

Name: _____
 Last First MI

Chemistry 233 Exam 2

Spring 2018

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. Any question with multiple answers selected 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																			18 VIIIA																		
	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 Al 26.98	4 Si 28.09	5 P 30.97	6 S 32.07	7 Cl 35.45	8 Ar 39.95													13 K 39.1	14 Ca 40.08	15 Sc 44.96	16 Ti 47.88	17 V 50.94	18 Cr 52.00	19 Mn 54.94	20 Fe 55.85	21 Co 58.93	22 Ni 58.69	23 Cu 63.55	24 Zn 65.39	25 Ga 69.72	26 Ge 72.61	27 As 74.92	28 Se 78.96	29 Br 79.90	30 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)								

Do not rip off this cover sheet

Name: _____
Last First MI

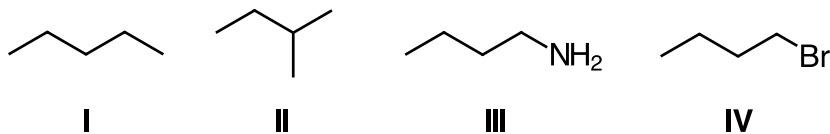
Grading Page (Exam 2):

Page	Points Possible	Points Earned
Multiple Choice (3-5)	36	
6	26	
7	20	
8	18 + 4 (bonus)	
TOTAL	100	

Multiple Choice

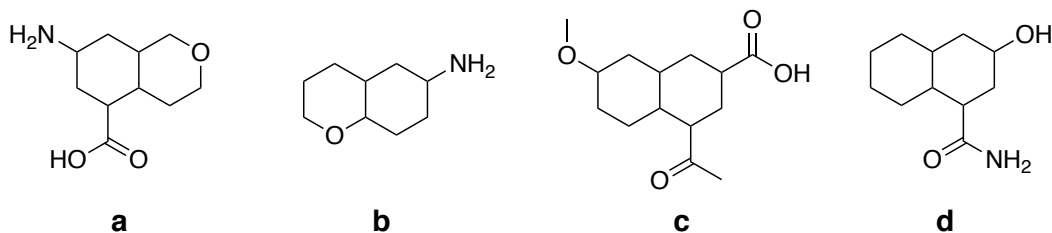
Choose the one best answer for each of the following questions. Using a pencil, record this answer on the provided Scantron sheet. (2 points each)

1. Arrange the compounds shown below in order of increasing boiling point.

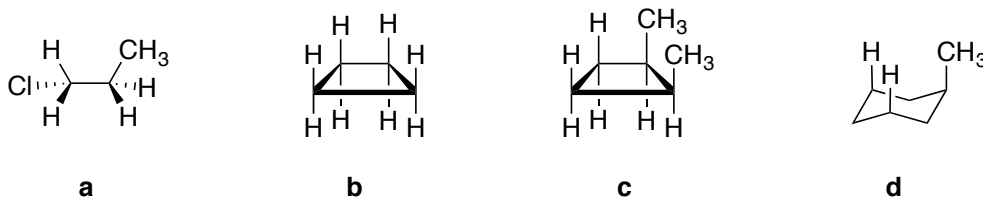


- a. $I < II < IV < III$
- b. $IV < I < III < II$
- c. $II < I < III < IV$
- d. $II < I < IV < III$
- e. None of the above are correct

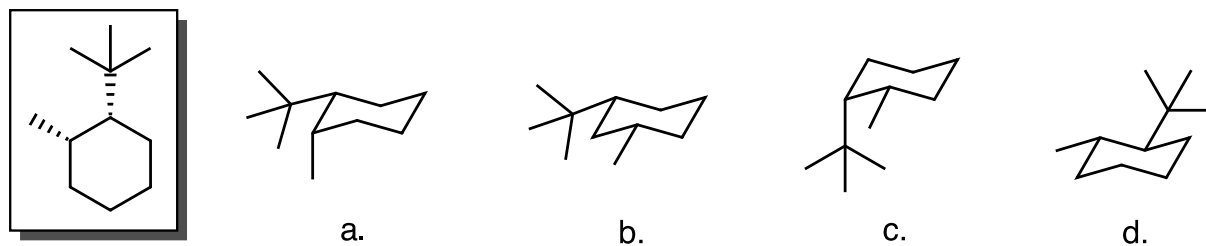
2. Which one of the following molecules would you expect to be the most soluble in water?



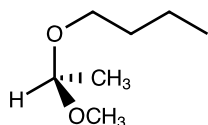
3. Which molecule shown below contains only ring strain and torsional strain?



4. Which of the following is the most stable chair conformation for the compound shown below?

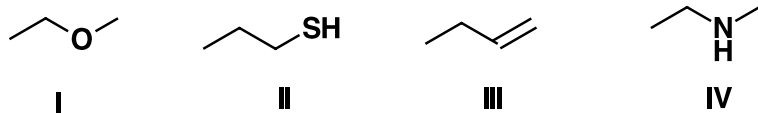


5. What is the configuration at the chiral center in the molecule below?



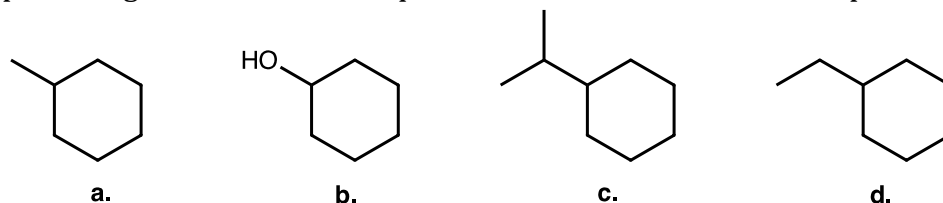
- a. *R*-configuration
- b. *S*-configuration
- c. This molecule does not have a chiral center

6. Which of the following molecules can hydrogen bond with water?

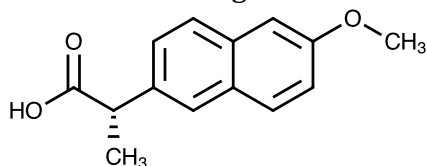


- a. I only
- b. IV only
- c. I and IV
- d. I, II, and IV
- e. All of these can H-bond with water

7. Which of the following mono-substituted cyclohexane derivatives will have the highest percentage of molecules in equatorial orientation at room temperature?

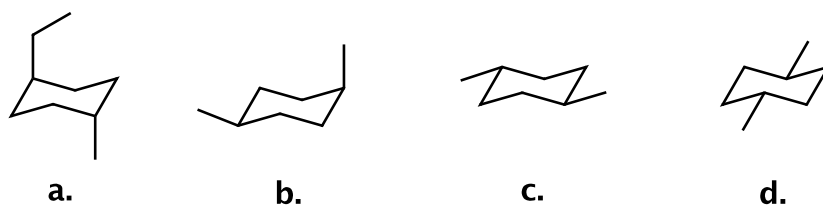


8. What is the configuration at the chiral center in the molecule shown below?



- a. *R*-configuration
- b. *S*-configuration
- c. This molecule does not have a chiral center

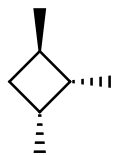
9. Which chair conformation below has *cis* substituents?



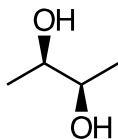
For questions 10-13, determine whether each molecule is:

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

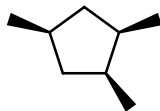
Bubble these answers in on your Scantron sheet for credit!



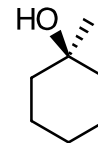
10.



11.



12.

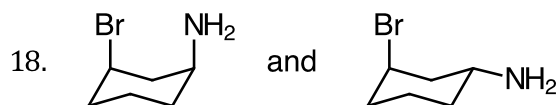
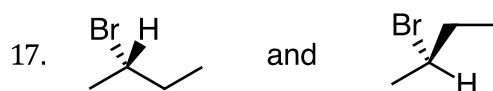
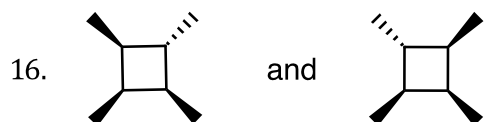
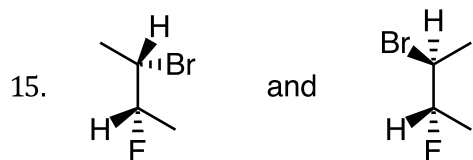
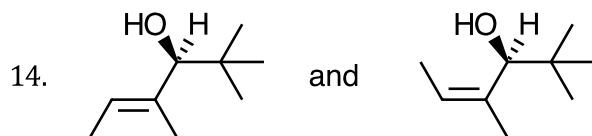


13.

For questions 14-18, 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!

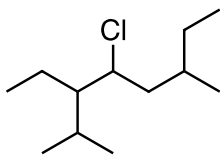


Completion Section

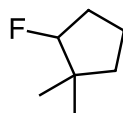
Answer the remaining questions in the spaces provided. Show all work and provide complete explanations.

19. Provide the IUPAC systematic names or structure for each compound below. (3 points each)

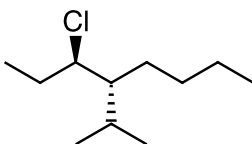
a)



b)

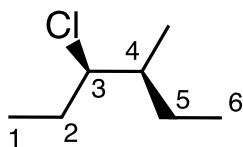


c) Include R/S assignment in name

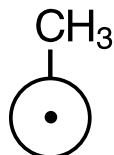


d) *trans*-1-tert-butyl-3-cyclopropylcyclobutane

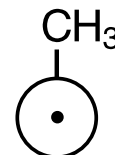
20. Use the structure below to complete the following questions. (8 points)



a) Using the template provided, draw the Newman projection viewing along the C3-C4 bond.



b) Using the template provided, draw the conformation that has the Cl and CH₃ eclipsed.



c) What is the stereochemical configuration at C3?

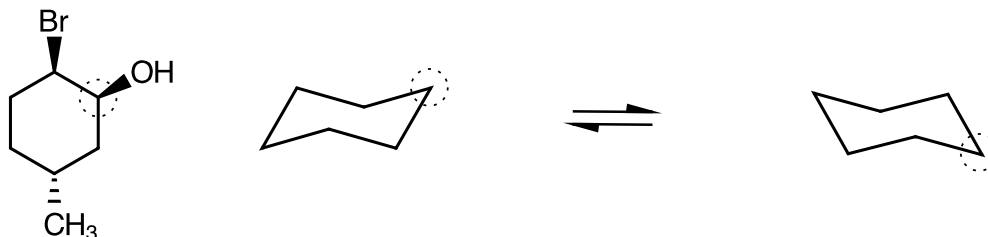
d) What is the stereochemical configuration at C4?

21. Draw representative structures for each of the following: (3 points each)

a) A chair cyclohexane with *cis* bromine atoms on C1 and C2.

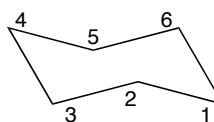
b) A compound with the molecular formula C₆H₁₂O that contains a five-membered ring, a tertiary alcohol, and a primary carbon.

22. Draw both chair conformations for the compound shown below using the templates provided. Put the -OH on the carbon indicated with the circle and orient your other groups based on that reference point. Circle the chair conformation that is lowest in energy. (6 points)



23. Draw a chair cyclohexane that meets the following criteria: (3 points)

- Equatorial -CH₃ at C6
- Axial -OH C4
- Br at C1 that is *cis* to -CH₃



24. Focusing on the C2-C3 bond of 2,3-dimethylbutane, draw the highest energy and lowest energy conformations in the form of a Newman projection and answer the remaining questions. (7 pts)

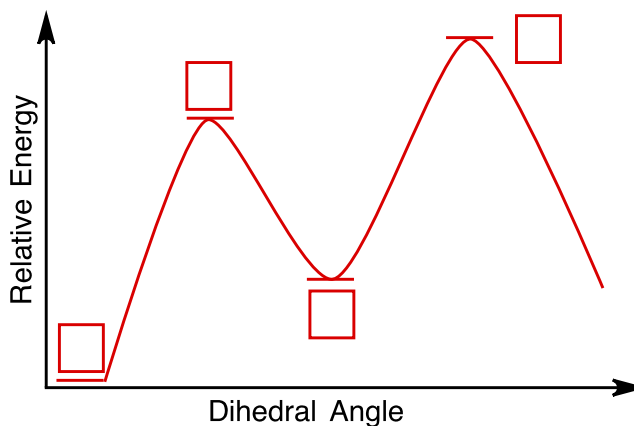
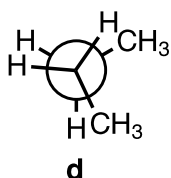
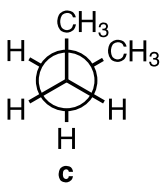
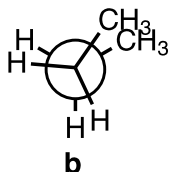
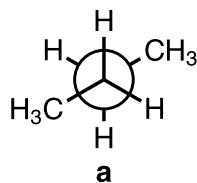
a) **Highest Energy Conformation**

b) **Lowest Energy Conformation**

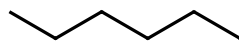
c) What is the energy difference between the two conformations in kcal/mol?

d) Which conformation above is the most stable?

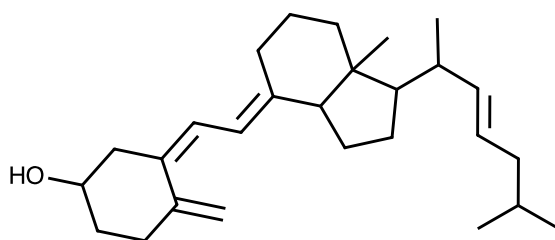
25. Match each butane conformation below to the appropriate location on the energy coordinate that is provided. (4 points)



26. In addition to hexane, draw the four other constitutional isomers for C_6H_{14} . In your structures circle and identify one secondary carbon and one quaternary carbon. (6 points)



27. Identify every chiral center in Vitamin D₂ with an asterisk (*). (3 points)



28. Answer the following questions regarding each molecule shown below. (9 points)

	<p>a. Identify every chiral center in the molecule with an asterisk (*).</p> <p>b. Bonus. What is the maximum possible number of stereoisomers for this molecule? (1 bonus point)</p>
<p>c. Draw a chiral stereoisomer</p>	<p>d. Draw the enantiomer of the stereoisomer in c.</p>
<p>e. Draw an achiral stereoisomer.</p>	<p>f. Draw a diastereomer of the stereoisomer in e.</p>

29. **Bonus:** The molecule shown below is chiral despite not having any chiral centers. Draw the enantiomer and briefly explain why it is chiral. (3 bonus points)

