Name: _____

Last First MI

Chemistry 234-002
Exam 2

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												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 H 1.01	2 IIA																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)

Diazonium Ion Displacement Reactions

Please do not rip off this cover sheet

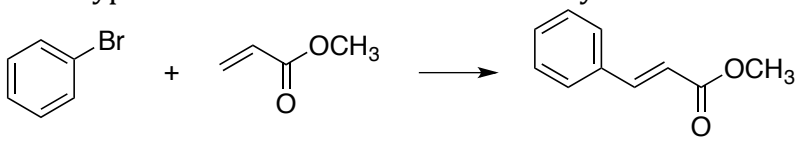
Name: _____
Last First MI

Grading Page (Exam 2):

Page	Points Possible	Points Earned
Multiple Choice (3-6)	36	
7	26	
8	23	
9	15 (+2 bonus)	
TOTAL	**100**	

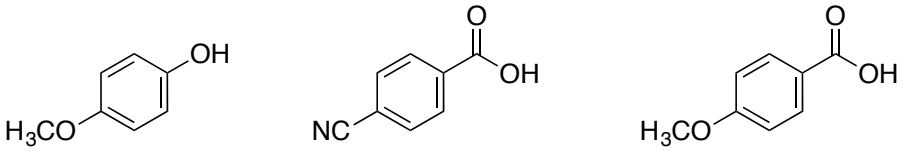
Multiple Choice
Choose the one best answer for each of the following questions. Bubble your answer in on the provided Scantron sheet. Additionally, circle your answer directly on the exam so that you can check your answers once the key is posted.

1. What type of reaction is best suited to carry out the following transformation?



   a. Grignard Reaction
   b. Suzuki Reaction
   c. Gillman Reaction (Organocuprate Coupling)
   d. Heck Reaction

2. Rank the compounds shown below in order of **increasing** acidity.

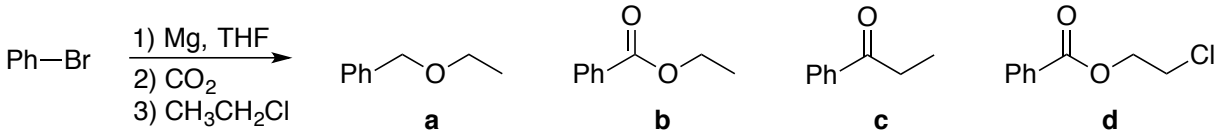


I **II** **III**

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

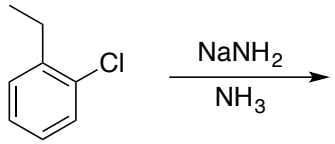
3. Consider each of the carbon-metal bonds. Which one contains the least nucleophilic carbon?
   a. C-Zn
   b. C-Hg
   c. C-Cu
   d. C-Mg

4. What is the product of the following reaction sequence?



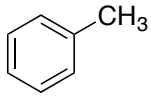
5. Which statement is **incorrect** regarding Grignard addition to an ester?
   a. The Grignard reagent will add twice to give a tertiary alcohol product following the workup.
   b. The workup step typically consists of adding dilute acid.
   c. The byproduct of the reaction is an alcohol
   d. The first tetrahedral intermediate collapses, expelling a leaving group to form a ketone.
   e. All of the above statements are correct.

6. How many different products are formed in the following reaction?

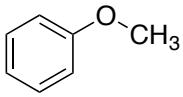


a. Zero
b. One
c. Two
d. Three
e. Four

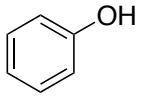
7. Compound ____ is expected to have the highest boiling point and compound ____ is expected to have the lowest boiling point.



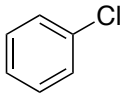
I



II



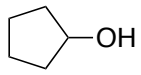
III



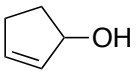
IV

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

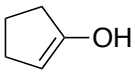
8. Which species shown below is an allylic alcohol?



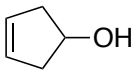
a



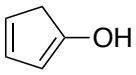
b



c

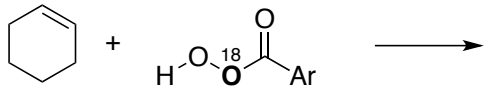


d



e

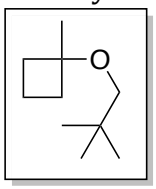
9. If an alkene were reacted with ^{18}O labeled mCPBA as shown below, which products would result?

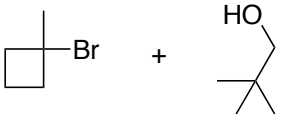


a **b**

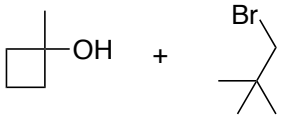
c **d**

10. What is the best set of starting materials to prepare the ether shown below via the Williamson ether synthesis?





a



b

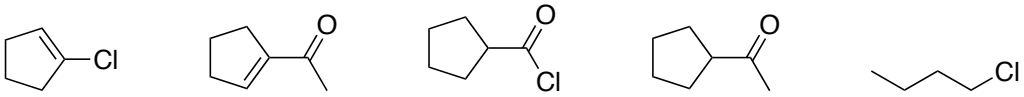
Both a and b could be used successfully

c

Neither a nor b could be used successfully

d

11. Which of the following substrates will undergo a successful reaction with methyl cuprate (Me_2CuLi)?



I **II** **III** **IV** **V**

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

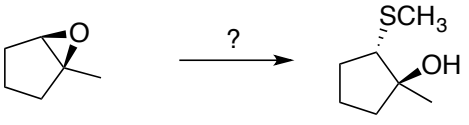
12. Which of the following alcohols would need to be protected prior to carrying out the indicated reaction?

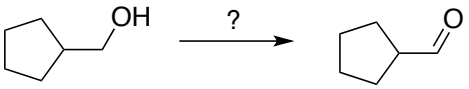
I **II**

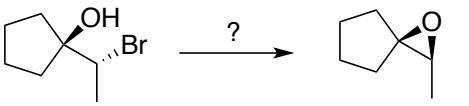
III **IV**

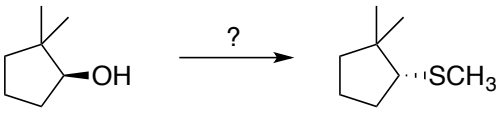
a. II and III
b. I, II, and III
c. I, II, III, and IV
d. II, III, and IV
e. None of the above alcohols need to be protected

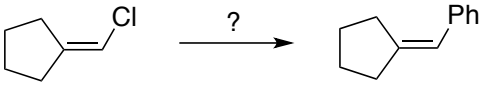
For questions 13-18, select the appropriate reagent from the reagent bank to accomplish each step in the synthetic sequence below. *Note that some answers may require you to bubble in more than one letter.* ***Record each answer on your Scranton sheet!***

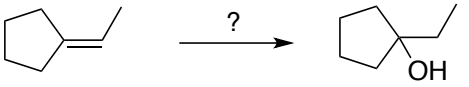
13. 

14. 

15. 

16. 

17. 

18 

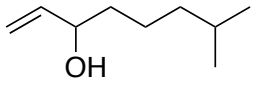
Reagent Bank

PCC **A**	1. BH_3•THF 2. NaOH H_2O_2 **B**	H^+ H_2O **C**
HBr **D**	NaH **E**	1. PBr_3 2. $NaSCH_3$ **AB**
Ph-H $Pd(OAc)_2$ **AC**	$Na_2Cr_2O_7$ H_2SO_4 **AD**	CrO_3 H^+ **AE**
1. TsCl Pyridine 2. $NaSCH_3$ **BC**	1. Ph_2CuLi 2. H_2O **BD**	H_2SO_4 $HSCH_3$ **BE**
$POCl_3$ Pyridine **CD**	$NaSCH_3$ **CE**	1. PhLi 2. H^+ workup **DE**

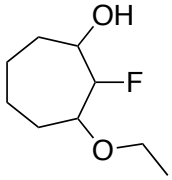
Completion Section: Answer the remaining questions on the exam itself. Read the questions carefully and provide complete explanations. If you have multiple answers written, circle the answer that you want graded.

19. Provide the IUPAC name or structure for each compound shown below. *(2 points each)*

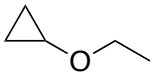
a)



b)



c)

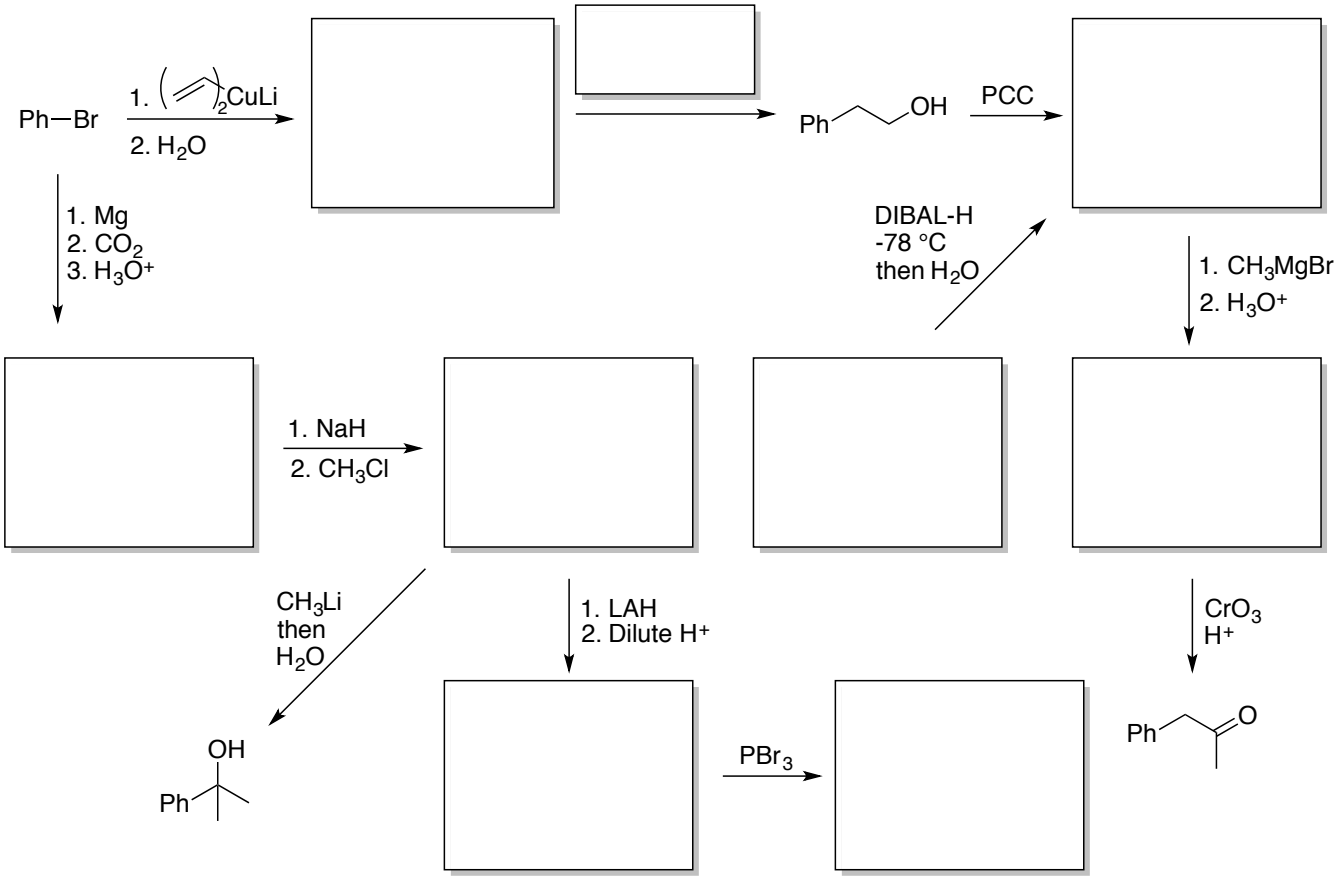


IUPAC:

Common:

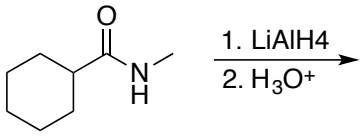
d) 4-methylpentane-1,2,3-triol
Structure:

20. Provide the missing structures or reagents in the synthetic scheme shown below. *(2 pts each)*

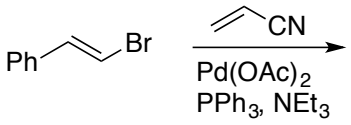


21. Predict the major organic product(s) for each reaction below. *Note: some questions have multiple steps associated with them. (2 points each)*

a.



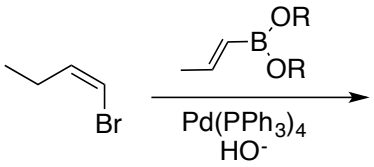
b.



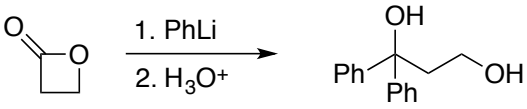
c.

d.

e.



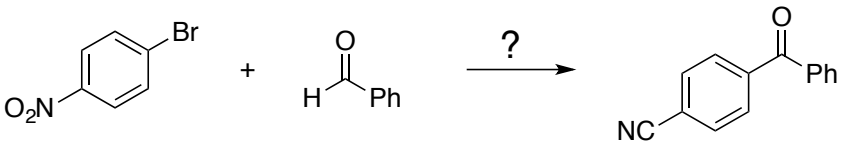
22. Show the complete electron pushing mechanism for the reaction shown below. *(6 points)*



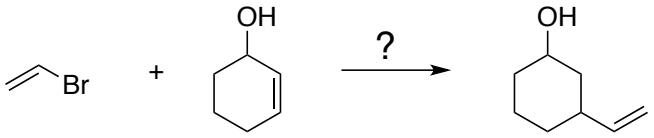
23. **Unknown X** is an acyclic 5-carbon alkane containing a chiral alcohol functional group. Oxidation with PCC provides a ketone product. Dehydration with $POCl_3$/Pyridine gives a di-substituted alkene product. Provide a plausible structure for **unknown X**. *(3 points)*

24. Design a reasonable synthesis for each molecule below using the provided starting materials and any other organic or inorganic reagents. *(10 points)*

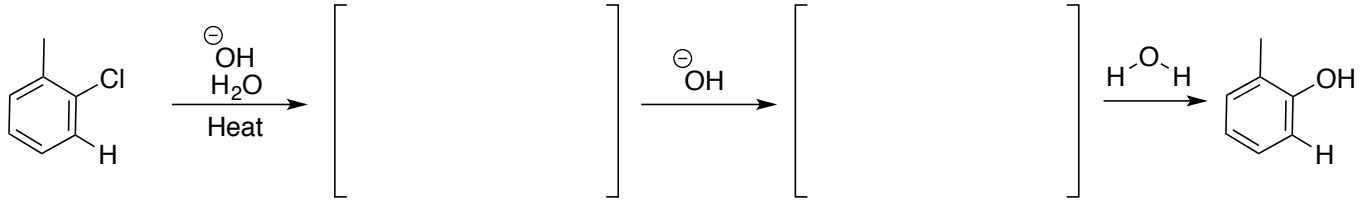
a.



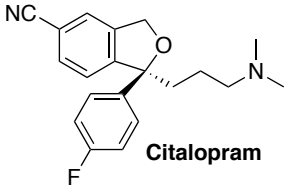
b.



25. Provide the intermediates in the reaction mechanism shown below and add curved arrows to show electron flow. *(5 points)*



26. Heywood Clonum, a biologist, has argued that Citalopram, an antidepressant, could be hazardous to human health because it could release toxic cyanide (NC^-) and fluoride (F^-) ions in the body via a substitution reaction with water acting as a nucleophile. Is his reasoning chemically sound? Explain why or why not. ***(2 bonus points)***



Citalopram