

Name: \_\_\_\_\_  
 Last First MI

## Chemistry 234-001 Exam 1

Fall 2017

Dr. J. Osbourn

**Instructions:** The first 18 questions of this exam should be answered on the provided Scantron. You must use a pencil for filling in the Scantron sheet. Ensure all erasures are complete. Any questions left blank will be marked incorrect. Answer the remaining questions on the exam itself. Show all work and provide complete explanations.

**Please write your name on:**

- The first page (Exam Cover Page)
- The second page (Grading Page)
- The Scantron Sheet – Circle your Last Name

**Please bubble in your WVU Student ID Number on your Scantron sheet.**

### The Periodic Table

1 IA																	18 VIIIA
1 <b>H</b> 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 <b>He</b> 4.00
3 <b>Li</b> 6.94	4 <b>Be</b> 9.01											5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18
11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.07	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
19 <b>K</b> 39.1	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.39	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.61	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <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	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.9	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
87 <b>Fr</b> (223)	88 <b>Ra</b> (226)	89 <b>Ac^</b> (227)	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (264)	108 <b>Hs</b> (265)	109 <b>Mt</b> (268)	110 <b>Ds</b> (271)	111 <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)		

Exams will be returned by placing them alphabetically on the table at the front of BUE 459. Your grade will not be visible as it is on the second page. If, however, you have a privacy concern, check the box below and your exams will be held back so that you can pick them up privately.

☐ **Hold Back My Exams**

\*Please do not rip off this cover sheet\*

Name: \_\_\_\_\_  
Last First MI

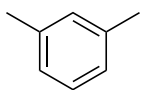
Grading Page (Exam 1):

Page	Points Possible	Points Earned
Multiple Choice (3-6)	36	
7	27	
8	37	
<b>TOTAL</b>	<b>100</b>	

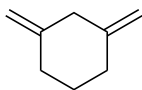
### Multiple-Choice

Choose the one best answer for each of the following questions. Record this answer on your Scantron sheet. Additionally, circle your answer on this exam. (2 points each)

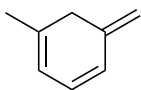
1. Arrange the following in order of increasing stability.



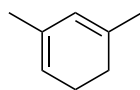
**A**



**B**

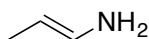


**C**

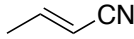


**D**

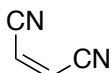
- a.  $D < B < C < A$   
b.  $A < B < C < D$   
c.  $D < C < B < A$   
d.  $B < D < C < A$   
e.  $B < A < C < D$
2. In a normal Diels-Alder reaction, compound \_\_\_\_ will react the fastest and \_\_\_\_ will react the slowest.



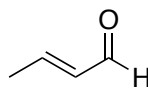
**I**



**II**



**III**

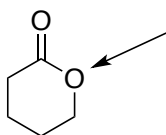


**IV**

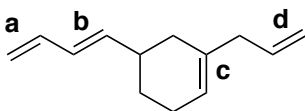


**V**

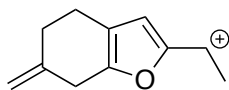
- a. I, II  
b. I, III  
c. II, V  
d. III, I  
e. IV, V
3. What is the hybridization of the indicated oxygen atom in the structure below?



- a.  $p$   
b.  $sp^2$   
c.  $sp$   
d.  $sp^3$   
e.  $s$
4. In the molecule shown below, which double bond will react the most rapidly with HBr?

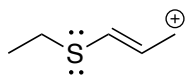


5. The compound shown below has \_\_\_\_ atoms in conjugation.



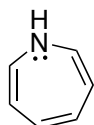
- a. 3
- b. 4
- c. 5
- d. 6
- e. 8

6. Consider the molecule shown below and determine the orbital location for each indicated species.



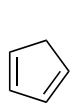
	Carbocation $\oplus$	S – lone pair 1	S – lone pair 2
a.	$sp^2$ orbital	$sp^2$ orbital	$sp^3$ orbital
b.	p orbital	p orbital	p orbital
c.	p orbital	$sp^3$ orbital	$sp^2$ orbital
d.	p orbital	$sp^2$ orbital	$sp^2$ orbital
e.	p orbital	$sp^2$ orbital	p orbital

7. The compound shown below is non-aromatic because:

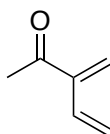


- a. it is not planar
- b. it is not completely conjugated (i.e. the N lone pair is in an  $sp^3$  orbital)
- c. it has  $6\pi$  electrons.
- d. a, b, and c
- e. both a and b

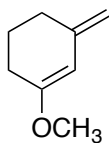
8. Which one of the following dienes will react the fastest in a normal Diels-Alder reaction?



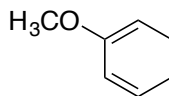
**a**



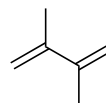
**b**



**c**



**d**



**e**

9. Which reaction shown below would you expect to occur at the fastest rate?



**a**

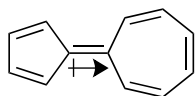


**b**

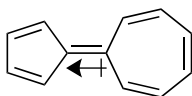


**c**

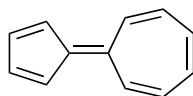
10. Which one of the following best represents the dipole for the molecule shown below?



**a**



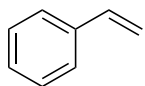
**b**



zero net dipole

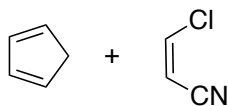
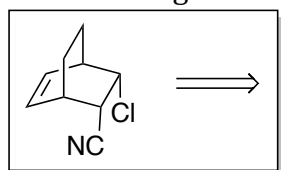
**c**

11. What is the common name for the compound shown below?

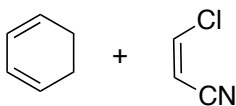


- a. Allyl benzene
- b. Styrene
- c. Xylene
- d. Benzoethylene
- e. Toluene

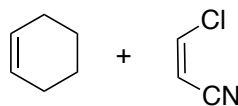
12. What starting materials could be used to prepare the following bicyclic compound?



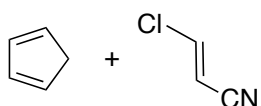
**a**



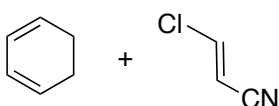
**b**



**c**



**d**

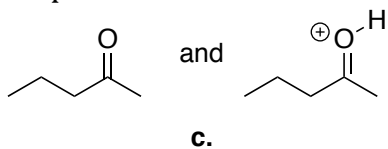
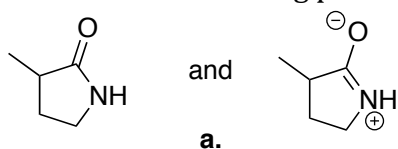


**e**

13. Which one of the following is **not** a correct statement regarding the mechanism of electrophilic aromatic substitution of benzene?

- a. Benzene acts as a nucleophile.
- b. The intermediate is a resonance stabilized carbocation.
- c. Aromaticity is regained by loss of  $H^+$  (base removal of  $H^+$ ).
- d. All of the above are correct

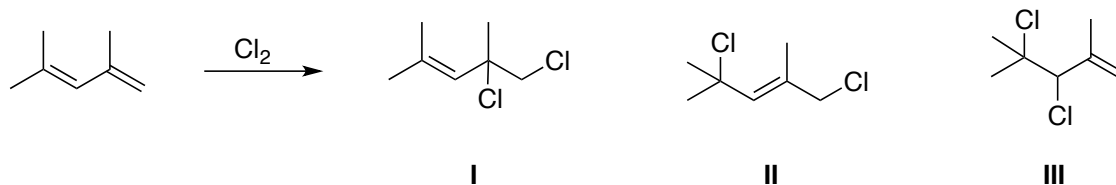
14. Which of the following pairs of structures represent resonance structure?



more than one of  
the pairs represent  
resonance structures

**e.**

Use the reaction shown below to answer questions (15-18).



15. Which of the products are 1,2 products?

- I
- II
- III
- I and II
- I and III

16. If the reaction were carried out at  $-78^{\circ}\text{C}$ , what would be the major products?

- I and II
- II and III
- I and III

17. If the reaction were carried out at  $40^{\circ}\text{C}$ , what would be the major product(s)?

- I, II, and III
- I and II
- II and III
- II only
- III only

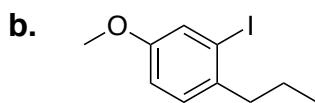
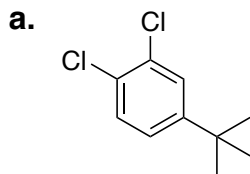
18. Which product (if any) is both a kinetic and a thermodynamic product?

- I
- II
- III
- I and II
- None

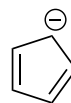
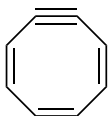
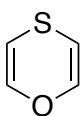
## Completion Section

Answer the questions below in the spaces provided.

19. Provide the IUPAC name or structure for each compound below. (3 points each)



20. For each compound below, determine if it is aromatic, anti-aromatic, or non-aromatic. For aromatic and anti-aromatic compounds, indicate the number of  $\pi$ -electrons. (2 points each)



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

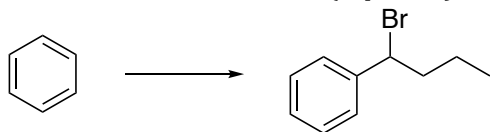
\_\_\_\_\_  $\pi$  e<sup>-</sup>

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

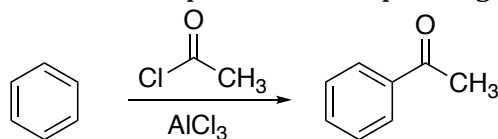
\_\_\_\_\_  $\pi$  e<sup>-</sup>

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

21. Starting with benzene, show the sequence of reactions that would be required to prepare the molecule shown below. (4 points)



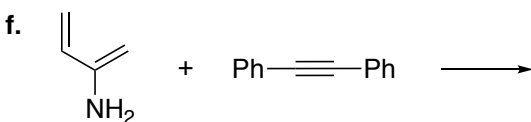
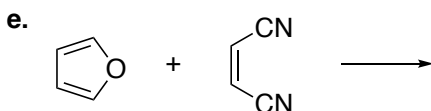
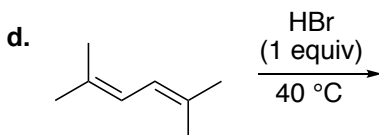
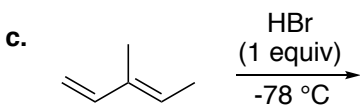
22. Draw the complete electron pushing mechanism for the reaction shown below. (7 points)



**A. Generation of the Active Electrophile**

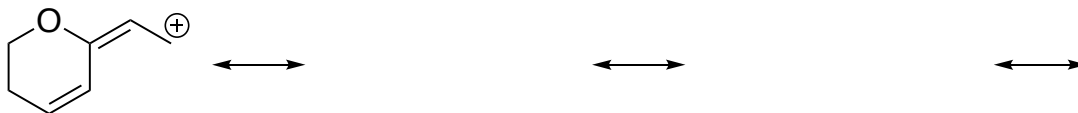
**B. Electrophilic Aromatic Substitution Reaction**

23. Predict the major product(s) for each reaction shown below. If the reaction does not proceed under the specified conditions, write "No Reaction" (3 points each)



24. Consider the molecule shown below and answer the following questions.

- Draw three additional resonance structures. (6 points)
- Circle the resonance structure that is the major contributor to the resonance hybrid. (1 point)



- Draw a picture of the molecule showing the location of every p-orbital. (2 pts)

- How many atoms are in conjugation? (1 pt)

- What is the hybridization of the oxygen? (1 pt)

- What is the hybridization of the carbon bearing the cation in the original structure? (1 pt)

- In what orbital(s) does/do the oxygen lone pairs reside? (1 pt)