Answer Key

Chemistry 234-101
Exam 2

Summer 2019 Dr. J. Osbourn

Instructions: Answer the first 20 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

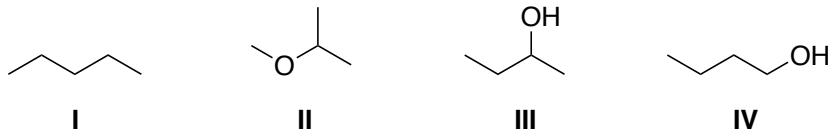
IA																	VIIIA
1 H 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 Al 26.98	14 Si 28.09	15 P 30.97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

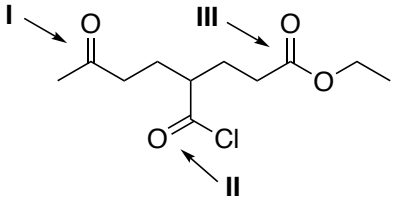
1. In the following series of compounds, IV will have the highest boiling point and I will have the lowest boiling point.



I II III IV

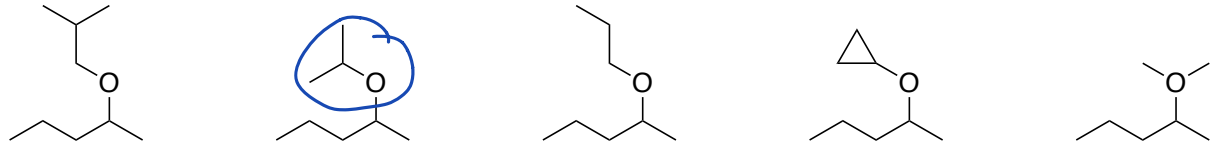
a. III, I
b. III, II
c. IV, I
d. IV, II
e. II, III

2. If the following compound is subjected to a sodium borohydride reduction, which of the functional groups will undergo reduction?



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

3. Which one of the following contains an isopropoxy substituent?

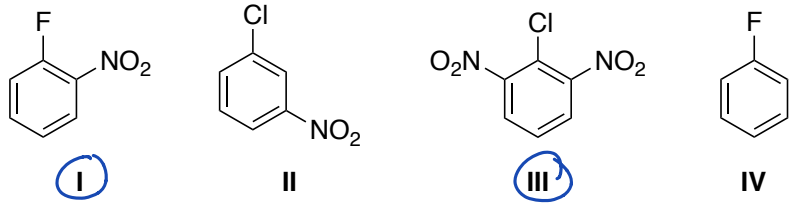


a b c d e

4. What is the neurotoxin produced when methanol is metabolized by the body?
   a. Formic Acid (HCO_2H)
   b. Acetic Acid ($H_3C\text{-}CO_2H$)
   c. Acetaldehyde ($H_3C\text{-}CHO$)
   d. Methyl Radical ($H_3C\bullet$)
   e. None of the above

5. Which of the following compounds will undergo nucleophilic substitution by an addition-elimination mechanism?

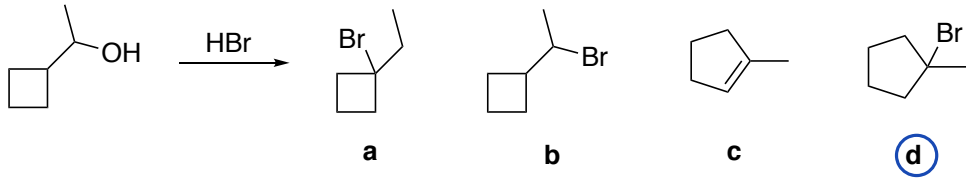
* Requires halogen w/ ortho or para EWG



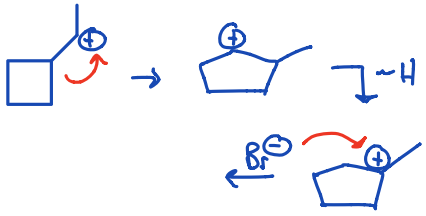
I II III IV

   a. IV only
   b. III only
   c. I, II, and III
   d. I and III
   e. I, II, III, and IV

6. What is the major product of the following reaction?

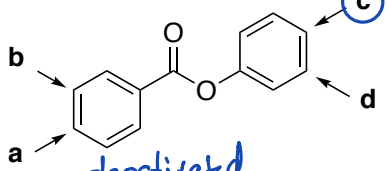


a b c d



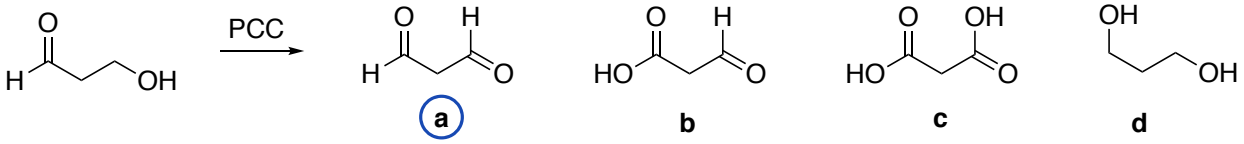
7. If the following compound is subjected to electrophilic nitration, at which position will the nitro group to add?

activated ring → o,p directed



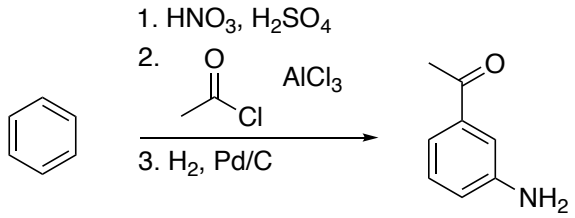
deactivated ring

8. What is the major product of the following reaction?



a b c d

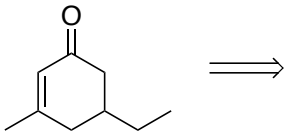
9. Will the following synthesis take place as written (i.e. will it work)?

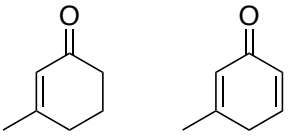


The Friedel-Crafts rxn does not work with the NO_2 on the ring.

a. Yes
b. No

10. Which starting materials can be used to prepare the following compound? *You should bubble in two letters!*





a b

EtMgBr c

Et_2CuLi d

$(CH_3)_2CuLi$ e

Structure Matching

For questions 11-14, match each term with the appropriate structure. Bubble these answers in on your bubble sheet for credit.

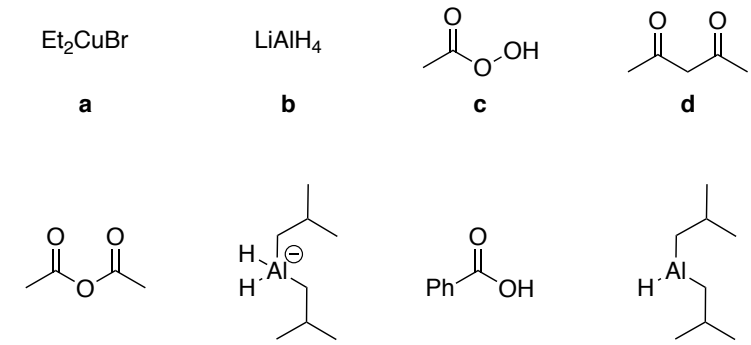
11. Peroxyacid c

12. Anhydride e

13. DIBAL-H ad

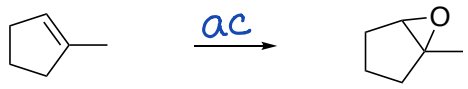
14. Ethyl Cuprate bd

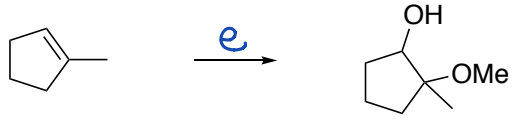
Structure Bank

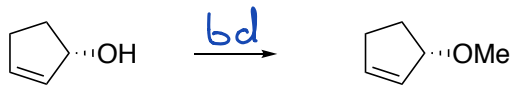


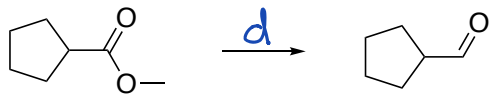
Reagent Matching

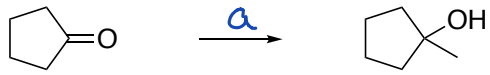
For questions 15-20 choose the appropriate reagent to accomplish each transformation. You may only use each reagent once. *Note: some answers may require you to bubble in two letters.*

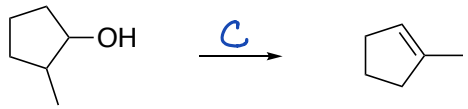
15. 

16. 

17. 

18. 

19. 

20. 

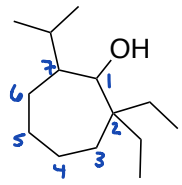
Reagent Bank

1. CH_3Li 2. Dilute H^+ **a**	1. TsCl Pyr. 2. NaOMe **b**	$POCl_3$ Pyridine **c**
1. Dibal-H 2. H_2O **d**	H_2SO_4 CH_3OH **e**	MDMA **ab**
1. Br_2, H_2O 2. NaH **ac**	1. NaOMe 2. Dilute H^+ **ad**	$NaBH_4$ CH_3OH **ae**
KOtBu **bc**	1. PCl_3 2. NaOMe **bd**	1. $(CH_3)_2CuLi$ 2. H_2O **be**

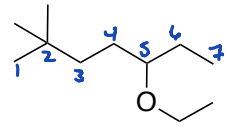
Completion Section

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

21. Provide IUPAC systematic names for each compound shown below. *(3 points each)*

a) 

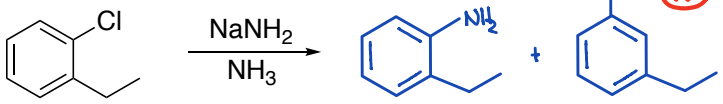
2,2-diethyl-7-isopropylcycloheptanol

b) 

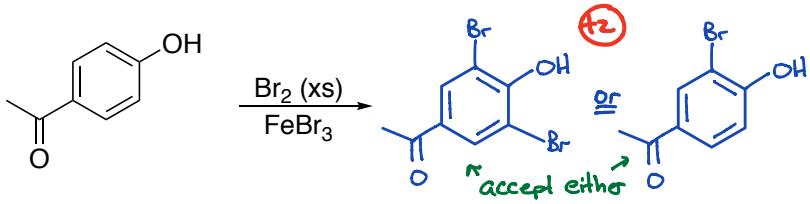
5-ethoxy-2,2-dimethylheptane

-1 wrong #
-1 wrong abc order of substituents
-1 incorrect substituent
-1 wrong parent

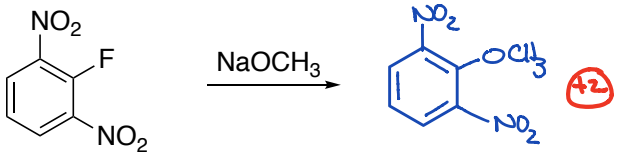
22. Predict the major product(s) for each of the following reactions. Then, circle the mechanism by which the reaction proceeds. *(3 points each)*

a) 

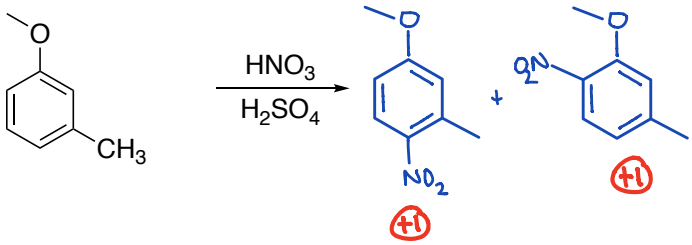
Addition-Elimination
Elimination-Addition +1
EAS

b) 

Addition-Elimination
Elimination-Addition
EAS +1

c) 

Addition-Elimination +1
Elimination-Addition
EAS

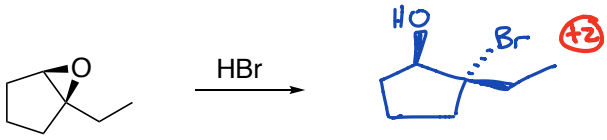
d) 

Addition-Elimination
Elimination-Addition
EAS +1

/18

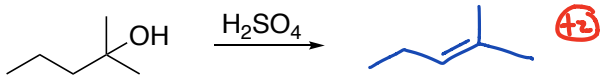
23. Predict the major product(s) for each of the following reactions. *(2 points each)*

a)



-1 wrong/no stereochem
-1 Br added to wrong C

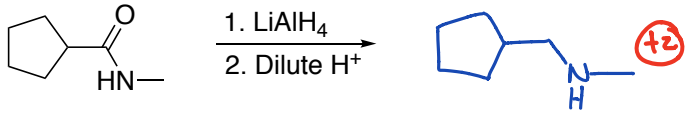
b)



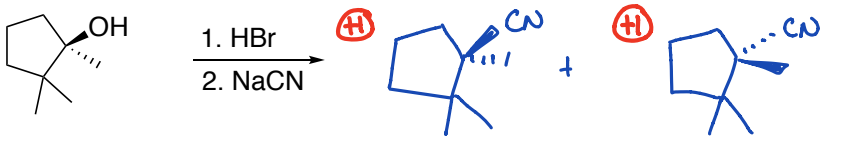
c)

d)

e)

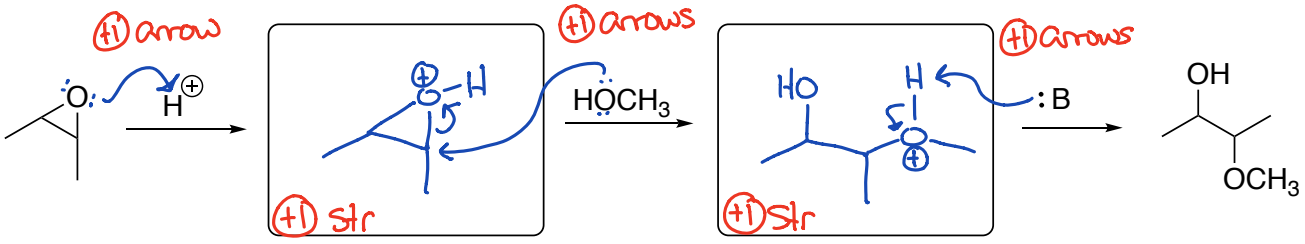


f)



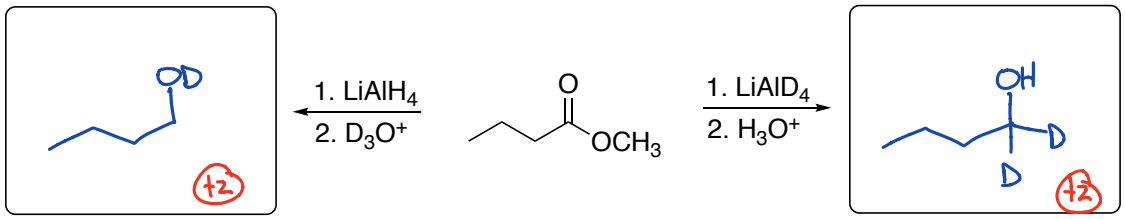
also accept 1 product with + enantiomer written

24. For the following mechanism: **a.** Provide the missing intermediates. **b.** Draw in curved arrows to show electron flow. *(5 points)*

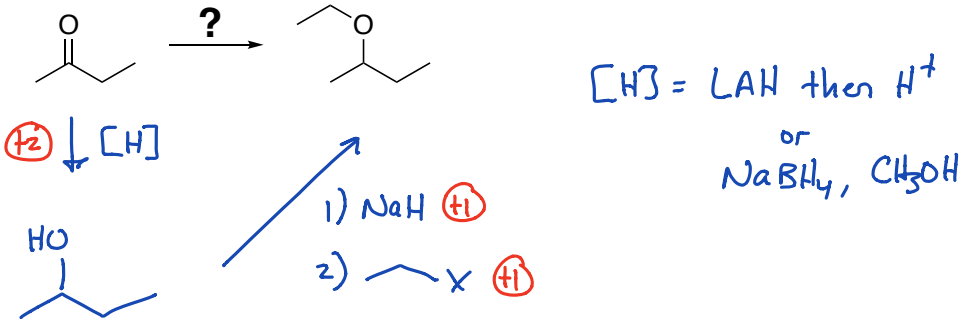


/21

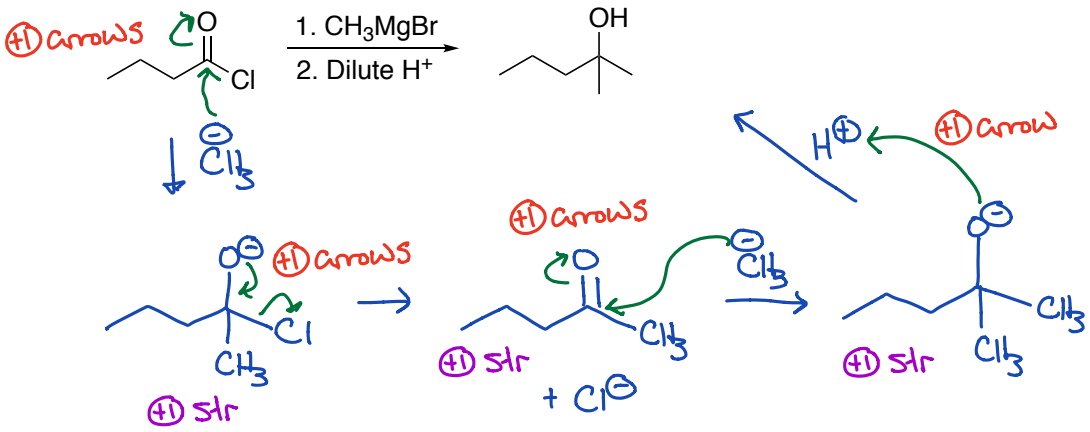
25. Draw the major product for each of the following reactions. *(2 points each)*



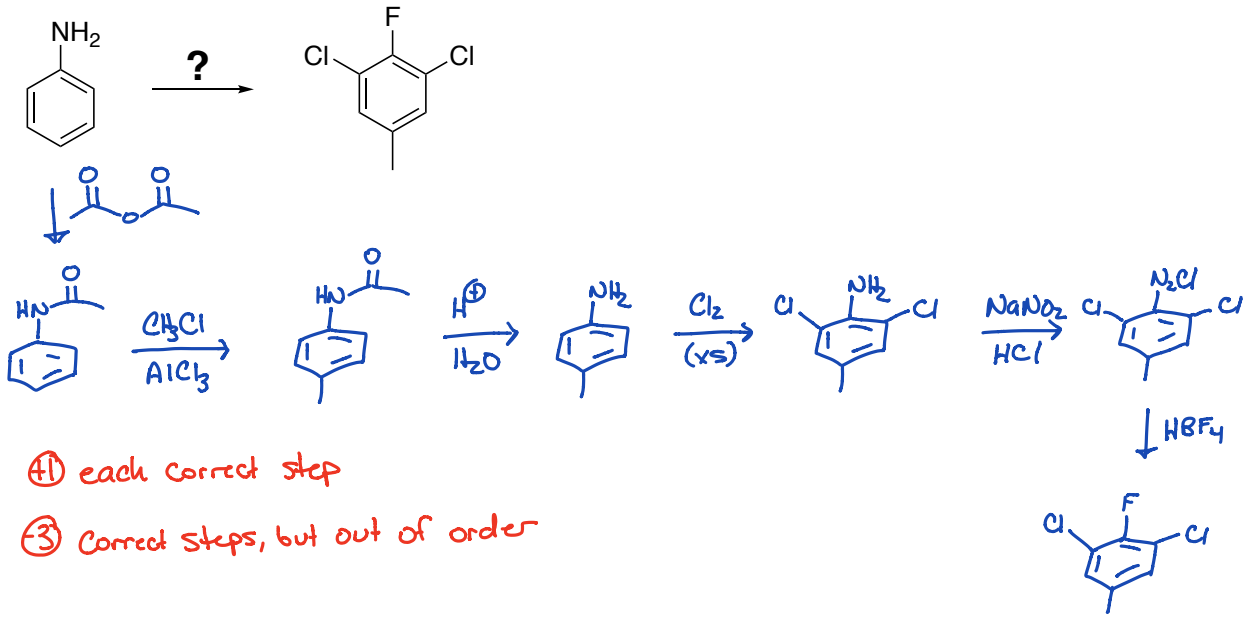
26. Design a reasonable synthesis to prepare the following product from the given starting material and any other organic or inorganic reagents. *(4 points)*



27. Show the complete electron pushing mechanism for the following reaction. *(7 points)*



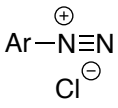
28. Design a synthesis for the following tetra-substituted arene starting with aniline. Your synthesis should not produce any undesired isomers. *(6 points)*



+1 each correct step

-3 Correct steps, but out of order

Diazonium Ion Displacement Reactions



+

H_2O	$\longrightarrow$ Ar—OH	CuCN	$\longrightarrow$ Ar—CN
$CuNO_2$	$\longrightarrow$ Ar—NO_2	H_3PO_2	$\longrightarrow$ Ar—H
CuBr	$\longrightarrow$ Ar—Br	CuCl	$\longrightarrow$ Ar—Cl
KI	$\longrightarrow$ Ar—I	HBF_4	$\longrightarrow$ Ar—F

/6