

Answer Key

Chemistry 233-101 Exam 2 – Version B

Summer 2019

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Instructions: Answer the first 20 questions of this exam using the bubble sheet attached to the end of this exam booklet. You may detach this sheet if you wish. Answer the remaining questions directly on this exam. Show all work and provide complete explanations.

The Periodic Table

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

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

Multiple-Choice

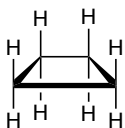
Choose the best answer for each of the following questions. Record each answer on the attached bubble sheet. **Ensure you completely bubble in your answers.** (2 points each)

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

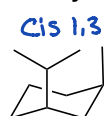


This question was messed up on the printed exam so everyone was awarded the 2 points.

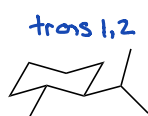
- a. 7
b. 6
c. 4
d. 2
e. 3
2. Which type(s) of strain is/are present in the following molecule? *Note: You may bubble in more than one letter for this question.*



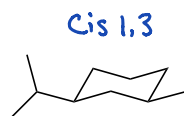
- a. Steric Strain
b. Angle Strain
c. Torsional Strain
d. This molecule does not contain any forms of strain.
3. Which one of the following is the most stable chair conformation for *cis*-1-isopropyl-3-methylcyclohexane?



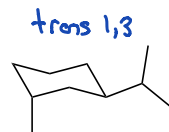
a



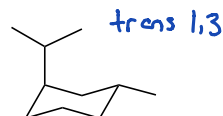
b



c

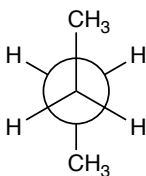


d

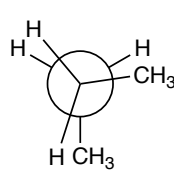


e

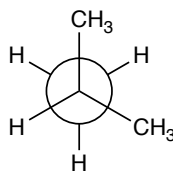
4. Which one of the Newman projections below has a 60° dihedral angle between the two methyl groups?



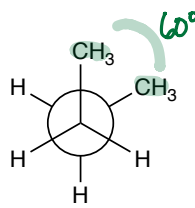
a



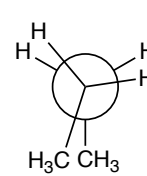
b



c

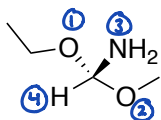


d'



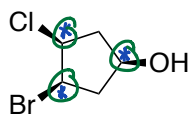
e

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

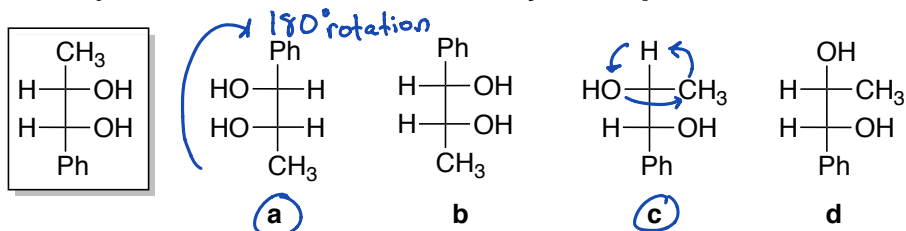


- a. R-configuration
 b. S-configuration

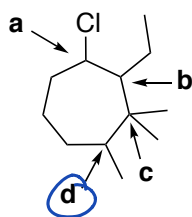
6. The molecule shown below has 3 chiral centers and 3 stereocenters.



- a. 2, 3
 b. 3, 2
 c. 3, 3
 d. 0, 3
 e. 3, 0
7. Which Fischer projections shown below are identical molecules to the one shown in the box. *Note: You may bubble in more than one letter for this question.*



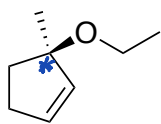
8. When determining the IUPAC name for the following molecule, which carbon is carbon #1?



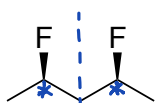
For questions 9-12, determine whether each molecule is:

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

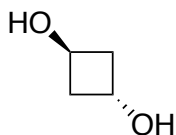
Bubble these answers in on your Scantron sheet for credit!



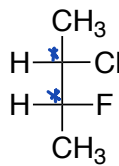
9. (a)



10. (c)



11. (b)



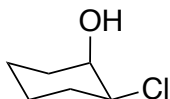
12. (a)

For questions 13-17, determine whether each pair of molecules represent:

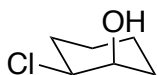
(a) Identical Compounds, (b) Constitutional Isomers, (c) Enantiomers, or (d) Diastereomers

Bubble these answers in on your Scantron sheet for credit!

13.



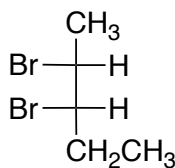
and



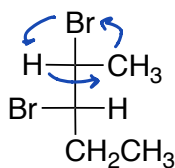
Hint: Convert the chairs to dash/wedge drawings and compare.

(a)

14.

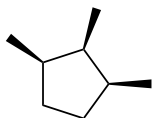


and

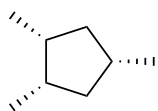


(a)

15.

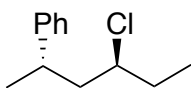


and

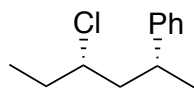


(b)

16.

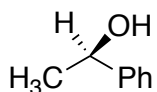


and

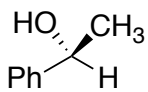


(d)

17.



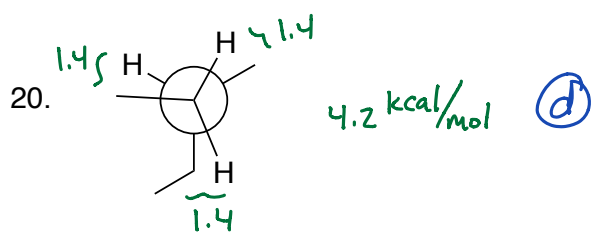
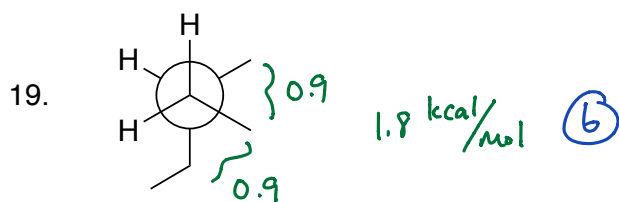
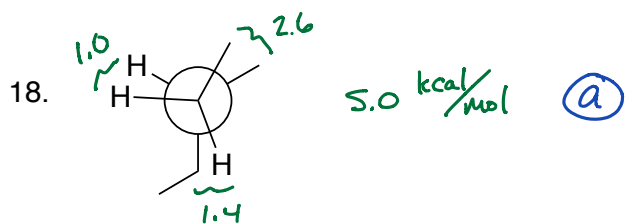
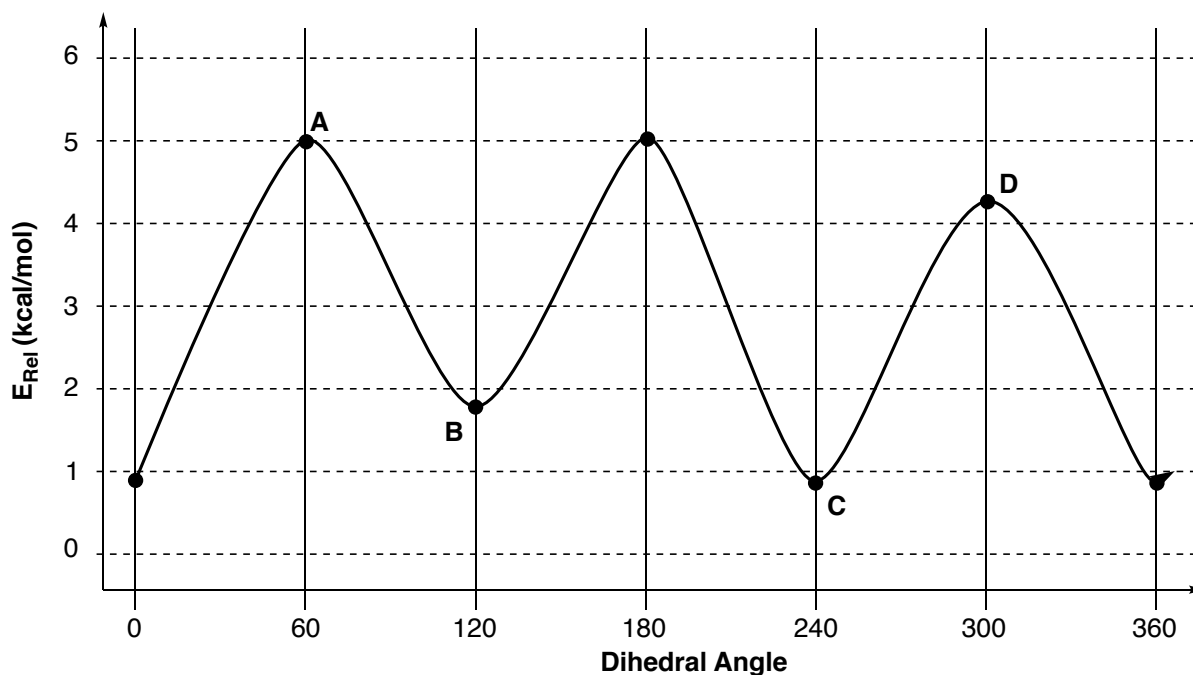
and



(c)

For questions 18-20, match each Newman projection with its corresponding location on the energy diagram. Bubble these answers in on your Scantron sheet for credit!

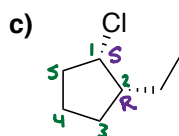
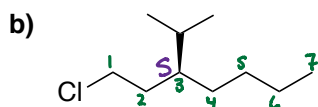
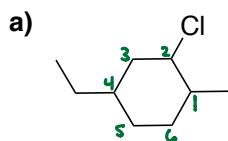
Note: You may make the assumption that conformational energies of the ethyl group are the same as the methyl group.



Completion Section

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

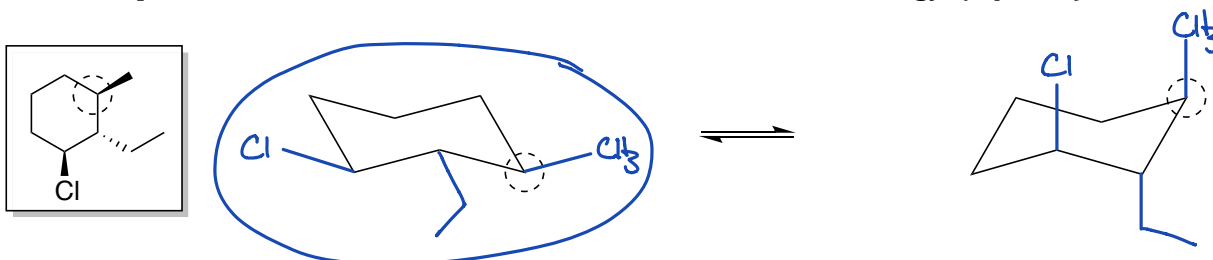
21. Provide IUPAC systematic names for each compound shown below. Include *R/S* for molecules b and c. (3 points each)



22. Use the molecule drawn in the first box to answer the following questions. (12 points)

	<p>a) What is the configuration at <i>a</i>?</p> <p style="text-align: center; font-size: 2em;">S</p> <p>b) What is the configuration at <i>b</i>?</p> <p style="text-align: center; font-size: 2em;">S</p>	<p>c) Draw a Newman projection using the template provided.</p>
<p>d) Draw the molecule as a Fischer projection.</p>	<p>e) Draw the enantiomer of the compound in d.</p>	<p>f) Draw a diastereomer of the compound in d.</p>

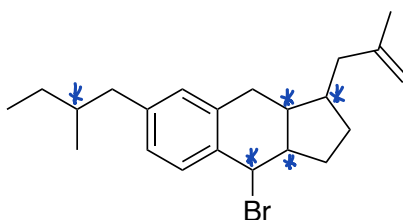
23. Draw both chair conformations for the compound shown below using the templates provided. Put the $-CH_3$ on the carbon indicated with the circle and orient your other groups based on that reference point. Circle the chair conformation that is lowest in energy. (5 points)



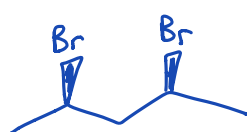
24. Draw the Newman projection for the lowest energy and highest energy conformation of 2-methylbutane viewing along the C2-C3 bond (in bold). Then, calculate the relative energy of each conformation. (8 points)

	Lowest Energy Conformation	Highest Energy Conformation
	$E_{rel} = 0.9 \text{ kcal/mol}$	$E_{rel} = 5.0 \text{ kcal/mol}$

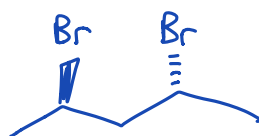
25. Identify every chiral center in the molecule below with an asterisk (*). (4 points)



26. Draw a chiral and an achiral stereoisomer of 2,4-dibromopentane. (2 points each)



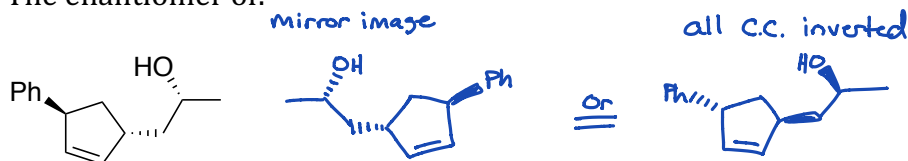
Achiral Stereoisomer



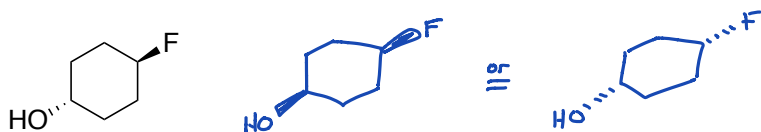
Chiral Stereoisomer

27. Draw each of the following (3 points each)

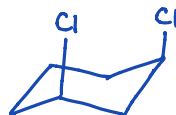
a. The enantiomer of:



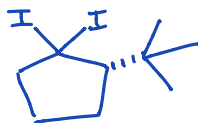
b. A diastereomer of:



c. The least stable chair conformation of *cis*-1,3-dichlorocyclohexane.

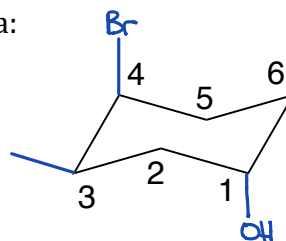


d. (*S*)-3-*tert*-butyl-1,1-diiodocyclopentane



e. A chair conformation that meets the following criteria:

- An axial OH at C#1
- An equatorial methyl at C#3
- A Br at C#4 that is *cis* to the methyl group.



28. Provide the definition of **torsional strain**. (3 points)

Strain that results from eclipsing atoms separated by 3-bonds.

29. **Bonus**: Label each as optically active (**OA**) or optically inactive (**OI**). (1 point each)

OA	OI	OI	OI