

CHEM 3311
Dr. Minger

Hour Exam #3
June 25, 2019

Name _____
PRINT CLEARLY

Circle your recitation section: 111 112 113 114 115 116
121 122 123 124 125 126

Sign the Honor Code pledge:

I pledge that on my honor, as a University of Colorado at Boulder student, I have neither given nor received unauthorized assistance on this exam.

Signature _____

**Instructions are on the other side of this page.
Please read them carefully!**

1A 2A 3A 4A 5A 6A 7A 8A

hydrogen 1 H 1.0079																	helium 2 He 4.0026						
lithium 3 Li 6.941	beryllium 4 Be 9.0122																	boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305																	aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80						
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29						
cesium 55 Cs 132.91	barium 56 Ba 137.33	* 57-70	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]					
francium 87 Fr [223]	radium 88 Ra [226]	** 89-102	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [263]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununium 111 Uuu [272]	unbibium 112 Uub [277]	ununquadium 114 Uuq [289]										

* Lanthanide series

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
--	-------------------------------------	---	--	--	---------------------------------------	---------------------------------------	---	--------------------------------------	---	--------------------------------------	-------------------------------------	--------------------------------------	--

** Actinide series

actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]
--------------------------------------	--------------------------------------	---	-------------------------------------	---------------------------------------	---------------------------------------	---------------------------------------	------------------------------------	---------------------------------------	---	---	--------------------------------------	--	---------------------------------------

General Instructions: There are 7 pages of questions plus this cover sheet. Be sure you have them all. Read each question carefully so that you know exactly what is being asked and what you need to write or draw. **DO NOT USE COLORED INK.** Your work on scratch pages will not be graded, so be sure everything you want graded is written on the exam itself and in the spaces provided for answers.

On your Scantron:

Bubble in your name, student ID number, and recitation section...

GENERAL PURPOSE ANSWER SHEET
5 OPTIONS - 180 QUESTIONS

INSTRUCTIONS
PLEASE USE A NO. 2 PENCIL ONLY
MAKE HEAVY BLACK MARKS THAT FILL THE CIRCLE COMPLETELY
DO NOT MAKE ANY STRAY MARKS ON THIS ANSWER SHEET
ERASE ALL ERASURES CLEANLY

EXAMPLES: PROPER MARK: IMPROPER MARKS:

STUDENT ID: 3 0 0 0 0 0 0 0 C

SECTION ID: 0 0 3 0

INSTRUCTOR USE ONLY
SUBJECTIVE SCORE: 0 0 0

TEST VERSION: A B C D E F

University of Colorado Boulder

DO NOT WRITE OUTSIDE OF THIS BOX

Sign your name in this box on the Scantron to acknowledge compliance with the CU Honor Code. ("I pledge on my honor as a CU student that I have neither given nor received unauthorized assistance on this exam.")

Recitation Sections (INCLUDE THE ZERO)

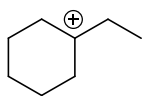
- 0111 Eric
- 0112 Wyatt
- 0113 Lacey
- 0114 Will
- 0115 Yiming (3 pm)
- 0116 Tianyi (3 pm)
- 0121 Hongxuan
- 0122 Andrew
- 0123 Shaofeng
- 0124 Zepeng
- 0125 Yiming (11 am)
- 0126 Tianyi (11 am)

Multiple choice. Each of the following multiple choice questions (1-10) is worth 5 points and has only one correct answer. Select the best answer for each question and bubble it in on your Scantron. Only the answers on your Scantron will be considered.

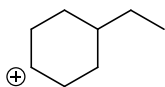
1. Identify the type(s) of strain present in cyclopropane.

- a. Angle
- b. Torsional
- c. Steric
- d. Angle and torsional
- e. Angle, torsional, and steric

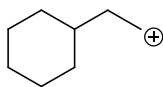
2. Select the most stable carbocation.



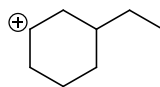
A



B



C

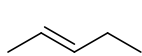


D

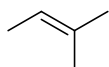
All these cations are equally stable

E

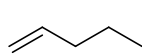
3. Select the most stable alkene in this set of isomers.



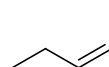
A



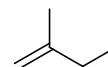
B



C

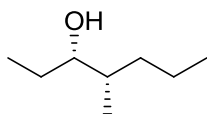


D

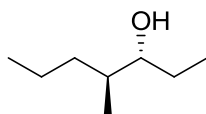


E

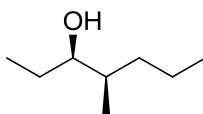
4. Pheromones are chemicals used by insects and some animals to communicate. For example, the ant species *Leptogenys diminuta* secretes one of the isomers of 4-methyl-3-heptanol to mark trails to food. The active stereoisomer is (3*R*,4*S*)-4-methyl-3-heptanol; the ants ignore the other stereoisomers. Which of these stereoisomers is (3*R*,4*S*)-4-methyl-3-heptanol?



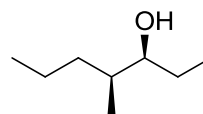
A



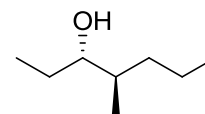
B



C

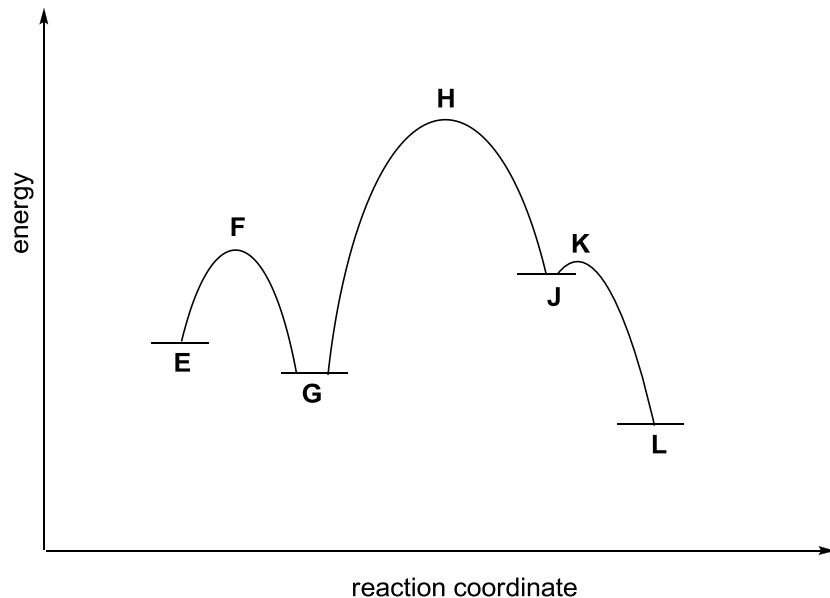


D



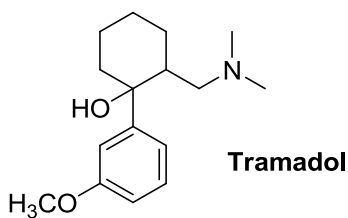
E

5. Here is an energy vs. reaction coordinate diagram for a multi-step reaction:



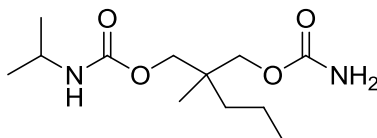
Proton transfers are often the fastest steps in organic reaction mechanisms. One of the steps in the reaction represented by the diagram is a proton transfer. Which of these species represents the transition state for the proton transfer?

- a. F
 - b. G
 - c. H
 - d. J
 - e. K
6. Tramadol is an opiate analgesic that is marketed as a mixture of stereoisomers. How many unique stereoisomers exist for Tramadol?



- a. 1
- b. 2
- c. 4
- d. 8
- e. 16

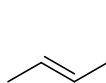
7. Carisoprodol, which is sold under the brand name “Soma”, is a musculoskeletal pain reliever.



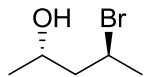
Carisoprodol (Soma)

Select the best label to describe carisoprodol.

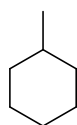
- a. Chiral
 b. Achiral
 c. Achiral and meso
8. Compound X is not superimposable on its mirror image and has two diastereomers, each of which is chiral. Which of these structures is Compound X?



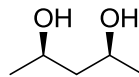
A



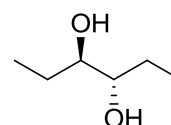
B



C

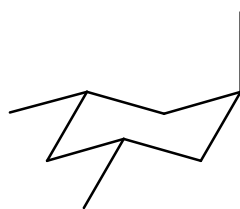


D

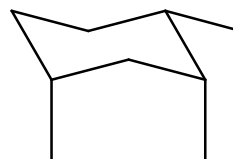


E

9. Select the true statement about these two structures.



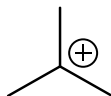
Structure A



Structure B

- a. These structures are the two chair conformations of the same molecule.
 b. There is a 1,3 diaxial interaction in Structure B.
 c. Structure A has more strain than Structure B.
 d. The two structures are stereoisomers.
 e. None of the statements “a” through “d” are true.

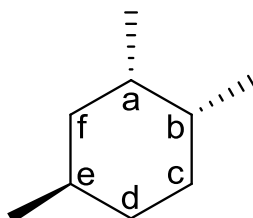
10. Identify the orbitals that are mixing to stabilize this carbocation by hyperconjugation.



- a. C-H σ and C-H σ^*
- b. p and sp^3
- c. p and sp^2
- d. p and C-H σ
- e. p and C-H σ^*

Free response. Provide the requested drawings or other information for the remaining questions.

- 11a. Draw both chair conformations of the molecule shown following the guidelines presented in class. Points will be deducted for improperly drawn chairs. Do not draw all the hydrogens on the ring, just the methyl groups. Each of the carbon atoms in the structure is labeled (a, b, c, etc.). Label the carbon atoms in both your chairs to identify exactly which carbons in your drawings correspond to the labeled atoms in this structure. (10 pts)



- 11b. Identify all gauche butane interactions in each chair by drawing lines between the carbons in each interaction as shown in lecture. (10 pts)
- 11c. Calculate the difference in energy between the two chair conformations. (Energy of a gauche butane interaction = 0.8 kcal/mol) (5 pts)

12. There are three unique stereoisomers of 1,2-dimethylcyclopropane. Two are chiral, and one is achiral.

12a) Draw all three stereoisomers in the boxes provided, using skeletal structures (**notice the labels in the boxes!**). Show stereochemistry at each asymmetric carbon using wedge and dash notation. (9 pts)

A ACHIRAL	B CHIRAL	C CHIRAL
--	---	---

12b) Assign an *R* or *S* absolute configuration to each asymmetric carbon in your structures. (6 pts)

12c) What is the stereochemical relationship of the two chiral isomers? (3 pts)

Identical

Diastereomers

Enantiomers

12d) What is the stereochemical relationship of the achiral isomer to either of the chiral isomers? (3 pts)

Identical

Diastereomers

Enantiomers

12e) Which two structures, when combined in the correct proportions, would form a racemic mixture? (Use the labels in the upper left corner of the boxes.) (2 pts)

12f) Is the achiral structure a meso compound? Circle one: **Yes** **No**
(2 pts)