

Name: _____
 Last First MI

Chemistry 233 Exam 3

Spring 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 correctly bubble in your WVU Student ID Number on your Scantron.

The Periodic Table

													18 VIII A																																		
1 IA																	2 II A																														
1 H 1.01																	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 192.2	77 Ir 195.1	78 Pt 197.0	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)																																					
<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 5%;">*</td> <td>58 Ce 140.1</td> <td>59 Pr 140.9</td> <td>60 Nd 144.2</td> <td>61 Pm (145)</td> <td>62 Sm 150.4</td> <td>63 Eu 152.0</td> <td>64 Gd 157.3</td> <td>65 Tb 158.9</td> <td>66 Dy 162.5</td> <td>67 Ho 164.9</td> <td>68 Er 167.3</td> <td>69 Tm 168.9</td> <td>70 Yb 173.0</td> <td>71 Lu 175.0</td> </tr> <tr> <td>^</td> <td>90 Th 232.0</td> <td>91 Pa (231)</td> <td>92 U 238.0</td> <td>93 Np (237)</td> <td>94 Pu (244)</td> <td>95 Am (243)</td> <td>96 Cm (247)</td> <td>97 Bk (247)</td> <td>98 Cf (251)</td> <td>99 Es (252)</td> <td>100 Fm (257)</td> <td>101 Md (258)</td> <td>102 No (259)</td> <td>103 Lr (260)</td> </tr> </table>																		*	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)
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Please do not rip off this cover sheet

Name: _____
Last First MI

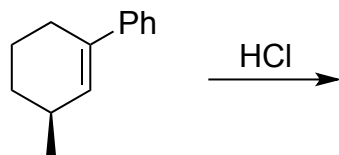
Grading Page (Exam 3):

Page	Points Possible	Points Earned
Multiple Choice (3-5)	30	
6	21	
7	31	
8	18	
TOTAL	100	

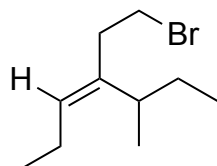
Multiple Choice

Choose the one best answer for each of the following questions. Using a pencil, record this answer on the provided Scantron sheet. (2 points each)

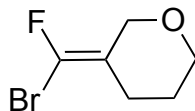
1. The reaction shown below would produce how many and what kind of different major products?



- 2 – a pair of enantiomers
 - 2 – a pair of diastereomers
 - 4 – two pairs of enantiomers
 - 3 – a pair of diastereomers and a constitutional isomer
 - 4 – two different pairs of diastereomers
2. How many unsaturations are in a compound with the molecular formula $C_8H_{11}NOBr_2$?
- One
 - Two
 - Three
 - Four
 - Five
3. Alkene I has ____ configuration and alkene II has ____ configuration.

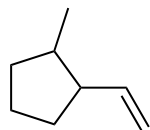


Alkene I

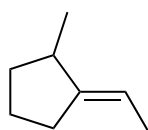


Alkene II

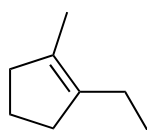
- E, E
 - Z, Z
 - E, Z
 - Z, E
4. Which compound shown below will undergo hydrogenation (H_2 , Pd/C) at the **fastest** rate?



a



b



c

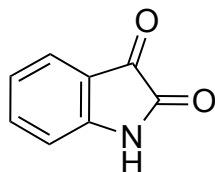
The alkenes will all undergo hydrogenation at an equal rate

d

5. Which of the following correctly describes an **optically inactive** solution?

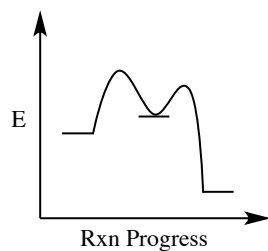
- a. A racemic mixture
- b. A solution of an achiral molecule
- c. A 1:1 mixture of enantiomers.
- d. Both a and c
- e. a, b, and c all describe an optically inactive solution

6. What is the degree of unsaturation in the following molecule?



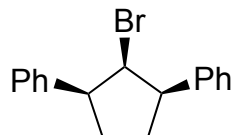
- a. Four
- b. Five
- c. Seven
- d. Eight
- e. None of the above

7. The reaction represented by the following reaction coordinate has ____ intermediate(s).



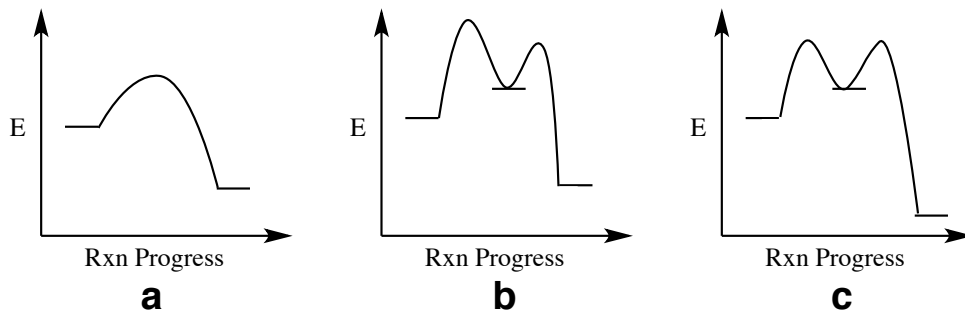
- a. one
- b. two
- c. three
- d. four
- e. five

8. The molecule shown below has ____ chiral centers and ____ stereocenters.

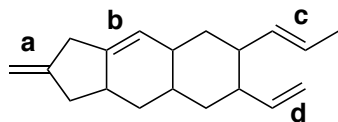


- a. 1, 3
- b. 2, 3
- c. 3, 3
- d. 3, 1
- e. 3, 3

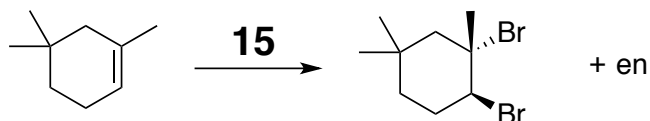
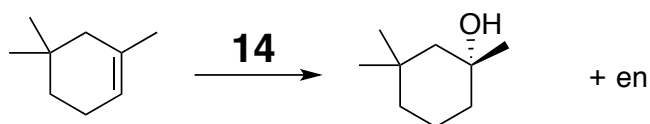
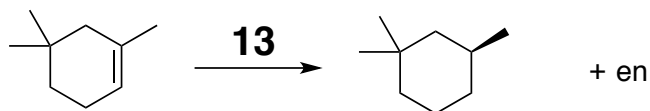
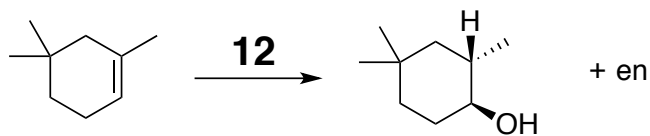
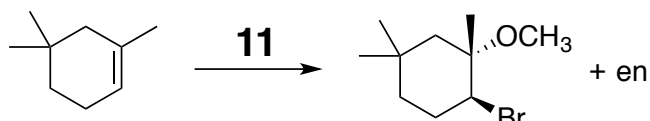
9. Which reaction has the largest activation energy?



10. Which alkene in the molecule below is the most stable?



For questions 11-15, 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 "H₂, Pd/C" you would bubble in both a and b).



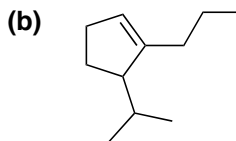
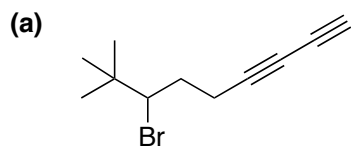
Reagent Bank		
H ₂ SO ₄ H ₂ O a	H ₂ SO ₄ CH ₃ OH b	H ₂ Lindlar Cat. c
HBr d	Br ₂ e	H ₂ Pd/C ab
HBr CH ₃ OH ac	Br ₂ H ₂ O ad	Br ₂ CH ₃ OH ae
NaOH H ₂ O bc	mCPBA bd	1. BH ₃ 2. NaOH H ₂ O ₂ be

Completion Section

Answer the remaining questions in the spaces provided. Show all work and provide complete explanations.

16. Provide the IUPAC systematic name or draw the structure for each molecule below.

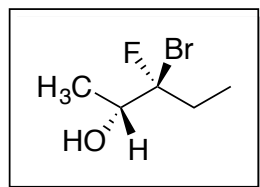
(2 points each)



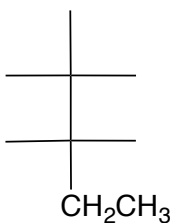
(c) (Z)-6-cyclopropyl-6-octen-2-yne

(d) (E)-6-methyl-1,3,5-heptatriene

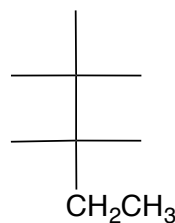
17. Using the templates provided, convert the molecule in the box to a Fischer projection. Then draw the enantiomer and a diastereomer of this molecule. (2 points each)



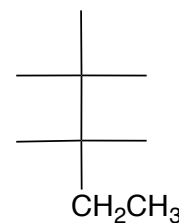
a) Fischer Projection of the molecule



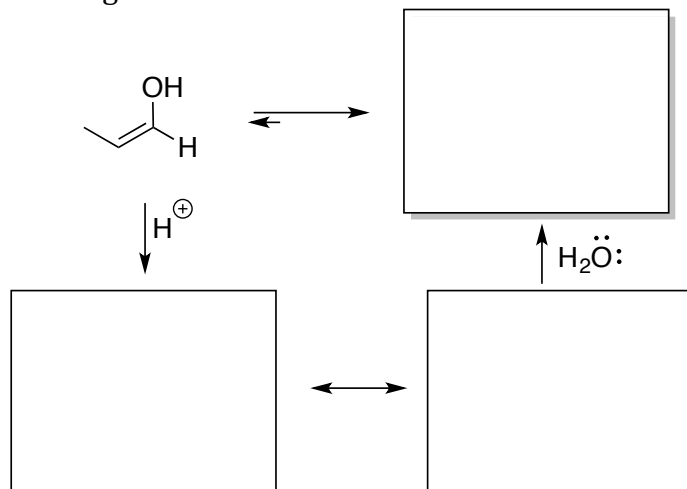
b) Enantiomer of "a"



c) Diastereomer of "a"

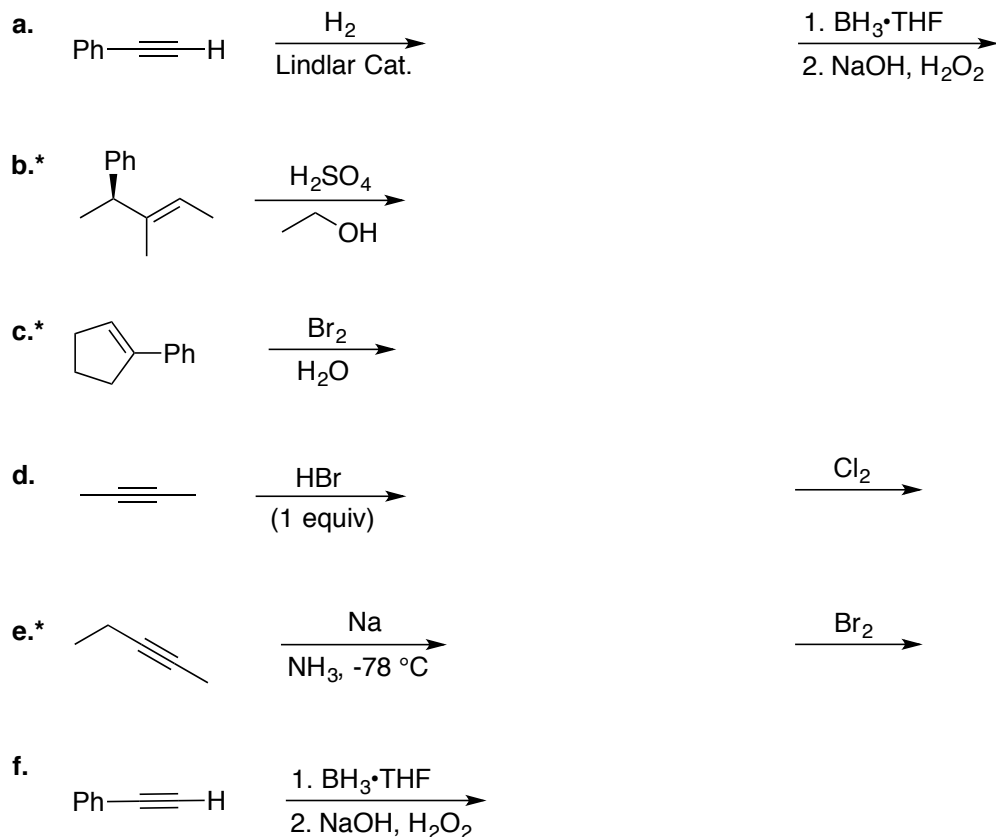


18. Draw the tautomer for the following enol then show the mechanism for tautomerization by drawing the intermediate structures **and** curved arrows to show electron flow. (6 points)

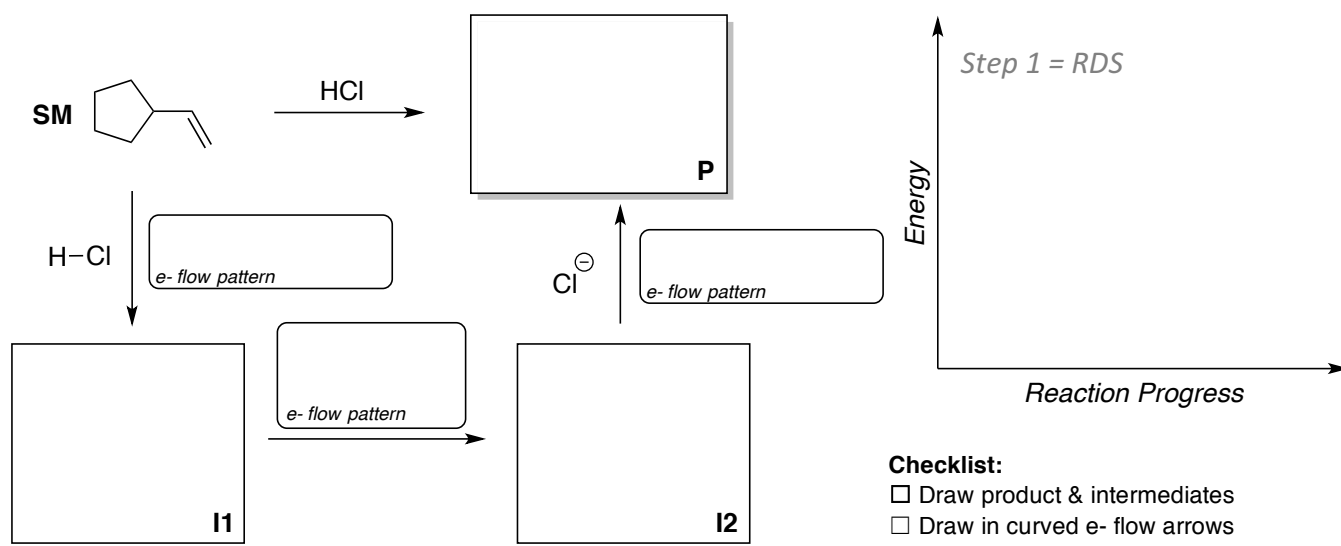


Define **tautomers**: (1 point)

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)

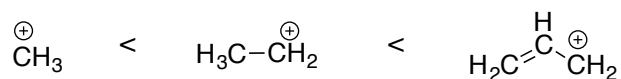


20. a. Predict the product for the reaction; b. Draw the intermediates; c. Draw in curved arrows to show electron flow in each step, d. Label the pattern of electron flow for each step, and e. Complete the reaction coordinate. Label SM, I1, I2, and P in your energy diagram. (13 points)

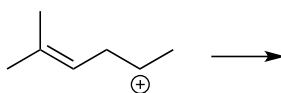
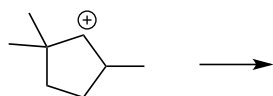


21. Explain why we see the following trend in carbocation stability. (5 points)

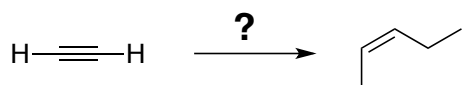
Note: Stating "a primary cation is more stable than a methyl cation" is not an explanation!



22. Draw the expected rearrangement product for each carbocation shown below. (2 points each)



23. Starting with acetylene, how could you synthesize *cis*-2-pentene? You can simply list the sequence of required reactions or you can draw out the product for each step if you wish. (5 points)



24. Each reaction shown below takes place in a single step. Draw in the curved arrows to show electron flow. (2 points each)

