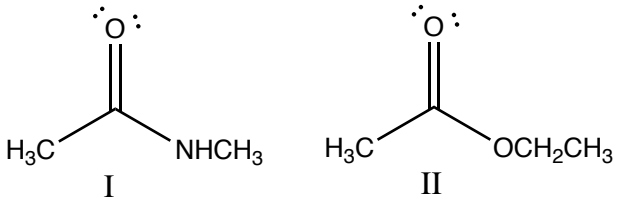
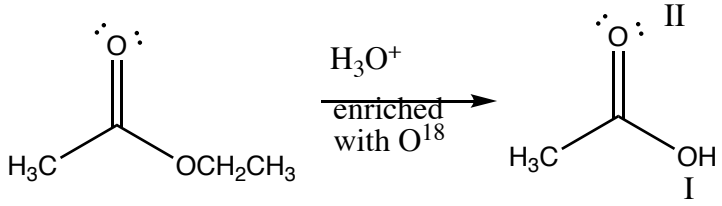
Mock Exam 2 Spring 2019 Part I: Multiple Choice.

1. Which is less reactive?



A. I, because the lone pair on the amide nitrogen is conjugated with the carbonyl group which stabilizes the system by delocalizing electron density and makes it less reactive
B. I, because amides have a carbonyl absorption in the IR at lower frequency
C. II, because the oxygen is removing electrons from the carbonyl which makes is less susceptible to nucleophilic attack
D. II, because esters have a carbonyl absorption in the IR at higher frequency

2. If ethyl acetate is treated with aqueous acid enriched with O^{18}, where would the isotope probably appear in the product?

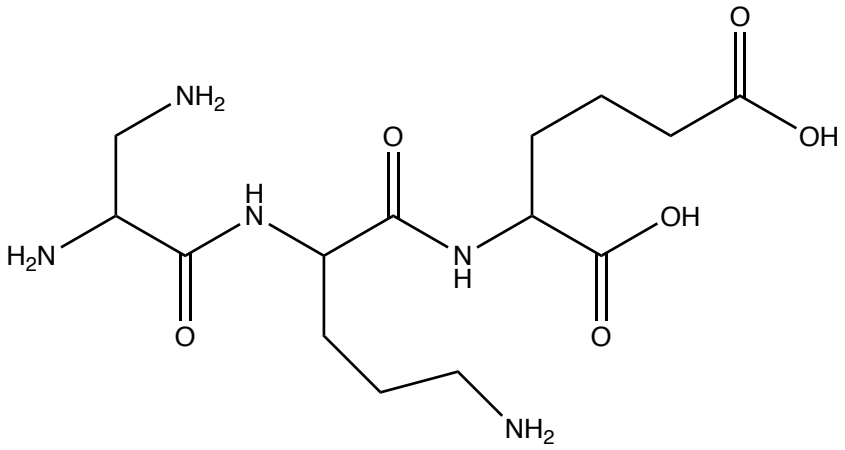


A. Mostly at position I
B. Mostly at position II
C. Equally at both I and II
D. Neither

3 Which is more basic, I. CH_3NH_2 or II. CH_3CONH_2. Why?

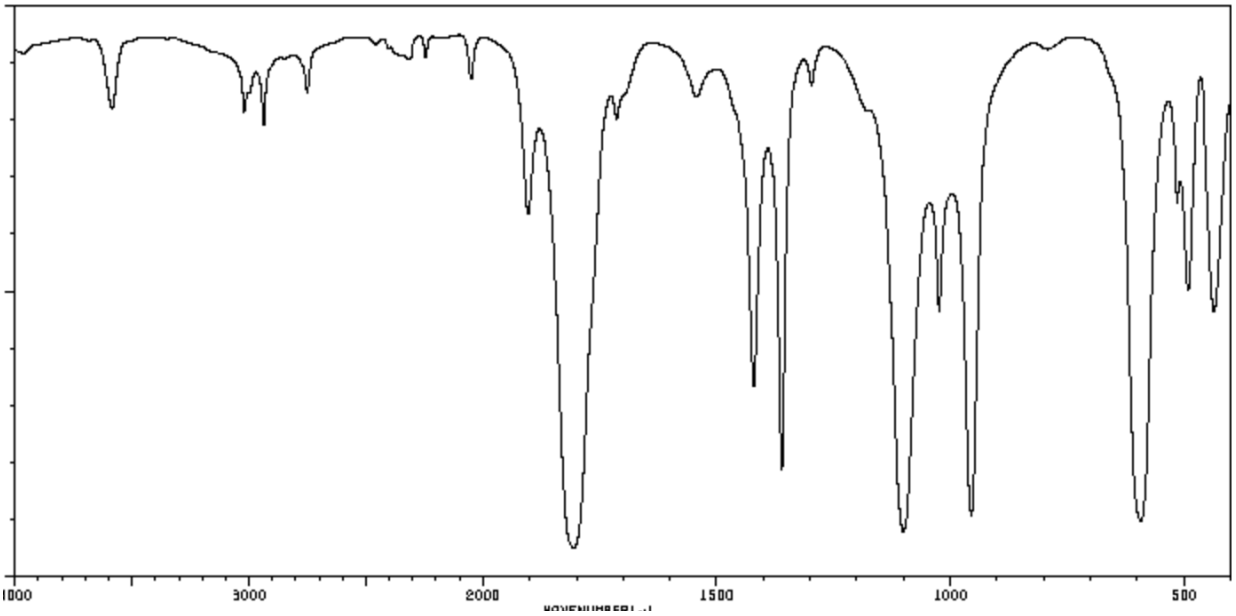
A. I because the lone pair is more available for donation
B. I because the nitrogen is less hindered
C. II because the lone pair is conjugated with the carbonyl and less available for donation
D. II because the presence of the oxygen increases the basicity

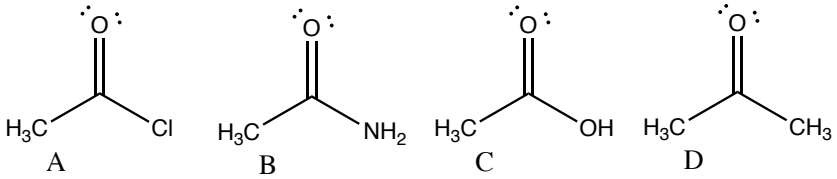
4. What is the overall charge of this polypeptide?



A. 1
B. –1
C. 2
D. -2
E. 3

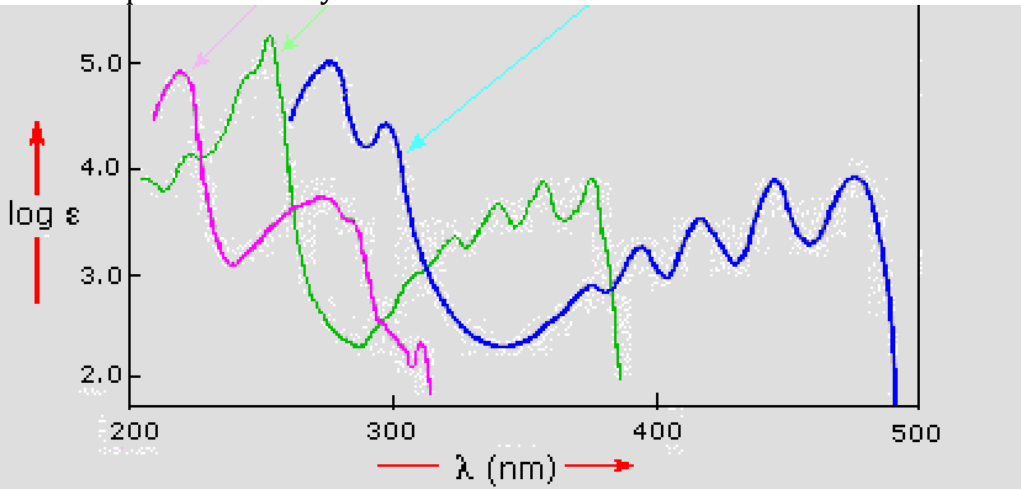
5. Which compound is most likely to give rise to this IR spectrum?

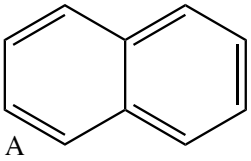




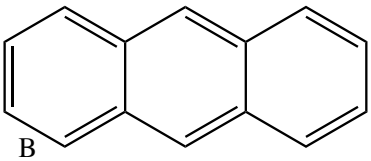
A B C D

6. This spectrum shows the UV-VIS spectra of compounds. Which one corresponds to the absorption shown by the blue line?

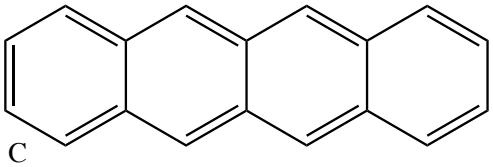




A



B

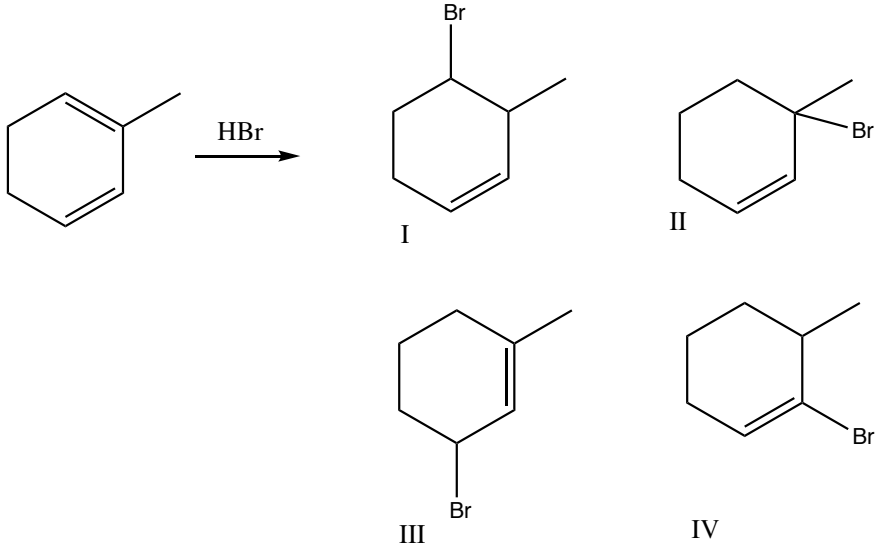


C

D. It is not possible to tell

7. You chose your answer because:
   A. This system has the longest conjugated system and therefore the largest energy gap between the HOMO and LUMO
   B. This system has the longest conjugated system and therefore the smallest energy gap between the HOMO and LUMO
   C. This system has the shortest conjugated system and therefore the largest energy gap between the HOMO and LUMO
   D. This system has the shortes conjugated system and therefore the smallest energy gap between the HOMO and LUMO

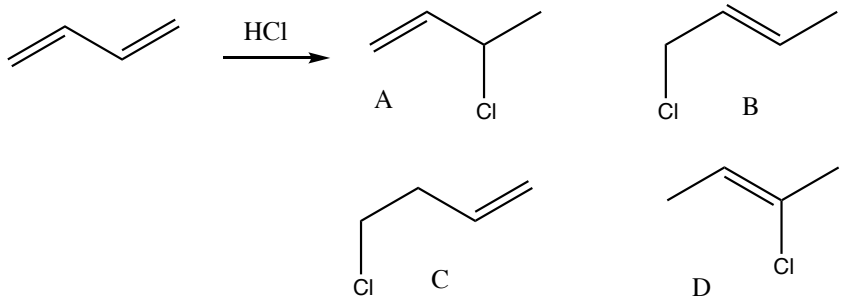
8. What are the possible products:



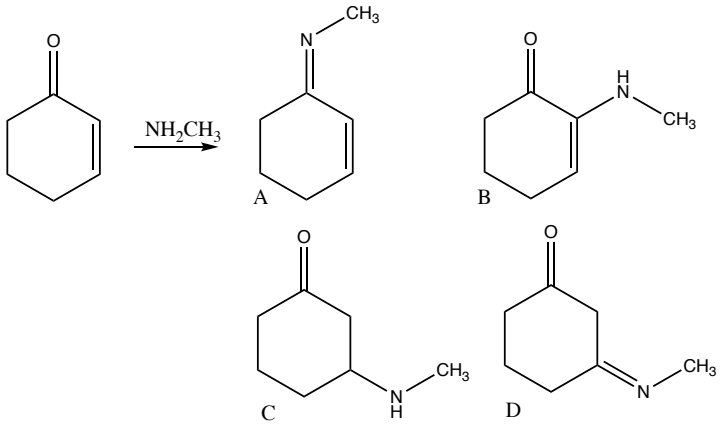
A. I, III,
B. II, IV
C. II, III
D. I, IV

.

9. which product is formed when this reaction is done at low temperature

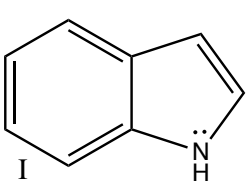


10. Which product do you expect to be produced?

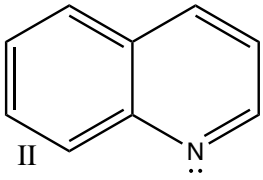


11. Where do you expect to see signals corresponding to aromatic systems in C-13 and H-1 NMR spectra. Why is this?
    A. At higher field than alkanes, because the ring is electron rich and therefore the extra electrons shield the carbons and hydrogens, so a stronger field is necessary to bring the nuclei to resonance
    B. At higher field than alkanes, because of the ring current induces a magnetic field that opposes the external field, so a stronger field is necessary to bring the nuclei to resonance
    C. At lower field than alkanes, because of the ring current induces a magnetic field that enhances the external field, so a weaker external field can to bring the nuclei to resonance
    D. At lower field than alkanes, because the ring is electron rich and therefore the extra electrons de-shield the carbons and hydrogens, so a weaker field can to bring the nuclei to resonance

12. Which is least basic?



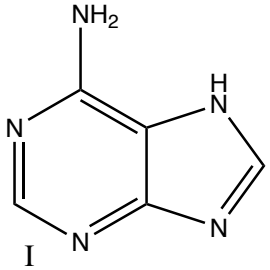
I



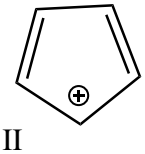
II

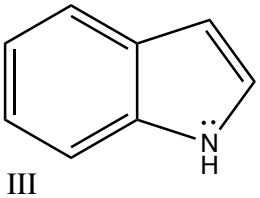
A. Both are basic because they both have a nitrogen with an available lone pair
B. Neither is basic because the lone pair in each compound is contributing to the aromatic pi system
C. I is less basic because the lone pair is part of the aromatic pi system and therefore not available for donation
D. II is less basic because the lone pair is part of the aromatic pi system and therefore not available for donation.

13. Which is/are aromatic?

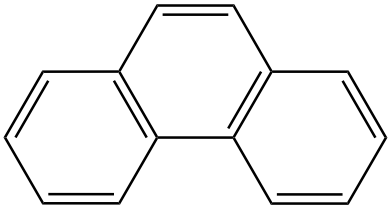


I


II

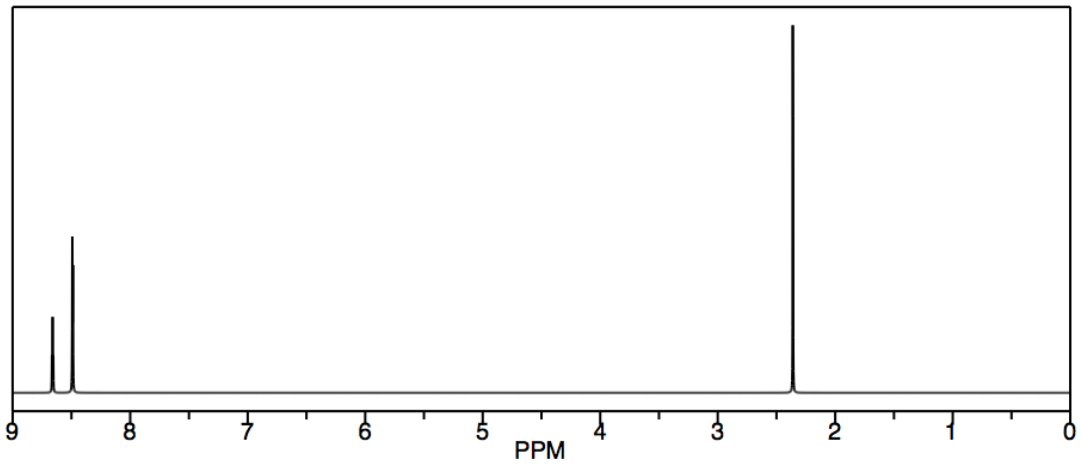


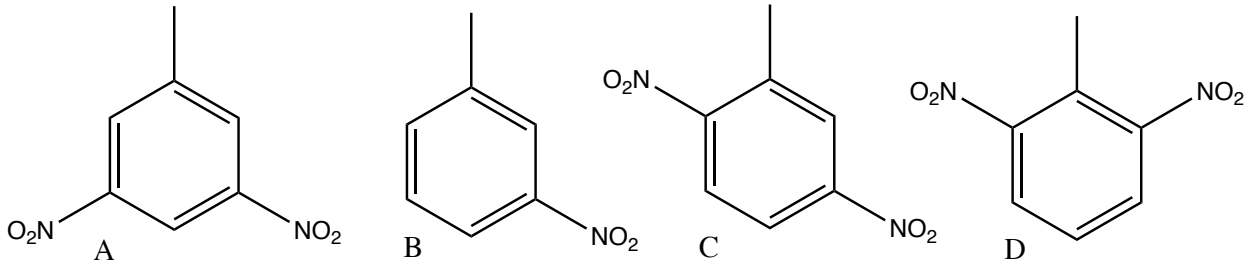
III


IV

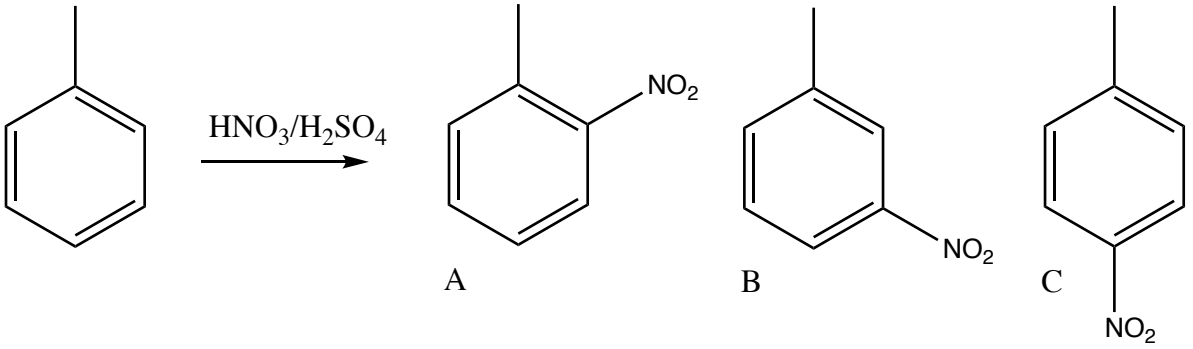
A. all are aromatic
B. None are aromatic
C. I and II
D. III and IV
E. I, III and IV

14. The compound that would give rise to this spectrum is



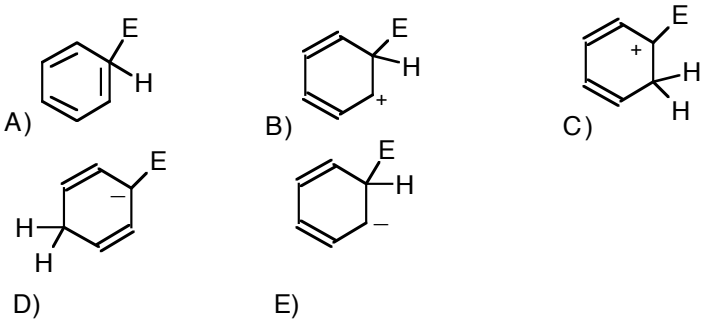


15. When toluene is nitrated the initial product is:



D. All of these products are formed.

16. Which of the following is one of the resonance contributors of the intermediate produced in a Friedel-Crafts alkylation of benzene?



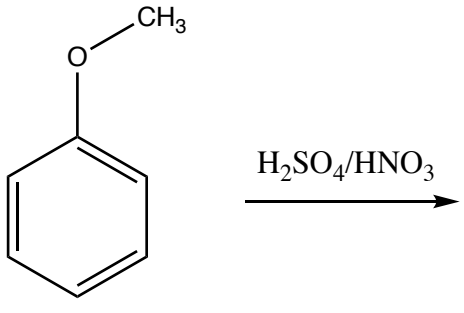
17. Which of the following is the best method for preparing *m*-chloroaniline?
    A. 1) NH_3; 2) $Cl_2/AlCl_3$
    B. 1) $Cl_2/AlCl_3$; 2) NH_3
    C. 1) $Cl_2/AlCl_3$; 2)HNO_3/H_2SO_4; 3) Zn/HCl
    D. 1)HNO_3/H_2SO_4; 2) $Cl_2/AlCl_3$; 3) Zn/HCl
    E. 1)HNO_3/H_2SO_4; 2) Zn/HCl: 3) $Cl_2/AlCl_3$;

Short answer questions

1. Construct an energy diagram for the nitration of toluene. Show clearly the structures of the transition states for *ortho meta* and *para* substitution, and explain which of these substitution patterns generally occurs.

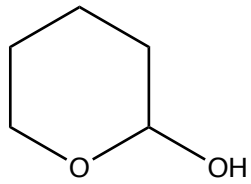
2. Draw mechanisms and predict the product(s) for each of these reactions.

a. 

b. 

3. Propose syntheses from the compound given and any other reactants or reagents you need.

a.



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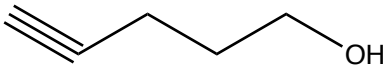
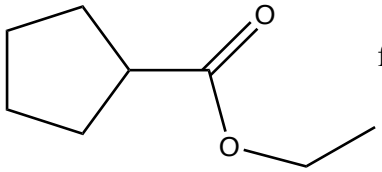


b.



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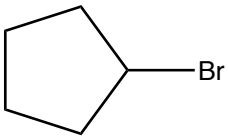

4. A compound has the molecular formula $C_7H_5NO_4$. The H-NMR, C-13NMR and IR are provided. Identify the compound and provide a synthesis of it from benzene.