CHEM 108A Summer 2015

UCSC, Binder Name _____

Student ID # _____

Organic Chemistry
FINAL EXAM (*400 points*)

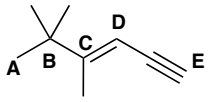
In each of the following problems, you will use your knowledge of organic chemistry conventions to answer the questions in the proper manner. Be sure to read each question carefully. For extra credit, write down your favorite summer location on the last page of the exam. You have 3 hours to complete this exam. Pay attention to point values and problems to skip to use your time wisely.

Keep your eyes on your own paper. Electronic devices of any kind are not allowed, including cell phones and calculators. Any student found using any of said devices, or found examining another student's exam, will be promptly removed from the exam room and at minimum will receive a zero on this exam. Such an incident may also be considered a form of academic dishonesty and reported to the UCSC Judiciary Affairs Committee.

1 (41)	
2 (48)	
3 (49)	
4 (34)	
5 (20)	
6 (45)	
7 (20)	
8 (20)	
9 (58)	
10 (35)	
11 (30)	
Total	

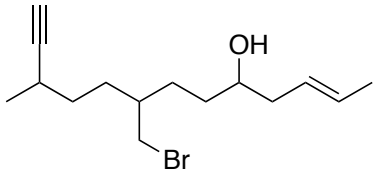
1. Fundamentals

(a) (*15 points*) Consider the structure below and fill in the table to indicate **hybridization, geometry, and substitution pattern for carbons A-E.**

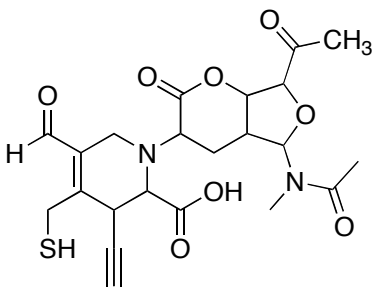


Carbon	Hybridization (sp^3, sp^2, sp)	Geometry (tetrahedral, trigonal planar, or linear)	Substitution (1°, 2°, 3°, or 4°)
A			
B			
C			
D			
E			

(b) (*16 points*) **Circle and name each functional group** and indicate whether that functional group is likely to act as a **nucleophile (N) or electrophile (E)** based on the synthesis reactions learned in 108A.



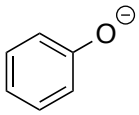
(c) (*10 points*) Consider the large and hopefully familiar molecule below.
Circle and name <u>any five</u> functional groups.



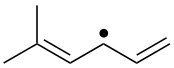
2. Resonance and Aromaticity

(a) (*36 points*) **Draw two additional non-equivalent resonance structures** for the following compounds. Use **arrow-pushing** to show electron movement from one structure to the next. Be sure to indicate formal charges where appropriate.

(i)

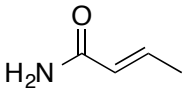


(ii)

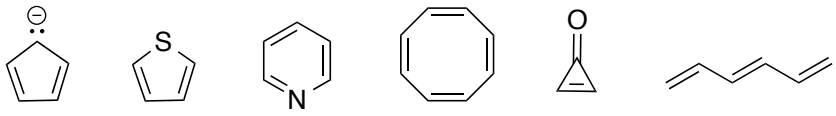


secondary radical

(iii)



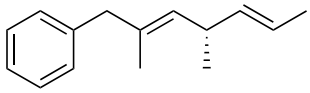
(b) (*12 points*) **Circle all the compounds that are aromatic.**



3. Nomenclature

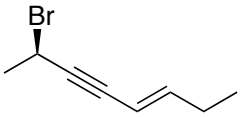
(a) (*15 points*) **Name** the following compounds. **Include stereochemistry** in the name, where appropriate.

(i)



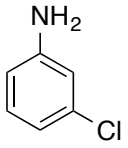
_____

(ii)



_____

(iii)



_____

(b) (*28 points*) **Draw structures** corresponding to the following names.

ortho-Iodoanisole

(R)-8-Methyl-1-benzylcyclooctene

(3*S*,6*S*,7*S*,4*Z*)-
3-Cyclopropyl-2,4-difluoro-6-(1-fluoroethyl)-7-phenyl-1,4-decadiene
Have fun with this one!

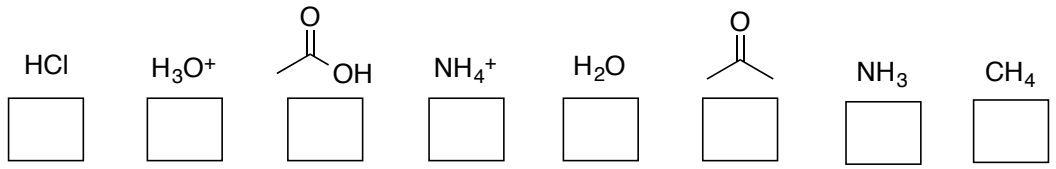
(c) (*6 points*) The above problem refers to an organic compound with the stereochemistry (3*S*,6*S*,7*S*,4*Z*). **What is the relationship of that compound to the following stereoisomers?**

(3*R*,6*S*,7*S*,4*Z*) (3*R*,6*R*,7*R*,4*Z*) (3*S*,6*R*,7*R*,4*Z*)

_____ _____ _____

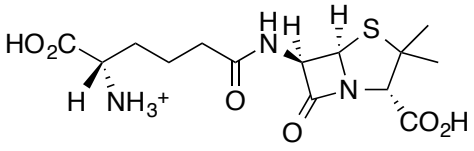
4. Acid-Base Chemistry

(a) (*8 points*) **List the pKa values** that belong to each compound in the boxes below.



(b) (*8 points*) **Circle the most acidic proton** on each molecule and **approximate its pKa** (think pKa family).

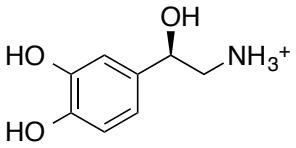
(i)



Isopenicillin N

Approx. pKa _____

(ii)

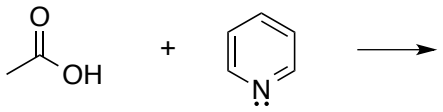


Norepinephrine

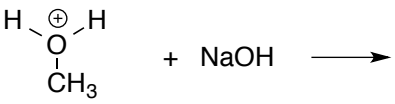
Approx. pKa _____

(c) (*18 points*) **Choose any two**. Draw the **products** in the following reactions and indicate the **direction of the equilibrium**. No arrow-pushing necessary.

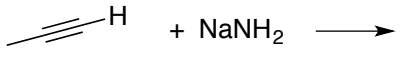
(i)



(ii)



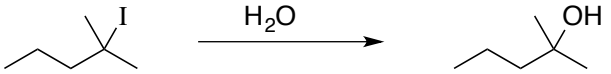
(iii)



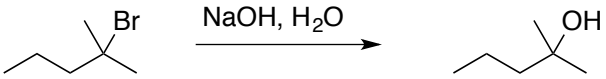
5. Substitution and Elimination Reactions

(a) (*6 points*) Consider the following reactions. **Which reaction is faster?**

Reaction 1



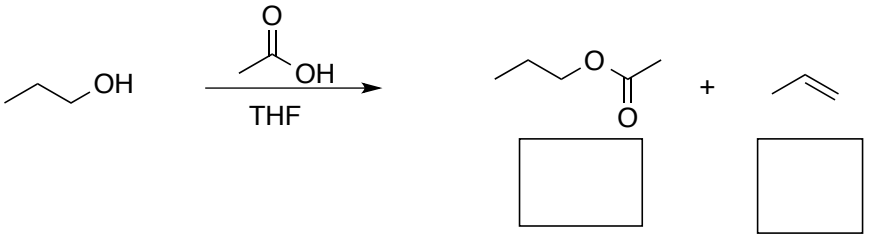
Reaction 2



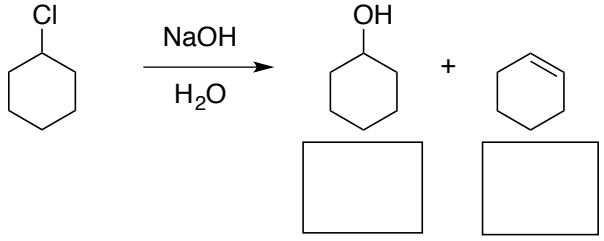
Reaction 1 or **Reaction 2** or **Neither** (Circle one)

(b) (*14 points*) **Fill in the box** to indicate whether the reaction as written proceeded by **SN1, SN2, E1, or E2.**

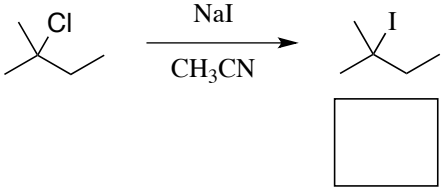
(i)



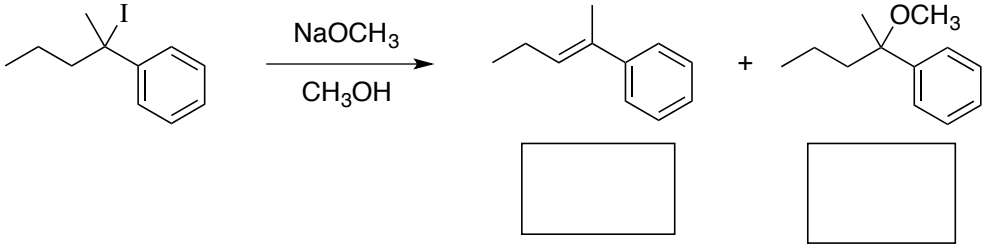
(ii)



(iii)



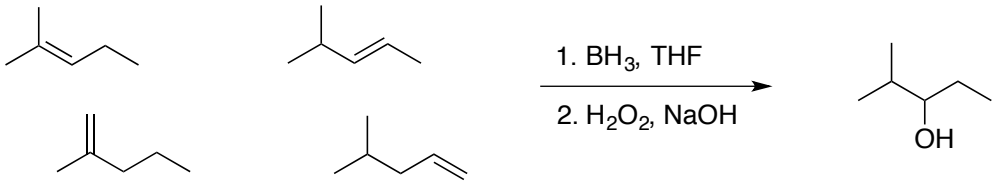
(iv)



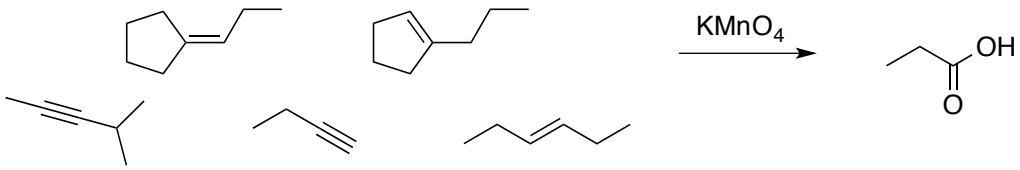
6. Reaction Puzzles

(*18 points*) **Circle each of the starting materials** that could potentially give the indicated compound as one of the products.

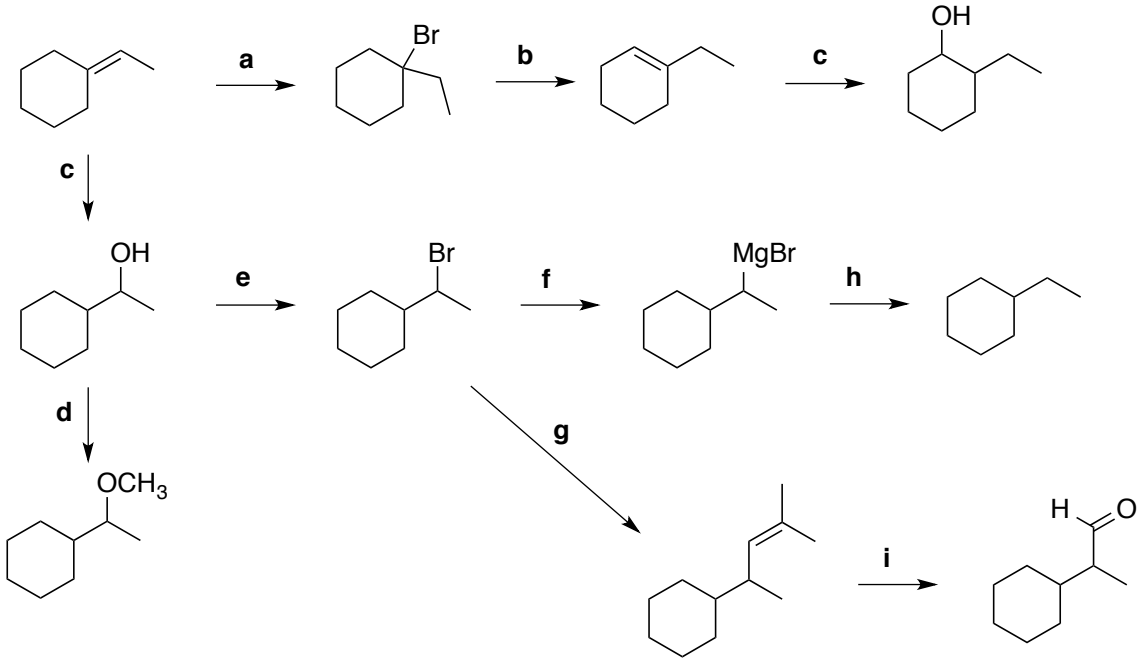
(i)



(ii)



(*27 points*) Consider the following reaction puzzle and **indicate the reagents** required for each step in the blanks provided below. Reagents "**c**" appears twice in the puzzle on purpose!



a _____ **b**_____ **c**_____

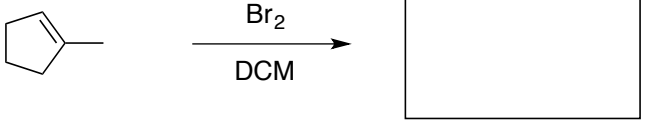
d _____ **e**_____ **f**_____

g_____ **h**_____ **i**_____

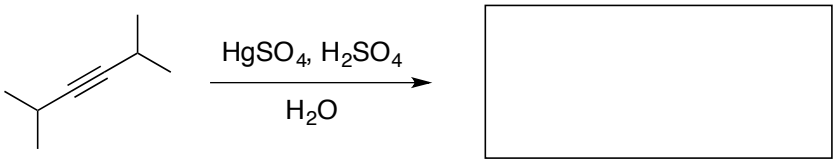
7. Single Step Reactions

(*20 points*) **WHAT'S IN THE BOX??**
Choose any four of the five reactions below and fill in the missing **product**. If no reaction occurs as written, fill in the box with "NR." Put a **large "X"** over the problem you are skipping. Otherwise the first four will be graded. **Indicate stereochemistry** where appropriate.

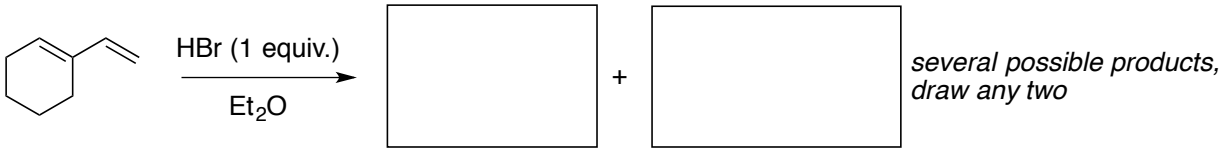
(a)



(b)

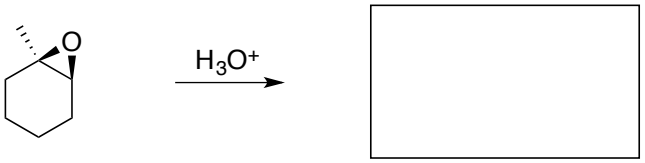


(c)

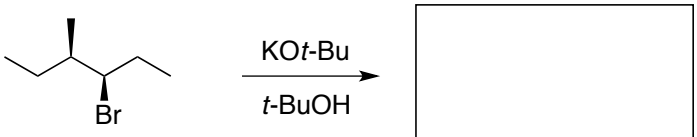


several possible products, draw any two

(d)



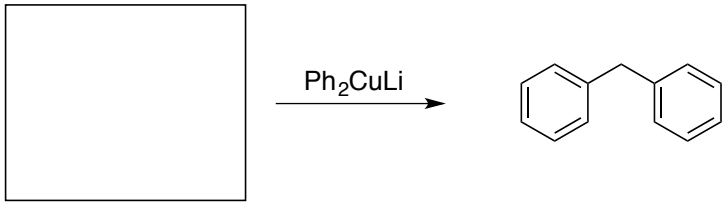
(e)



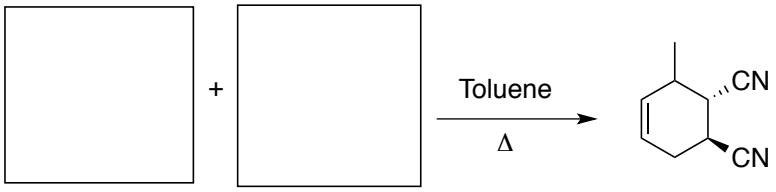
8. Single-Step Reactions

(*20 points*) **WHAT'S IN THE BOX??**
Choose any four of the five reactions below and fill in the missing **reactant**. Put a **large "X"** over the problem you are skipping. Otherwise the first four will be graded. **Indicate stereochemistry** where appropriate.

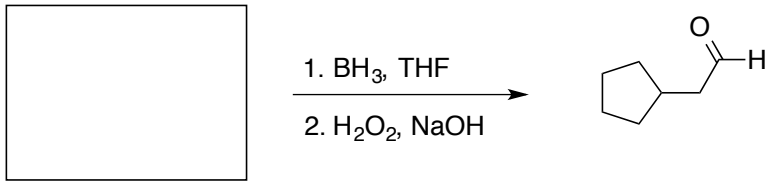
(a)



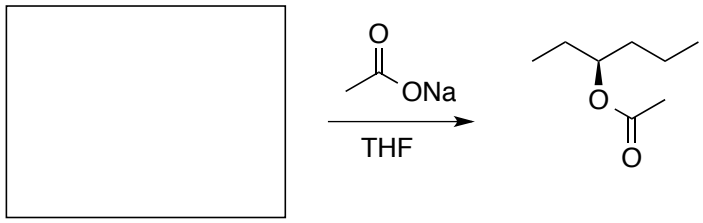
(b)



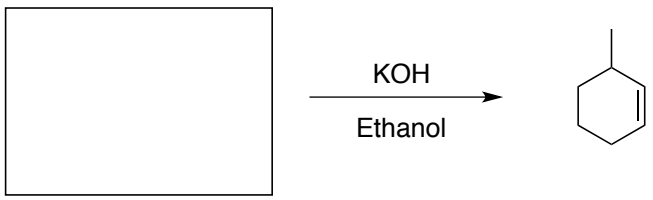
(c)



(d)



(e)



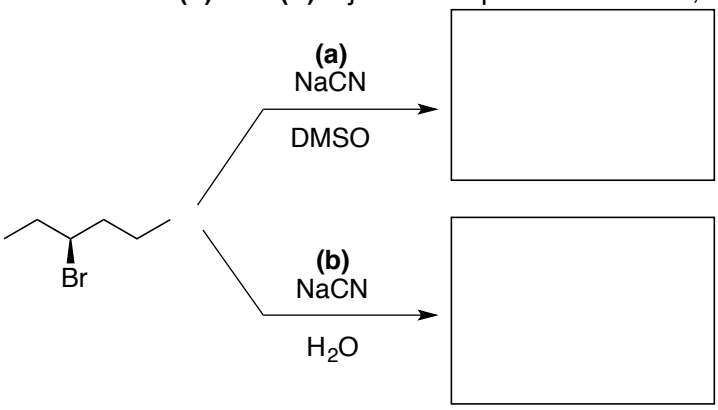
9. Mechanisms

(*26 points*) Draw the **reaction scheme** (reactants, reagents, and products) for the halogenation of **methylcyclohexene** with molecular chlorine in dichloromethane. Draw the full **arrow-pushing mechanism** to include ***all possible stereochemical outcomes***.

(*32 points*) Draw the **reaction scheme** for the hydrohalogenation of **4-methyl-2-pentene** with hydrochloric acid. This reaction gives an unexpected rearrangement product as a mixture with the anticipated alkyl halide products. Draw the full **arrow-pushing mechanisms** to account for all three products – these should be separate mechanisms!

10. Mechanisms

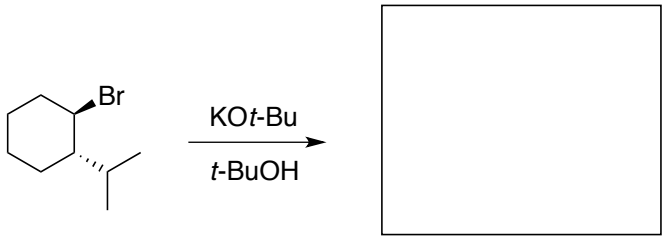
(*23 points*) The stereochemical outcome of substitution reactions can be controlled with the choice of solvent. **Draw the products** in reactions **(a)** and **(b)** below then **draw the full arrow-pushing mechanism** for each reaction in the space provided. Briefly comment on the difference in stereochemistry between reactions **(a)** and **(b)** – just a few phrases are fine, no need for essays!



Mechanism for reaction (a)

Mechanism for reaction (b)

(*12 points*) The regiochemistry of elimination reactions is dictated by the stereochemistry of the starting material. Consider the alkyl halide below and its reaction with potassium *tert*-butoxide. There is only one product in this reaction and it is slightly unexpected, unless you understand the 3D-nature of the mechanism. Draw the alkyl halide in the proper **chair conformation** to facilitate the elimination mechanism (not necessarily the most stable conformation), **add arrows** to show the mechanism, and **draw the product**.



11. (*30 points*) **Multi-Step Synthesis**

Choose any two of the following synthetic problems. You may use any alkyl halide to introduce new carbons and any other reagents necessary. Show the product after each step.