

Name: _____
 Last First MI

Chemistry 233-002 Exam 2

Fall 2016

Dr. J. Osbourn

Instructions: This exam contains two parts: a multiple-choice section and a completion section. The first 20 multiple-choice questions should be answered on the provided Scantron. You should also circle your multiple-choice answers on the exam itself. The remaining 3 pages of the exam is a completion section. Answer these questions on the exam itself. Show all work and provide complete explanations. If you tend to doodle on your exam or have multiple possibilities drawn, circle the answer that you want graded.

The Periodic Table

1 IA H 1.01	2 IIA He 4.00											13 IIIA B 10.81	14 IVA C 12.01	15 VA N 14.01	16 VIA O 16.00	17 VIIA F 19.00	18 VIIIA Ne 20.18
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 VIII	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

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Grading Page: Exam 2

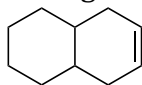
Page	Points Possible	Points Earned
Multiple Choice (3-5)	40	
6	22	
7	20	
8	18	
TOTAL	100	

Multiple-Choice

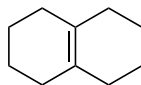
Choose the one best answer for each of the following questions. Record each answer on the provided Scantron sheet. (2 points each)

1. In cyclopropane, which of the following would be the **least** significant when determining its overall stability.
- Angle Strain
 - Torsional Strain
 - Steric Strain
 - All of the above would be significant

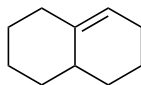
2. Arrange the bicyclic alkenes below in order of increasing stability



I

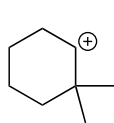


II

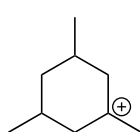


III

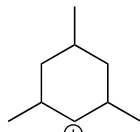
- I < II < III
 - III < II < I
 - II < III < I
 - I < III < II
 - III < I < II
3. Which one of the carbocations shown below is most likely to undergo a hydride shift?



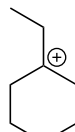
a



b

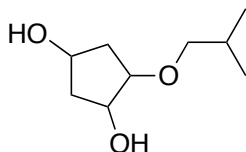


c



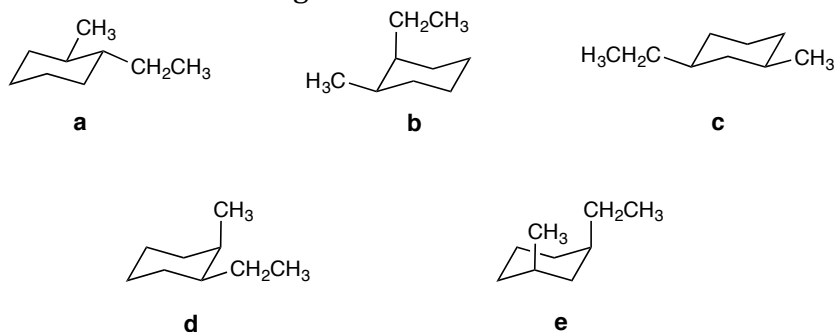
d

4. What is the maximum number of possible stereoisomers for the compound shown below?

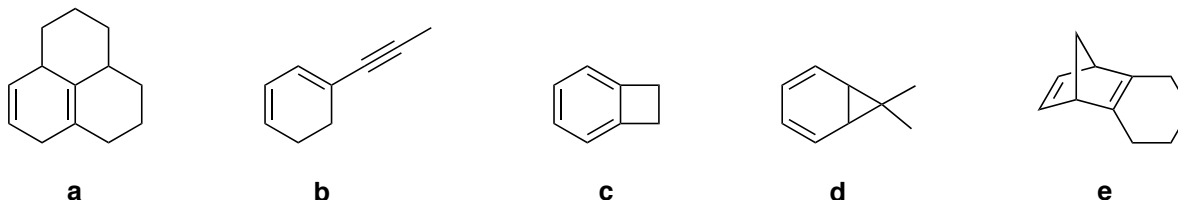


- Two
 - Three
 - Eight
 - Nine
 - Sixteen
5. Which one of the following statements is **false**?
- A meso compound is achiral.
 - A racemic mixture is optically active.
 - Diastereomers generally have different boiling points.
 - A pair of enantiomers have equal optical rotations with opposite signs.
 - A pair of enantiomers have identical melting points.

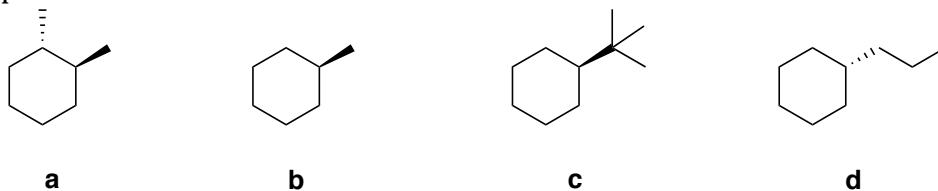
6. Which of the following is the most stable chair conformation of *cis*-1-ethyl-2-methylcyclohexane?



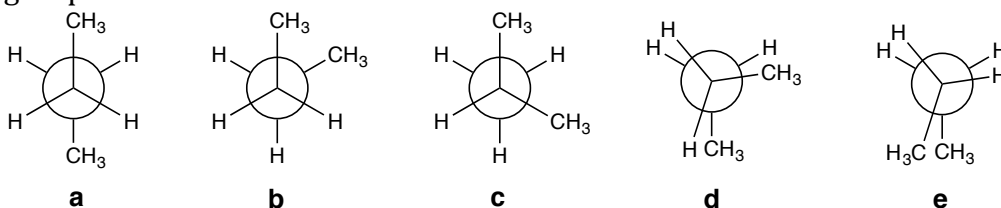
7. Which molecule below does not have 5 unsaturations?



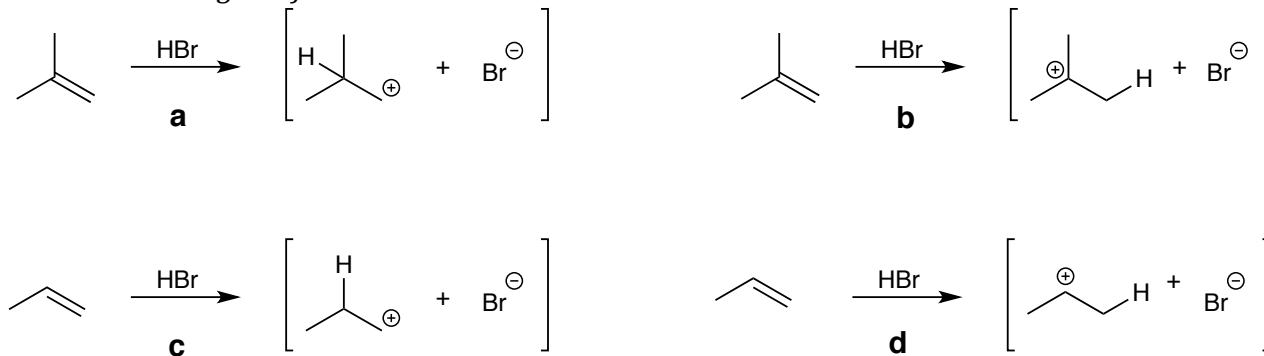
8. For which of the following would you expect the greatest percentage of molecules existing in **axial** position?



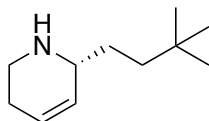
9. Which one of the Newman projections below has a 60° dihedral angle between the two methyl groups?



10. Which reaction step shown below is the most endergonic? *Hint: draw energy diagrams comparing the relative energies of the alkenes and carbocation intermediates.*



11. What is the configuration at the chiral center in the molecule shown below?

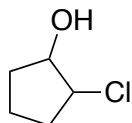


- a. *R*-configuration
- b. *S*-configuration

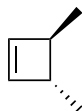
For questions 12-15, determine whether each molecule is:

(a) Chiral, **(b)** Achiral, or **(c)** Meso-Achiral

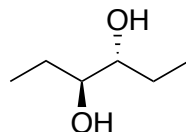
Bubble these answers in on your Scantron sheet for credit!



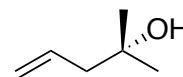
12.



13.



14.

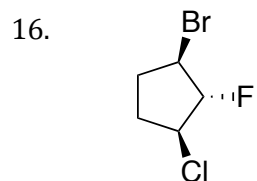


15.

For questions 16-20, determine whether each pair of molecules represent:

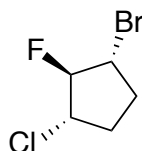
(a) Identical Compounds, **(b)** Constitutional Isomers, **(c)** Enantiomers, or **(d)** Diastereomers

Bubble these answers in on your Scantron sheet for credit!

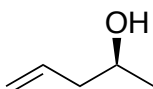


16.

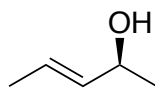
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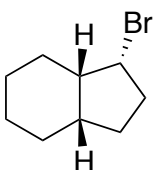
17.



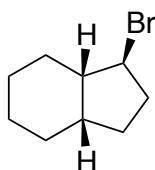
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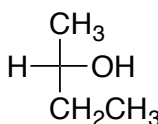
18.



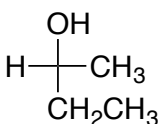
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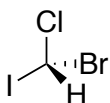
19.



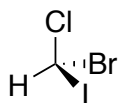
and



20.



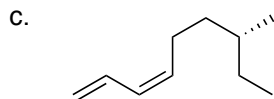
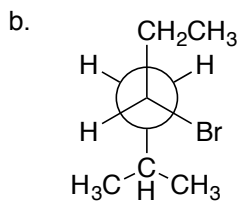
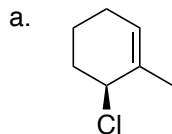
and



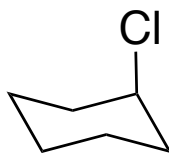
Completion Section

Answer the remaining questions in the spaces provided.

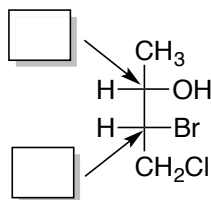
21. Provide the IUPAC name for each. Include *R*, *S*, *E*, and *Z* where appropriate. (3 points each)



22. Using the template below, complete the chair structure of (1*S*,3*S*)-1-bromo-3-chlorocyclohexane. (3 points)



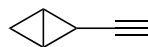
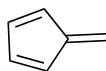
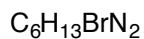
23. Assign R/S Configurations to the Fischer projection below. Then draw the enantiomer and a diastereomer. (6 points)



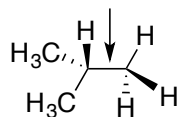
enantiomer

diastereomer

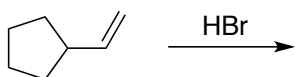
24. Determine the degree of unsaturation for each molecule or formula below. (1 points each)



25. Draw the Newman Projection (viewing along the indicated bond) for the highest energy and lowest energy conformation of the molecule shown below. Calculate the relative energy for each conformation. (4 points)

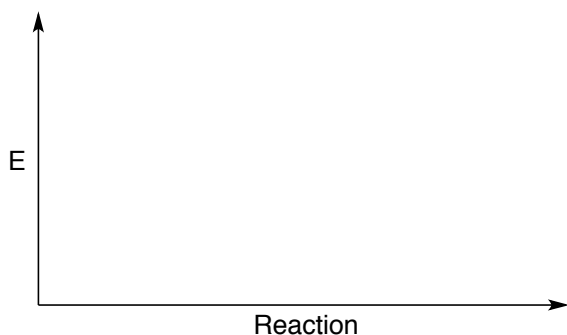


26. Predict the major product for the reaction shown below. (3 points)

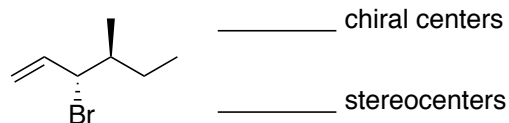
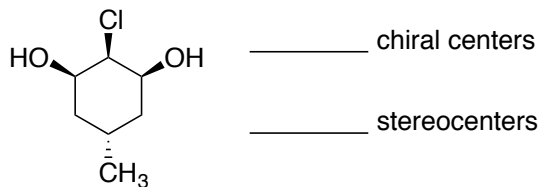


27. Provide the full electron pushing mechanism for the reaction in question 26. (5 points)

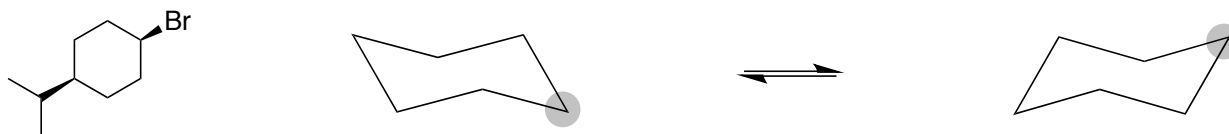
28. Draw a reaction coordinate (energy diagram) for the reaction in question 26. Label the starting material (SM), product (P), and Intermediates (I) on the coordinate. (4 points)



29. Determine the number of chiral centers and stereocenters in each molecule below. (4 points)



30. Draw both chair conformations for the compound shown below using the templates provided. Put the Br on the carbon highlighted with the gray circle and orient your other group based on that reference point. Circle the chair conformation that is lowest in energy. (5 points)



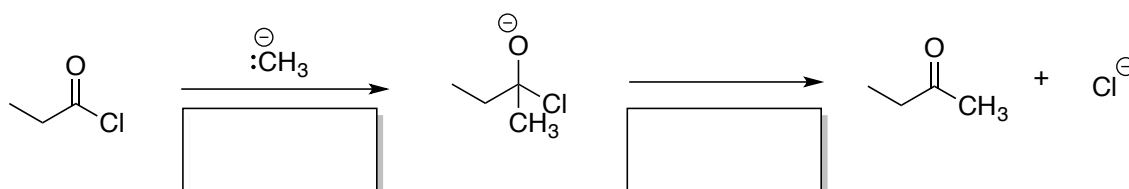
31. Draw the following representations of 1,2-dibromocyclopentane. (2 points each)

 optically inactive
 stereoisomer

 optically active
 stereoisomer

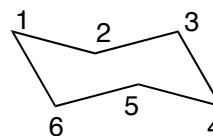
 (1R,2R)
 stereoisomer

32. For the reaction mechanism shown below: **1.** Draw in curved arrows to show electron flow. **2.** Identify the pattern of electron flow (Nu Attack, Loss of Leaving Group, Proton Transfer, or Carbocation Rearrangement). (4 points)



33. Draw a chair conformation that meets the following criteria. (3 points)

- Axial chlorine at C5
- Equatorial methyl at C4
- Bromine on C2 that is cis to the chlorine



34. **Bonus:** The compound shown below is chiral despite having no chiral centers. This allene functional group has a central carbon with perpendicular pi-bonds. Explain why this molecule is chiral. *Hint: Don't overthink it, just think about the definition of a chiral molecule.* (2 points)

