Name: Key
Last First MI

Chemistry 233-001/002
Exam 3 – Version Green

Fall 2018 Dr. J. Osbourn

Instructions: The first 15 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.

Failure to correctly bubble in your student ID number will result in a 2-point deduction from your exam score.

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)

****Please do not rip off this exam cover page****

GREEN

Name: _____
Last First MI

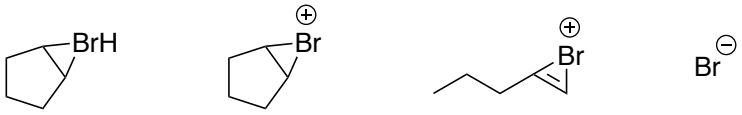
Grading Page (Exam 3)

Page	Points Possible	Points Earned
Multiple Choice (3-5)	30	
6	29	
7	28	
8	13 (+2)	
TOTAL	**100**	

GREEN

Multiple-Choice
Choose the best answer for each of the following questions. Record each answer on the provided Scantron sheet. Also, circle each answer directly on the exam. *(2 points each)*

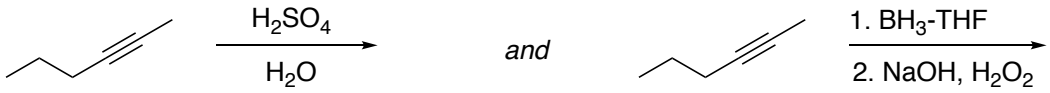
1. Which structure(s) represent bromonium ion(s)?



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

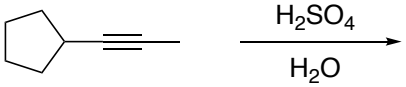
a. II only
b. IV only
c. II and III
d. I and II
e. I, II, and III

2. True or False: Both reactions below give identical products.



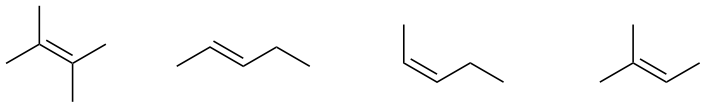
a. True
b. False

3. How many different products (stereoisomers and/or constitutional isomers) result from the following reaction?



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

4. Alkene III is the least stable while alkene I is the most stable.



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

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

5. Which one of the following statements is incorrect?

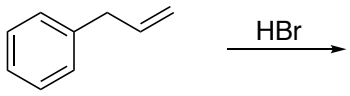
   a. In hydroboration-oxidation, H and OH are added *syn* across a double bond.
   b. When HBr is added to an alkene, the bromide will add from both the front side and the back side of the carbocation intermediate.
   c. Chlorination (addition of Cl_2) of an alkene proceeds with Markovnikov selectivity.
   d. Carbocation rearrangement does not occur during the chlorination of an alkene because a carbocation intermediate is not involved.

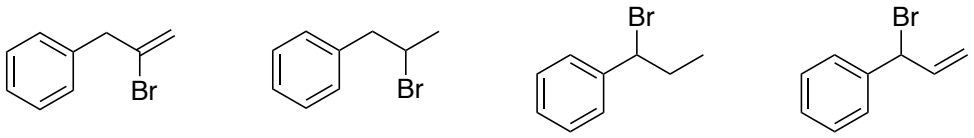
6. Which compounds below can be alkylated by treating with $NaNH_2$ followed by CH_3-I?

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

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

7. What is the major product of the following reaction? *Hint: we talked about this in recitation.*



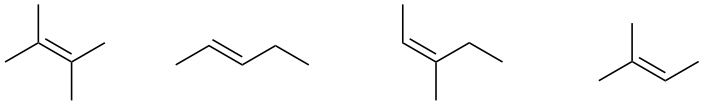


a **b** **c** **d**

8. What is the industrial process by which an alkane such as ethane is converted to an alkene such as ethene?

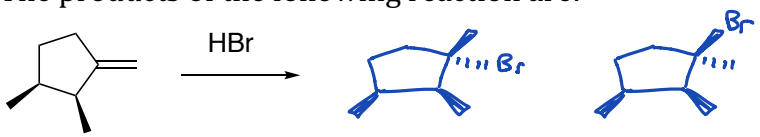
   a. Cracking
   b. Fractionating
   c. Distilling
   d. Refining
   e. None of the Above

9. Which compound shown below will undergo hydrogenation (H_2, Pd/C) at the fastest rate?



a **b** **c** **d**

10. The products of the following reaction are:

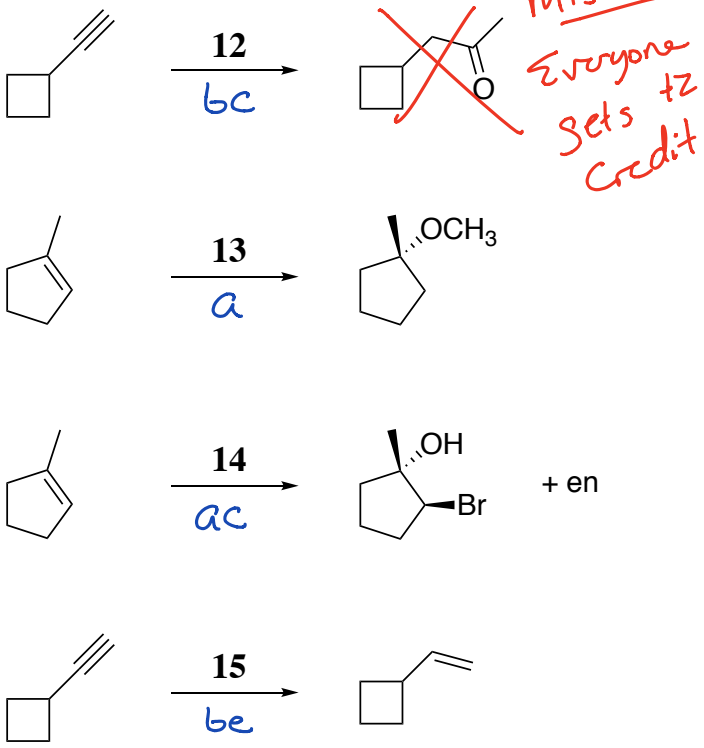


a. Enantiomers
b. Diastereomers
c. Constitutional Isomers
d. Not Isomers

11. In the hydroboration-oxidation reaction, BH_3 acts as a/an

a. nucleophile.
b. electrophile.
c. neither a nucleophile nor an electrophile.

For questions 12-15, choose the correct reagent from the reagent bank to accomplish each transformation. You may only use each reagent once. Some answers will require you to bubble in two letters (i.e. if you choose "H_2, Pd/C" you would bubble in both a and b). *Bubble these answers in on your scantron sheet to receive credit!*

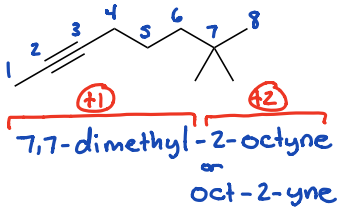


Reagent Bank		
H_2SO_4 CH_3OH **a**	$NaNH_2$ CH_3I **b**	H_2SO_4 H_2O **c**
Br_2 **d**	HBr **e**	H_2 Pd/C **ab**
Br_2 H_2O **ac**	Br_2 CH_3OH **ad**	HBr H_2O **ae**
$HgSO_4$ H_2SO_4 H_2O **bc**	1. BH_3 2. NaOH H_2O_2 **bd**	Na*(s)* NH_3*(l)* -78 °C **be**

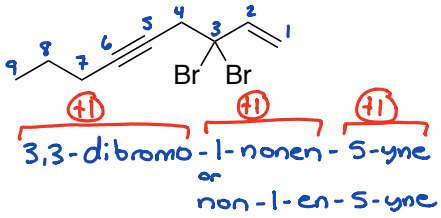
Completion Section
Answer the remaining questions in the spaces provided.

16. Provide the IUPAC name or structure for each. *(3 points each)*

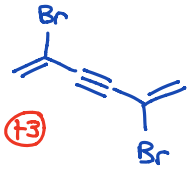
a.



b.



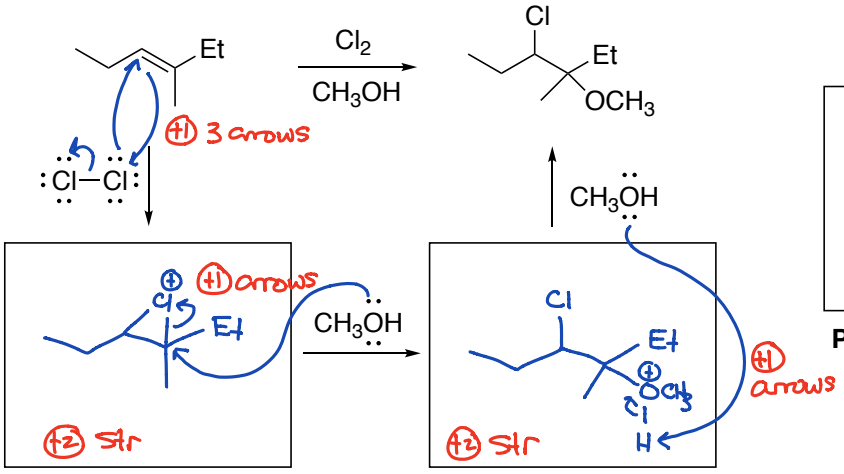
c. 2,5-dibromohexa-1,5-dien-3-yne

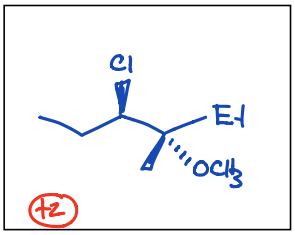


Partial: +1.5 if str has two C=C and one C≡C

d. *tert*-butyl ethyl acetylene

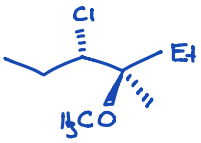
17. For the following reaction: **a.** Draw the structure of each intermediate; **b.** Draw in curved arrows to show electron flow; **c.** Draw one enantiomer of the product with correct stereochemistry. *(9 points)*





Product With Correct Stereochemistry

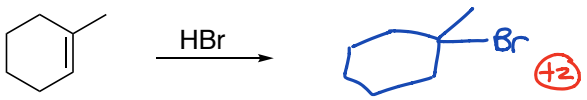
or



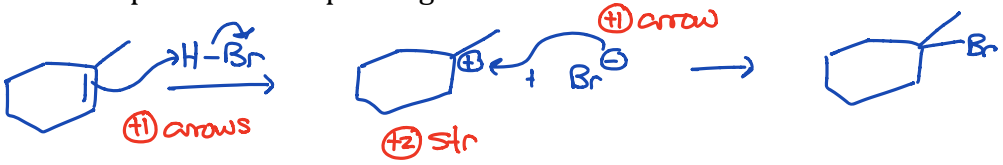
Cl + OCH_3 must be anti

18. Consider the reaction shown below and answer the following questions. *(8 points)*

a. Draw the reaction product.



b. Draw the complete electron pushing mechanism.



c. Explain why this reaction proceeds with Markovnikov selectivity. *Note: stating that one carbon has more H is not an explanation!*

H adds to the less substituted carbon so that the ⊕ can go to the more substituted C. A more substituted ⊕ = more stable.

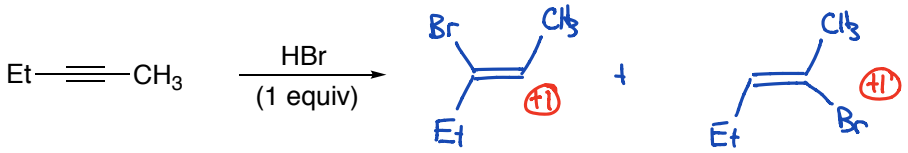
+2 explanation

19. Predict the major organic product(s) for each reaction shown below. For reactions indicated with an asterisk (*), be sure to include stereochemistry. If the reaction produces a racemic mixture, you only need to draw one enantiomer. *(2 points each)*

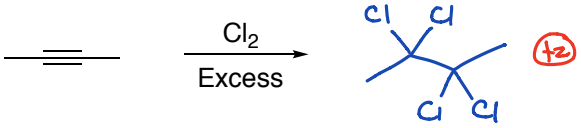
a.* 

b.* 

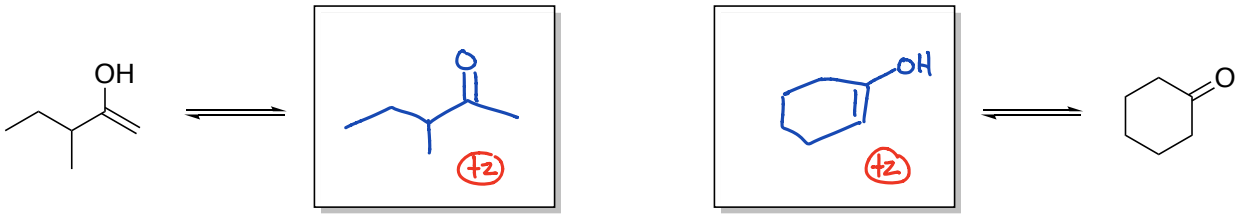
c. 

d.* 

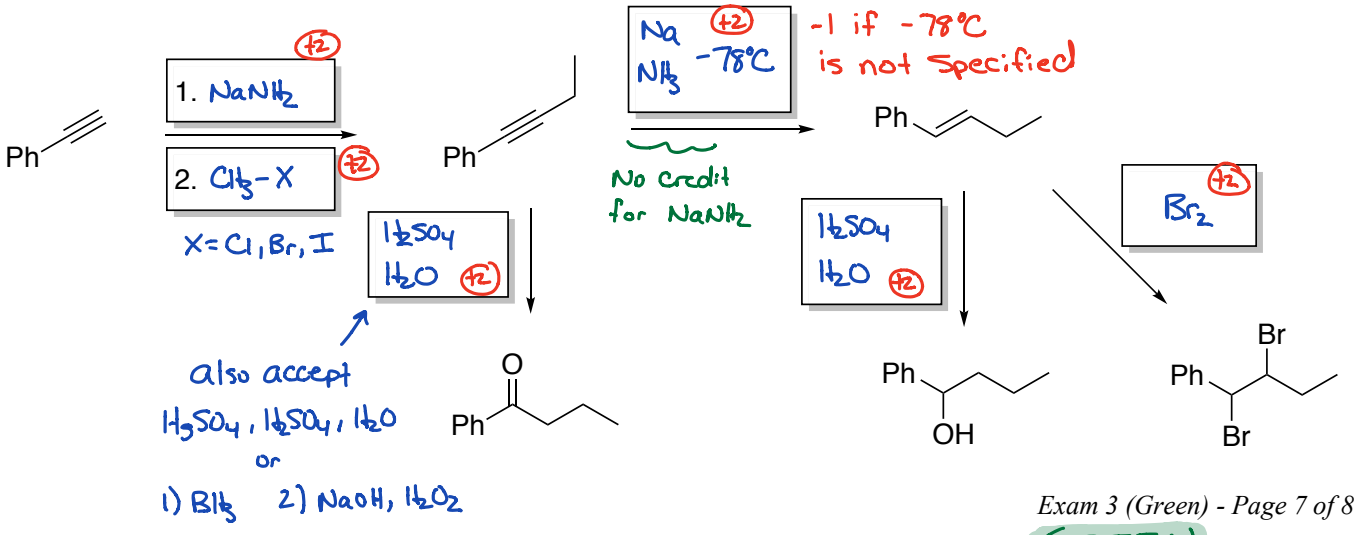
e.* 

f. 

20. Draw the keto or enol tautomer for each compound shown below. *(2 point each)*

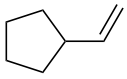
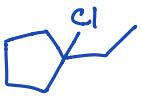


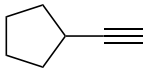
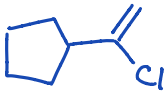
21. Complete the synthetic scheme shown below by supplying the necessary reagents. *(2 points each)*



GREEN

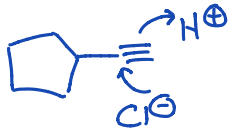
22. Reaction **a** gives a product resulting from carbocation rearrangement while reaction **b** does not. Draw the product for each reaction and then explain why **b** does not undergo a carbocation rearrangement (this is most easily demonstrated by drawing the mechanism). *(7 points)*

a)  HCl (1 equiv) →  +2

b)  HCl (1 equiv) →  +2

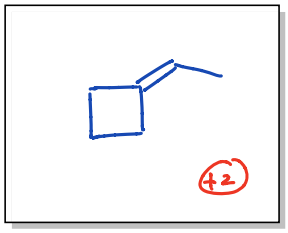
Why does **b** not give a carbocation rearrangement product?

Reaction b gives the product in a single step without the formation of a carbocation intermediate. There is no ⊕ in the mechanism to rearrange.

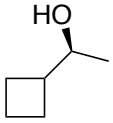


+3 for saying/showing no $C^{\oplus}$ is involved in the mechanism

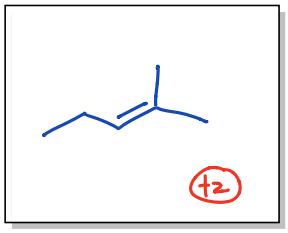
23. Draw the appropriate starting material necessary to accomplish each transformation. *(2 pts each)*

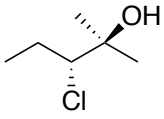
a)  +2

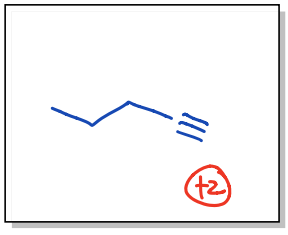
1. BH_3-THF
2. NaOH, H_2O_2

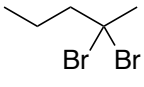
→ 

-1 if they draw 

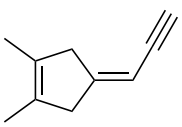
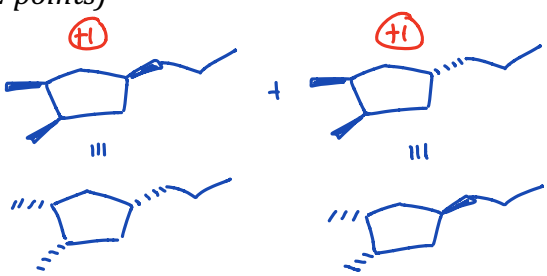
b)  +2

Cl_2, H_2O → 

c)  +2

HBr, excess → 

24. **Bonus:** Draw the two stereoisomerc products that would result if the following compound is treated to excess H_2 and Pt. *(2 points)*

 H_2, Pt → 

+1 +1

GREEN