



# CHE 322 Organic Chemistry II

Exam 1 Form 1

Thursday February 16, 2023

8:15 PM – 9:35 PM

1. Write your nine digit University ID number in the nine boxes provided and then bubble in each of the nine digits.
2. Print your name and sign your answer form using the spaces provided.
3. Questions 1 to 10 are multiple choice questions worth 5 points. Bubble your answers on the answer form. Questions 11-18 are short answer questions with points as indicated. Write out your answers in the indicated place on the answer form.

## Effects of Substituents on Electrophilic Aromatic Substitution

### Ortho-Para Directors

#### Strongly Activating

-NH<sub>2</sub> -NHR -NR<sub>2</sub>

-OH -O<sup>-</sup>

#### Moderately Activating

-NHCOCH<sub>3</sub> -NHCOR

-OCH<sub>3</sub> -OR

#### Weakly Activating

-CH<sub>3</sub> -C<sub>2</sub>H<sub>5</sub> -R -C<sub>6</sub>H<sub>5</sub>

#### Weakly Deactivating

-F -Cl -Br -I

### Meta Directors

#### Moderately Deactivating

-C≡N

-SO<sub>3</sub>H

-CO<sub>2</sub>H -CO<sub>2</sub>R

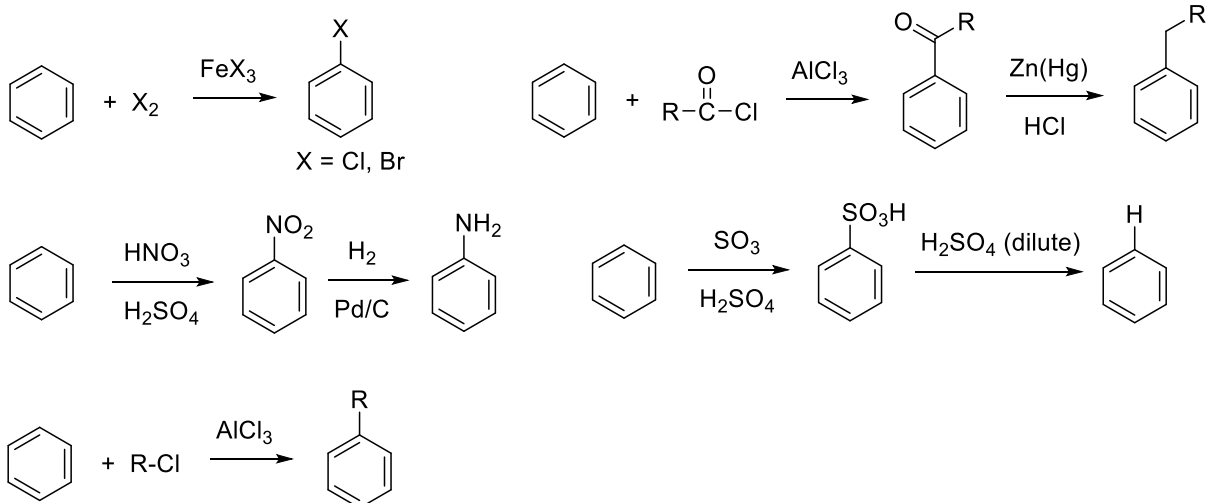
-CHO -COR

#### Strongly Deactivating

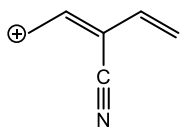
-NO<sub>2</sub>

-NH<sub>3</sub><sup>+</sup> -NR<sub>3</sub><sup>+</sup>

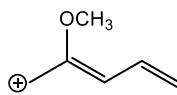
-CF<sub>3</sub> -CCl<sub>3</sub>



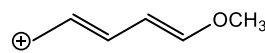
1. Choose the order that has the following pentadienyl cations correctly arranged with respect to increasing stability.



1



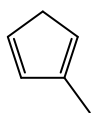
2



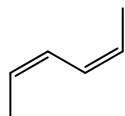
3

- A  $\xrightarrow{\text{increasing stability}}$  1 2 3  
 B  $\xrightarrow{\text{increasing stability}}$  1 3 2  
 C  $\xrightarrow{\text{increasing stability}}$  2 1 3  
 D  $\xrightarrow{\text{increasing stability}}$  2 3 1  
 E  $\xrightarrow{\text{increasing stability}}$  3 1 2  
 F  $\xrightarrow{\text{increasing stability}}$  3 2 1

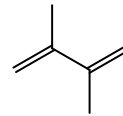
2. Select the order that has the following dienes correctly arranged with respect to increasing reactivity in a Diels-Alder reaction.



1



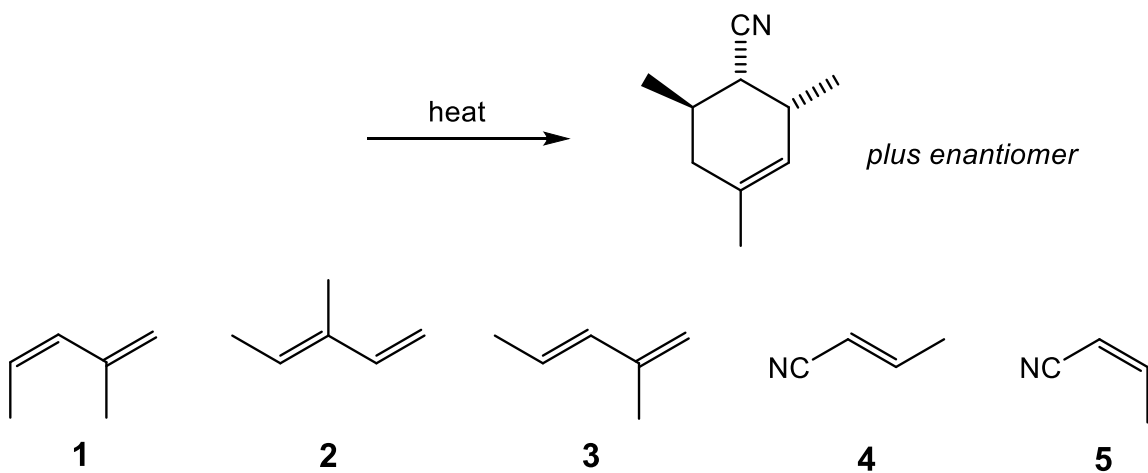
2



3

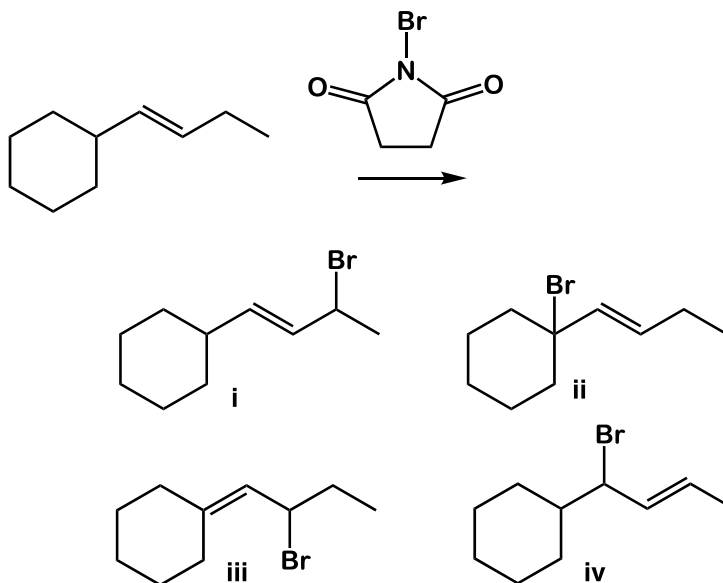
- A  $\xrightarrow{\text{increasing reactivity}}$  1 2 3  
 B  $\xrightarrow{\text{increasing reactivity}}$  1 3 2  
 C  $\xrightarrow{\text{increasing reactivity}}$  2 1 3  
 D  $\xrightarrow{\text{increasing reactivity}}$  2 3 1  
 E  $\xrightarrow{\text{increasing reactivity}}$  3 1 2  
 F  $\xrightarrow{\text{increasing reactivity}}$  3 2 1

3. Which diene and dienophile will react in a Diels-Alder reaction to form the product shown?



- A. 1 and 4    B. 1 and 5    C. 2 and 4    D. 2 and 5    E. 3 and 4    F. 3 and 5

4. Which product(s) would you expect from reaction with *N*-bromosuccinimide (NBS)?



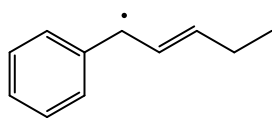
- A. i and ii    B. ii and iii    C. i and iii    D. i and iv    E. ii and iv    F. iii and iv

5. Choose the correct statement concerning the  $\pi$  molecular orbital system of the following cation.

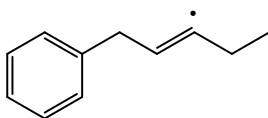


- A. The two highest energy electrons are paired in an antibonding molecular orbital.  
 B. The two highest energy electrons are paired in a bonding molecular orbital.  
 C. All the electrons are paired, but the bonding shell is not filled.  
 D. All the electrons are paired and completely fill every bonding molecular orbital.  
 E. The two highest energy electrons are unpaired, residing in degenerate antibonding molecular orbitals.  
 F. The two highest energy electrons are unpaired, residing in degenerate bonding molecular orbitals.

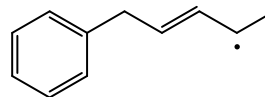
6. Choose the order that has the following radicals correctly arranged with respect to increasing stability.



1



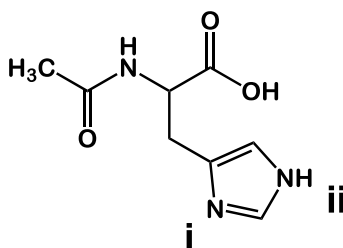
2



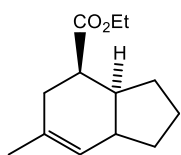
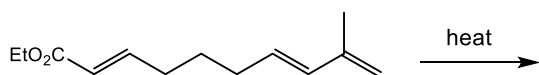
3

- A  $\xrightarrow{\text{increasing stability}}$  1 2 3    B  $\xrightarrow{\text{increasing stability}}$  1 3 2    C  $\xrightarrow{\text{increasing stability}}$  2 1 3    D  $\xrightarrow{\text{increasing stability}}$  2 3 1    E  $\xrightarrow{\text{increasing stability}}$  3 1 2    F  $\xrightarrow{\text{increasing stability}}$  3 2 1

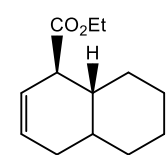
7. Choose the statement that best describes the basicity of histidine's heterocyclic nitrogens.



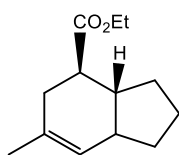
- A. Nitrogen i is more basic because protonation of nitrogen ii destroys aromaticity.  
 B. Neither nitrogen can be protonated without destroying *resonance* stabilization.  
 C. Both nitrogens have equivalent basicities. (they interconvert)  
 D. Nitrogen ii is more basic because protonation of nitrogen i destroys aromaticity.
8. Choose the major product of the following intramolecular Diels-Alder reaction. The reaction will produce a racemic mixture, but only one enantiomer is shown in each choice.



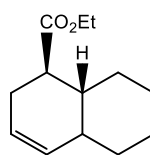
A



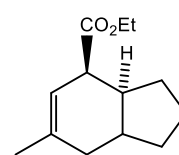
B



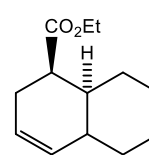
C



D

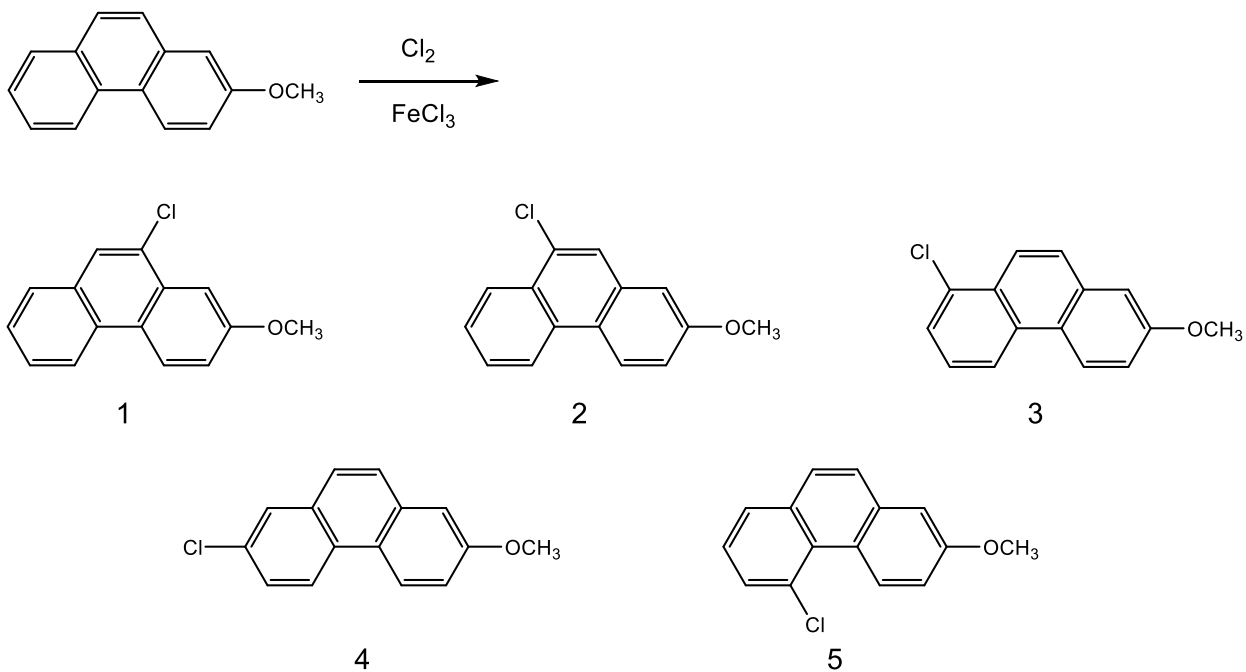


E



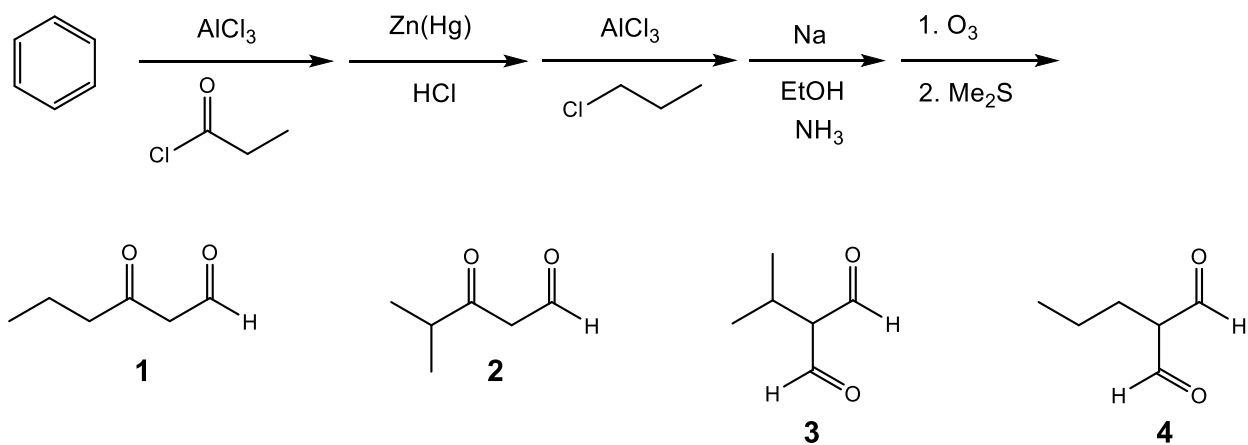
F

9. Predict the expected products of the following reaction.



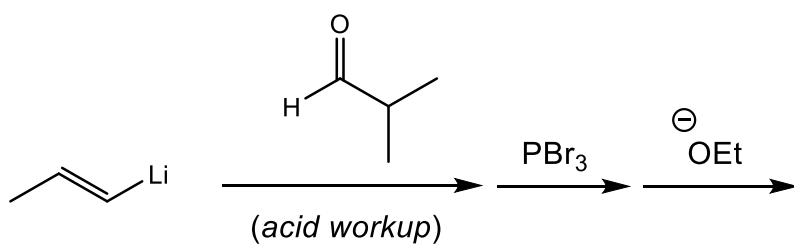
- A. 1 and 2    B. 1 and 4    C. 2 and 3    D. 3 and 5    E. 1, 4 and 5    F. 2, 3 and 4

10. Choose the expected major product(s) of the following reaction sequence.

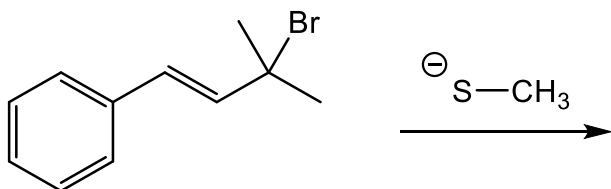


- A. two moles of 1    B. two moles of 4    C. 1 and 2    D. 1 and 3    E. 2 and 3    F. 3 and 4

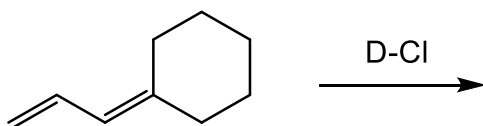
11. Draw the major product of the following reaction sequence. (5 points)



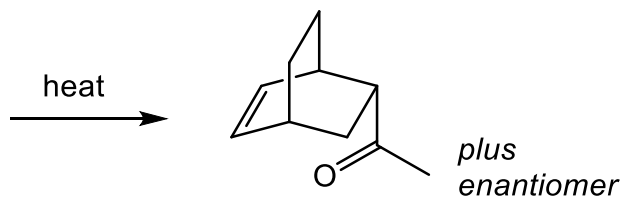
12. Draw the expected major product of the following reaction. (5 points)



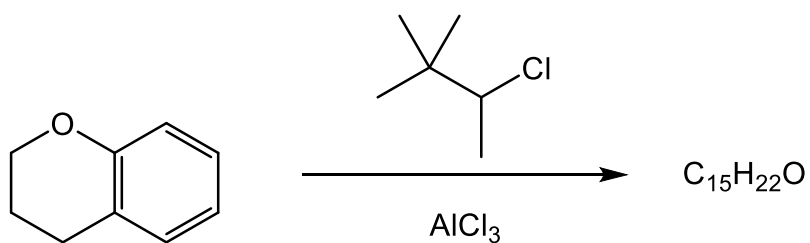
13. The following reaction gives one major product at any temperature (the kinetic and thermodynamic products are the same). Draw the major product of the following reaction that utilizes deuterated hydrochloric acid. (5 points)



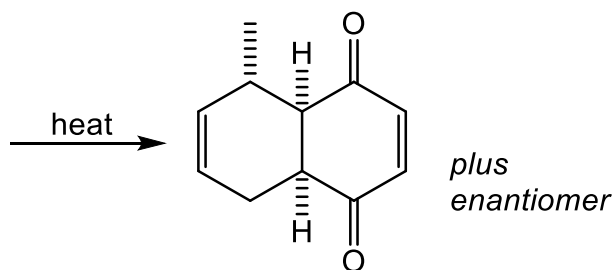
14. Draw the diene and dienophile that would give the following Diels-Alder product as the major one of the following reaction. (5 points)



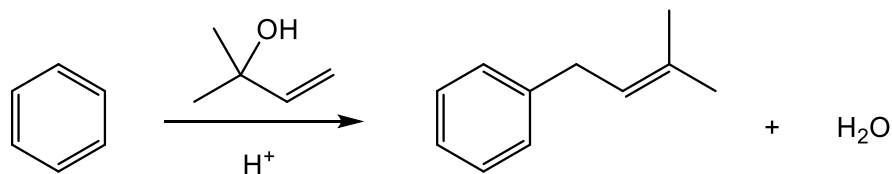
15. Draw the major product of the following reaction. (5 points)



16. Draw the diene and dienophile that would give the following Diels-Alder product as the major one of the following reaction. (5 points)



17. Provide a curved arrow mechanism to illustrate all the bond breaking and bond making steps of the following reaction. Show all intermediate structures. (10 points)



18. Propose a synthesis of the following compound starting from benzene. You may use any other reagents that contain four carbon atoms or less. (10 points)

