Name: _____

Last First MI

Chemistry 234
Exam 1

Summer 2018 Dr. J. Osbourn

Instructions: The first ~~12~~ 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																	18 VIIIA
1 H 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	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.

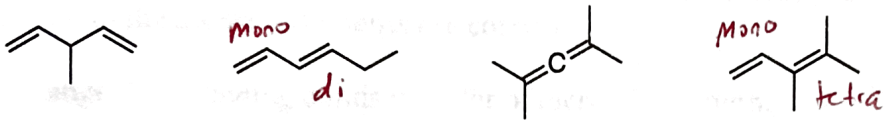
☐ **Hold Back My Exams**

Please do not rip off this cover sheet

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

C < A < B < D

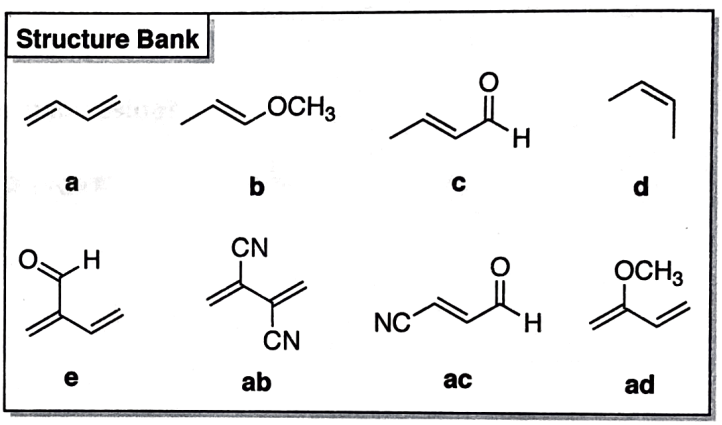
2. Which **diene** from the structure bank on the right will give the fastest normal Diels-Alder reaction?

ad

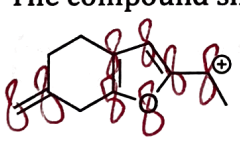
3. Which **dienophile** from the structure bank on the right will give the fastest normal Diels-Alder reaction?

ac

Structure Bank

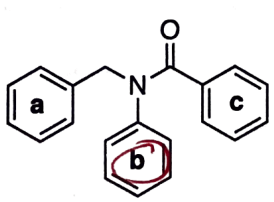


4. The compound shown below has _____ p-orbitals.



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

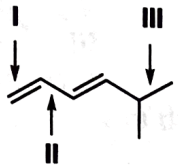
5. When subjected to electrophilic aromatic substitution conditions, which one of the following aromatic rings will react the fastest?



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

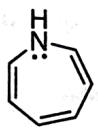
a. Carbocation rearrangement does not occur in the Friedel-Crafts acylation.
b. A Lewis acid catalyst is required for the Friedel-Crafts reaction.
c. Nitrobenzne will not undergo a Friedel-Crafts reaction.
d. The Friedel-Crafts alkylation can be used to prepare propyl benzene.
e. All of the above statements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

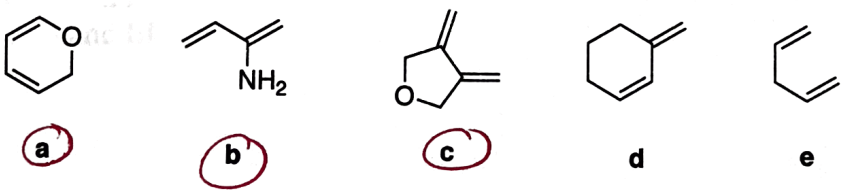
8. In what type of orbital does the nitrogen lone pair reside?



you're given the answer in Q23

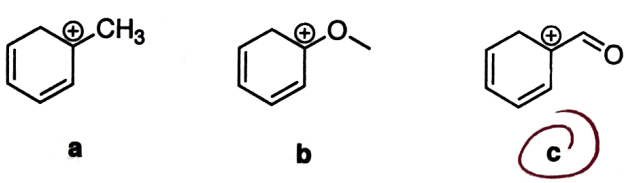
a. s
b. sp
c. sp^2
d. sp^3
e. p

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!*



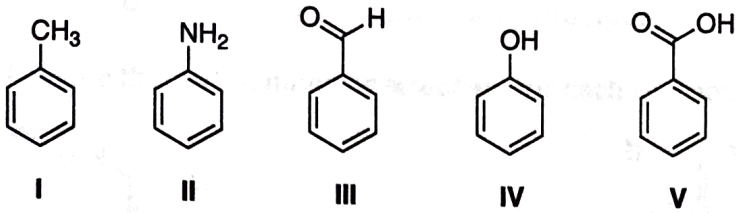
a b c d e

10. Which one of the following is the least stable?



a b c

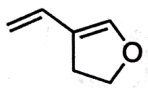
11. Structure I represents toluene and III represents ~~benzaldyhede~~ benzaldehyde.



I II III IV V

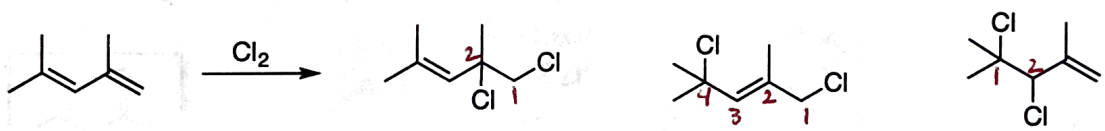
a. I, V
b. II, V
c. I, III
d. IV, V
e. None of the above

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)?



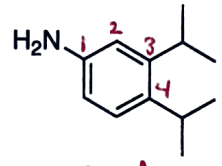
I II III

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

Completion Section
Answer the questions below in the spaces provided.

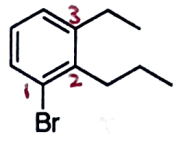
(6) 14. Provide the IUPAC name ~~or structure~~ for each compound below. *(3 points each)*

a.



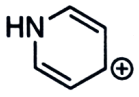
3,4-diisopropylaniline
(+1) (+1) (+1)

b.

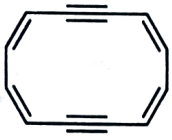


1-bromo-3-ethyl-2-propylbenzene
(+1) Correct substituents in order (+1) Correct #

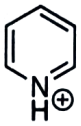
(10) 15. For each compound below, determine if it is aromatic, anti-aromatic, or non-aromatic. For aromatic and anti-aromatic compounds, indicate the number of π-electrons. *(2 points each)*



Aromatic (+1)
6 (+1) π e-



non-aromatic (+2)
— π e-

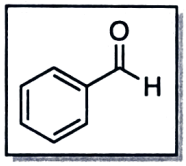


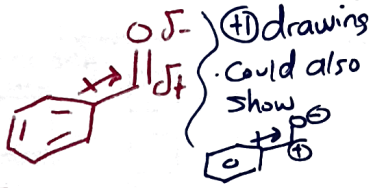
Aromatic (+1)
6 (+1) π e-

anti-aromatic (+1)
4 (+1) π e-

Aromatic (+1)
2 (+1) π e-

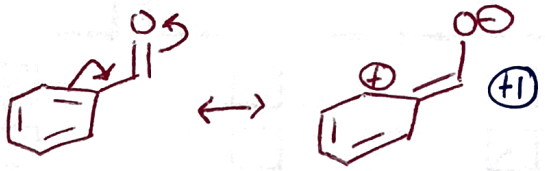
(4) 16. Explain why the aldehyde is both resonance and inductively electron withdrawing. Use structures and drawings to depict your answer. *(4 points)*





(+1) drawing
Could also show

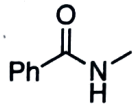
δ+ withdraws e⁻ density out of the ring (+1)



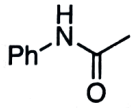
(+1)

resonance takes the π e⁻ out of the ring. (+1)

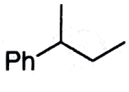
(2) 17. Arrange the following from most activated (1) to least activated (4). *(2 points)*



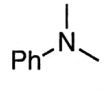
4



2



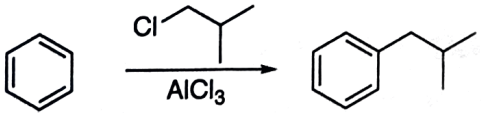
3



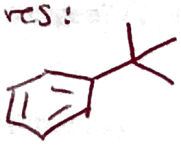
1

(+2) Must have entire order Correct for credit.

(3) 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)*



Carbocation rearrangement gives:



(+1) explanation of problem

Better method: 1) 

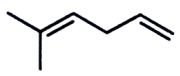
2) H_2N-NH_2, OH^- or $Zn(Hg)$, HCl

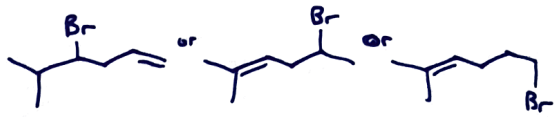
(+2) Synthetic workaround

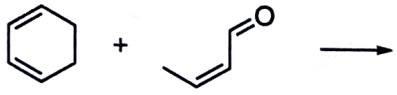
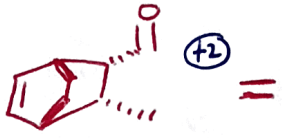
Could just state:
- Do a F.C. acylation followed by reducing off the C=O

/25

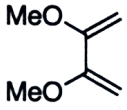
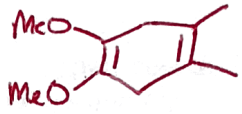
(8) 19. Predict the major product(s) for each reaction shown below. If the reaction does not proceed under the specified conditions, write "No Reaction" *(2 points each)*

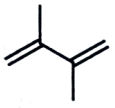
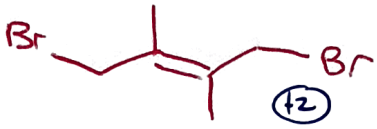
a.  HBr (1 equiv.)  (+2)

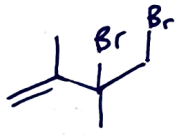
-1 for 

b.   (+2) = 

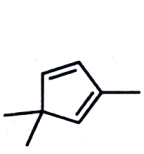
-1 for no/wrong stereochemistry

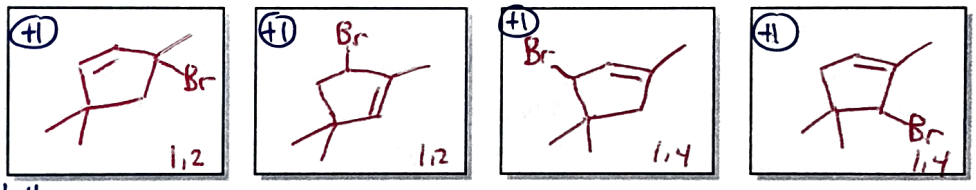
c.   (+2)

d.  Br_2, 40 °C  (+2)

-1 for  or multiple products

(6) 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)*

 HBr



↗ must pick both

(+1) *Kinetic Products:* ☒ ☒ ☐ ☐

(+1) *Thermo. Products:* ☐ ☒ ☒ ☒

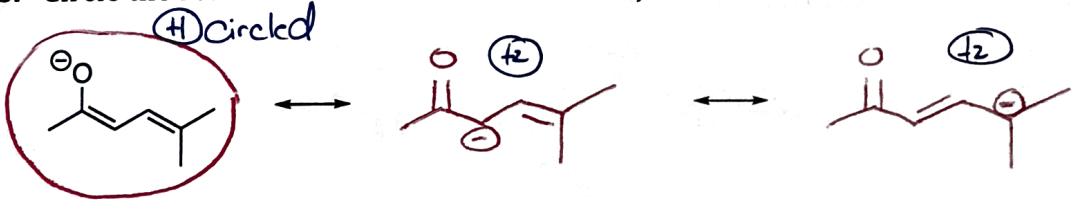
↳ must pick all 3

* note: they may have the 4 products in different order

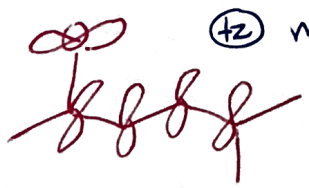
(11) 21. Consider the molecule shown below and answer the following questions.

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)*



(+2) must show all 5 p-orbitals on the molecule

okay if they include double bonds in S/R

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

5 (+1)

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

sp^2 (+1)

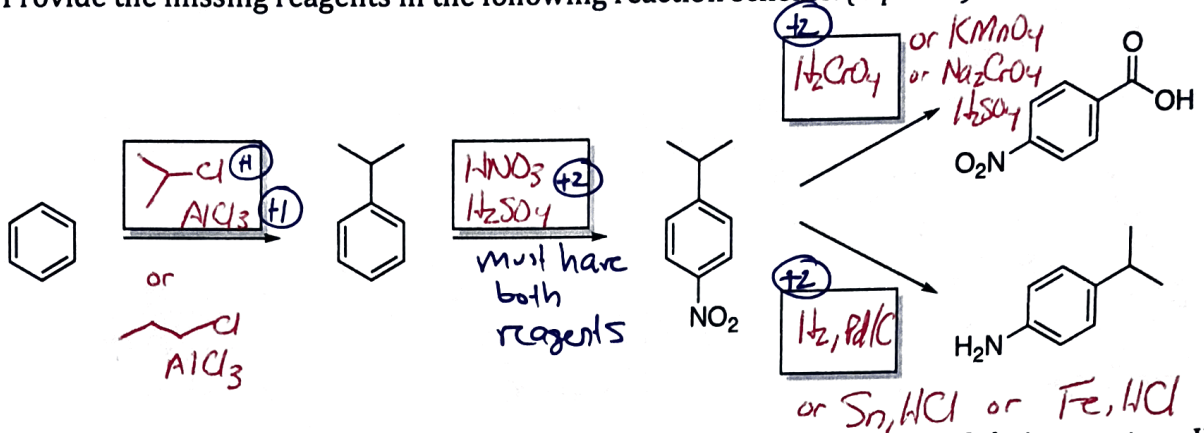
f. In what orbital(s) do each of the three oxygen lone pairs reside? *(2 pts)*

P, sp^2, sp^2

(+1) (+0.5) (+0.5)

/25

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



(3) 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)*

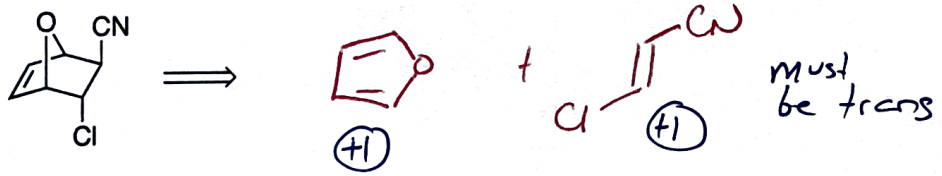
+3 for a reasonable explanation citing aromaticity:

Structure I Structure II

In str I, the lone pair is in a p-orbital to give a conjugated aromatic ring.

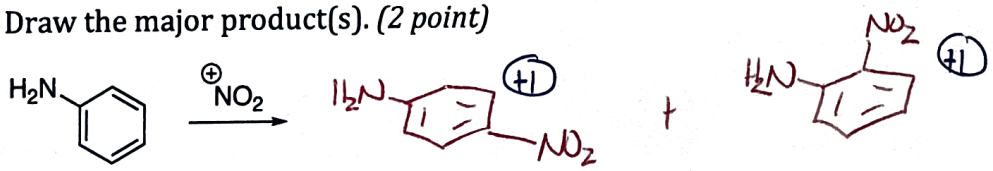
In str II, the lone pair is in an sp^3 orbital b/c putting it in a p-orbital gives an antiaromatic ring.

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

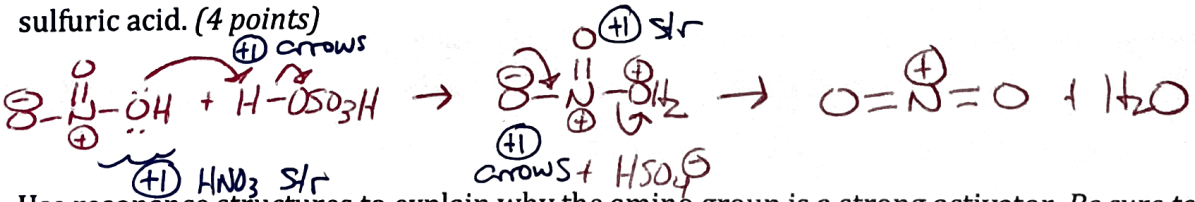


(11) 25. Consider the reaction shown below and answer the following questions.

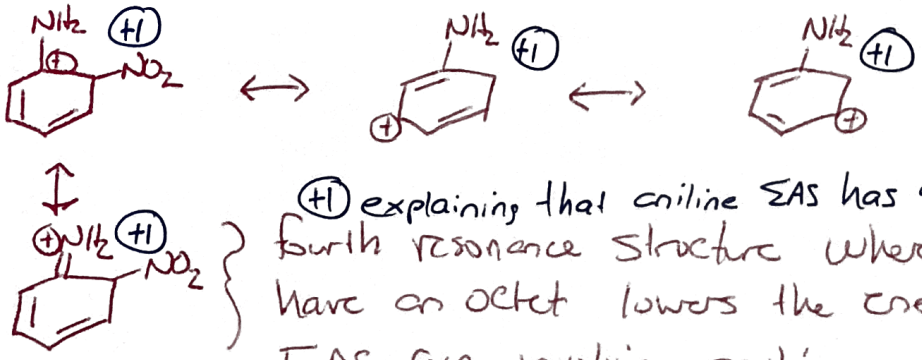
a. Draw the major product(s). *(2 point)*



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)*



+1 explaining that aniline EAS has 4th resonance str

fourth resonance structure where all atoms have an octet lowers the energy for EAS rxn involving aniline

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