UCSC, Binder Name ________________________________________

Student ID # ____________________________________

**Survey of Organic Chemistry**
**CHEM 108A, EXAM 2 (*300 points*)**

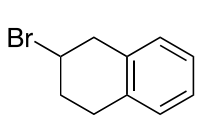
In each of the following problems, you will use your knowledge of organic chemistry conventions to answer the questions in the proper manner. Be sure to read each question carefully. You have the most of the class period (90 minutes) to complete this exam. Pay attention to point values and problems to skip to use your time wisely. You are welcome to use pre-built models. Make sure there are 6 pages (6 problems). Please write your last name and first initial on the top of each page once instructed to start the exam.

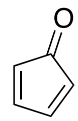
Keep your eyes on your own paper. Electronic devices of any kind are not allowed, including cell phones and calculators. Any student found using any of said devices, or found examining another student's exam, will be promptly removed from the exam room and at minimum will receive a zero on this exam.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

| | |
|---|---|
| **1** (40) | |
| **2** (50) | |
| **3** (40) | |
| **4** (60) | |
| **5** (60) | |
| **6** (50) | |
| **Total** | |

**1. Fundamentals**

**(a)** (*8 points*) Provide the **degrees of unsaturation** in the following structures or formulas.



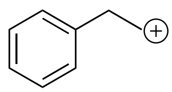


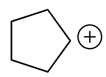
$C_7H_{10}Cl_2$

$C_5H_9NO_2$

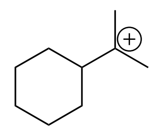
________ ________ _______ _______

**(b)** (*8 points*) Rank the following carbocations from **most stable (1)** to **least stable (4)**.





$\overset{\oplus}{C}H_3$



_______ _______ _______ ________

**(c)** (*12 points*) Indicate whether the following types of compounds act as **nucleophiles (N)** or **electrophiles (E).**

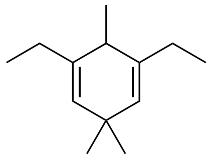
Acids ______ Bases ________ Alkenes _______

**(d)** (*12 points*) For each functional group, **draw a simple example containing 3 carbons.**

| Ether | Carboxylic Acid | Alcohol | Alkyl Halide | Ester | Ketone |
|---|---|---|---|---|---|
| | | | | | |

**2. Nomenclature**

**(a)** (*30 points*) Name the following compounds. Include stereochemistry in the name, where appropriate.



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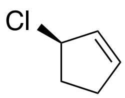


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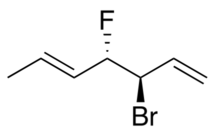


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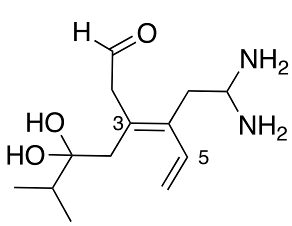
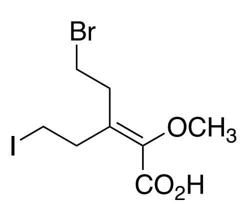
**(b)** (*10 points*) Draw structures corresponding to the following names.

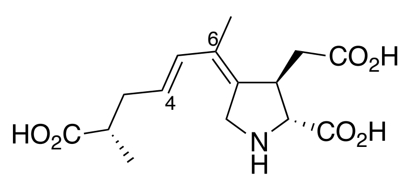
(4*E*)-2,4-Dimethyl-1,4-hexadiene

*trans*-5-*tert*-Butyl-2-methyl-3-octene

**(c)** (*10 points*) Provide a *cis/trans* or *E/Z* designation for each isomerizable alkene on the lines provided. Write "NI" if the alkene is non-isomerizable (cannot be assigned).




**Isodomoic acid H**

3 _____, 5 _____

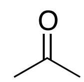
________

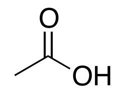
4 ______, 6 _____

**3. Acid-Base & Arrow Pushing**

**(a)** (*8 points*) List the pKa values that belong to each compound in the boxes below (not given in order of acidity).

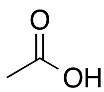
HCl  $NH_3$  $NH_4^+$  $H_2O$  $H_3O^+$  $CH_4$




**(b)** (*12 points*) Draw the products in the following reactions. No arrow-pushing necessary here.

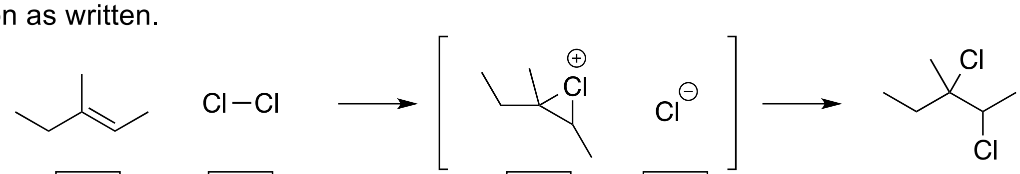
**(i)**



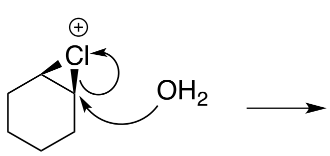

\+ $CH_3NH_2$ ⟶

**(ii)** $CH_3OH$ + $H_2SO_4$ →

**(c)** (*16 points*) Indicate whether each reaction component is a **nucleophile (N)** or **electrophile (E)** in the boxes provided, then **add curved arrows** to indicate electron movement to complete the reaction as written.



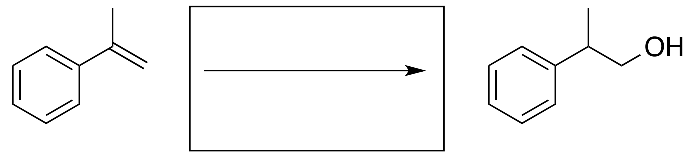

**(d)** (*4 points*) Follow the curved arrows and **draw the product** in the box provided.



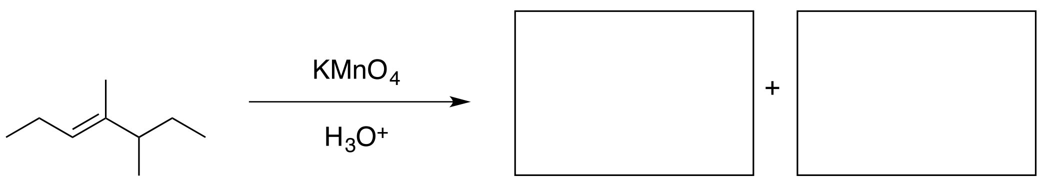

*Include stereochemistry*

**4.** (*60 points*) **Single step reactions** – FILL IN THE BOX with the appropriate reactant, reagent, or product to complete each reaction. *Show stereochemistry in the products where appropriate.*

**(a)**

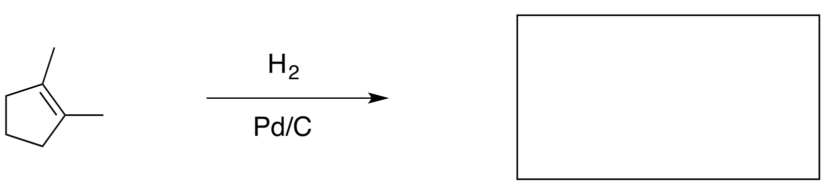



**(b)**

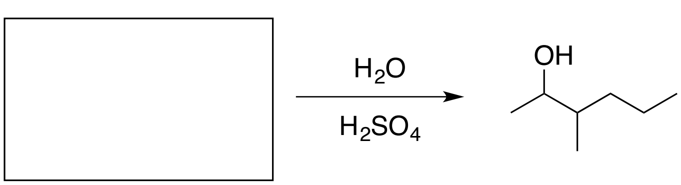



**(c)**

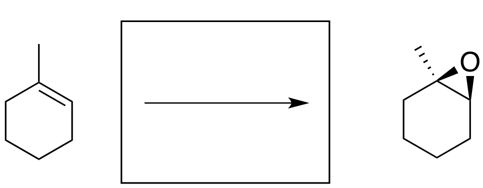

**(d)**




**(e)**




**(f)**



**5.** (*60 points*) **Reaction Puzzle: Determination of Unknowns.** Use the information below to elucidate the structures of compounds **A**, **B**, **C**, **D1**, and **D2**. You may use the space below to show your work but write your final answers in the boxes below. *Only your final answers will be graded.*

**Unknown A** ($C_6H_8$) reacts with 2 molar equivalents of hydrogen with Pd/C catalyst to give **unknown B** ($C_6H_{12}$).

$$\underset{(C_6H_8)}{\textbf{UNK A}} \xrightarrow[\text{Pd/C}]{2\,H_2} \underset{(C_6H_{12})}{\textbf{UNK B}}$$

Upon treatment of **A** with ozone followed by zinc under acidic conditions, two equivalents of the same **product C** is formed. **Unknown C** is a symmetric dialdehyde (contains two aldehydes) with molecular formula $C_3H_4O_2$.

$$\underset{(C_6H_8)}{\textbf{UNK A}} \xrightarrow[\text{2. Zn, H}^+]{\text{1. O}_3} 2\ \underset{(C_3H_4O_2)}{\textbf{UNK C}}$$

**Compound A** also reacts with 2 molar equivalents of $OsO_4$ and yields **2 stereoisomeric products** (**UNK D1** and **UNK D2**) with molecular formula $C_6H_{12}O_4$ after treatment with aqueous sodium bisulfite.

$$\underset{(C_6H_8)}{\textbf{UNK A}} \xrightarrow[\text{2. NaHSO}_3\ (aq)]{\text{1. OsO}_4} \textbf{UNK D1} \text{ and } \textbf{UNK D2}$$

*mixture of stereoisomers*
($C_6H_{12}O_4$)

A

B

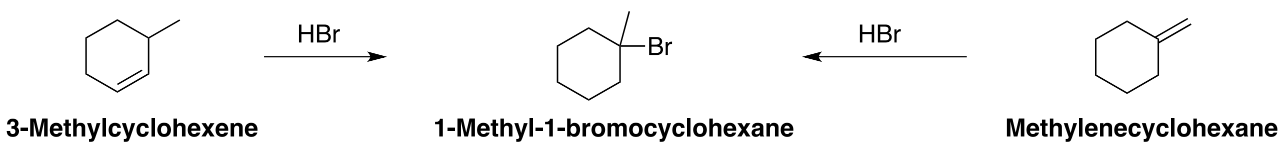
C

D1

D2

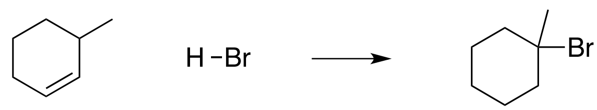
**6.** (*50 points*) Mark and Nick are beginning students in an organic chemistry lab and are arguing about the best way to synthesize **1-methyl-1-bromocyclohexane**. Mark wants to start with **3-methylcyclohexene** while Nick thinks **methylenecyclohexane** is a better choice for the starting material. Their lab-mate Kat Ayan breaks up the fight, tells them that both could theoretically give the same product, but that one route is more ideal.

**(i)** Draw separate arrow-pushing mechanisms for both reactions.
**(ii)** Circle the better synthetic route and give a *brief explanation* for your choice.

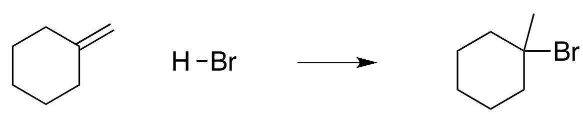



**(i)**

Mark:




Nick:




**(ii)** Explanation (plus don't forget to circle your choice for the better route above)…