Name: _____
Last First MI

# Chemistry 234
# Exam 1

Summer 2018 Dr. J. Osbourn

*Instructions:* The first 13 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 | | | | | | | | | | | | 13 IIIA | 14 IVA | 15 VA | 16 VIA | 17 VIIA | 18 VIIIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.01 | 2 IIA | | | | | | | | | | | | | | | | 2 He 4.00 |
| 3 Li 6.94 | 4 Be 9.01 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 11 Na 22.99 | 12 Mg 24.31 | 3 IIIB | 4 IVB | 5 VB | 6 VIB | 7 VIIB | 8 | 9 VIIIB | 10 | 11 IB | 12 IIB | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.07 | 17 Cl 35.45 | 18 Ar 39.95 |
| 19 K 39.1 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.88 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.69 | 29 Cu 63.55 | 30 Zn 65.39 | 31 Ga 69.72 | 32 Ge 72.61 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.94 | 43 Tc (98) | 44 Ru 101.07 | 45 Rh 102.91 | 46 Pd 106.42 | 47 Ag 107.87 | 48 Cd 112.41 | 49 In 114.82 | 50 Sn 118.71 | 51 Sb 121.76 | 52 Te 127.6 | 53 I 126.9 | 54 Xe 131.29 |
| 55 Cs 132.9 | 56 Ba 137.3 | 57 La* 138.9 | 72 Hf 178.5 | 73 Ta 180.9 | 74 W 183.9 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209 | 84 Po (209) | 85 At (210) | 86 Rn (222) |
| 87 Fr (223) | 88 Ra (226) | 89 Ac^ (227) | 104 Rf (261) | 105 Db (262) | 106 Sg (263) | 107 Bh (264) | 108 Hs (265) | 109 Mt (268) | 110 Ds (271) | 111 Rg (272) | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * | 58 Ce 140.1 | 59 Pr 140.9 | 60 Nd 144.2 | 61 Pm (145) | 62 Sm 150.4 | 63 Eu 152.0 | 64 Gd 157.3 | 65 Tb 158.9 | 66 Dy 162.5 | 67 Ho 164.9 | 68 Er 167.3 | 69 Tm 168.9 | 70 Yb 173.0 | 71 Lu 175.0 |
| ^ | 90 Th 232.0 | 91 Pa (231) | 92 U 238.0 | 93 Np (237) | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (260) |

Exams will be returned by placing them alphabetically in the Chemistry Learning Center to pick up. 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 all of 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***

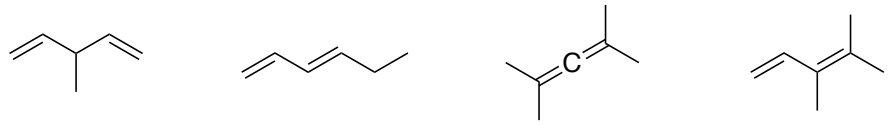
Name: _____
Last First MI

Grading Page (Exam 1):

| Page | Points Possible | Points Earned |
|---|---|---|
| Multiple Choice (3-5) | 26 | |
| 6 | 25 | |
| 7 | 25 | |
| 8 | 24 | |
| **TOTAL** | **100** | |

**Multiple-Choice**
Choose the 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 <u>increasing</u> stability.



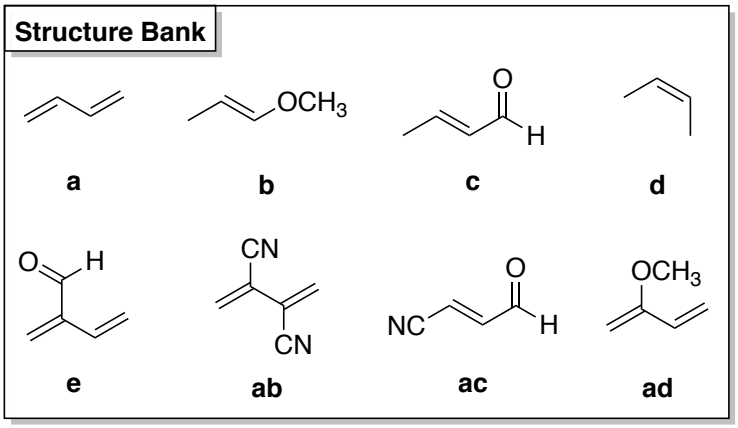
**A** **B** **C** **D**

a. D < B < C < A
b. C < A < B < D
c. D < C < B < A
d. A < C < B < D
e. C < D < B < A

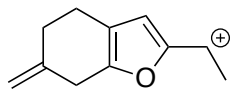
2. Which **diene** from the structure bank on the right will give the fastest normal Diels-Alder reaction?

3. Which **dienophile** from the structure bank on the right will give the fastest normal Diels-Alder reaction?

**Structure Bank**

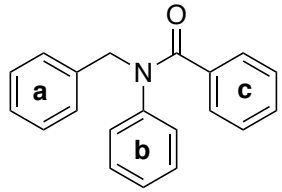



4. The compound shown below has _____ p-orbitals.




a. 1
b. 4
c. 5
d. 7
e. 8

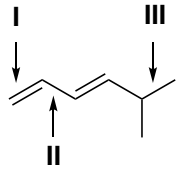
5. When subjected to electrophilic aromatic substitution conditions, which one of the following aromatic rings will react the fastest?



6. Which statement regarding the Friedel-Crafts reaction is **incorrect**?

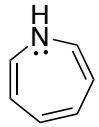
   a. Carbocation rearrangement does not occur in the Friedel-Crafts acylation.
   b. A Lewis acid catalyst is required for the Friedel-Crafts reaction.
   c. Nitrobenzne will not undergo a Friedel-Crafts reaction.
   d. The Friedel-Crafts alkylation can be used to prepare propyl benzene.
   e. All of the above statements are correct.

7. Arrange the following bonds in order of increasing length.



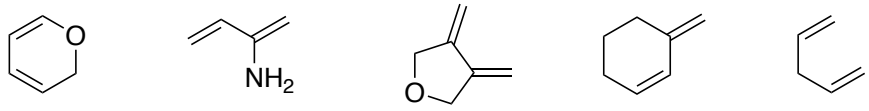

   a. I < II < III
   b. III < II < I
   c. II < I < III
   d. I < III < II
   e. III < I < II

8. In what type of orbital does the nitrogen lone pair reside?



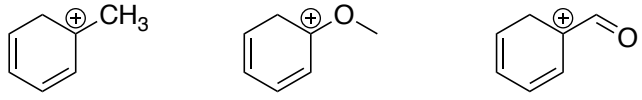

   a. s
   b. sp
   c. $sp^2$
   d. $sp^3$
   e. p

9. Which of the following can successfully be used as a diene in a Diels-Alder reaction? *Bubble in the letter for all that apply!*



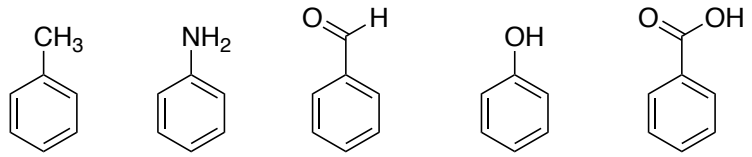

   a  b  c  d  e

10. Which one of the following is the <u>least stable</u>?




   a  b  c

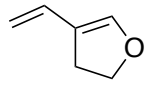
11. Structure ___ represents toluene and ___ represents benzaldehyde.




**I** **II** **III** **IV** **V**

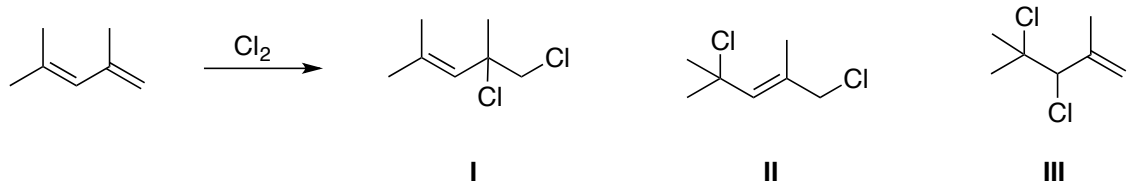
a. I, V
b. II, V
c. I, III
d. IV, V
e. None of the above

12. What is the hybridization of the oxygen atom in the following structure?




a. s
b. sp
c. $sp^2$
d. $sp^3$

13. Consider the reaction shown below, which structure(s) represent the 1,4 product(s)?



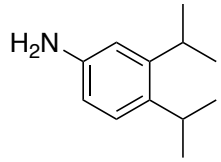

**I** **II** **III**

a. I
b. II
c. III
d. I and II
e. I and III

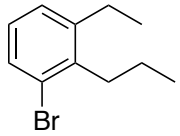
**Completion Section**
Answer the questions below in the spaces provided.

14. Provide the IUPAC name for each compound below. *(3 points each)*

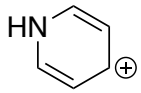
**a.**

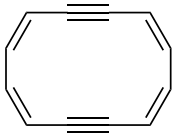


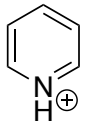

**b.**

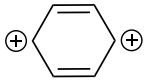



15. For each compound below, determine if it is aromatic, anti-aromatic, or non-aromatic. For aromatic and anti-aromatic compounds, indicate the number of π-electrons. *(2 points each)*



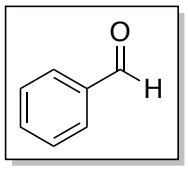





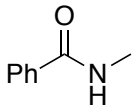



_____ π e-  _____ π e-  _____ π e-  _____ π e-  _____ π e-

16. Explain why the aldehyde is both resonance and inductively electron withdrawing. Use structures and drawings to depict your answer. *(4 points)*




17. Arrange the following from most activated (1) to least activated (4). *(2 points)*

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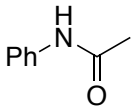


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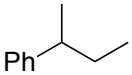


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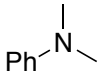


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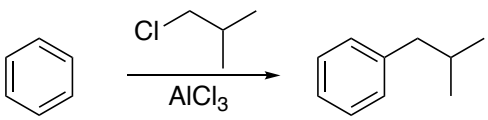
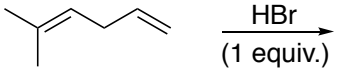
18. Explain why the following Friedel-Crafts reaction does not work as written. What could you do instead to get the desired product? *(3 points)*

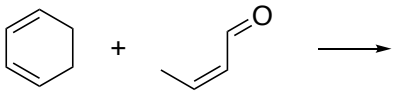


19. Predict the major product(s) for each reaction shown below. If the reaction does not proceed under the specified conditions, write "No Reaction" *(2 points each)*

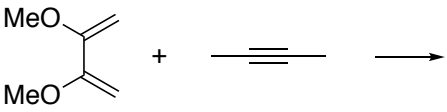
**a.**



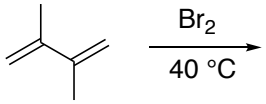

**b.**



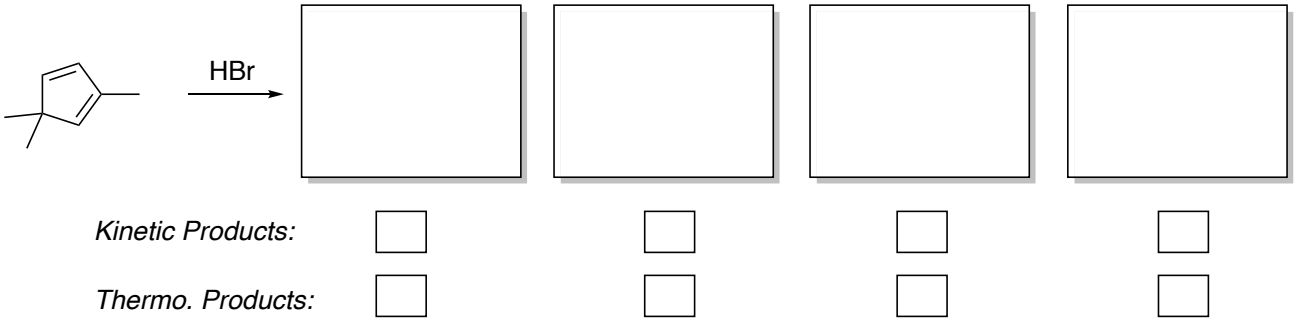

**c.**



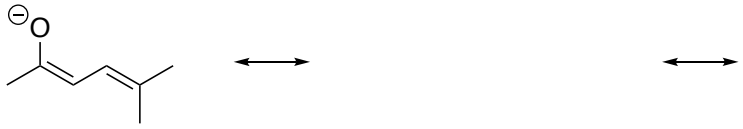

**d.**




20. Draw all four potential products for the following reaction. Then, using an **X**, indicate which products are kinetic products and which products are thermodynamic products. *(6 points)*




21. Consider the molecule shown below and answer the following questions.
    **a.** Draw two additional resonance structures. *(4 points)*
    **b.** Circle the resonance structure that is the major contributor to the resonance hybrid. *(1 point)*



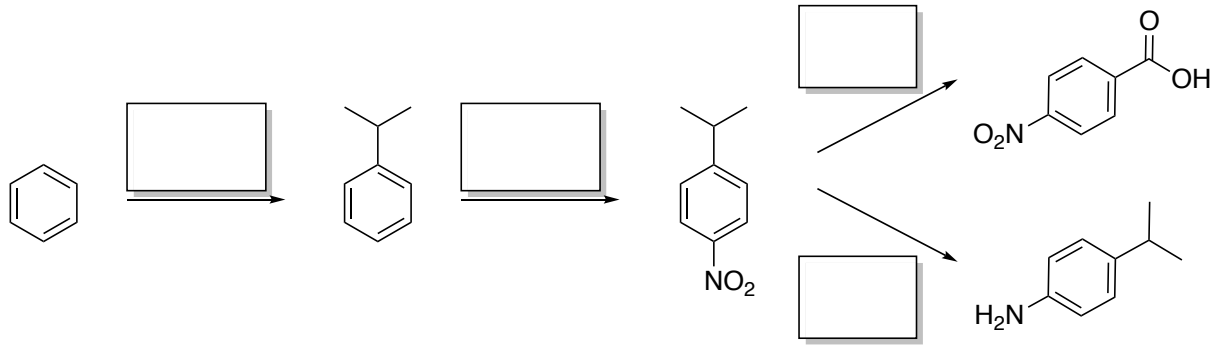

**c.** Draw a picture of the molecule showing the location of every p-orbital. *(2 pts)*

**d.** How many atoms are in conjugation? *(1 pt)*

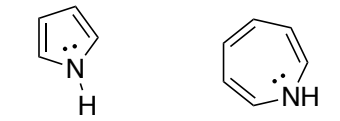
**e.** What is the hybridization of the oxygen? *(1 pt)*

**f.** In what orbital(s) do each of the three oxygen lone pairs reside? *(2 pts)*

22. Provide the missing reagents in the following reaction scheme. *(8 points).*

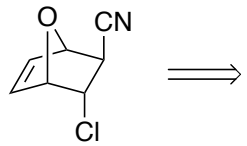



23. Explain why in structure I, the nitrogen lone pair resides in a p-orbital while in structure II, the nitrogen lone pair resides in an $sp^3$ orbital. *(3 points)*

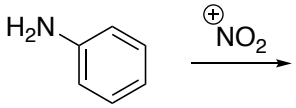



Structure I Structure II

24. What starting materials were used to prepare the following Diels-Alder adduct? *(2 points)*




25. Consider the reaction shown below and answer the following questions.
    a. Draw the major product(s). *(2 point)*




    b. Show the electron pushing mechanism for the formation of the nitronium ion from nitric and sulfuric acid. *(4 points)*

    c. Use resonance structures to explain why the amino group is a strong activator. *Be sure to show all of the relevant resonance structures after initial nitronium ion addition. (5 points)*