

Name: Answer Key

Last

First

MI

Chemistry 233-002 Exam 2

Fall 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. 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															13 B 10.81	14 C 12.01	15 N 14.01	16 O 16.00	17 F 19.00	18 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												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)																										

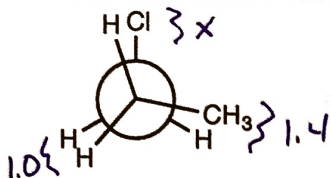
*	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
^	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Please do not rip off this cover sheet

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 total relative energy of the conformation shown below is 4.1 kcal/mol. What is the energy cost associated with the H/Cl eclipse?



$$1.0 + 1.4 + x = 4.1$$

$$x = 1.7$$

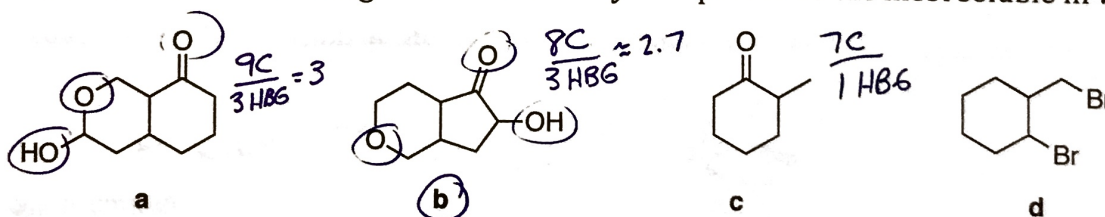
- a. 2.4 kcal/mol
 b. 0.5 kcal/mol
 c. 1.7 kcal/mol
 d. 1.0 kcal/mol
 e. 1.4 kcal/mol
2. Arrange the compounds shown below in order of increasing boiling point.



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

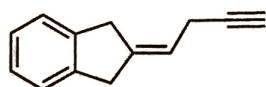
$$IV < I < III < II$$

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



Both a + b would likely be H₂O soluble

4. How many unsaturations are present in the molecule shown below?



$$2 \text{ rings} = 2$$

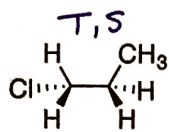
$$4 \text{ db} = 4$$

$$1 + 6 = 2$$

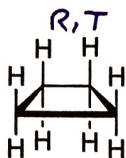
$$8$$

- a. 2
 b. 6
 c. 7
 d. 8
 e. 9

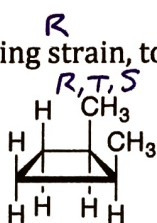
5. Which molecule shown below contains ring strain, torsional strain, and steric strain?



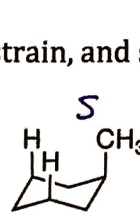
a



b

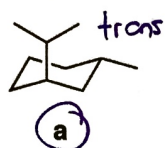
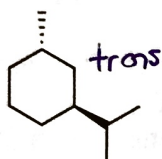


c



d

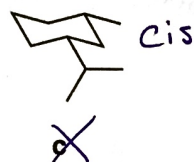
6. Which of the following is the least stable chair conformation for the compound shown below?



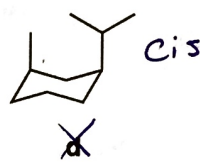
a



b



~~c~~



~~d~~

7. A racemic mixture:

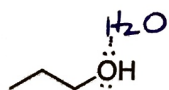
- a. is optically inactive.
- b. contains a 1:1 mixture of enantiomers.
- c. contains a 1:1 mixture of diastereomers.
- d. both a and b
- e. both a and c

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

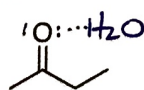


- a. R-configuration
- b. S-configuration

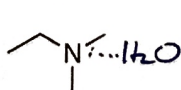
9. Which of the following molecules can hydrogen bond with water?



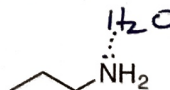
I



II



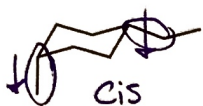
III



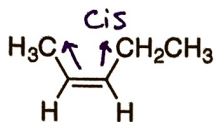
IV

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

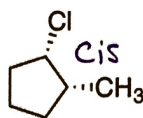
10. Which of the following contain *cis* substituents?



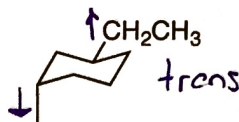
I



II



III



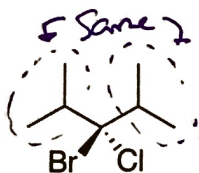
IV

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

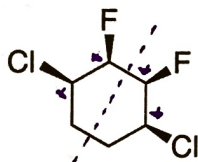
For questions 11-14, determine whether each molecule is:

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

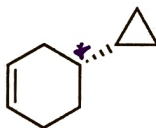
Bubble these answers in on your Scantron sheet for credit!



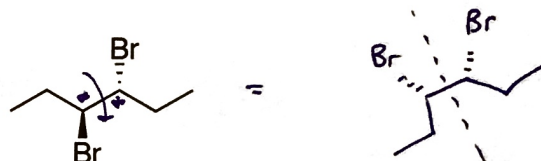
11. (b)



12. (c)



13. (a)

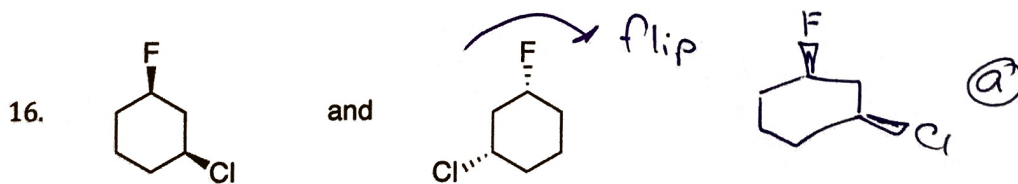


14. (c)

For questions 15-18, determine whether each pair of molecules represent:

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

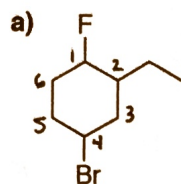
Bubble these answers in on your Scantron sheet for credit!



Completion Section

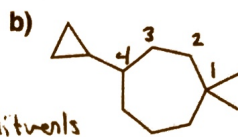
Answer the remaining questions in the spaces provided. Show all work and provide complete explanations.

19. Provide IUPAC systematic names for each compound shown below. Include *R/S* for molecules c and d. (3 points each)



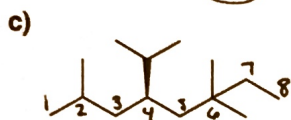
4-bromo-2-ethyl-1-fluorocyclohexane
 (+2) (+1)

-1 Wrong #
 -1 Wrong abc order of substituents

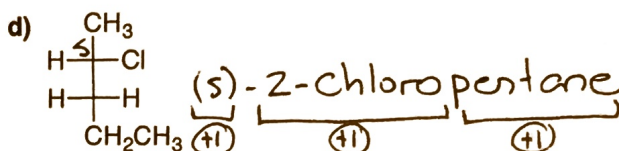


4-cyclopropyl-1,1-dimethylcycloheptane
 (+1) (+1) (+1)

-0.5 for only having 1- instead of 1,1-

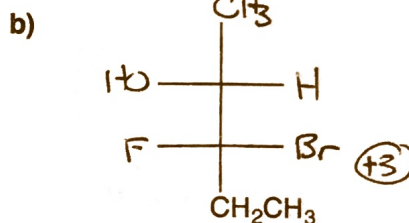
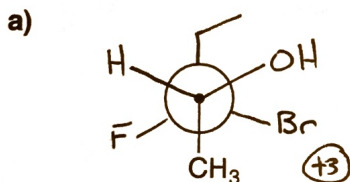
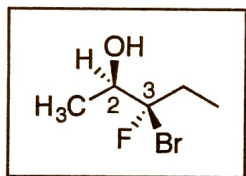


(R)-4-isopropyl-2,6,6-trimethyloctane
 (+1) (+1) (+1)



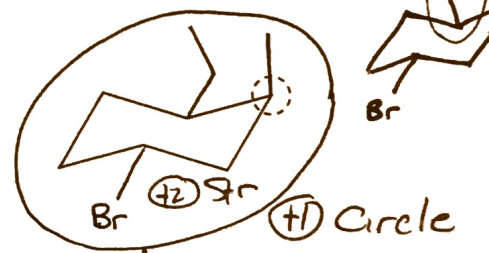
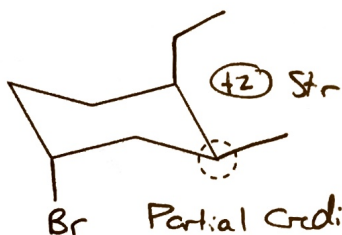
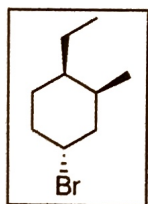
(S)-2-chloropentane
 (+1) (+1) (+1)

20. Convert the structure shown below to a) a Newman projection viewing along the C2-C3 bond and b) a Fischer projection. Use the templates provided. (3 points each)



are enantiomers and are not correct
 No partial credit

21. Draw both chair conformations for the compound shown below using the templates provided. Put the -CH₃ on the carbon highlighted with the gray circle and orient your other groups based on that reference point. Circle the chair conformation that is lowest in energy. (5 points)

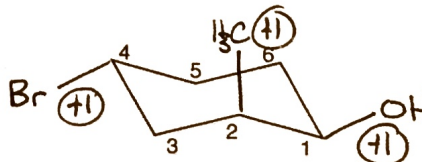
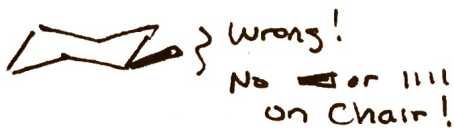


Partial credit: Give +1

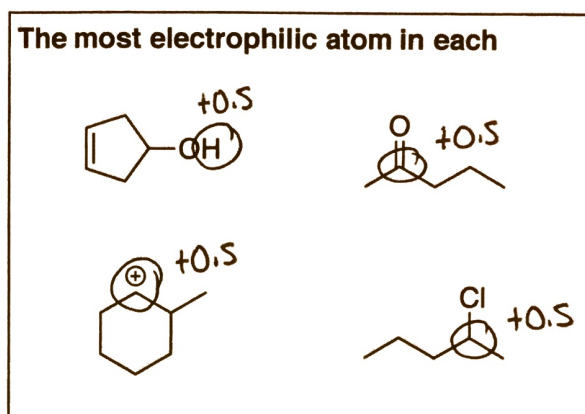
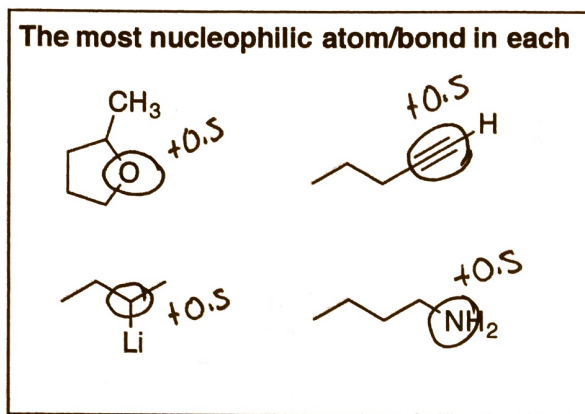
if two/three substituents are placed

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

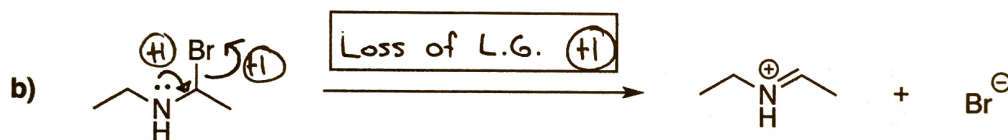
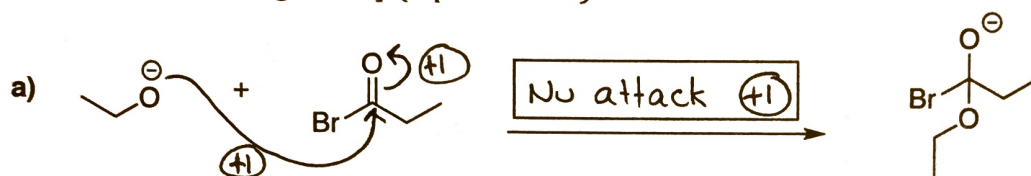
- Axial -CH₃ at C2
- OH with R-configuration at C1
- Br at C4 that is *trans* to OH



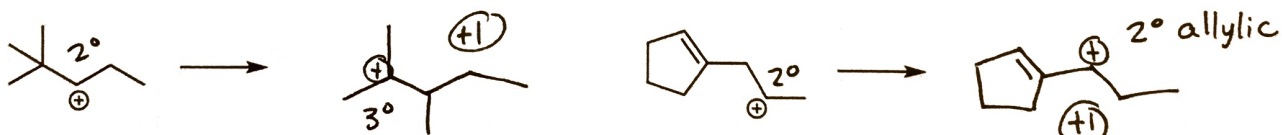
23. In each molecule shown below, circle: (4 points)



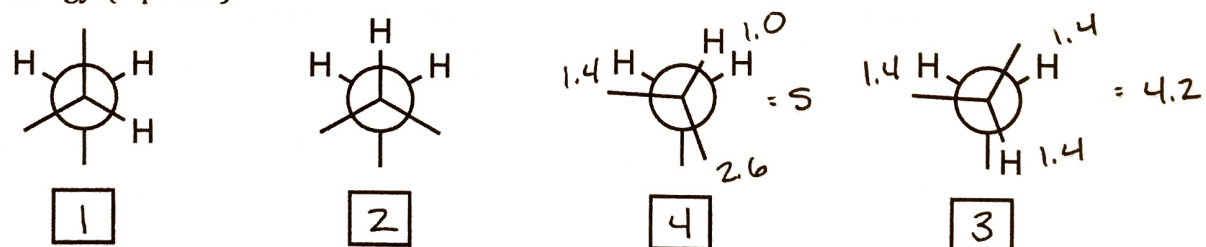
24. For each mechanistic step shown below, a) add curved arrows to show electron flow, and b) indicate the pattern of electron flow [Nu attack, loss of leaving group, proton transfer, or carbocation rearrangement]. (3 points each)



25. Show the carbocation rearrangement product for each. (1 point each)



26. Rank the following conformations from most stable/lowest energy (1) to least stable/highest energy. (3 points)



+3 if all 4 are correct
+1 if 1 + 4 are correct

27. Identify every chiral center in cholesterol (below) with an asterisk (*). (3 points)

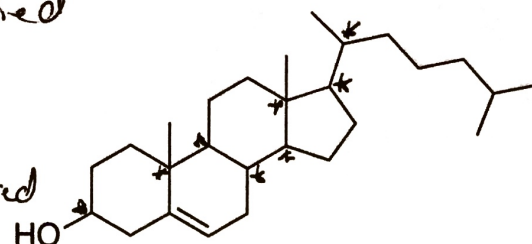
+3 - all 8 identified

+2 - 7/8

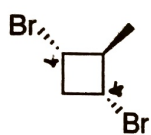
+1 - 6/8

+1 - if all 8 identified

but one extra
C marked



28. Answer the following questions regarding each molecule shown below. (4 points each)



Number of chiral centers 2 (+1)

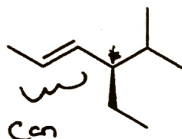
Number of stereocenters 3 (+1)

Max possible # of stereoisomers 8 (+1)

chiral achiral **achiral(meso)**

circle one

(+1)



Can

Count as 1 or 2 stereocenters

Number of chiral centers 1 (+1)

Number of stereocenters 2 (or 3) (+1)

Max possible # of stereoisomers 4 (also accept 8) circle one

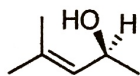
(+1)

(+1)

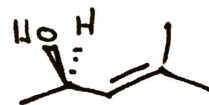
chiral achiral achiral(meso)

29. Draw each of the following (2 points each)

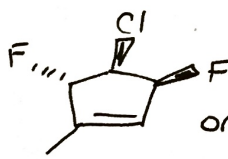
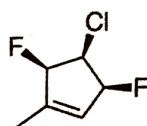
a. The enantiomer of:



Could have also drawn via mirror image



b. A diastereomer of:

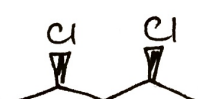
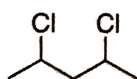


(+2)

one possibility

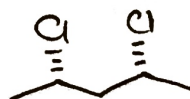
The diastereomer should have one or two of the 3 chiral centers inverted.

c. An achiral stereoisomer of:



(+2)

or



30. Tartaric acid is a chiral molecule that can be obtained as the (+) or the (-) enantiomer. If you have a solution that contains a mixture of 10 g of the (+)-enantiomer and 5 g of the (-)-enantiomer, will this solution be optically active? Explain why or why not. (3 points)

(+1)

(+2) - explanation

Yes. Because there is an excess of one enantiomer (the + enantiomer) the soln will be optically active and will rotate light in the + direction.