Name: Answer Key
Last First MI

Chemistry 233-001
Exam 2

Spring 2017 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. 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												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 H 1.01	2 IIA																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 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

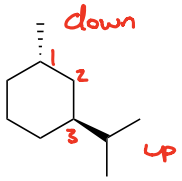
Name: _____
Last First MI

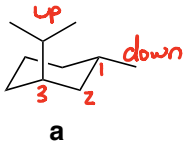
Grading Page (Exam 2):

Page	Points Possible	Points Earned
Multiple Choice (3-5)	30	
6	17	
7	18	
8	17	
9	18	
TOTAL	**100**	

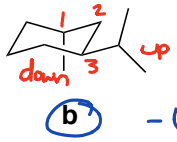
Multiple Choice
Choose the one best answer for each of the following questions. Using a pencil, record this answer on the provided Scantron sheet. *(2 points each)*

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

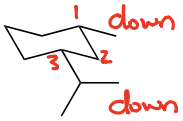




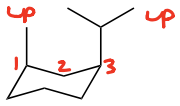
a



b - bulkier group equatorial

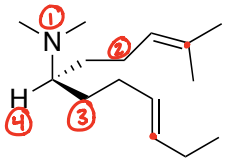


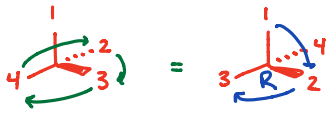
c



d

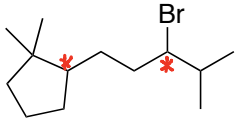
2. What is the configuration at the chiral center in the molecule below?





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

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



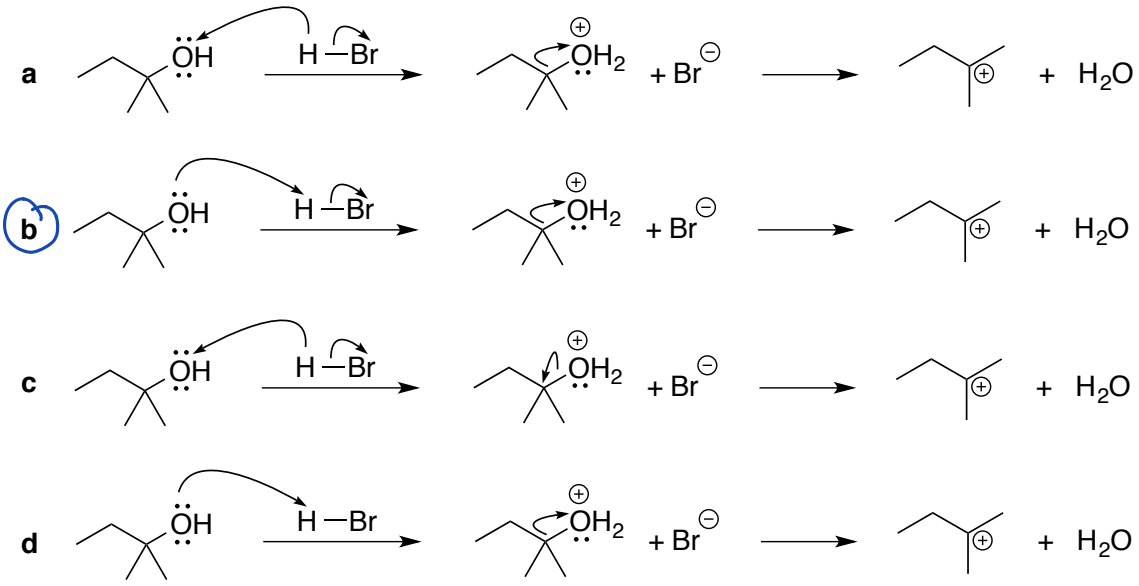
$2^2 = 4$

a. Two
b. Four
c. Eight
d. Nine
e. Sixteen

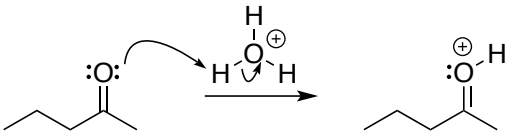
4. Which one of the following leads to the most exergonic reaction?
a. A negative ΔH and a negative ΔS.
b. A positive ΔH and a positive ΔS.
c. A negative ΔH and a positive ΔS.
d. A positive ΔH and a negative ΔS.

$\Delta G = \Delta H - T\Delta S$ (−) (+)

5. Consider the partial reaction mechanism shown below. Which of the following has the correct mechanistic arrows?

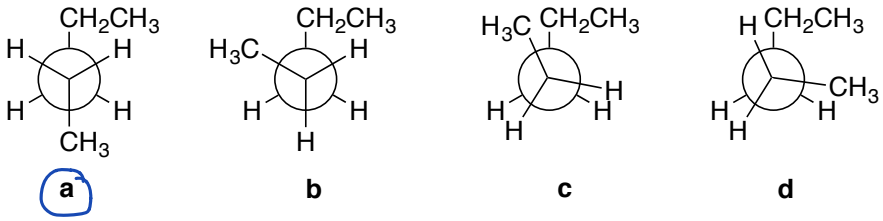


6. What mechanistic step(s) is/are represented in the reaction shown below?

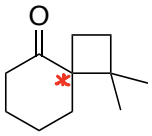


a. Proton transfer
b. Nucleophilic attack
c. Loss of a leaving group
d. Nucleophilic attack & loss of a leaving group
e. Electrophilic attack

7. Which Newman projection below is an anti conformation?

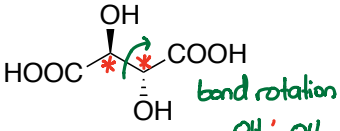


For questions 8-11, determine whether each molecule is:
(a) Chiral, **(b)** Achiral, or **(c)** Meso-Achiral
Bubble these answers in on your Scantron sheet for credit!

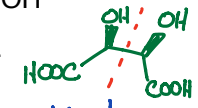


8.

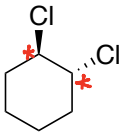
@ Chiral



9.

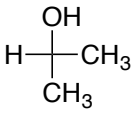


© Meso-achiral



10.

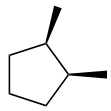
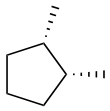
(b) Chiral

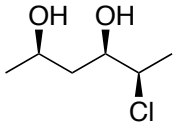
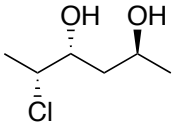


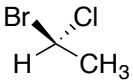
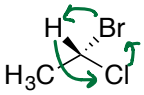
11.

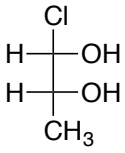
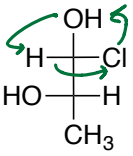
(b) achiral

For questions 12-15, 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!

12.  and  (a)

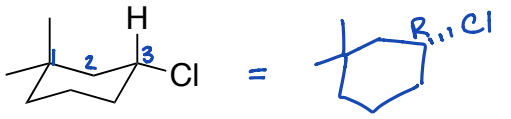
13.  and  (d)

14.  and  (c)

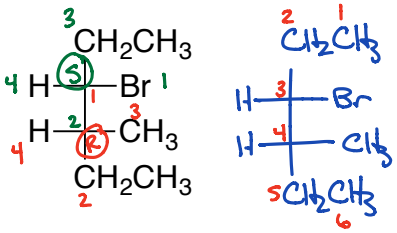
15.  and  (c)

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

16. Provide IUPAC systematic names for each compound shown below. Include *R/S* only where appropriate. *(3 points each)*

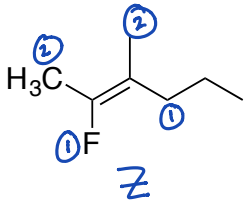
a. 

(R)-3-chloro-1,1-dimethylcyclohexane
or
(3R)

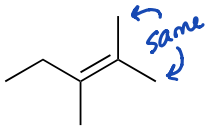
b. 

(3S,4R)-3-bromo-4-methylhexane

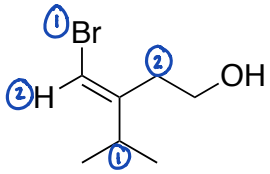
17. Label each alkene below as *E*, *Z*, or neither. *(1 point each)*



Z

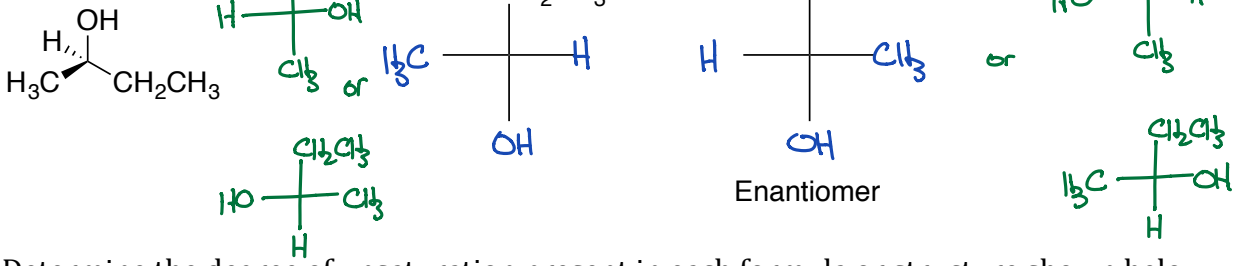


neither

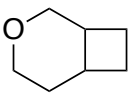


E

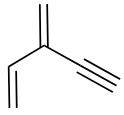
18. Using the template provided, convert the structure shown below to a Fischer projection then draw the enantiomer of your Fischer projection. *(4 points)*



19. Determine the degree of unsaturation present in each formula or structure shown below. *(1 point each)*



2



4

C_6H_{12}

1

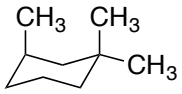
$\frac{2(6)+2-12}{2}$

$C_5H_{13}NO$

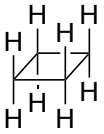
0

$\frac{2(5)+2-13+1}{2}$

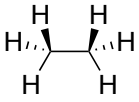
20. Label the major form(s) of strain (angle, torsional, steric) present in the provided conformation of each compound shown below. *(1 point each)*



steric

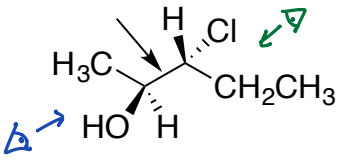


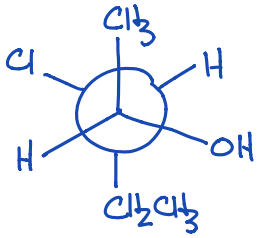
angle
torsional



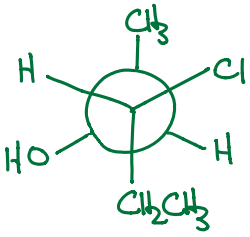
torsional

21. Convert the molecule shown below to a Newman projection viewing along the indicated bond. *(4 points)*

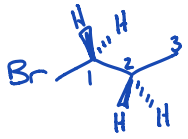


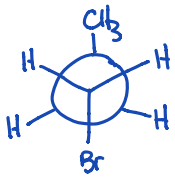


or

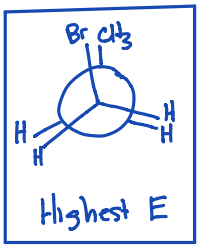


22. **a.** Draw the highest energy Newman projection about the C**1**-C**2** bond of 1-bromopropane. *(3 points)*





Lowest E



Highest E

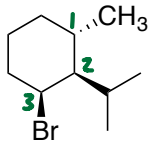
b. If the relative energy of the above conformation is 5.1 kcal/mol, what is the energy cost associated with a Br/CH_3 eclipse? *(1 point)*

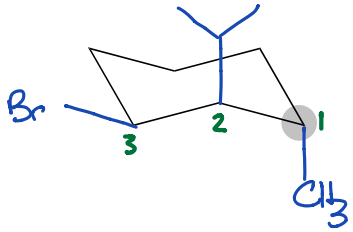
2 (H/H eclipses) + 1 Br/CH_3 eclipse = 5.1 kcal/mol =>

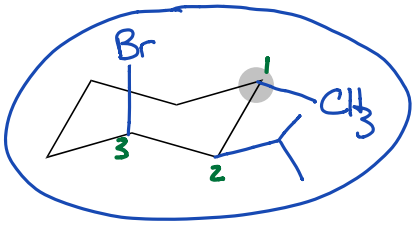
2(1.0) + X = 5.1 kcal/mol

X = 3.1 kcal/mol

23. Draw both chair conformations for the compound shown below using the templates provided. Put the –CH_3 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)*

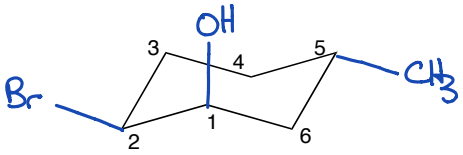






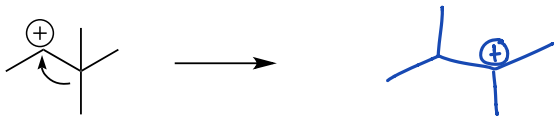
24. Draw a chair conformation that meets the following criteria: *(2 points)*

- Axial OH at C1
- Equatorial CH_3 at C5
- Br at C2 that is *trans* to CH_3

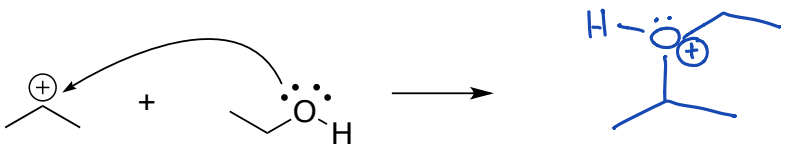


25. Predict the product(s) for each reaction step below by tracking the electron flow. *(2 points each)*

a.

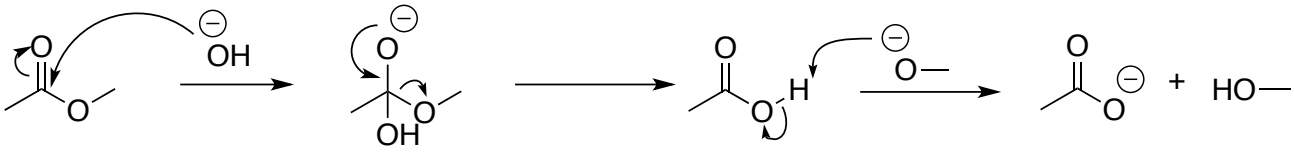


b.



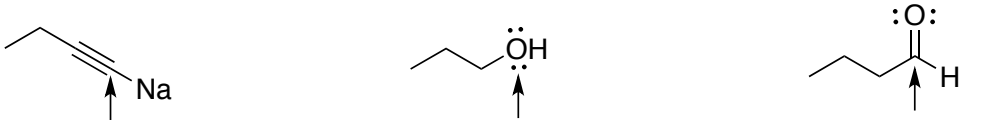
c.

26. Label each mechanistic step below as a Nu attack, proton transfer, loss of leaving group, or carbocation rearrangement. *(3 points)*



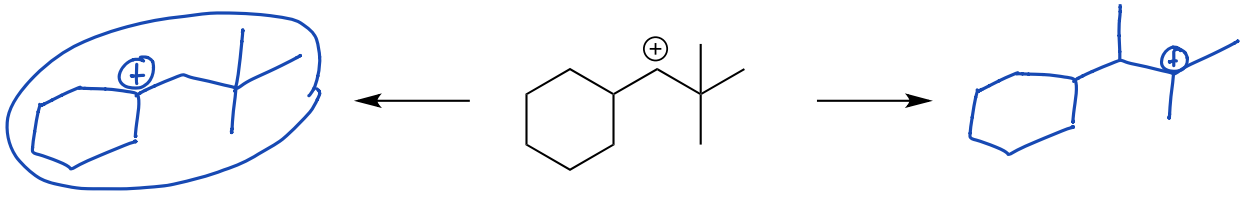
Nu Attack | Loss of Leaving Group | Proton Transfer

27. Determine whether the indicated atom in each species shown below will act as a nucleophile, electrophile, or both. *(1 point each)*

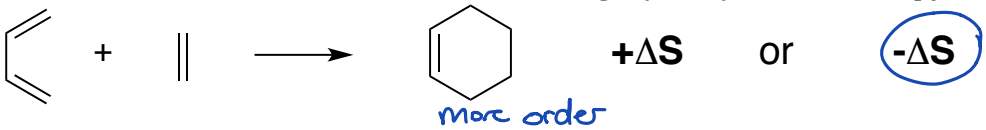


Nucleophile | Nucleophile | Electrophile

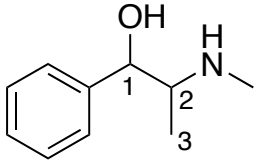
28. Show two different rearrangement products for the carbocation shown below. Circle the rearrangement product that is preferred (more likely to form). *(4 points)*



29. For the reaction shown below, what is the sign (+ or -) for the entropy term (ΔS)? *(1 point)*



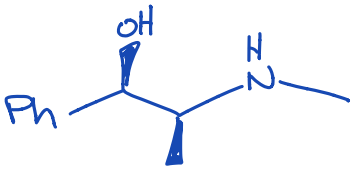
30. Consider the molecule ephedrine shown below and answer the following questions. *(9 points)*



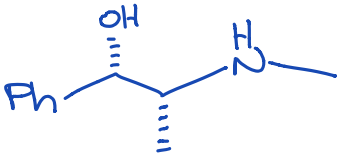
a. What is the maximum number of stereoisomers?

$2^2 = 4$

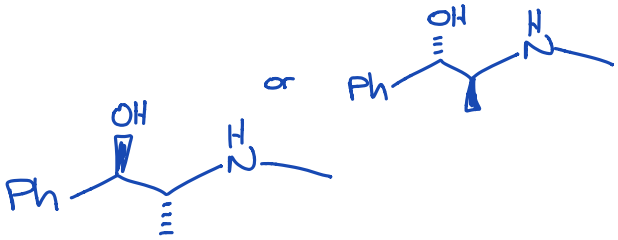
b. Draw the *1R,2S* stereoisomer.



c. Draw the enantiomer of the stereoisomer from b.



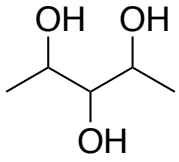
d. Draw a diastereomer of the stereoisomer from part ~~b~~.

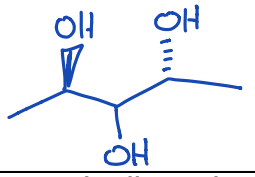


e. Explain exactly what a bottle of racemic ephedrine would contain.

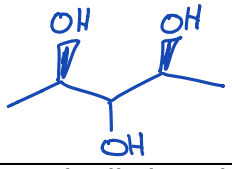
A 1:1 mixture of the two enantiomeric forms

31. Draw an optically active and optically inactive stereoisomer for the compound shown below. *(4 points)*



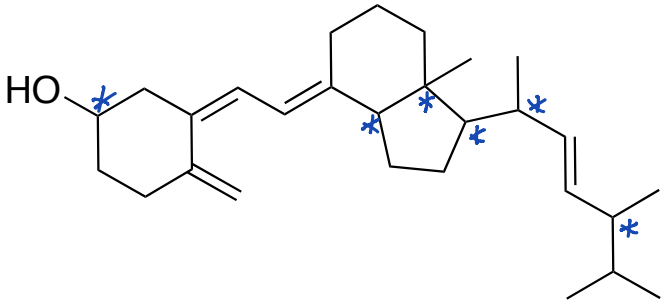


optically active



optically inactive

32. Identify every chiral center in Vitamin D (shown below) using an asterisk(*). *(3 points)*



33. Draw the enantiomer of the chair cyclohexane shown below. You must draw the enantiomer as a chair! *(2 points)*