Answer Key

Chemistry 233-001/002
Exam 2 – Version A

Fall 2019 Dr. J. Osbourn

Instructions: Answer the first 23 questions of this exam using the bubble sheet attached to the end of this exam booklet. You may detach this sheet if you wish. As a bonus for reading the instructions. The answer to question 9 is a. Answer the remaining questions directly on this exam. Show all work and provide complete explanations.

The Periodic Table

IA																	VIIIA
1 H 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	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)

Multiple-Choice

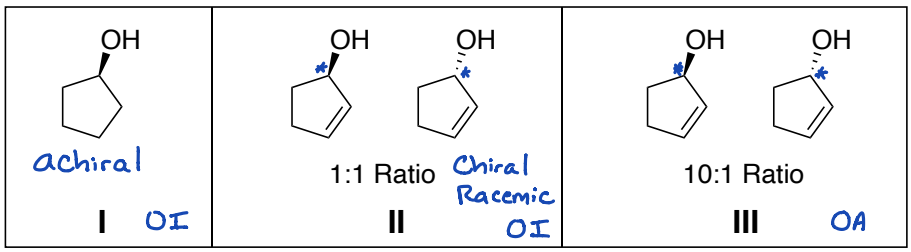
Choose the best answer for each of the following questions. Record each answer on the attached bubble sheet. **Ensure you completely bubble in your answers**. *(2 points each)*

1. Which of the following is the least stable conformation of trans-1-isopropyl-3-methylcyclohexane?

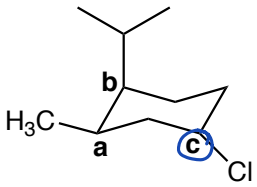
a **b** **c** **d**

2. Which of the following would make up an optically active solution?

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

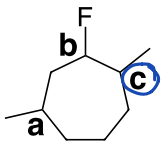


3. Which substituent on the following chair structure is drawn in an invalid fashion?

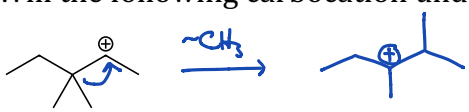


d. None of the substituents are invalid

4. When determining the IUPAC name for the following compound, which carbon is carbon #1?



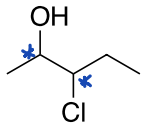
5. Will the following carbocation undergo rearrangement? If so, by which mechanism?



a. No. This carbocation will not rearrange.
b. Yes. This carbocation will rearrange via a methyl shift.
c. Yes. This carbocation will rearrange via a hydride shift.

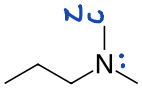
6. What is the maximum possible number of stereoisomers for the following compound?

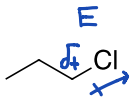
a. One
b. Two
c. Four
d. Eight
e. Cannot be determined

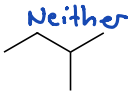


$2^2 = 4$

7. Classify each of the following as a nucleophile or electrophile.

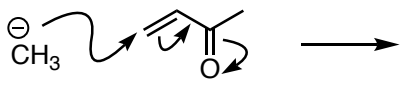


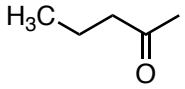




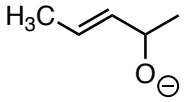
a.	Nucleophile	Nucleophile	Neither
b.	Electrophile	Nucleophile	Neither
c.	Both Nu and E	Electrophile	Nucleophile
d.	Nucleophile	Electrophile	Neither
e.	Both Nu and E	Both Nu and E	Nucleophile

8. What is the correct product from the following electron flow pattern?

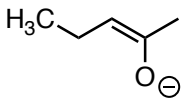




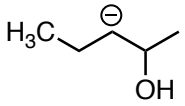
a



b



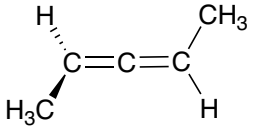
c

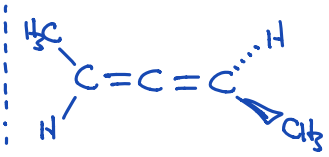


d

9. How would you classify the following molecule?

a. Chiral
b. Achiral
c. Achiral Meso

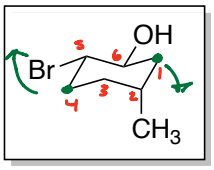


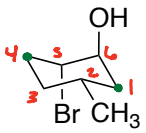


Non-superimposable on its mirror image.

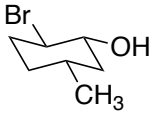
Also, answer was given in the instructions on the Cover page.

10. Which of the following is a correct ring-flip conformation of the chair cyclohexane in the box below?

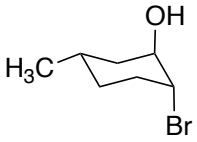




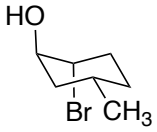
a



b



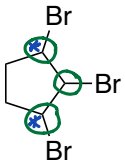
c



d

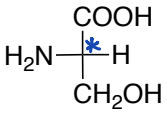
11. The compound shown below has 2 chiral centers and 3 stereocenters.

a. 1, 3
b. 2, 3
c. 3, 2
d. 2, 2
e. 2, 1



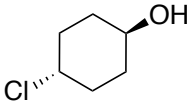
Chirality Assessment

For questions 12-15, identify each compound as: **a**. Chiral; **b**. Achiral; or **c**. Achiral-Meso. *Bubble each answer in on your bubble sheet for credit!*



12.

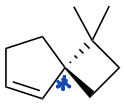
a



13.

b

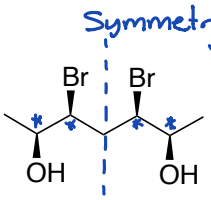
No Chiral Centers



14.

a

Symmetry



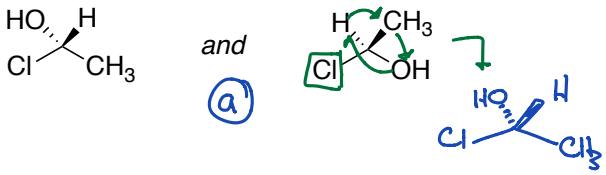
15.

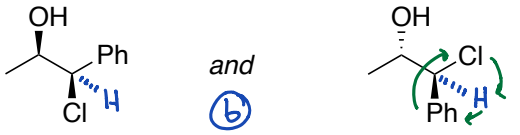
c

Molecule Relationships

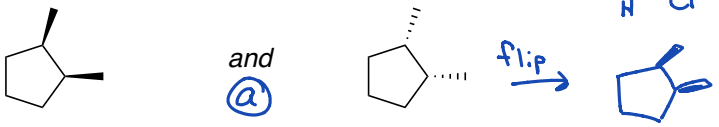
For questions 16-20 identify each pair as: **a.** Identical; **b**. Enantiomers; **c**. Diastereomers; **d**. Constitutional Isomers; or **e**. Not Isomers. *Bubble each answer in on your bubble sheet for credit!*

16.  *and* (c)

19.  *and* (a)

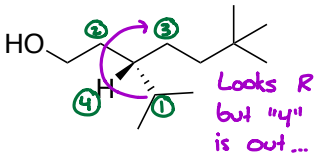
17.  *and* (b)

20.  *and* (d)

18.  *and* (a)

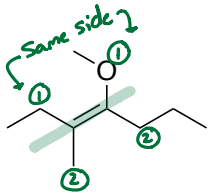
Assigning Configurations

For questions 21-23, determine the configuration at the stereocenter in each molecule. *Bubble each answer in on your bubble sheet for credit!*

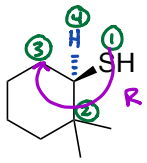
21. 

Looks R but "4" is out... really S

a. *R*-configuration
b. *S*-configuration
c. *E*-configuration
d. *Z*-configuration

22. 

a. *R*-configuration
b. *S*-configuration
c. *E*-configuration
d. *Z*-configuration

23. 

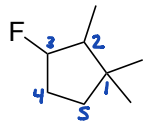
a. *R*-configuration
b. *S*-configuration
c. *E*-configuration
d. *Z*-configuration

Completion Section

Answer the remaining questions directly on the exam itself. Please write neatly and **darkly** as your answers will be scanned for grading.

(9) 24. Write the IUPAC name for each molecule shown below. *(3 points each)*

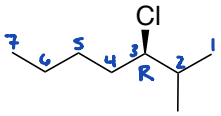
a.



3-fluoro-1,1,2-trimethylcyclopentane (+1) (+1) (+1)

-1 wrong #

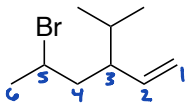
b.



(+1) R-3-chloro-2-methylheptane (+2) (+1)
or
3R

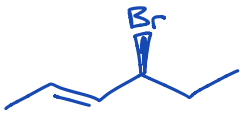
-1 if an R/S/E/Z is added where it doesn't belong.

c.



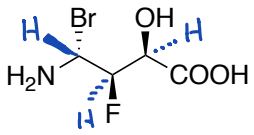
(+1) 5-bromo (+1) 3-isopropyl (+1) 1-hexene
or
hex-1-ene

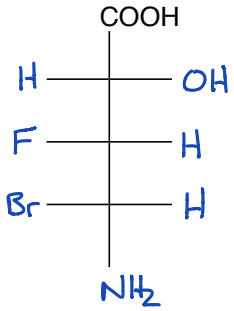
(3) 25. Draw the structure of **(2*E*,4*S*)-4-bromo-2-hexene**. *(3 points)*



(+1) E-2-hexene chain
(+1) for 4-bromo
(+1) for correct S config

(3) 26. Convert the molecule shown below to a Fischer projection. Use the provided template, placing the COOH group at the top. *(3 points)*

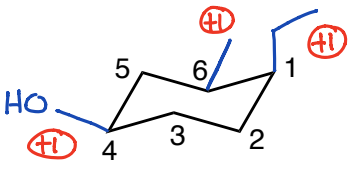




(+3) No Partial Credit

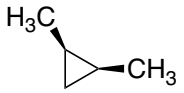
(3) 27. Using the template provided draw the structure of the chair cyclohexane that meets the following criteria. *(3 points)*

- Axial ethyl at C1
- OH at C4 that is cis to the ethyl
- Equatorial CH_3 at C6



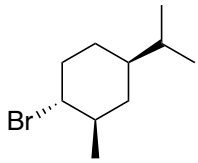
18

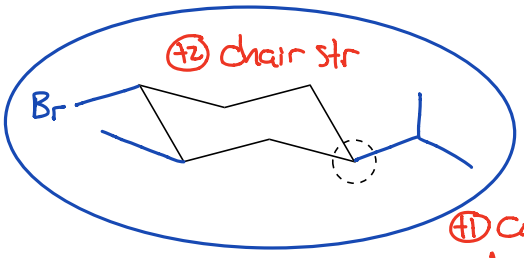
(3) 28. Identify the types of strain present in the following molecule. *(3 points)*

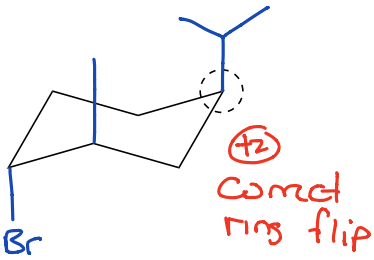


- Ring Strain (angle Strain) +1
- Torsional Strain +1
- Steric Strain +1

(5) 29. Draw both chair conformations for the compound shown below using the templates provided. Put the isopropyl on the carbon indicated by the circle and orient your other group based on that reference point. Circle the chair conformation that is lowest in energy. *(5 points)*



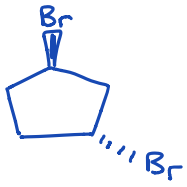




-1 if only 1 substituent is mis-drawn

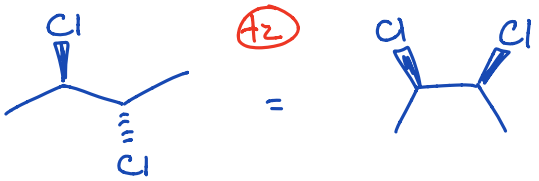
(8) 30. Draw each of the following: *(2 points each)*

a. An optically active stereoisomer of 1,3-dibromocyclopentane.



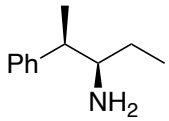
+2

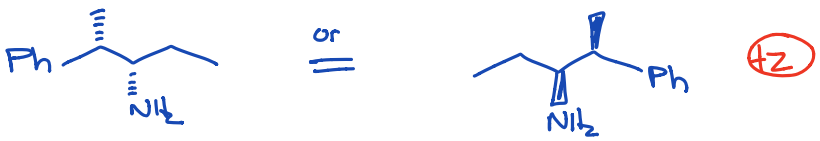
b. An optically inactive stereoisomer of 2,3-dichlorobutane.



+2

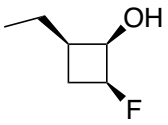
c. The enantiomer of:

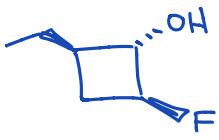




+2

d. A diastereomer of:





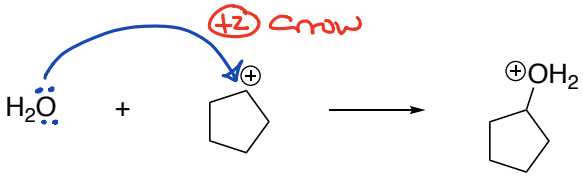
is one possibility +2

Any Stereoisomer with one or two Chiral Centers inverted

16

(9) 31. For each of the following, draw in curved arrows in the reactants to show electron flow. Then, classify the pattern of electron flow (i.e. proton transfer). *(3 points each)*

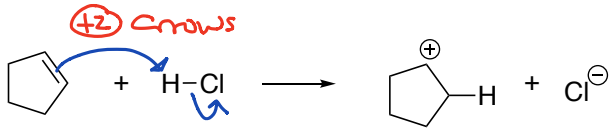
a.



Pattern of Electron Flow:

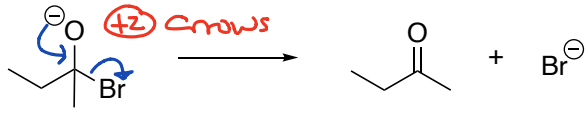
Nucleophilic Attack +1

b.



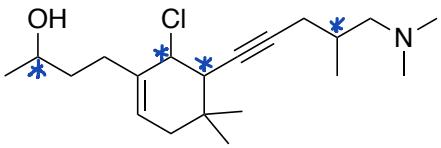
Proton Transfer +1

c.



Loss of a Leaving Group +1

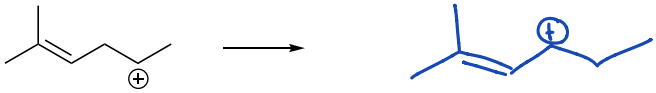
(4) 32. Identify every chiral center in the following molecule with an asterisk *. *(4 points)*



+1 each correct *
-1 each incorrect *
} max +4 min Ø

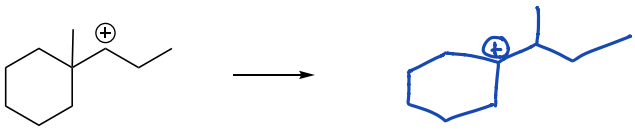
(4) 33. Draw the carbocation rearrangement product for each of the following. *(2 points each)*

a.



+2

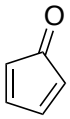
b.



+2

(3) 34. Calculate the degree of unsaturation for each compound below. *(1 point each)*

a.



4 +1

b. $C_{10}H_{18}$

2 +1

$\frac{10(2)+2-18}{2} = \frac{22-18}{2} = \frac{4}{2}$

c. $C_{10}H_{15}NCl_2$

3 +1

$\frac{10(2)+2-15-2+1}{2} = \frac{6}{2}$

/20