

# 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.

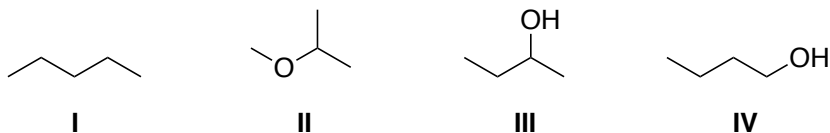
**The Periodic Table**

1 <b>H</b> 1.01	2 <b>He</b> 4.00											13 <b>B</b> 10.81	14 <b>C</b> 12.01	15 <b>N</b> 14.01	16 <b>O</b> 16.00	17 <b>F</b> 19.00	18 <b>Ne</b> 20.18
3 <b>Li</b> 6.94	4 <b>Be</b> 9.01											13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.07	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31	3 <b>III</b>	4 <b>IV</b>	5 <b>V</b>	6 <b>VI</b>	7 <b>VII</b>	8	9 <b>VIII</b>	10	11 <b>IB</b>	12 <b>IIB</b>	13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.07	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
19 <b>K</b> 39.1	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.39	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.61	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80
37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.91	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.29
55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La*</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.9	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
87 <b>Fr</b> (223)	88 <b>Ra</b> (226)	89 <b>Ac^</b> (227)	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (264)	108 <b>Hs</b> (265)	109 <b>Mt</b> (268)	110 <b>Ds</b> (271)	111 <b>Rg</b> (272)							
		* 58 <b>Ce</b> 140.1	59 <b>Pr</b> 140.9	60 <b>Nd</b> 144.2	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.4	63 <b>Eu</b> 152.0	64 <b>Gd</b> 157.3	65 <b>Tb</b> 158.9	66 <b>Dy</b> 162.5	67 <b>Ho</b> 164.9	68 <b>Er</b> 167.3	69 <b>Tm</b> 168.9	70 <b>Yb</b> 173.0	71 <b>Lu</b> 175.0		
		^ 90 <b>Th</b> 232.0	91 <b>Pa</b> (231)	92 <b>U</b> 238.0	93 <b>Np</b> (237)	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (260)		

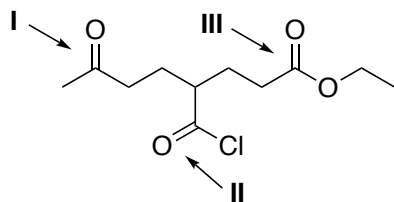
### Multiple-Choice

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)

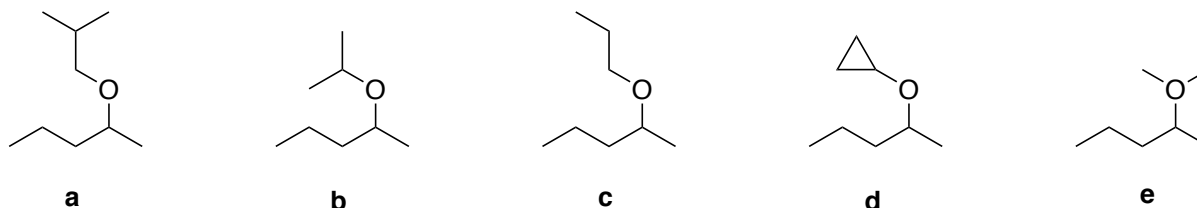
1. In the following series of compounds, \_\_\_ will have the highest boiling point and \_\_\_ will have the lowest boiling point.



- 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?



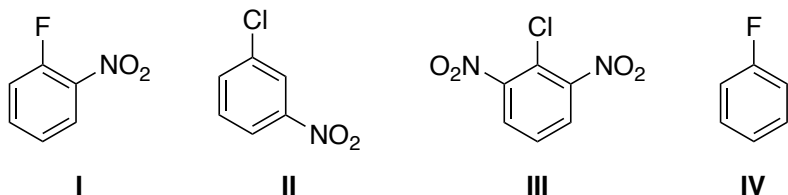
- a. I only  
b. I and II  
c. I and III  
d. II only  
e. I, II, and III
3. Which one of the following contains an isopropoxy substituent?



4. What is the neurotoxin produced when methanol is metabolized by the body?

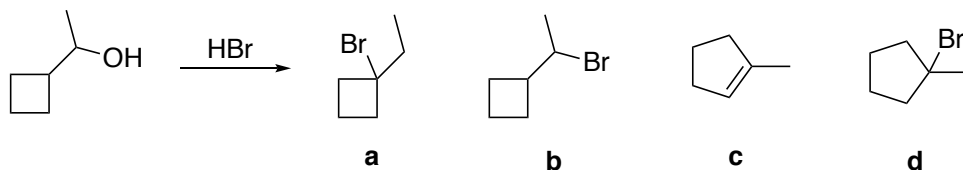
- a. Formic Acid ( $\text{HCO}_2\text{H}$ )
- b. Acetic Acid ( $\text{H}_3\text{C-CO}_2\text{H}$ )
- c. Acetaldehyde ( $\text{H}_3\text{C-CHO}$ )
- d. Methyl Radical ( $\text{H}_3\text{C}\bullet$ )
- e. None of the above

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

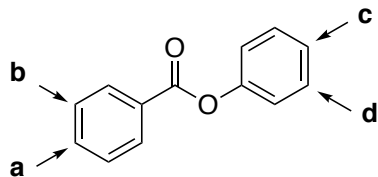


- a. IV only
- b. III only
- c. I, II, and III
- d. I and III
- e. I, II, III, and IV

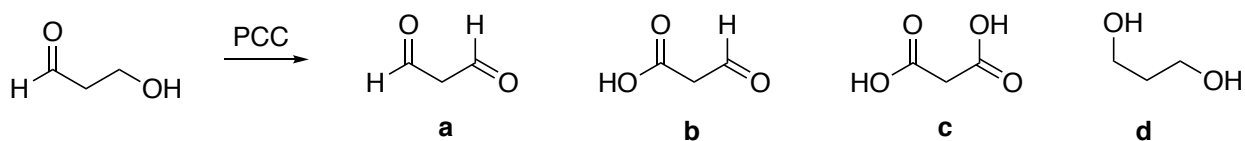
6. What is the major product of the following reaction?



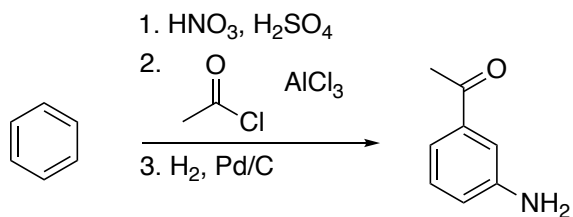
7. If the following compound is subjected to electrophilic nitration, at which position will the nitro group to add?



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

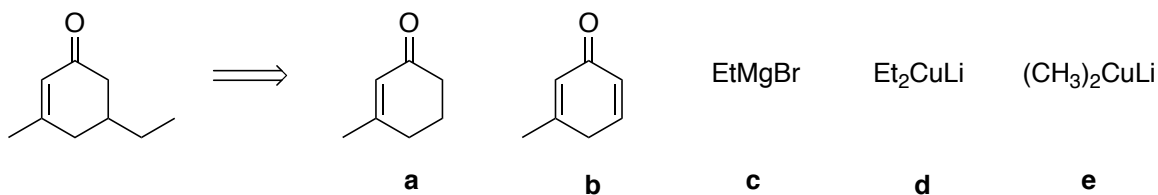


9. Will the following synthesis take place as written (i.e. will it work)?



- a. Yes  
 b. No

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



### 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

12. Anhydride

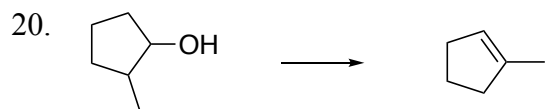
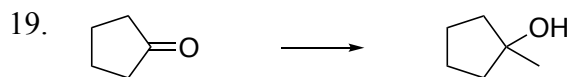
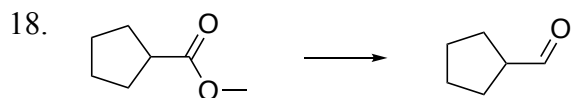
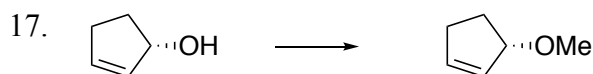
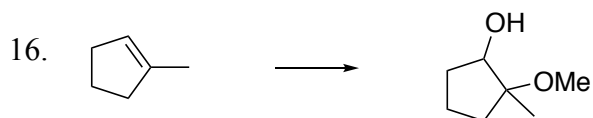
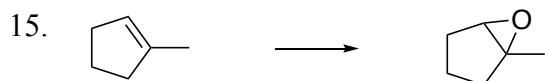
13. DIBAL-H

14. Ethyl Cuprate

Structure Bank			
<chem>CC(=O)OC(=O)C</chem> <b>a</b>	<chem>Li[AlH4]</chem> <b>b</b>	<chem>CC(=O)OO</chem> <b>c</b>	<chem>CC(=O)CC(=O)C</chem> <b>d</b>
<chem>CC(=O)OC(=O)C</chem> <b>e</b>	<chem>CC(C)C[AlH2]C(C)C</chem> <b>ab</b>	<chem>CC(=O)O</chem> <b>ac</b>	<chem>CC(C)C[AlH2]C(C)C</chem> <b>ad</b>
<chem>COCOC</chem> <b>ae</b>	<chem>H3PO2</chem> <b>bc</b>	<chem>CC(C)C[Li]Cu</chem> <b>bd</b>	<chem>C1CCC(CC1)[CuLi]</chem> <b>be</b>

## 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.*

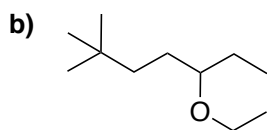
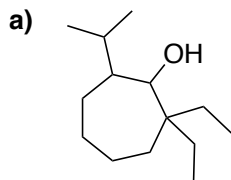


Reagent Bank		
1. CH <sub>3</sub> Li 2. Dilute H <sup>+</sup> <b>a</b>	1. TsCl Pyr. 2. NaOMe <b>b</b>	POCl <sub>3</sub> Pyridine <b>c</b>
1. DIBAL-H 2. H <sub>2</sub> O <b>d</b>	H <sub>2</sub> SO <sub>4</sub> CH <sub>3</sub> OH <b>e</b>	MDMA <b>ab</b>
1. Br <sub>2</sub> , H <sub>2</sub> O 2. NaH <b>ac</b>	1. NaOMe 2. Dilute H <sup>+</sup> <b>ad</b>	NaBH <sub>4</sub> CH <sub>3</sub> OH <b>ae</b>
KOtBu <b>bc</b>	1. PCl <sub>3</sub> 2. NaOMe <b>bd</b>	1. (CH <sub>3</sub> ) <sub>2</sub> CuLi 2. H <sub>2</sub> O <b>be</b>

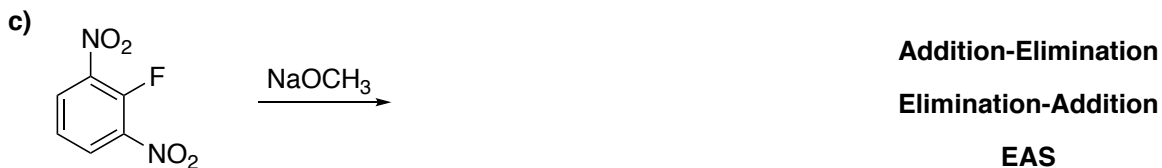
### Completion Section

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)

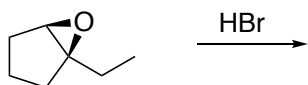


22. Predict the major product(s) for each of the following reactions. Then, circle the mechanism by which the reaction proceeds. (3 points each)

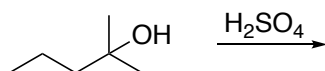


23. Predict the major product(s) for each of the following reactions. Be sure to indicate stereochemistry in parts **a** and **f**. (2 points each)

a)



b)



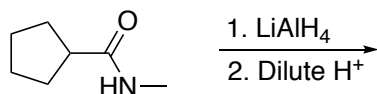
c)



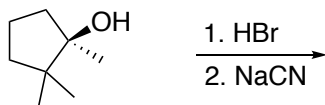
d)



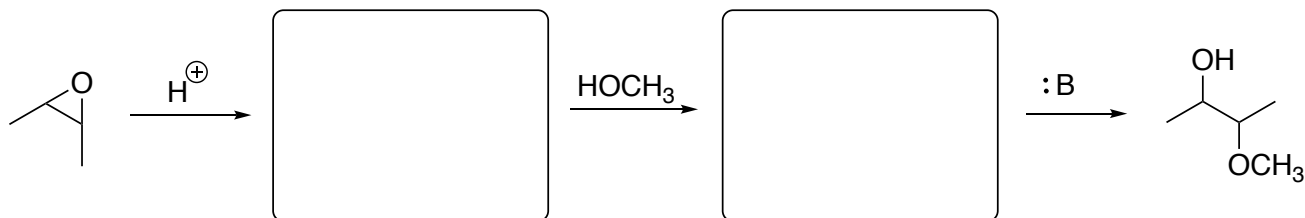
e)



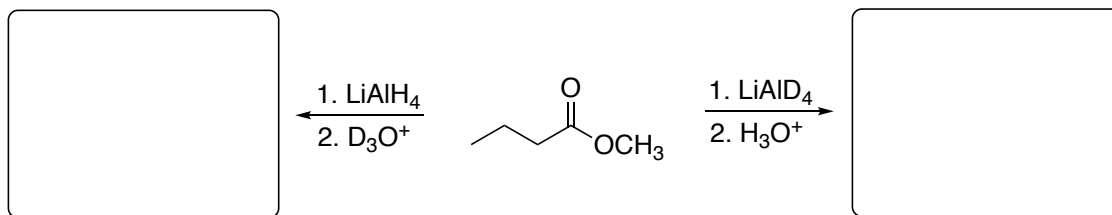
f)



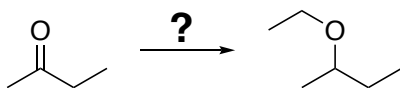
24. For the following mechanism: **a**. Provide the missing intermediates. **b**. Draw in curved arrows to show electron flow. (5 points)



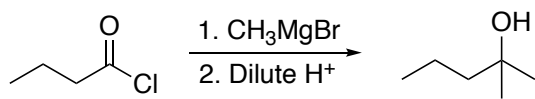
25. Draw the major product for each of the following reactions. (2 points each)



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

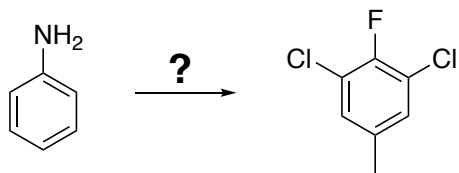


27. Show the complete electron pushing mechanism for the following reaction. (7 points)





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



### Diazonium Ion Displacement Reactions

