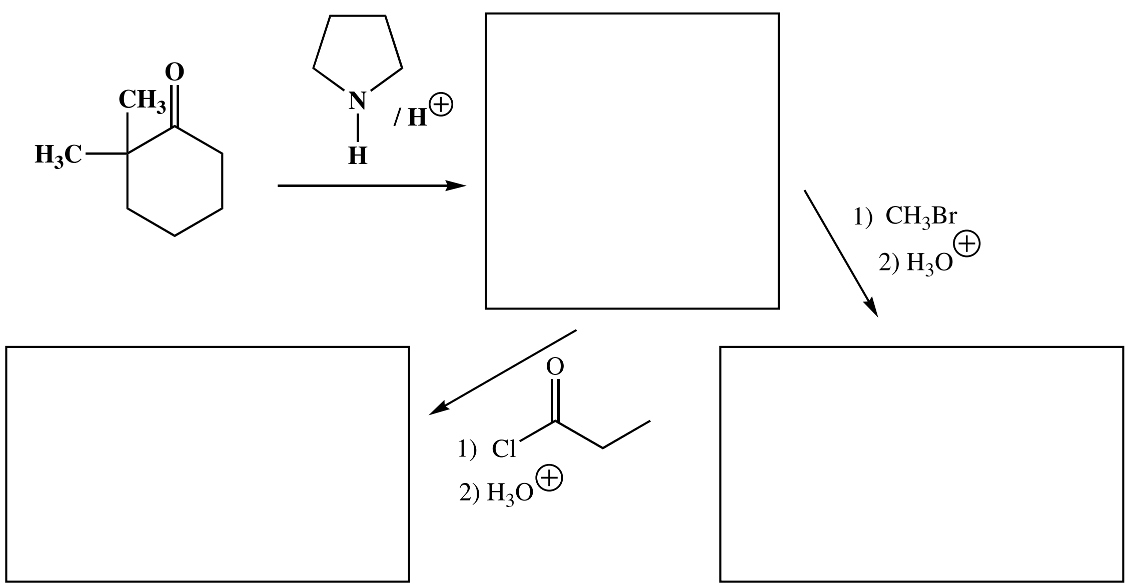


11. (23 pts) Complete the mechanism for the following Dieckmann reaction. Be sure to show arrows to indicate movement of all electrons, write all lone pairs, all formal charges, and all the products for each step. Remember, I said all the products for each step. IF A NEW CHIRAL CENTER IS CREATED IN AN INTERMEDIATE OR THE PRODUCTS, MARK IT WITH AN ASTERISK AND LABEL AS "RACEMIC" IF RELEVANT. IN THE BOX BY EACH SET OF ARROWS, WRITE WHICH OF THE 4 MECHANISTIC ELEMENTS IS INDICATED IN EACH STEP OF YOUR MECHANISM (For example, "Add a proton").



13. (3 or 5 pts each) For the following reactions, draw the predominant product or products. **When a new chiral center is created, mark it with an asterisk (*) and if a racemic mixture is produced, you must write "racemic" under your structure. If an E,Z mixture is produced as the result of a dehydration step, write "E,Z mixture", but you only have to draw one isomer, not both.** These directions are different than you may have seen before, and are intended to make it easier for you. You should read them again so you know what we want.





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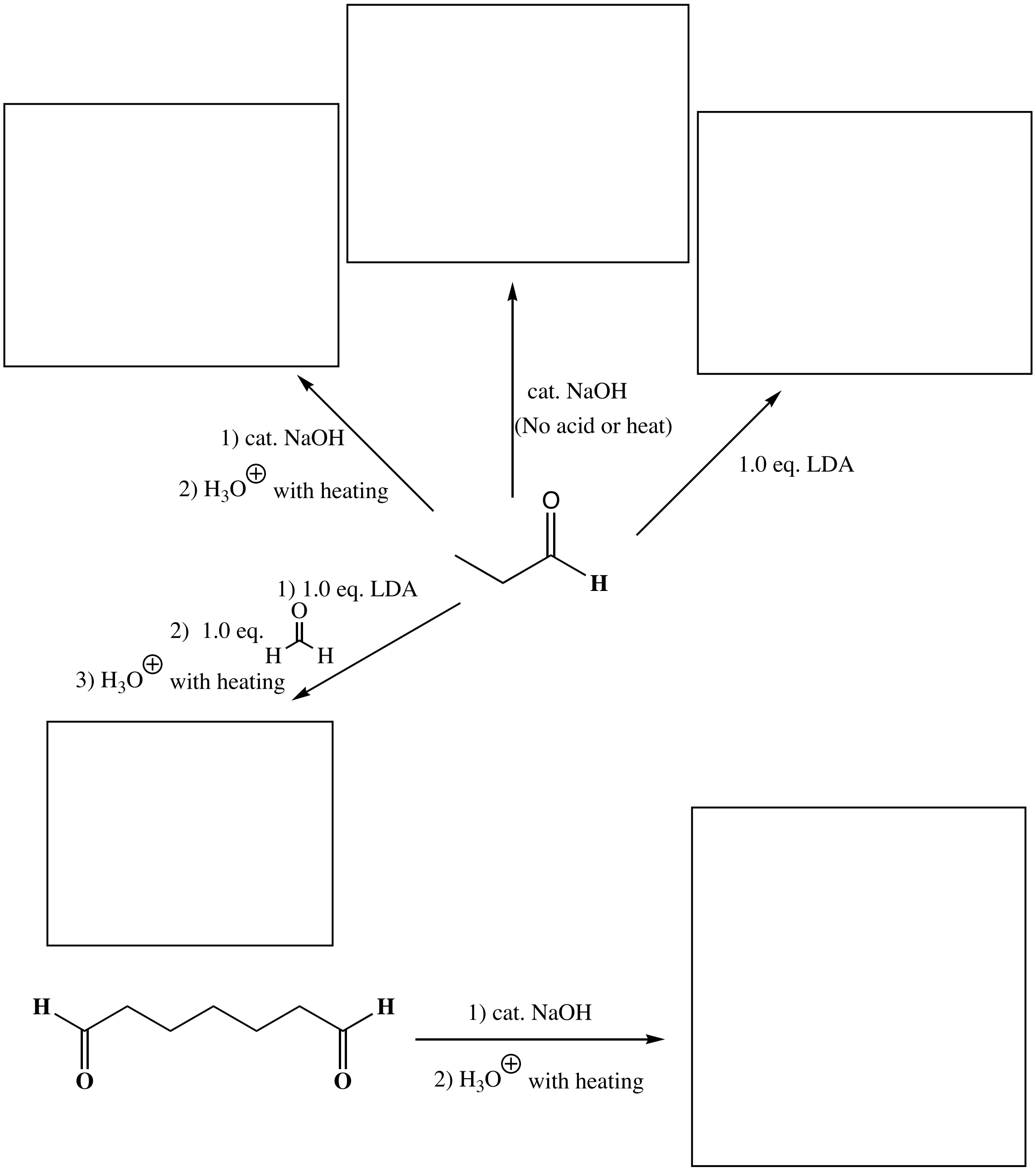

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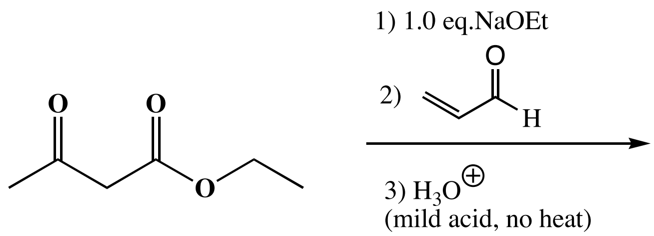
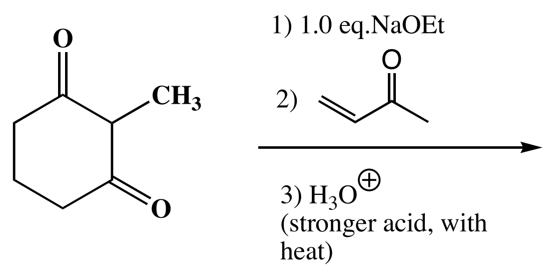
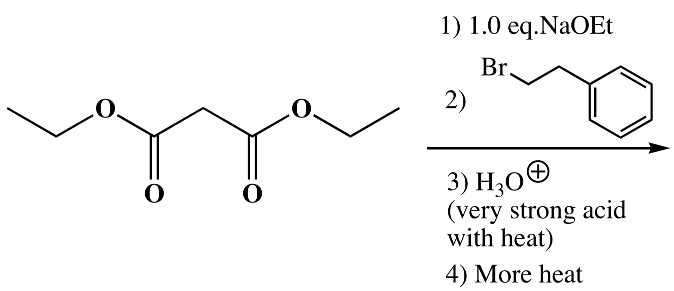
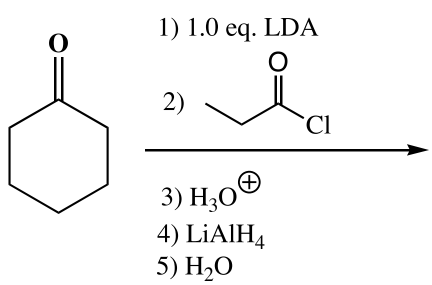


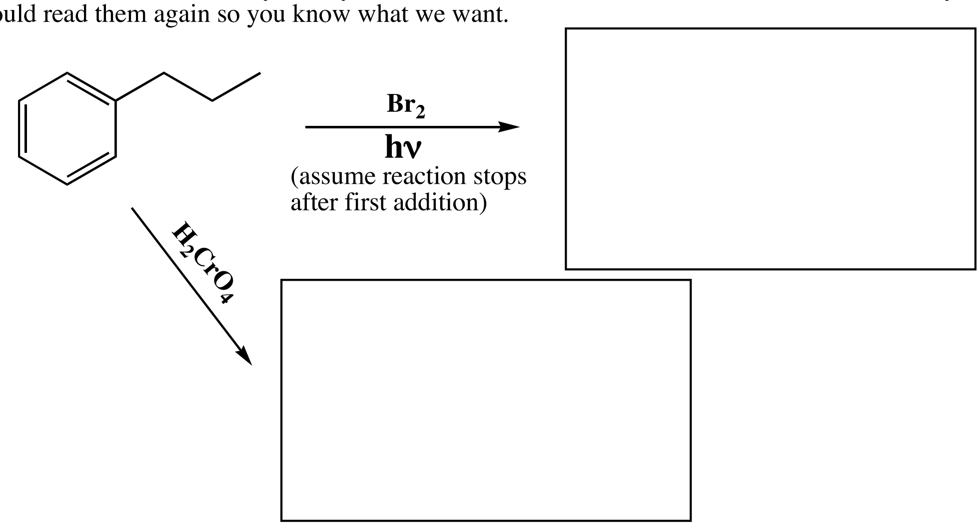




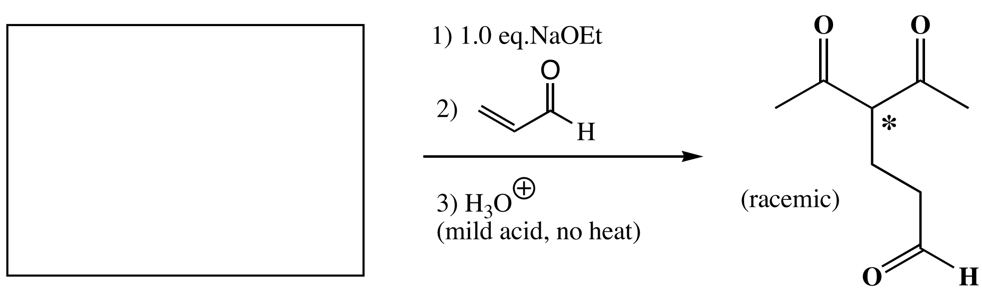


NOTICE THIS ⟹ **How many stereoisomers are possible for this product?** ___

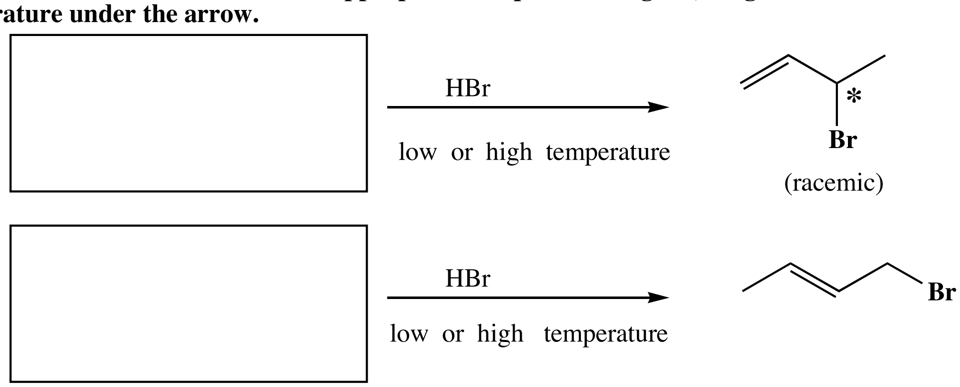
13. (3 or 5 pts each) For the following reactions, draw the predominant product or products. **When a new chiral center is created, mark it with an asterisk (*) and if a racemic mixture is produced, you must write "racemic" under your structure. If an E,Z mixture is produced as the result of a dehydration step, write "E,Z mixture", but you only have to draw one isomer, not both.** These directions are different than you may have seen before, and are intended to make it easier for you. You should read them again so you know what we want.



14. (3 pts each) For the following reactions, analyze the products and reagents and predict the appropriate starting material.

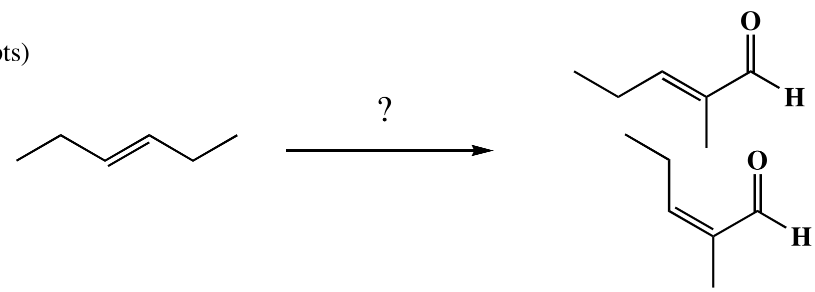


For the next two reactions circle the appropriate temperature regime, "high" or "low" temperature under the arrow.



15. Using any reagents turn the starting material into the indicated product. All the carbons in the product must come from the given starting material or starting materials. Draw all molecules synthesized along the way. When it doubt, draw the molecule!

A) (7 pts)



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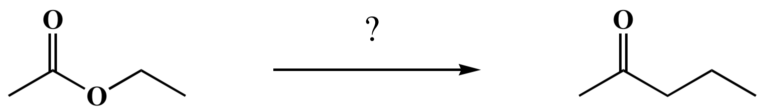
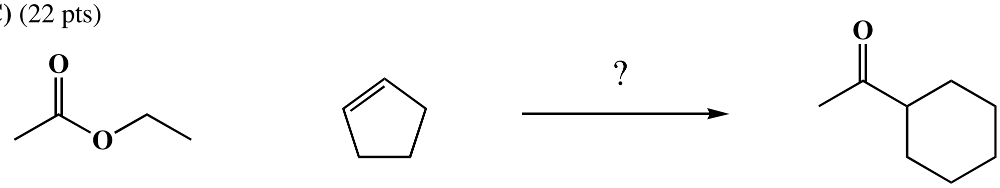
B) (16 pts)



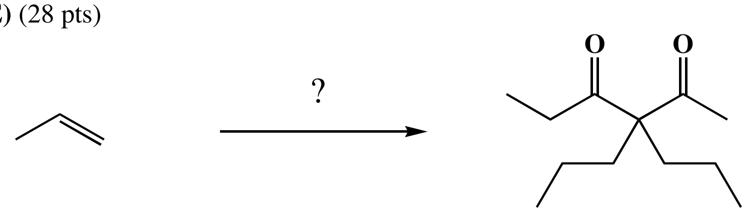
15. Using any reagents turn the starting material into the indicated product. All the carbons in the product must come from the given starting material or starting materials. Draw all molecules synthesized along the way. When it doubt, draw the molecule!

C) (22 pts)



15. Using any reagents turn the starting material into the indicated product. All the carbons in the product must come from the given starting material or starting materials. Draw all molecules synthesized along the way. When it doubt, draw the molecule!

E) (28 pts)



16. (18 pts) Here is an apply what you know problem. The following is a scan from a technical bulletin that accompanied a product we had purchased in my research laboratory. It is from a company called Clontech Laboratories, Inc. Whomever wrote this did not take my class!!! **It is not important** that you understand the product itself or the description of how it is used. However, there are problems with the figure **A. In no more than three sentences,say what is wrong with the figure**. **B. Draw your own version of the diagram that is entirely correct.**

TALON® Metal Affinity Resins User Manual

I. Introduction *continued*

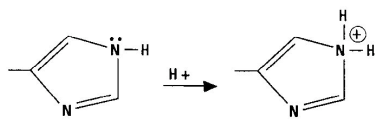


Figure 2. Elution mechanism of recombinant polyhistidine-tagged proteins from TALON® Resin. Elution occurs when the imidazole nitrogen (pKa = 5.97) is protonated, generating a positively charged ammonium ion which is repelled by the positively charged metal ion. Alternatively, the bound polyhistidine-tagged protein can be competitively eluted by adding imidazole to the elution buffer.

A. (8 pts) Explain what is wrong with the figure in no more than three sentences

B. (10 pts) Redraw the figure correctly.