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

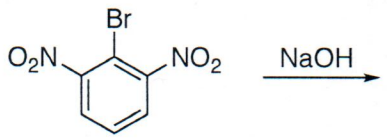
IA																	VIIIA
1 H 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 Al 26.98	14 Si 28.09	15 P 30.97	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)

Multiple-Choice

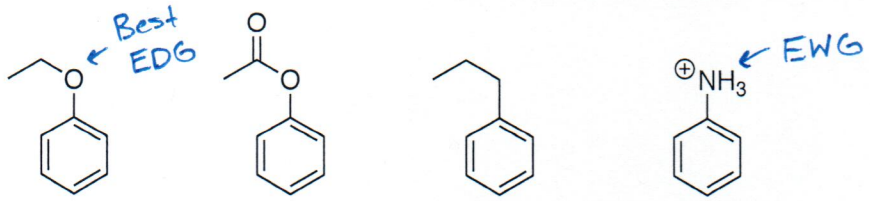
Choose the best answer for each of the following questions. Record each answer on the attached bubble sheet. **Ensure you completely bubble in your answers.** *(2 points each)*

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



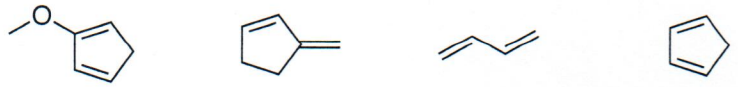
   a. Electrophilic Aromatic Substitution
   b. Addition-Elimination
   c. Benzyne (Elimination-Addition)

2. Which aromatic ring will undergo electrophilic bromination at the fastest rate?



a b c d

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



I II III IV

   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

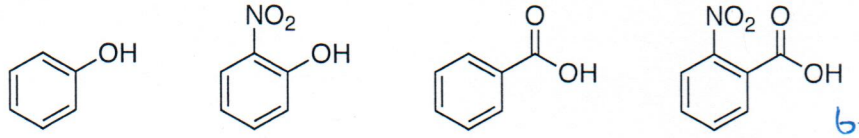
S-cis w/ EDG

II < III < IV < I

locked S-trans

S-cis

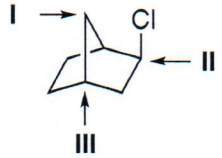
4. Which compound below is the most acidic?



a b c d

benzoic acid w/ EWG

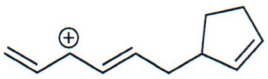
5. Which of the indicated carbons is a bridgehead carbon?

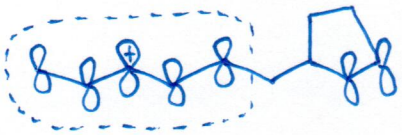


I + III are bridge Carbons

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

6. The following compound contains 7 p-orbitals and 5 atoms in conjugation.

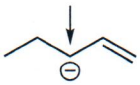




Conjugated portion

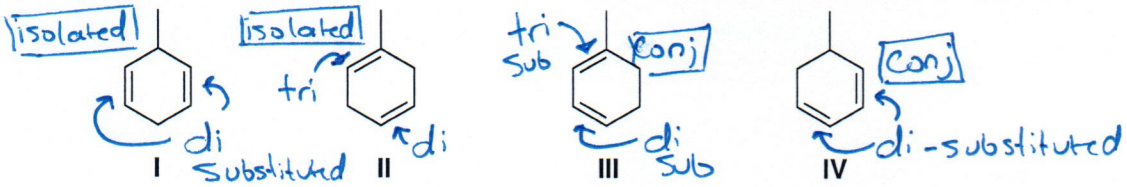
a. 4, 4
b. 5, 5
c. 7, 5
d. 7, 4
e. 6, 5

7. What is the hybridization of the indicated atom?



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

8. Structure III is the most stable and structure I is the least stable in the group.



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?

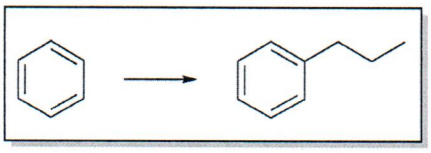
a b

Deprotonation of a results in an aromatic compound.

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

Ph–OCH_3 (a) Ph–NO_2 (b) Ph–C(=O) (c) Ph–CH_3 (d)

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



a: Cl, $AlCl_3$

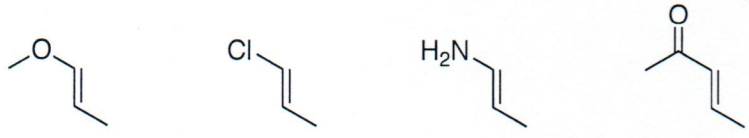
b: Cl, $AlCl_3$

c: 1. O, Cl, $AlCl_3$ 2. Zn(Hg), HCl

d: 1. O, Cl, $AlCl_3$ 2. $NaNO_2$, HCl

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

↳ EWG ↑ rate



a b c d

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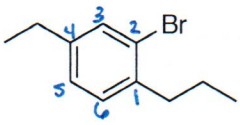
Completion Section

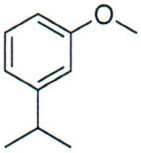
Answer the remaining questions directly on the exam itself. Please write neatly and darkly as your answers will be scanned.

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

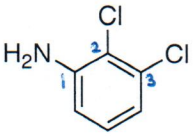
(+1) Correct substituents in abc order
(+1) Correct #
(+1) Correct parent

a. 

2-bromo-4-ethyl-1-propylbenzene

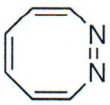
b. 

meta-isopropylanisole (+1) (+1) (+1) or 3-isopropylanisole

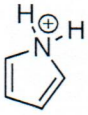
c. 

2,3-dichloroaniline (+1) (+1) (+1)

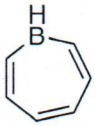
14. Label each compound below as: aromatic, non-aromatic, or antiaromatic. For aromatic and antiaromatic compounds, write the number of participating π-electrons. *(2 points each)*



(+2) non-aromatic
— π e⁻



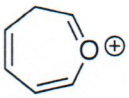
(+2) non-aromatic
— π e⁻



(+1) aromatic
(+1) 6 π e⁻

(+1) aromatic
(+1) 6 π e⁻

(+1) antiaromatic
(+1) 4 π e⁻



(+2) non-aromatic
— π e⁻

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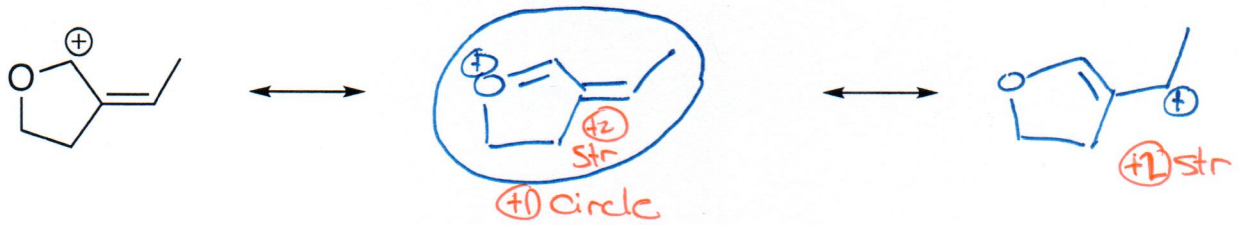
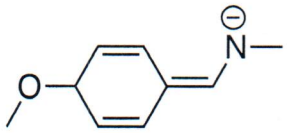
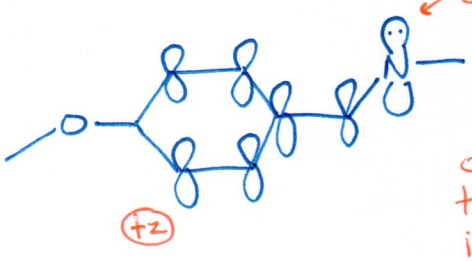
15. Draw two additional resonance structures for the following molecule then circle the major contributor to the resonance hybrid. *(5 points)*



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.



don't have to show .. in p-orbital

okay if they draw in π bonds

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

2 (+2)

c. What is the hybridization of the nitrogen?

sp^2 (+2)

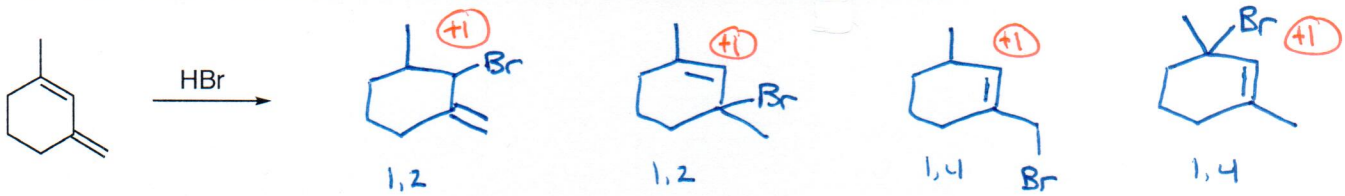
d. How many atoms are in conjugation?

7 (+2)

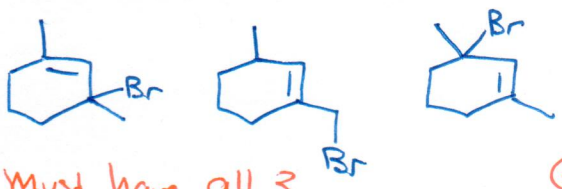
e. In what orbitals do the oxygen lone pairs reside?

Both in sp^3 orbitals (+2)

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
 must have both (+1)	 must have all 3 (+1)

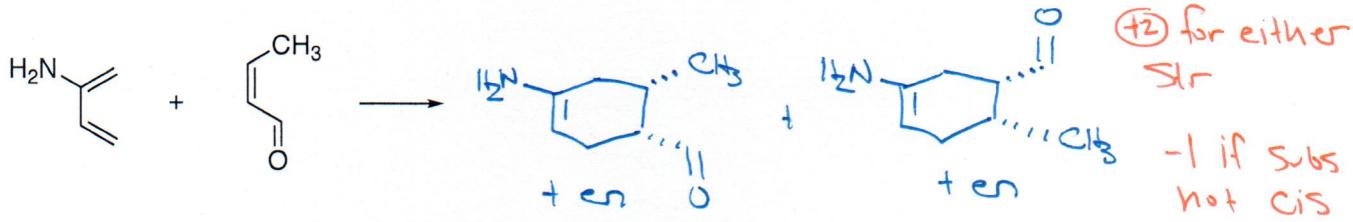
19. The products formed at low temperature are known as kinetic (+1) products. *(1 point)*

also accept 1,2

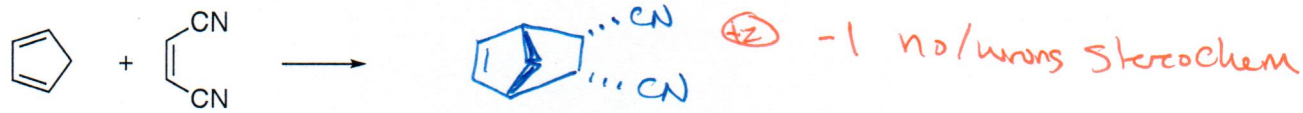
20. Predict the major product(s) for each of the following reactions. If the reaction does not proceed under the indicated conditions, write "*no reaction*". *(2 points each)*

a.

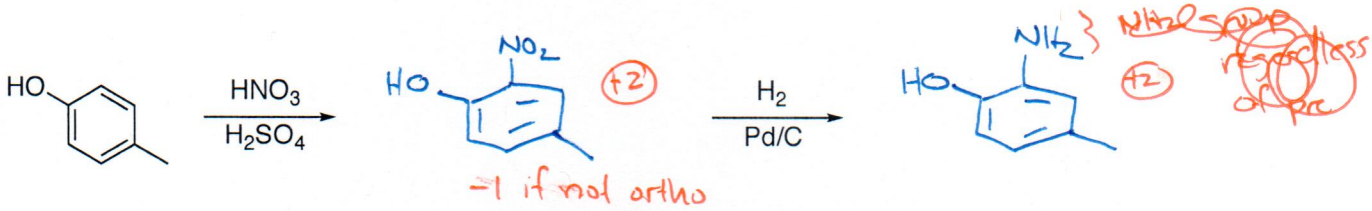
b.



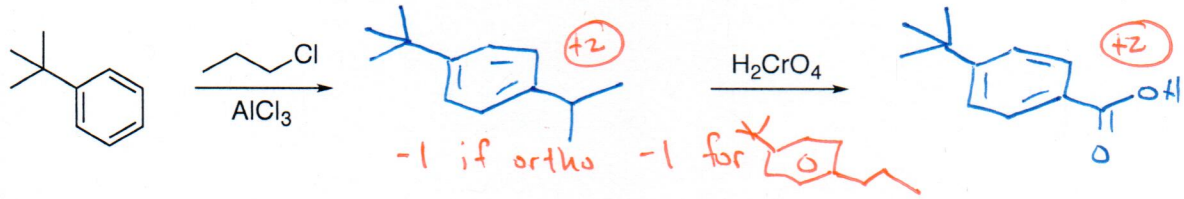
c.



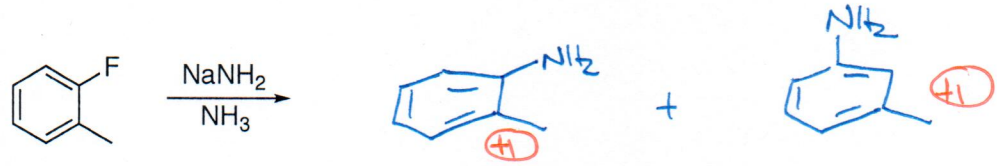
d.



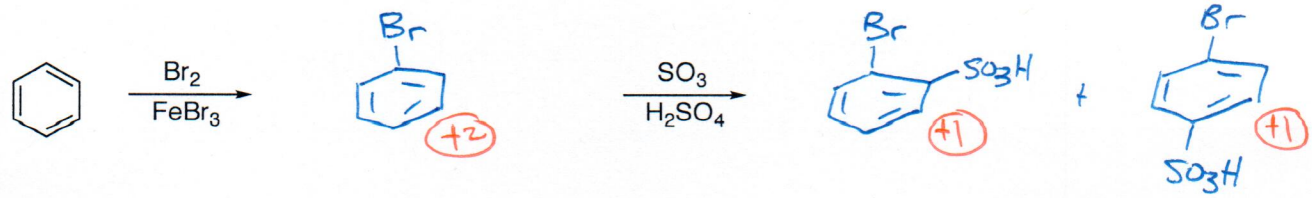
e.



f.



g.



Pg 7/8

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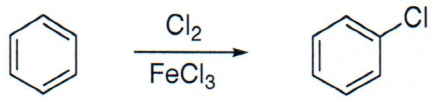
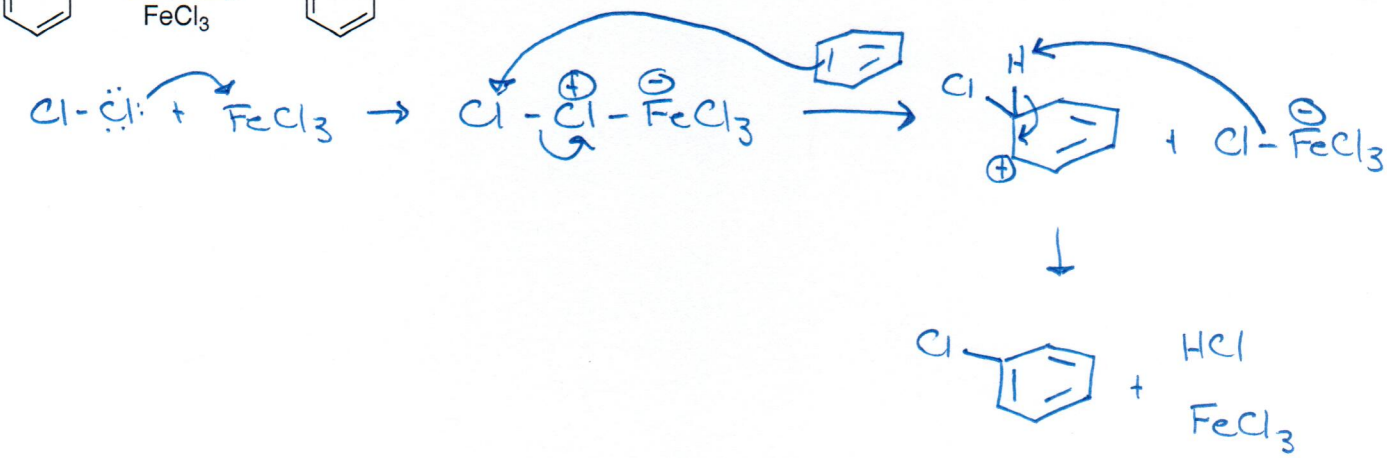
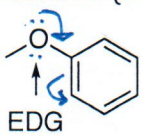
21. Provide the complete electron pushing mechanism for the following reaction. Be sure to show the mechanism for active electrophile generation and for electrophilic aromatic substitution. *(6 points)*

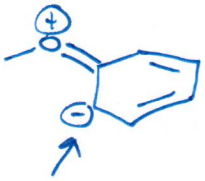




22. Briefly explain why the methoxy group is electron donating. Use structures to support your answer. *(3 points)*

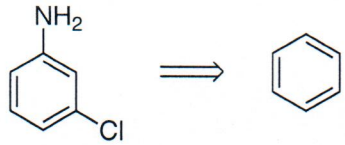


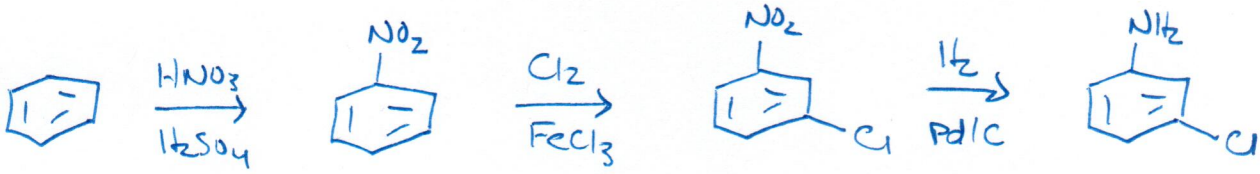
The lone pair donates to the ring via resonance



resonance puts e⁻ density on ring

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





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