

**Chemistry 234-002**  
**Exam 1 – Version A**

Spring 2019

Dr. J. Osbourn

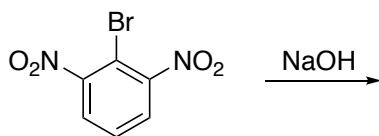
**Instructions:** Answer the first 12 questions of this exam using the bubble sheet attached to the end of this exam booklet. You may detach this sheet if you wish. Answer the remaining questions directly on this exam. Show all work and provide complete explanations.

The Periodic Table																		IIA																											
1 <b>H</b> 1.01																		2 <b>He</b> 4.00																											
3 <b>Li</b> 6.94		4 <b>Be</b> 9.01																13 <b>B</b> 10.81	14 <b>C</b> 12.01	15 <b>N</b> 14.01	16 <b>O</b> 16.00	17 <b>F</b> 19.00	18 <b>Ne</b> 20.18																						
11 <b>Na</b> 22.99		12 <b>Mg</b> 24.31		3 <b>Al</b> 26.98	4 <b>Si</b> 28.09	5 <b>P</b> 30.97	6 <b>S</b> 32.07	7 <b>Cl</b> 35.45	8 <b>Ar</b> 39.95									9 <b>K</b> 39.1	10 <b>Ca</b> 40.08	11 <b>Sc</b> 44.96	12 <b>Ti</b> 47.88	13 <b>V</b> 50.94	14 <b>Cr</b> 52.00	15 <b>Mn</b> 54.94	16 <b>Fe</b> 55.85	17 <b>Co</b> 58.93	18 <b>Ni</b> 58.69	19 <b>Cu</b> 63.55	20 <b>Zn</b> 65.39	21 <b>Ga</b> 69.72	22 <b>Ge</b> 72.61	23 <b>As</b> 74.92	24 <b>Se</b> 78.96	25 <b>Br</b> 79.90	26 <b>Kr</b> 83.80										
37 <b>Rb</b> 85.47		38 <b>Sr</b> 87.62		39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.91	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.29									55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La*</b> 138.9	58 <b>Hf</b> 178.5	59 <b>Ta</b> 180.9	60 <b>W</b> 183.9	61 <b>Re</b> 186.2	62 <b>Os</b> 190.2	63 <b>Ir</b> 192.2	64 <b>Pt</b> 195.1	65 <b>Au</b> 197.0	66 <b>Hg</b> 200.6	67 <b>Tl</b> 204.4	68 <b>Pb</b> 207.2	69 <b>Bi</b> 209	70 <b>Po</b> (209)	71 <b>At</b> (210)	72 <b>Rn</b> (222)
87 <b>Fr</b> (223)		88 <b>Ra</b> (226)		89 <b>Ac^</b> (227)	90 <b>Rf</b> (261)	91 <b>Db</b> (262)	92 <b>Sg</b> (263)	93 <b>Bh</b> (264)	94 <b>Hs</b> (265)	95 <b>Mt</b> (268)	96 <b>Ds</b> (271)	97 <b>Rg</b> (272)																																	
*		58 <b>Ce</b> 140.1		59 <b>Pr</b> 140.9		60 <b>Nd</b> 144.2		61 <b>Pm</b> (145)		62 <b>Sm</b> 150.4		63 <b>Eu</b> 152.0		64 <b>Gd</b> 157.3		65 <b>Tb</b> 158.9		66 <b>Dy</b> 162.5		67 <b>Ho</b> 164.9		68 <b>Er</b> 167.3		69 <b>Tm</b> 168.9		70 <b>Yb</b> 173.0		71 <b>Lu</b> 175.0																	
^		90 <b>Th</b> 232.0		91 <b>Pa</b> (231)		92 <b>U</b> 238.0		93 <b>Np</b> (237)		94 <b>Pu</b> (244)		95 <b>Am</b> (243)		96 <b>Cm</b> (247)		97 <b>Bk</b> (247)		98 <b>Cf</b> (251)		99 <b>Es</b> (252)		100 <b>Fm</b> (257)		101 <b>Md</b> (258)		102 <b>No</b> (259)		103 <b>Lr</b> (260)																	

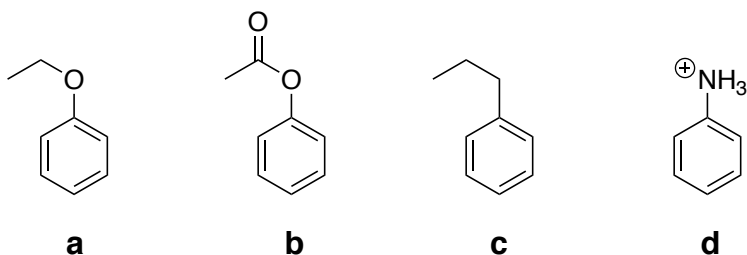
### Multiple-Choice

Choose the best answer for each of the following questions. Record each answer on the attached bubble sheet. **Ensure you completely bubble in your answers.** (2 points each)

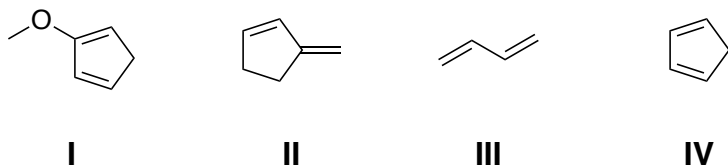
1. By what type of mechanism does the following aromatic substitution reaction proceed?



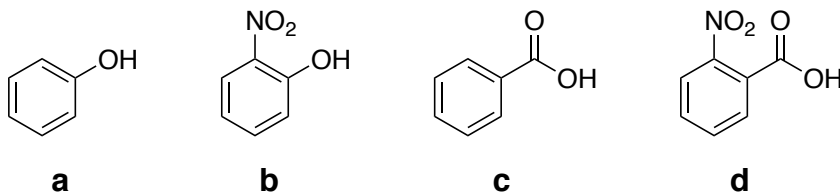
- a. Electrophilic Aromatic Substitution
  - b. Addition-Elimination
  - c. Benzyne (Elimination-Addition)
2. Which aromatic ring will undergo electrophilic bromination at the fastest rate?



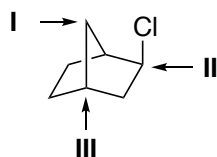
3. Rank the following dienes from least reactive to most reactive in a normal Diels-Alder reaction.



- a. II < III < IV < I
  - b. II < III < I < IV
  - c. I < II < III < IV
  - d. II < I < IV < III
  - e. None of the above
4. Which compound below is the most acidic?

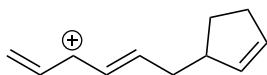


5. Which of the indicated carbons is a bridgehead carbon?



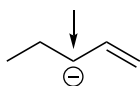
- a. I only
- b. III only
- c. II only
- d. I & II
- e. I, II, & III

6. The following compound contains \_\_\_\_ p-orbitals and \_\_\_\_ atoms in conjugation.



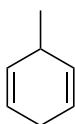
- a. 4, 4
- b. 5, 5
- c. 7, 5
- d. 7, 4
- e. 6, 5

7. What is the hybridization of the indicated atom?

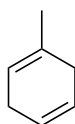


- a. sp
- b.  $sp^2$
- c.  $sp^3$
- d. p

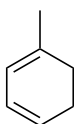
8. Structure \_\_\_\_ is the most stable and structure \_\_\_\_ is the least stable in the group.



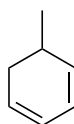
I



II



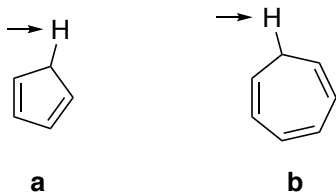
III



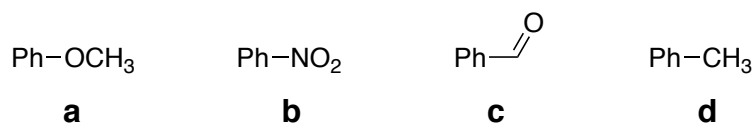
IV

- a. II, I
- b. III, IV
- c. III, I
- d. III, II
- e. IV, I

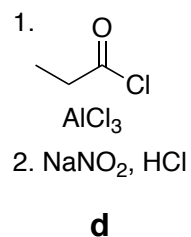
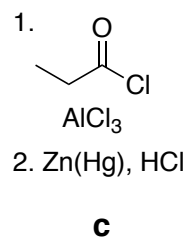
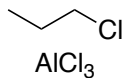
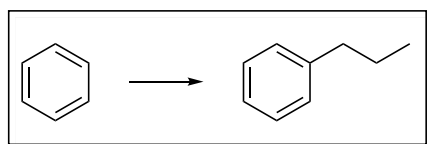
9. Which one of the indicated protons is more acidic?



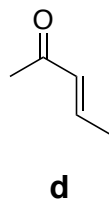
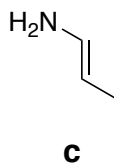
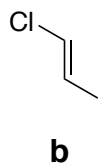
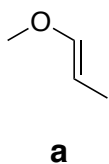
10. Which of the following arene substituents is inductively withdrawing and resonance donating?



11. Which reagent/set of reagents would be the most efficient way to synthesize the following compound?



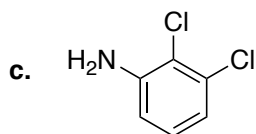
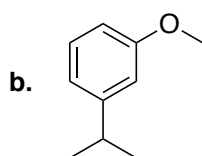
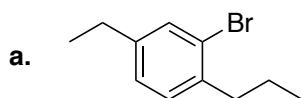
12. Which one of the following would be the most reactive dienophile in a normal Diels-Alder reaction?



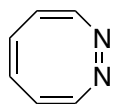
### Completion Section

Answer the remaining questions directly on the exam itself. Please write neatly and darkly as your answers will be scanned.

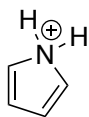
13. Provide the IUPAC name for each compound shown below. (3 points each)



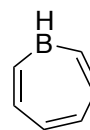
14. Label each compound below as: aromatic, non-aromatic, or antiaromatic. For aromatic and antiaromatic compounds, write the number of participating  $\pi$ -electrons. (2 points each)



\_\_\_\_\_  
 $\pi$  e<sup>-</sup>  
\_\_\_\_\_



\_\_\_\_\_  
 $\pi$  e<sup>-</sup>  
\_\_\_\_\_



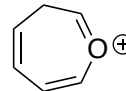
\_\_\_\_\_  
 $\pi$  e<sup>-</sup>  
\_\_\_\_\_



\_\_\_\_\_  
 $\pi$  e<sup>-</sup>  
\_\_\_\_\_



\_\_\_\_\_  
 $\pi$  e<sup>-</sup>  
\_\_\_\_\_

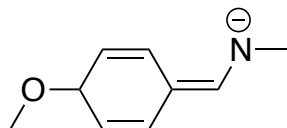


\_\_\_\_\_  
 $\pi$  e<sup>-</sup>  
\_\_\_\_\_

15. Draw two additional resonance structures for the following molecule then circle the major contributor to the resonance hybrid. (5 points)



16. Use the molecule shown below to answer the following questions. (10 points)



a. Draw a picture of the molecule showing the location of every p-orbital.

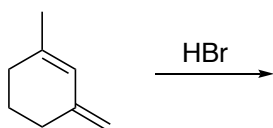
b. How many lone pairs are present on the nitrogen?

c. What is the hybridization of the nitrogen?

d. How many atoms are in conjugation?

e. In what orbitals do the oxygen lone pairs reside?

17. Draw all of the possible products for the following reaction: (4 points)

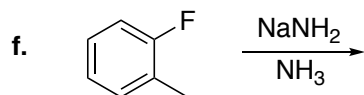
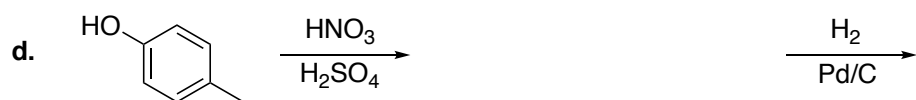
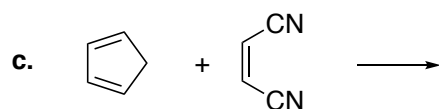
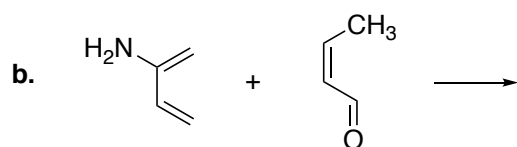
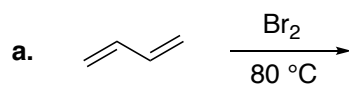


18. Consider the above reaction and draw the major product(s) at the indicated temperatures. (1 point each)

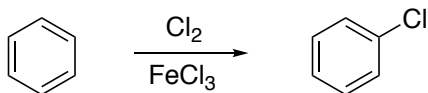
Major Product(s) at -78 °C	Major Product(s) at 80 °C

19. The products formed at low temperature are known as \_\_\_\_\_ products. (1 point)

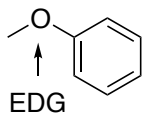
20. Predict the major product(s) for each of the following reactions. If the reaction does not proceed under the indicated conditions, write "no reaction". (2 points each)



21. Provide the complete electron pushing mechanism for the following reaction. Be sure to show the mechanism for active electrophile generation and for electrophilic aromatic substitution. (6 points)



22. Briefly explain why the methoxy group is electron donating. Use structures to support your answer. (3 points)



23. Provide a reasonable synthesis of the following compound starting with benzene. (4 points)

