

Please sign the Honor Pledge.

I pledge that

“On my honor, as a University of Colorado-Boulder student, I have neither given nor received unauthorized assistance on this work.”

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Please Sign Here

**General Instructions: (I) Scantron: Questions 1-10 (50 pts) AND (II) Short Answers: Questions 11-15 (50 pts)**

**Section I:** Complete the information requested on the scantron and bubble in the appropriate spaces using a No. 2 pencil.

**GENERAL PURPOSE ANSWER SHEET**  
5 OPTIONS - 240 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  
MAKE ALL ERASURES CLEANLY

**EXAMPLES:** PROPER MARK  IMPROPER MARKS

**STUDENT ID**

0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9

**SECTION ID**

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3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

**INSTRUCTOR USE ONLY**

**SUBJECTIVE SCORE**

0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9

**BATCH HEADER**

**KEY**

**TEST VERSION**  
A B C D E F

University of Colorado  
Boulder

If you change an answer, erase the undesired mark thoroughly. Mark only the best answer to each multiple-choice question. There are 5 exam pages (with 10 MC questions and 5 short answer questions), a cover page, and two blank pages (scratch paper). When you are instructed to begin the exam, please check that you have all pages. Good luck! **Please return the completed scantron sheet, SHORT ANSWER section, and this cover page (sign Honor Code) to the exam proctors.** You may take the MULTIPLE-CHOICE section of the exam and scratch paper with you.

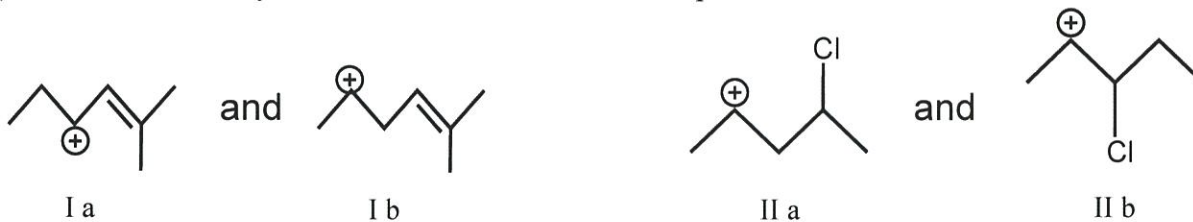
**Partial Periodic Table**

1A							8A
1	H						2
		2A					He
3	Li	4	Be				
				3A	4A	5A	6A
				5	6	7	8
				B	C	N	O
				9	10		
				F	Ne		
				13	14	15	16
				Al	Si	P	S
				17	18		
				Cl	Ar		
				35			
				Br			
				53			
				I			

Recit.	Location	Day	Time	TA
221	EKLC M2B26	Tue	9:00 AM - 9:50 AM	Ed Guzman
222	EKLC M2B26	Tue	10:00 AM - 10:50 AM	Ed Guzman
226	EKLC M2B26	Tue	12:00 PM - 12:50 PM	Will Hartwig
230	EKLC M2B26	Wed	8:00 AM - 8:50 AM	Jordan Theriot
238	EKLC M2B26	Wed	4:00 PM - 4:50 PM	Jordan Theriot
244	EKLC M2B26	Thu	11:00 AM - 11:50 AM	Will Hartwig
247	EKLC M2B26	Thu	1:00 PM - 1:50 PM	Price Kirby

**Table of Acidities**

Acid	pK <sub>a</sub> Value	Acid	pK <sub>a</sub> Value
HI	-10.1	H <sub>2</sub> O	15.7
HCl	-3.9	Alcohols	16-18
H <sub>3</sub> O <sup>+</sup>	-1.7	HC≡CH	26
CH <sub>3</sub> COOH	4.7	NH <sub>3</sub>	36
NH <sub>4</sub> <sup>+</sup>	9.3	H <sub>2</sub> C=CH <sub>2</sub>	45
Phenol	10	CH <sub>4</sub>	60

**Section I: Questions 1-10 (5 points each; total: 50 points)**1) Select the relatively *more stable* carbocation in each pair.**(A) I a, II a**

(B) I a, II b

(C) I b, II a

(D) I b, II b

2) Select the relatively *more stable* molecule in each pair.

(A) I a, II a

**(B) I a, II b**

(C) I b, II a

(D) I b, II b

3) Which constitutional isomer releases the *most heat* on combustion?

(A) 2,3-dimethyl-2-butene

**(B) 4-methyl-1-pentene**

(C) 2-methyl-1-pentene

(D) (*E*)-3-methyl-2-pentene4) Assign the *absolute* configuration at each asymmetric carbon in compounds I and II.(A) *R* and *R*(B) *R* and *S*(C) *S* and *R***(D) *S* and *S***

5) What is the stereochemical relationship between the molecules shown?



- (A) Constitutional Isomers (B) Diastereomers  
**(C) Enantiomers** (D) Homomers (identical)

6) What is the stereochemical relationship between the molecules shown?

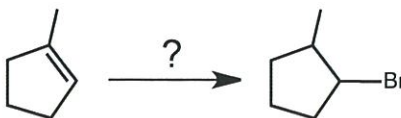


- (A) Constitutional Isomers **(B) Diastereomers**  
 (C) Enantiomers (D) Structural (constitutional) isomers

7) Which reaction or reaction sequence involves *syn* addition?

- (A) Acid-catalyzed hydration of alkene  
 (B) Bromination of alkene in  $\text{CH}_2\text{Cl}_2$  as solvent  
**(C) Hydroboration-oxidation of alkene**  
 (D) Oxymercuration-demercuration (reduction) of alkene

8) Which reagent(s)/reaction conditions should be used to carry out the following transformation?



- (A) HBr,  $\text{H}_3\text{C-O-O-CH}_3$ , heat** (B) HBr (C)  $\text{Br}_2$ ,  $\text{H}_2\text{O}$  (D)  $\text{Br}_2$ ,  $\text{CH}_3\text{OH}$

9) Which constitutional isomer of  $\text{C}_6\text{H}_{14}$  yields *four* different monochlorinated products?

- (A) 2-methylpentane **(B) 3-methylpentane** (C) 2,2-dimethylbutane (D) 2,3-dimethylbutane

10) Which reaction is best explained by a *single* mechanistic step?

- (A) Alkene + HBr **(B) Alkene +  $\text{BH}_3$  in THF**  
 (C) Alkene + HBr/ROOR (D) Alkene +  $\text{Br}_2$  in  $\text{H}_2\text{O}$

**Section II: SHORT ANSWER Questions 11-15 (total: 50 points)***Answer Key*Please sign the Honor Pledge.

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Assigned Seat # \_\_\_\_\_

Recitation Section # \_\_\_\_\_

(Note: -5 points for Recitation section #)

For Grading Purposes Only

Question 11 (6 points) \_\_\_\_\_

Question 12 (8 points) \_\_\_\_\_

Question 13 (14 points) \_\_\_\_\_

Question 14 (10 points) \_\_\_\_\_

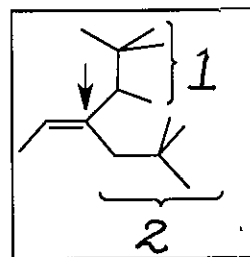
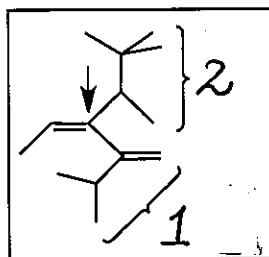
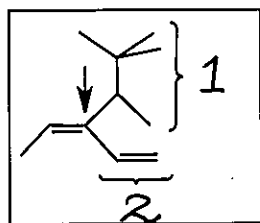
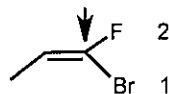
Question 15 (12 points) \_\_\_\_\_

Total Points (50 points possible) \_\_\_\_\_

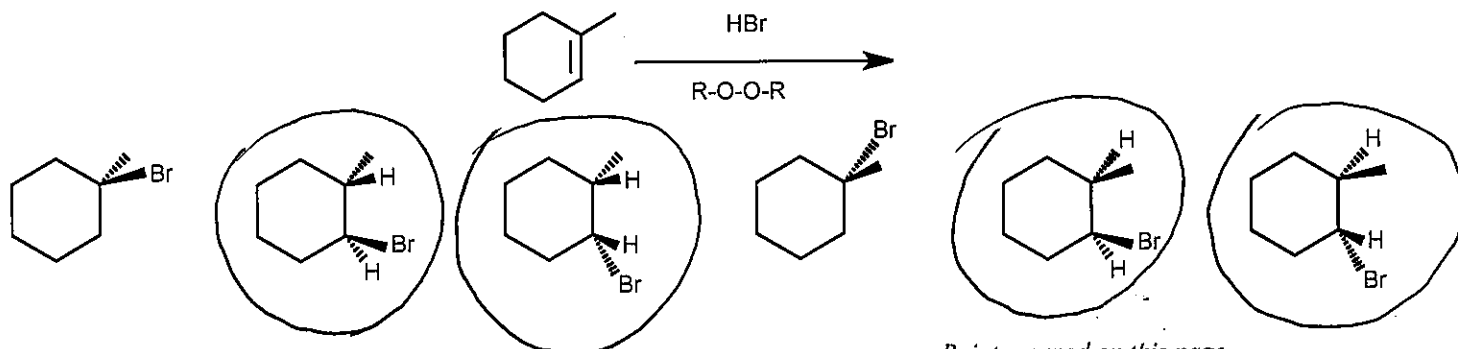
**11) 6 points**

Rank each group at the alkene carbon (with an arrow) priority 1 or 2 according to the Cahn-Ingold-Prelog (CIP) nomenclature system.

Example:

**12) 8 points**

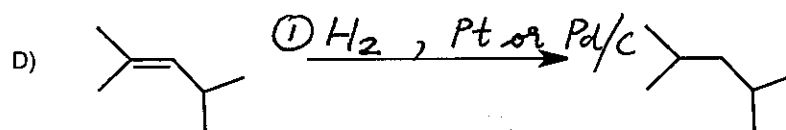
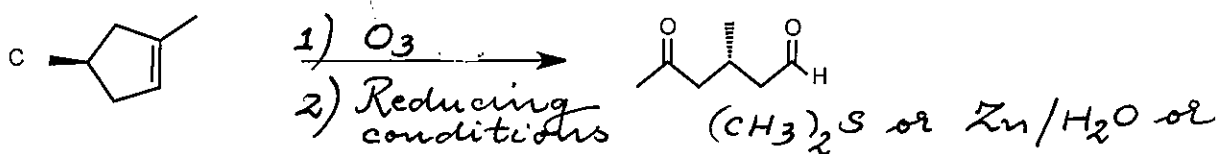
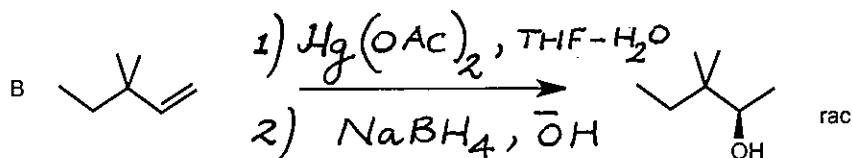
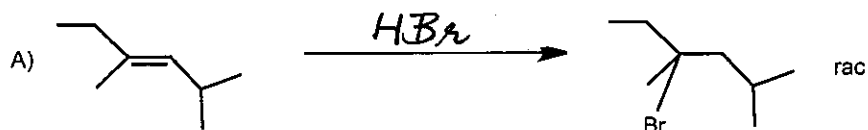
Circle ALL the products formed in the reaction shown below:



Points earned on this page \_\_\_\_\_

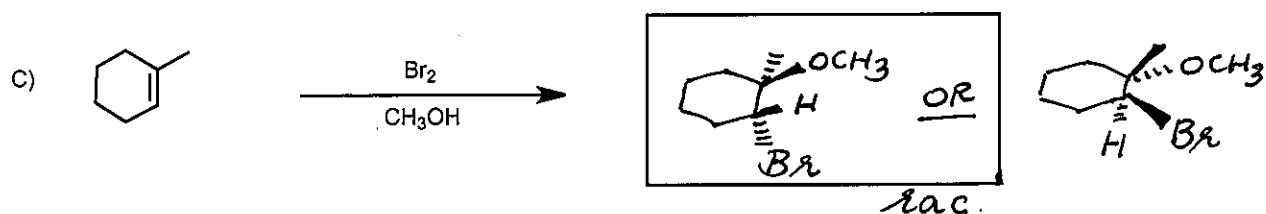
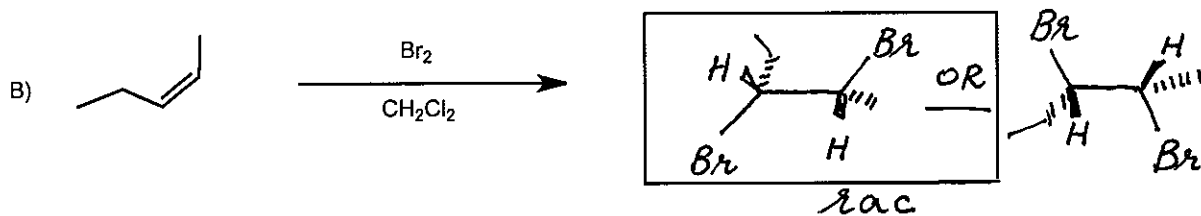
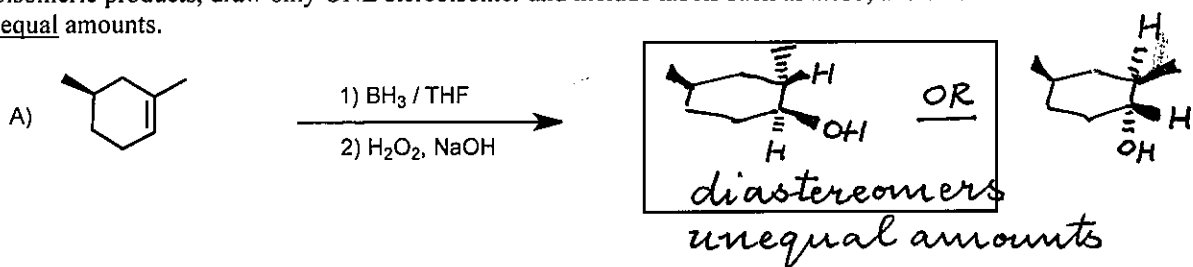
13) 14 points

Propose reagents for accomplishing each of the following reactions. Make your reaction efficient (i.e., target product should be the major product). Assume chiral starting materials and products are single pure enantiomers unless they are labeled "rac". For a series of steps, please write 1), 2), etc.



14) 10 points

Draw the major product(s) in each reaction, carefully showing stereochemistry (where appropriate) using wedges and dashes. If a racemic mixture is formed, draw only 1 enantiomer of the product and include label "rac". For other stereoisomeric products, draw only ONE stereoisomer and include labels such as *meso*, and diastereomers in equal or unequal amounts.



Points earned on this page \_\_\_\_\_

15) 12 points

The reaction shown below yields THREE products in *unequal amounts*. All three products are formed from a *common intermediate*. Draw the structure of this intermediate, and draw the mechanism for the formation these products in the appropriate spaces (more than one step from the intermediate might be required in some cases). Be sure to include all arrows and all charges!

