Name: Answer Key

Last First MI

Chemistry 234-002
Exam 1

Spring 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 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 on the table at the front of Ming-Hsieh G21. 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

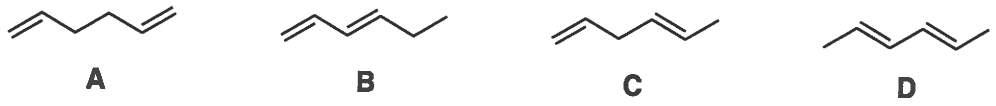
Grading Page (Exam 1):

Page	Points Possible	Points Earned
Multiple Choice (3-6)	36	
7	21	
8	24	
9	19	
TOTAL	**100**	

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)*

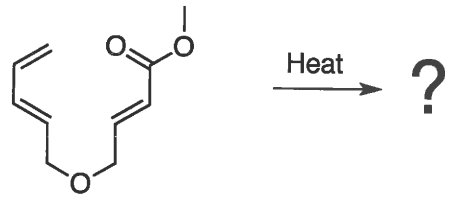
1. Arrange the following dienes in order of increasing stability.

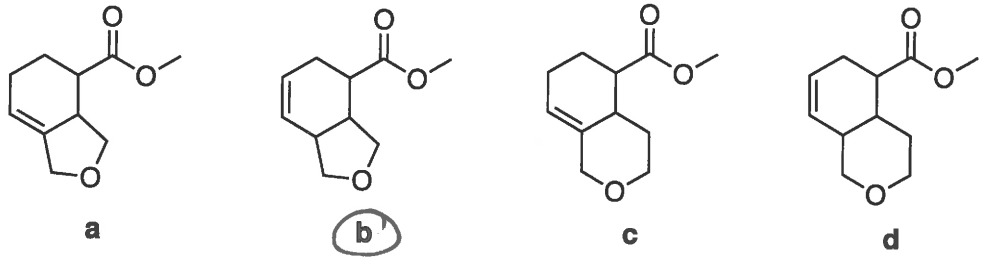


a. A < C < B < D
b. A < B < C < D
c. C < A < D < B
d. A < D < C < B
e. B < A < C < D

A < C < B < D

2. What is the product of the intramolecular Diels-Alder reaction shown below?

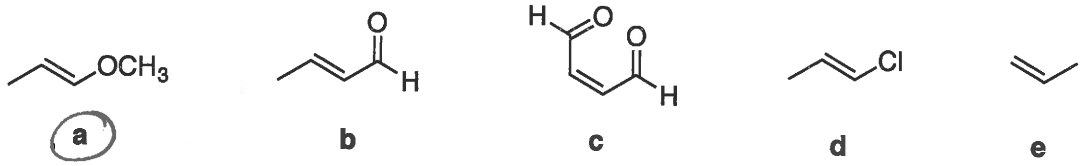




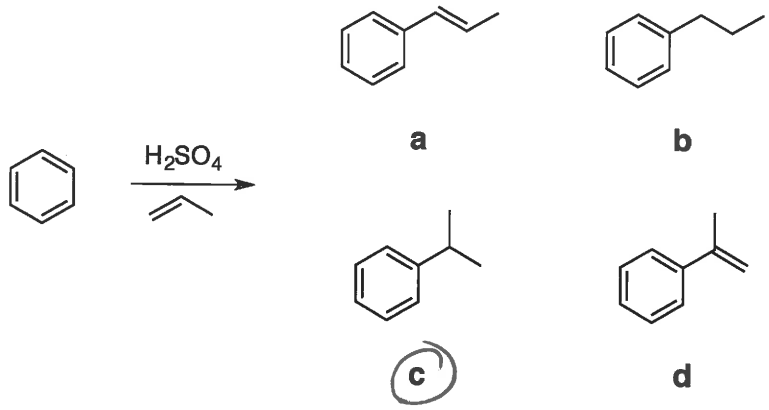
3. Which one of the following statements is true regarding the kinetic and thermodynamic control of reactions?

a. The kinetic product is lower in energy than the thermodynamic product.
b. The kinetic product is formed via a lower energy transition state than the thermodynamic product.
c. The kinetic product is favored at higher temperatures
d. Energetically, the thermodynamic product is less stable than the kinetic product.

4. Which one of the following dienophiles would you expect to be the least reactive in a normal Diels-Alder reaction?

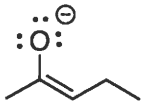


5. Predict the product for the reaction shown below.



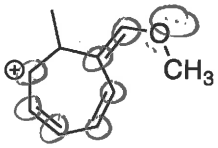
a b c d

6. What is the hybridization of the oxygen atom in the structure below?



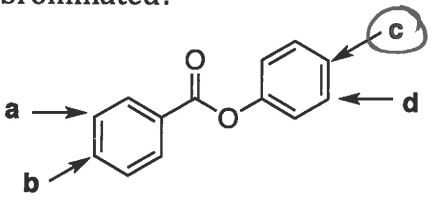
a. *p*
b. sp^2
c. *sp*
d. sp^3
e. *s*

7. The compound shown below has _____ atoms in conjugation.

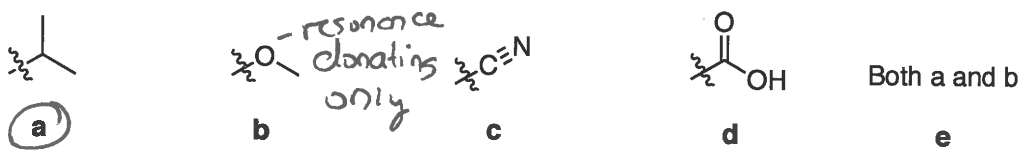


a. 3
b. 6
c. 7
d. 8
e. 9

8. If the compound shown below were subjected to Br_2, $FeBr_3$, which position would be most rapidly brominated?



9. Which group shown below is inductively donating?

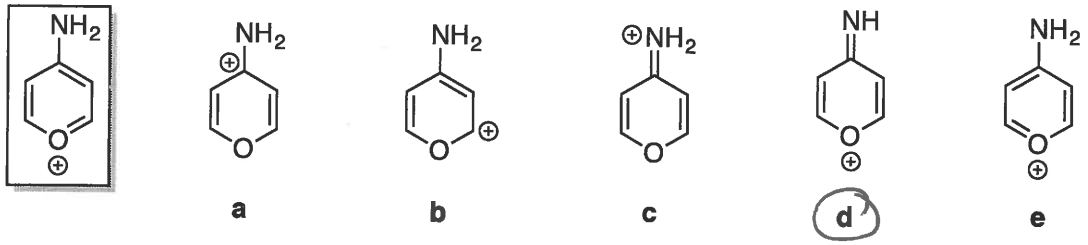


a b c d Both a and b e

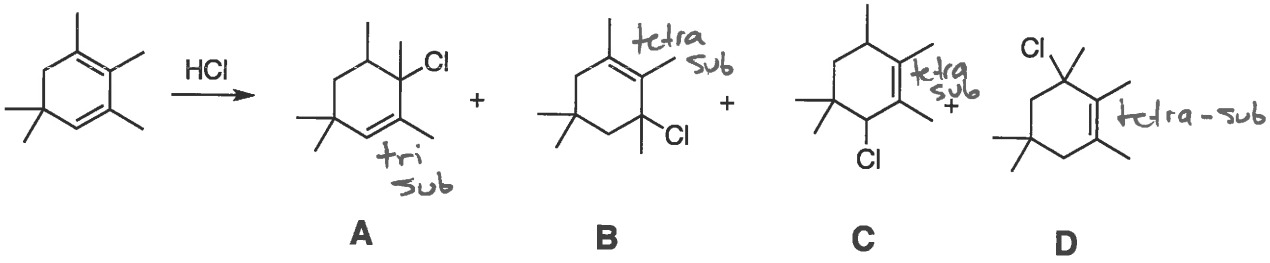
10. Which one of the statements is **incorrect** regarding the structure of benzene?

a. Benzene is an aromatic compound.
b. Benzene contains a cyclic array of conjugated p-orbitals.
c. Benzene is unusually unreactive.
d. The three double bonds in benzene are in rapid equilibrium around the six atoms of the ring.
e. All of the above statements are correct.

11. Which one of the following is not a resonance structure of the compound shown in the box below?



12. In the reaction below, which product(s) would be considered theromodynamic products?

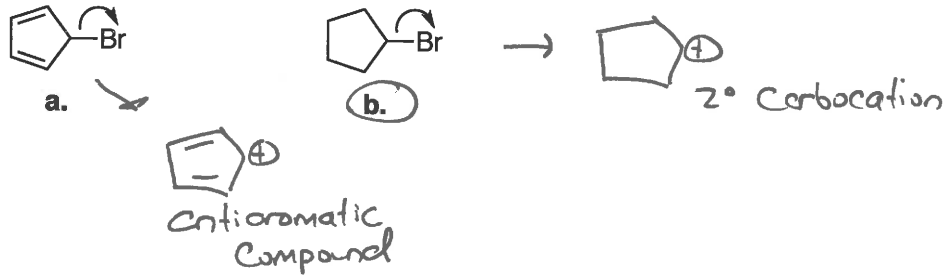


a. A & B
b. C & D
c. B, C, & D
d. A, B, C, & D

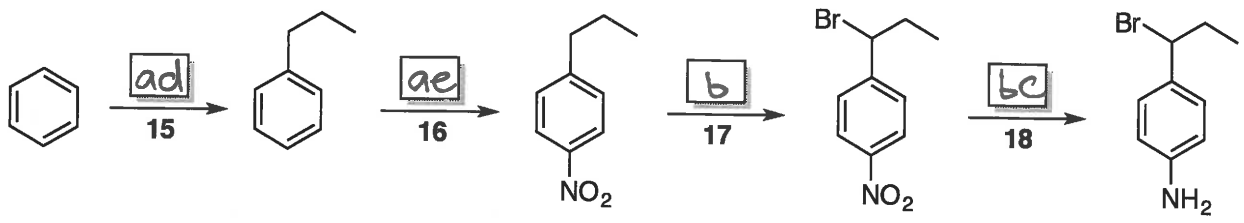
13. Which statement regarding the oxygen lone pairs in furan (shown below) is correct?

a. Both lone pairs are in p-orbitals
b. Both lone pairs are in sp^3 orbitals
c. Both lone pairs are in sp^2 orbitals.
d. One lone pair is an sp^2 orbital and one is in a p-orbital.
e. One lone pair is an sp^3 orbital and one is in a p-orbital.

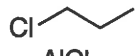
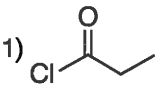
14. Which "loss of a leaving group" would you expect to occur at the faster rate?



For questions 15-18, select the appropriate reagent from the reagent bank to accomplish each step in the synthetic sequence below. *Note that some answers may require you to bubble in two letters.* ***Record each answer on your Scranton sheet!***



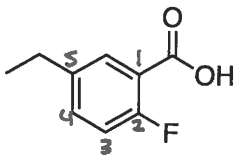
Reagent Bank

 $AlCl_3$	NBS light (hν)	$NaNO_2$ HCl	$Na_2Cr_2O_7$ H_2SO_4
a	**b**	**c**	**d**
Br_2	Br_2 $FeBr_3$	 $AlCl_3$	 $AlCl_3$ 2) Zn(Hg), HCl
e	**ab**	**ac**	**ad**
HNO_3 H_2SO_4	Sn HCl	$NaNH_2$	NaOH Br_2
ae	**bc**	**bd**	**be**

Completion Section
Answer the questions below in the spaces provided.

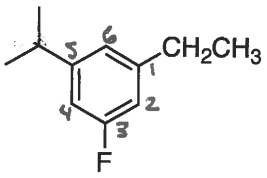
(9) 19. Provide the IUPAC name or structure for each compound below. *(3 points each)*

a.



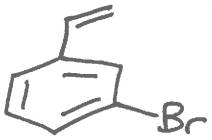
5-ethyl-2-fluorobenzoic acid
+1 +1 +1

b.

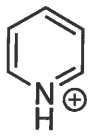


1-ethyl-3-fluoro-5-isopropylbenzene
+1 +1 +1

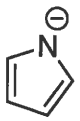
c. *meta*-bromostyrene



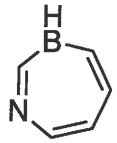
(10) 20. For each compound below, determine if it is aromatic, anti-aromatic, or non-aromatic. For aromatic and anti-aromatic compounds, indicate the number of π-electrons. *(2 points each)*



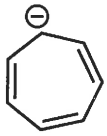
aromatic
6 π e-



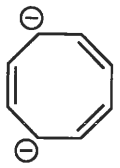
aromatic
6 π e-



aromatic
6 π e-

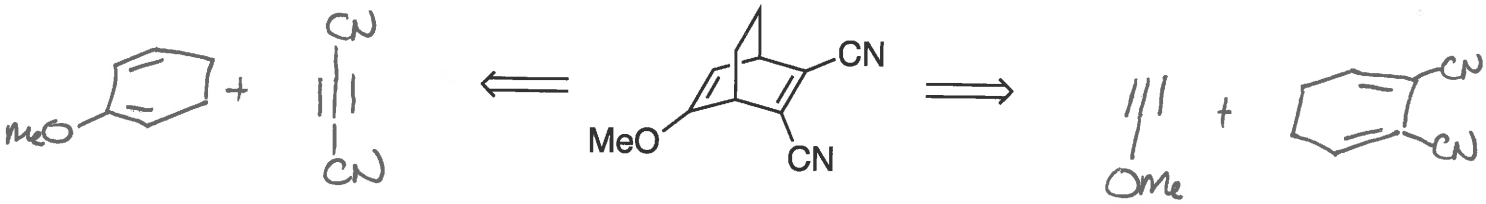


non-aromatic
π e-



aromatic
10 π e-

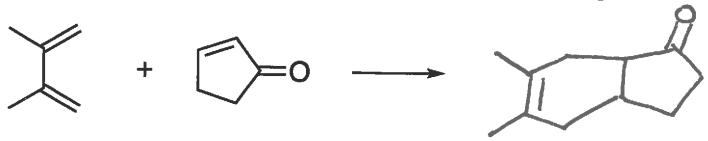
(2) 21. The compound below can be prepared via a Diels-Alder reaction using two different sets of starting materials. Show both possible sets of starting materials. *(2 points)*



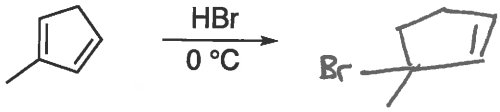
21

(18) 22. 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)*

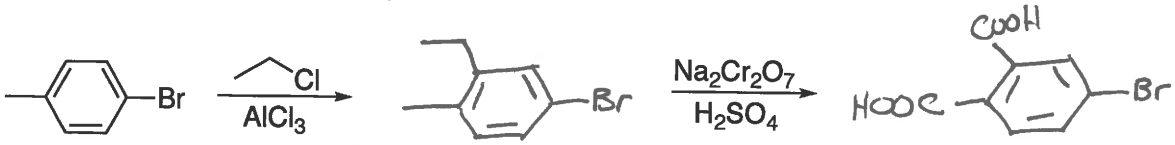
a.



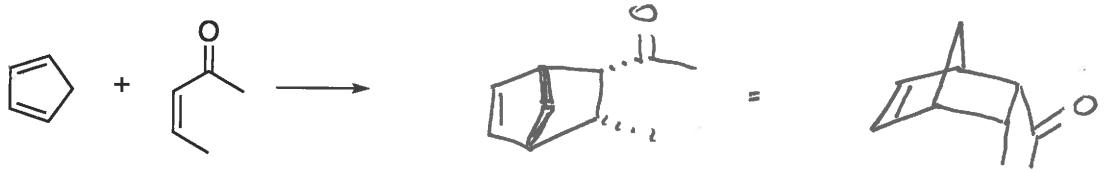
b.



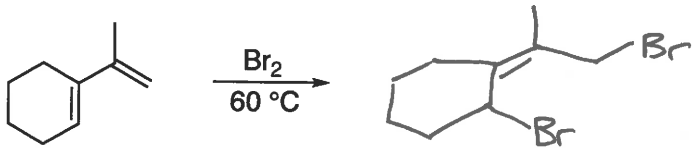
c.



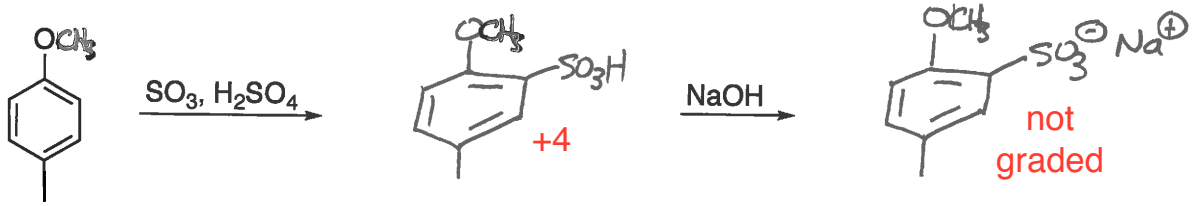
d.



e.

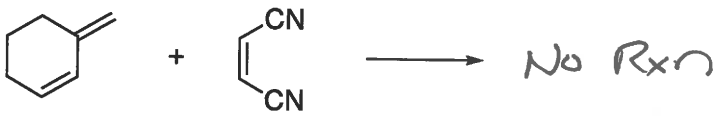


f.

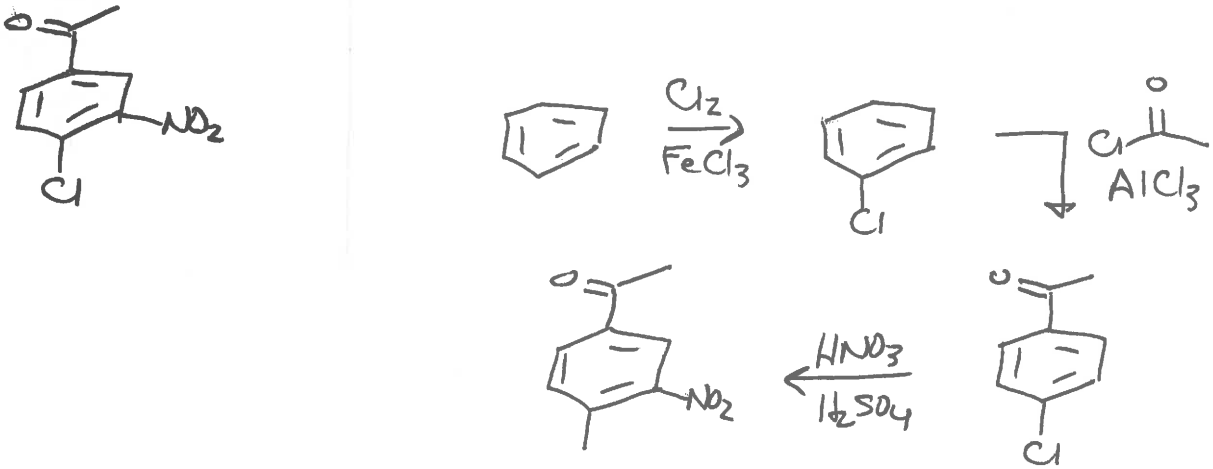


+4

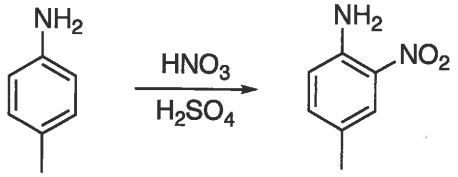
g.



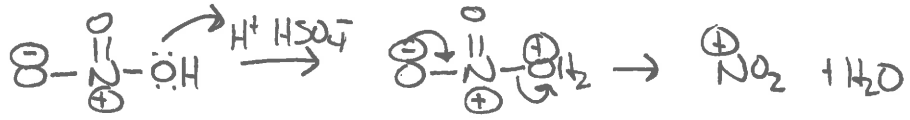
(6) 23. Design a synthesis for the ~~tetra~~-substituted benzene below starting with benzene. *(6 points)*



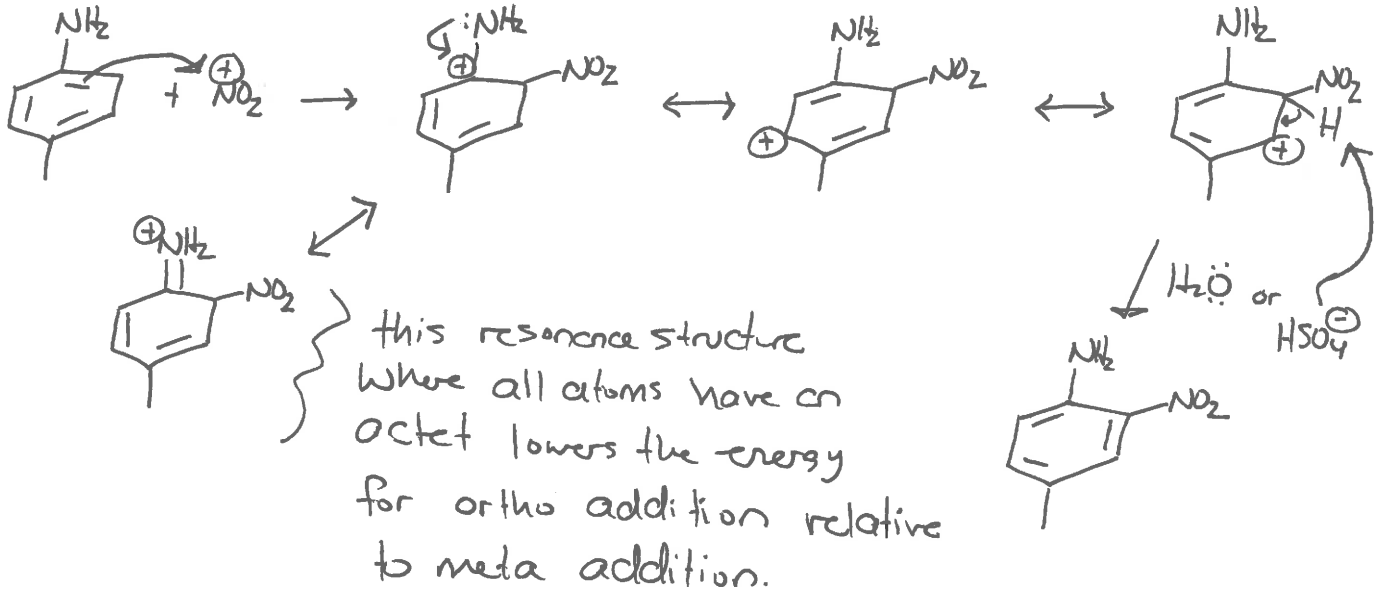
(9) 24. Draw the complete electron pushing mechanism for the reaction shown below. Be sure to show all resonance structures. Using your resonance structures, explain the regioselectivity. *(9 points)*



A. Electrophile Generation:



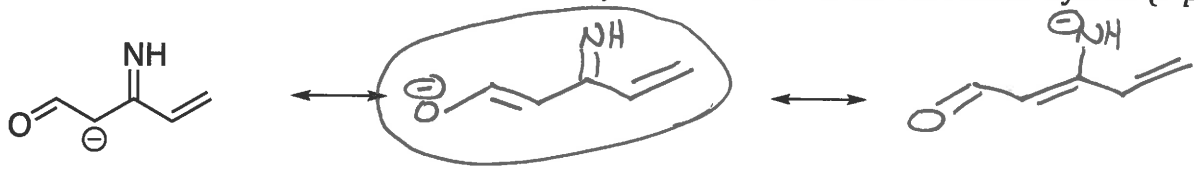
B. Electrophilic Addition to the Benzene Ring:



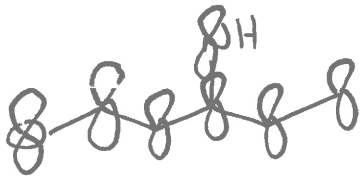
(10) 25. Consider the molecule shown below and answer the following questions.

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)*

7

e. What is the hybridization of the carbon bearing the negative charge? *(1 pt)*

sp^2

f. In what type of orbital does the nitrogen lone pair reside? *(1 pt)*

sp^2

26. **Bonus:** The reaction shown below takes place via a Diels-Alder reaction and subsequent retro-Diels-Alder reaction with the loss of N_2 gas. What is the final product? ***(2 bonus points)***