

Name: **ANSWER KEY**

Last

First

MI

## Chemistry 233-001 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	2											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 <b>H</b> 1.01																	2 <b>He</b> 4.00
3 <b>Li</b> 6.94	4 <b>Be</b> 9.01											5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18
11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31	3	4	5	6	7	8	9	10	11	12	13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.07	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
19 <b>K</b> 39.1	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.39	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.61	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80
37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.91	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.29
55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La*</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.9	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
87 <b>Fr</b> (223)	88 <b>Ra</b> (226)	89 <b>Ac^</b> (227)	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (264)	108 <b>Hs</b> (265)	109 <b>Mt</b> (268)	110 <b>Ds</b> (271)	111 <b>Rg</b> (272)							

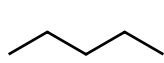
	58	59	60	61	62	63	64	65	66	67	68	69	70	71
*	<b>Ce</b> 140.1	<b>Pr</b> 140.9	<b>Nd</b> 144.2	<b>Pm</b> (145)	<b>Sm</b> 150.4	<b>Eu</b> 152.0	<b>Gd</b> 157.3	<b>Tb</b> 158.9	<b>Dy</b> 162.5	<b>Ho</b> 164.9	<b>Er</b> 167.3	<b>Tm</b> 168.9	<b>Yb</b> 173.0	<b>Lu</b> 175.0
^	90 <b>Th</b> 232.0	91 <b>Pa</b>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

**\*Do not rip off this cover sheet\***

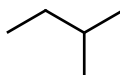
### Multiple Choice

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)

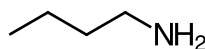
1. Arrange the compounds shown below in order of increasing boiling point.



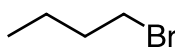
I



II



III

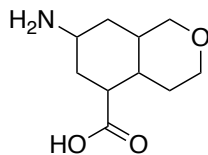


IV

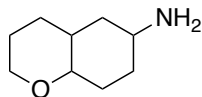
Same question type in F17 Exam

- 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

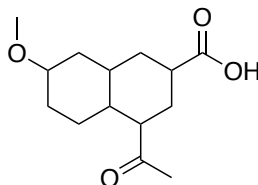
2. Which one of the following molecules would you expect to be the most soluble in water?



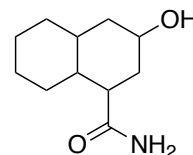
**a**



b



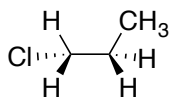
c



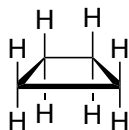
d

Same question type in F17 Exam

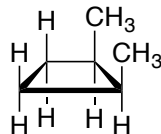
3. Which molecule shown below contains only ring strain and torsional strain?



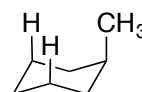
a



**b**



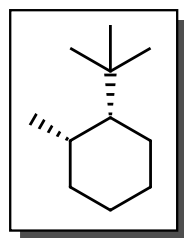
c



d

Same question type in F17 Exam

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



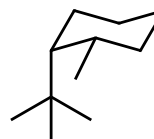
**a**



b.



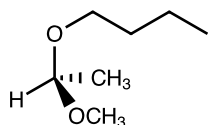
c.



d.

Same question type in F17 Exam

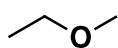
5. What is the configuration at the chiral center in the molecule below?



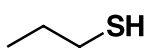
Top Hat Question

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

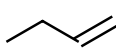
6. Which of the following molecules can hydrogen bond with water?



I



II



III

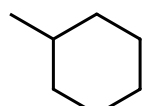


IV

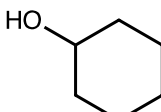
Same question type in F17 Exam

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

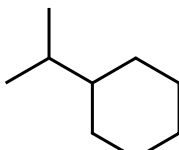
7. Which of the following mono-substituted cyclohexane derivatives will have the highest percentage of molecules in equatorial orientation at room temperature?



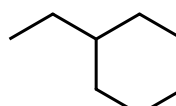
a.



b.

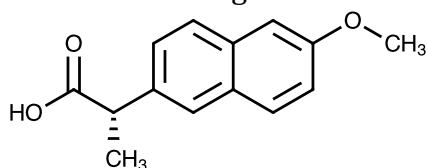


c.



d.

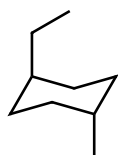
8. What is the configuration at the chiral center in the molecule shown below?



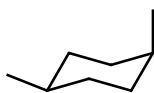
Top Hat Question

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

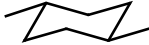
9. Which chair conformation below has *cis* substituents?



a.



b.



c.



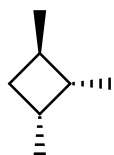
d.

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

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

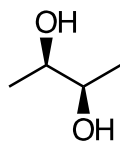
Bubble these answers in on your Scantron sheet for credit!

Each of these was taken directly from Top Hat or Ch. 5 PS



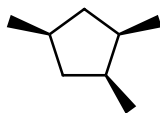
10.

a. Chiral



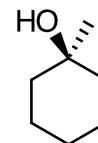
11.

a. Chiral



12.

c. Meso-Achiral



13.

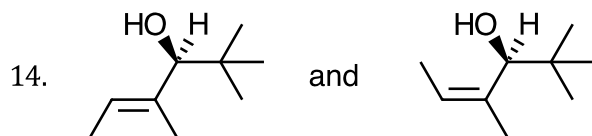
b. Achiral

For questions 14-18, determine whether each pair of molecules represent:

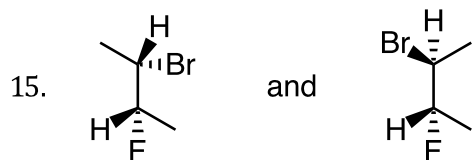
(a) Identical Compounds, (b) Constitutional Isomers, (c) Enantiomers, or (d) Diastereomers

Bubble these answers in on your Scantron sheet for credit!

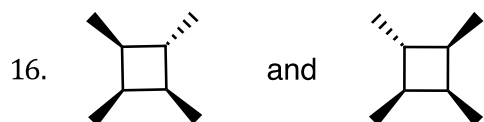
15-18 was taken directly from Top Hat or Ch. 5 PS



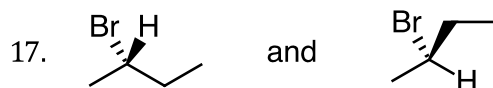
d. Diastereomers



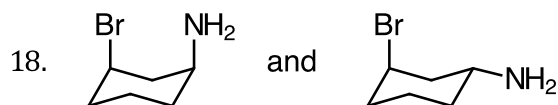
a. Identical Compounds



a. Identical Compounds



c. Enantiomers



d. Diastereomers

## 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)

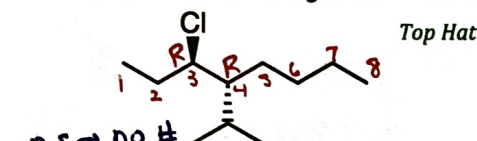
a)  Ch. 3 PS

4-chloro-3-ethyl-2,6-dimethyloctane  
 (+0.5) (+0.5) (+1) (+1)

b)  Ch. 3 & 4 PS

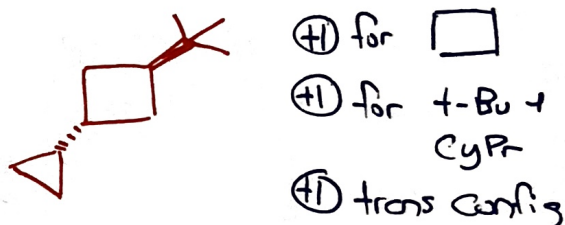
2-fluoro-1,1-dimethylcyclopentane  
 (+1) (+1) (+1)  
 -0.5 if 1- instead of 1,1-

c) Include R/S assignment in name

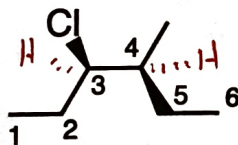


(3R,4R)-3-chloro-4-isopropyloctane  
 (+1) (+0.5) (+1) (+0.5)  
 -0.5 → no #

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

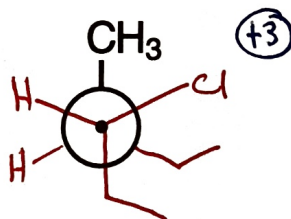


20. Use the structure below to complete the following questions. (8 points)



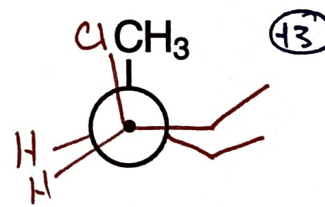
a) Using the template provided, draw the Newman projection viewing along the C3-C4 bond.

Top Hat



-2 for any other staggered conf.

b) Using the template provided, draw the conformation that has the Cl and CH<sub>3</sub> eclipsed.



-2 for any other eclipsed conf.

c) What is the stereochemical configuration at C3?

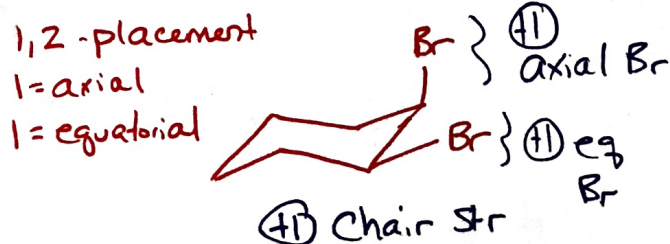
R (+1)

d) What is the stereochemical configuration at C4?

S (+1)

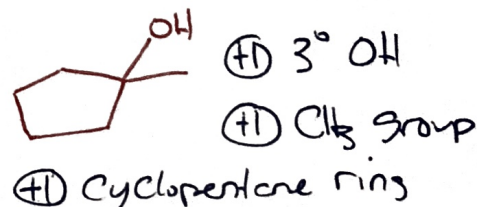
21. Draw representative structures for each of the following: (3 points each)


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



-1 if not 1,2 substituted

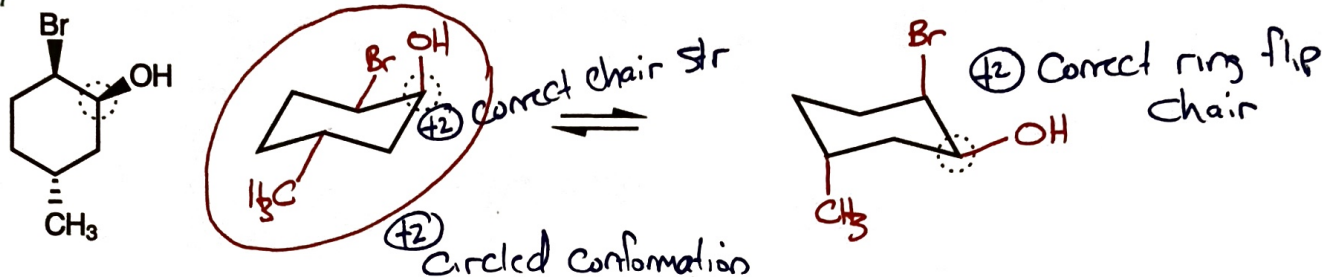
b) A compound with the molecular formula C<sub>6</sub>H<sub>12</sub>O that contains a five-membered ring, a tertiary alcohol, and a primary carbon.



-1 if wrong equatorial angle (  )

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)

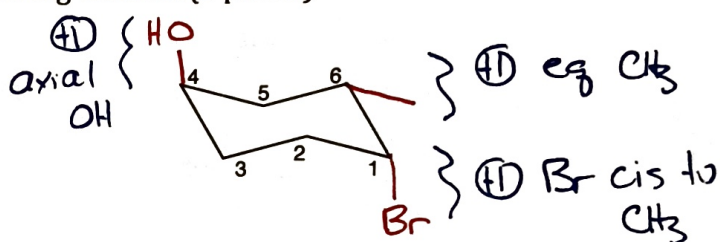
Chair Tutorial



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

Ch. 4 PS

- Equatorial -CH<sub>3</sub> at C6
- Axial -OH C4
- Br at C1 that is cis to -CH<sub>3</sub>

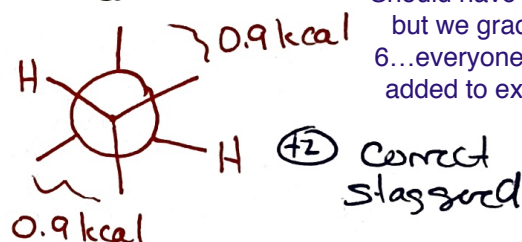
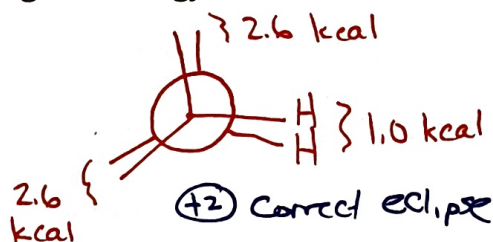


24. Focusing on the C2-C3 bond of 2,3-dimethylbutane, draw the highest energy and lowest energy conformations in the form of a Newman projection and answer the remaining questions. (6 pts)

Ch. 3 PS

**a) Highest Energy Conformation**

**b) Lowest Energy Conformation**



Should have been 7 pts, but we graded out of 6...everyone will get +1 added to exam score.

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

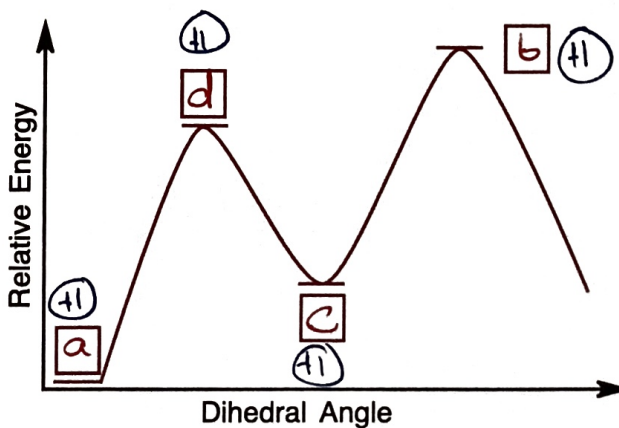
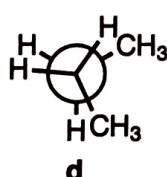
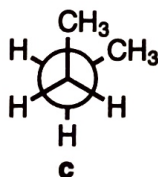
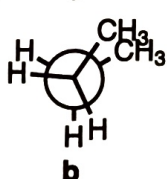
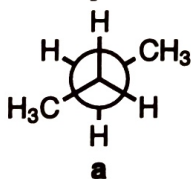
$$6.2 - 1.8 = 4.4 \text{ kcal/mol } (+1)$$

d) Which conformation above is the most stable?

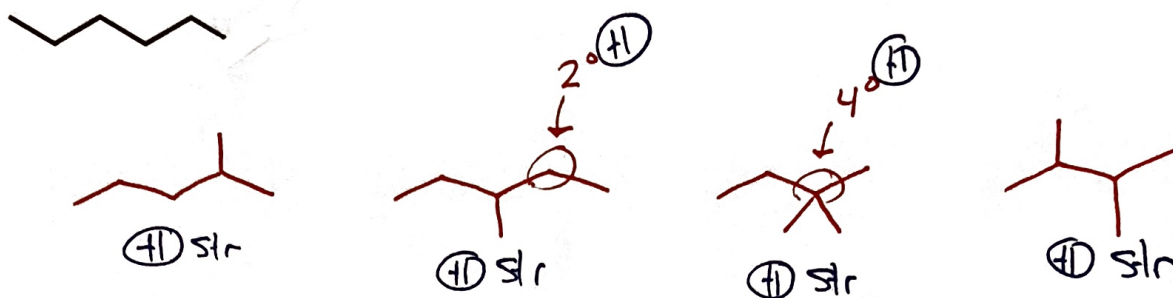
Conformation b (+1)

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

Covered this exact example in lecture

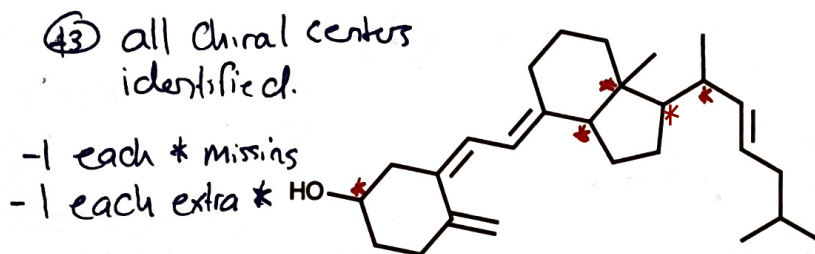


26. In addition to hexane, draw the four other constitutional isomers for C<sub>6</sub>H<sub>14</sub>. In your structures circle and identify one secondary carbon and one quaternary carbon. (6 points)



27. Identify every chiral center in Vitamin D<sub>2</sub> with an asterisk (\*). (3 points)

Spring 2017 Exam



28. Answer the following questions regarding each molecule shown below. (10 points) 9 pts + 1 bonus

Covered nearly identical acyclic version in recitation

	<p>a. Identify every chiral center in the molecule with an asterisk (*). (+1)</p> <p>Bonus: b. What is the maximum possible number of stereoisomers for this molecule? <math>2^3 = 8</math> (+1)</p>
<p>c. Draw a chiral stereoisomer</p> <p>okay if on <math>\blacktriangleleft</math> or <math>\blacksquare</math></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> <p>any diastereomer of compd e. (+2)</p>

Structures c, d, e, & f must correspond to the 1,2,3-pentanetriol str.

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)

