

CHEM 3311-100

Exam 2, October 21, 2010

Time: 2 Hours

By printing my name below, I pledge that

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

Your Name (**PRINTED IN CAPITAL LETTERS**)

_____ **Last Name**

_____ **First Name**

_____ **Middle Initial**

Your CU Student ID # (**NOT** Your Social Security Number)

Your Recitation TA's Name

_____ **Last Name**

_____ **First Name**

[-1 if missing or incorrect]

Circle Your Recitation Day & Time [-1 if missing or incorrect]

Mon 8 AM (Denman)

Tues 8 AM (Denman)

Wed 8 AM (Denman)

Thurs 8 AM (Manion)

Mon 2 PM (Moran)

Tues 5 PM (Manion)

Wed 8AM (Hartwig)

Mon 5 PM (Denman)

Wed 11 AM (Denman)

Wed 12 PM (Hartwig)

Wed 5 PM (Denman)

Grading Details

Page # (Question #s)

Points Possible

Points Earned

2 (Q 1)

20

3 (Q 2)

14

4 (Q 3)

15

5 (Q 4A)

20

6 (Q 4B)

20

7 (Q 5)

11

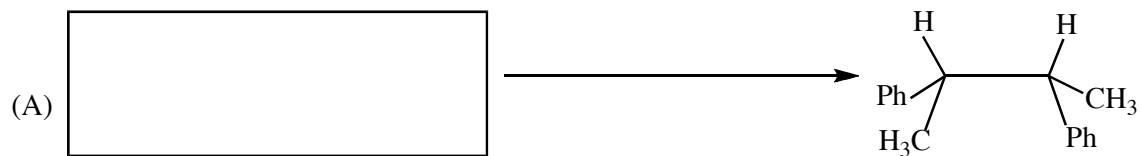
TOTAL SCORE (out of 100)

General Instructions

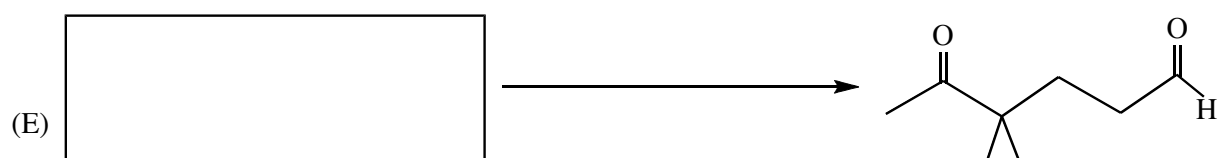
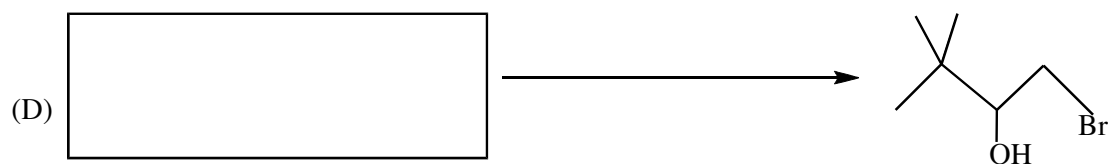
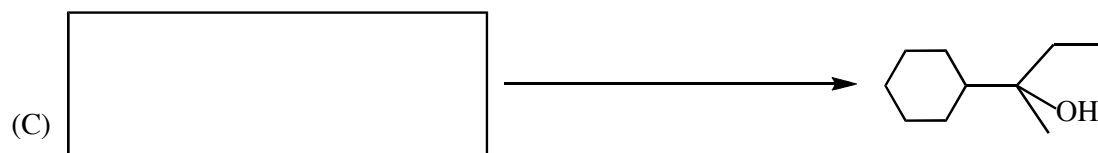
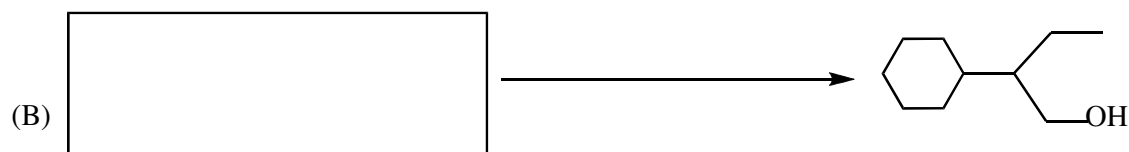
- (1) This is a CLOSED BOOK exam; nothing is allowed except a few pencils or pens, eraser, and student ID.
- (2) Please WRITE LEGIBLY & CLEARLY; minimize erasing! Untidy/illegible work will NOT be graded.
- (3) Print your name after acknowledging the student honor code. Write your name on each exam page in the space provided.
- (4) Use the back of the exam pages as scratch paper, if necessary.
- (5) If suspected of or caught cheating, you will receive at best an F for the exam. The instructor reserves the right to proceed further in compliance with university policies on academic violations.
- (6) You may not leave the room after the exam has started. Please leave quietly after you submit your exam to the TA or instructor.

Question 1 (20 points)

Complete the following syntheses [**BEST yield of product(s)**] starting with an **appropriate alkene** (in **box**) and the necessary reactants/reagents/solvents (above/below arrow). **All chiral products are racemic mixtures** (4 points each). Show stereochemistry of reactant **ONLY IF RELEVANT!**

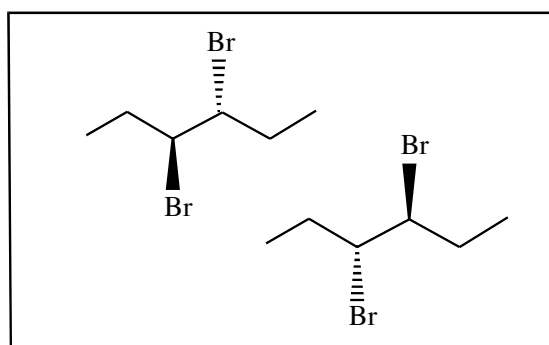
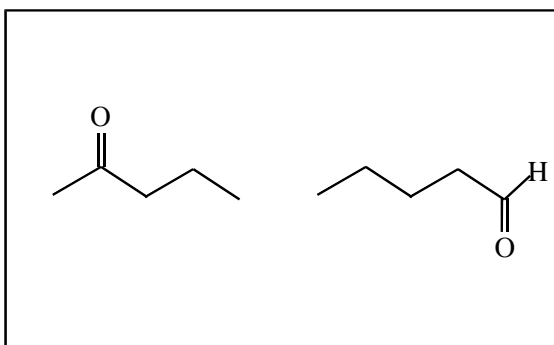
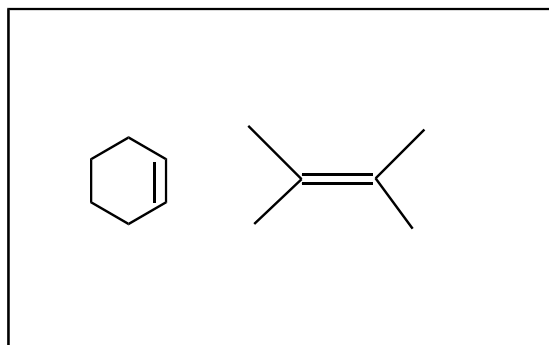
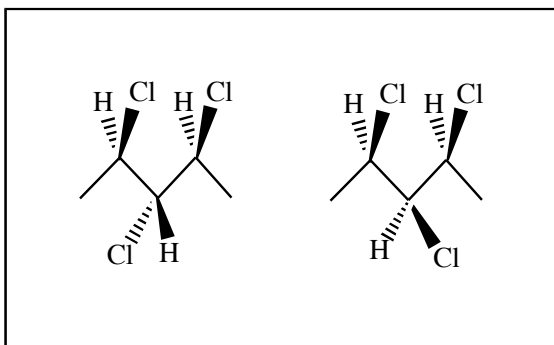


[NOTE: Ph stands for Phenyl]



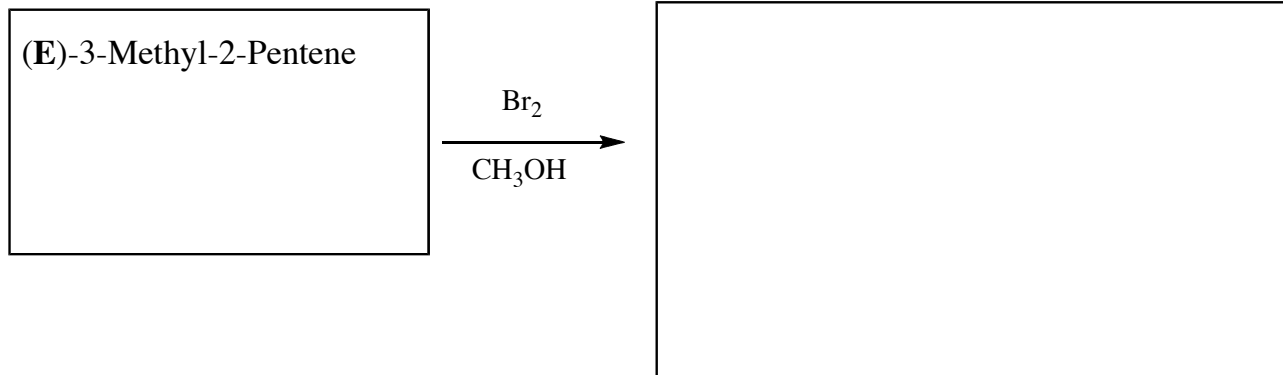
Question 2 (14 points)

Write correct IUPAC names for the compounds shown below:

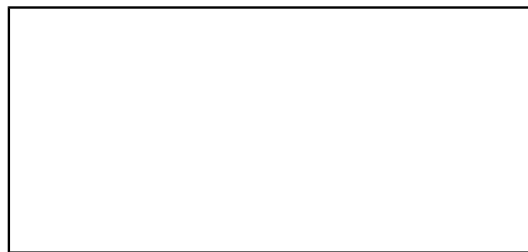
Label the pairs of molecules shown below as constitutional isomers, diastereomers, enantiomers, identical, or not related. **Write each label inside the box.**

Question 3 (15 points)

Draw the structure of (**E**)-3-methyl-2-pentene and show all **major** stereoisomeric products formed when it reacts with Br₂ in CH₃OH. Show stereochemistry using wedges and dashes.



Draw the structures of ALL the intermediates from (**E**)-3-methyl-2-pentene that lead to the stereoisomeric products that you have shown in the box at the top right. Show stereochemistry using wedges and dashes, as well as lone pairs and formal charges where relevant. (The boxes shown below help to organize your answers and DO NOT necessarily reflect the number of intermediates formed in this reaction).



Question 4A (20 points)

Multiple Choice (4 points each): Select the best answer to each question.

(I) Predict the unsaturation number for the hydrocarbon with the molecular formula C_6H_{10} .

- (A) 1 (B) 2 (C) 3 (D) 4

(II) Which alkene releases the most heat on combustion?

- (A) (E)-3-Methyl-2-pentene (B) (Z)-3-Methyl-2-pentene
(C) (E)-3-Hexene (D) (Z)-3-Hexene

(III) What is the major product in the reaction of (E)-3-methyl-2-pentene with 1 M HNO_3 ?

- (A) 2-Methyl-2-pentanol (B) 3-Methyl-2-pentanol
(C) 2-Methyl-3-pentanol (D) 3-Methyl-3-pentanol

(IV) Which alkene, when reacted with HCl at $0^\circ C$, would produce a mixture of 2-chloro-3-methylbutane (40%) and 2-chloro-2-methylbutane (60%)?

- (A) 2-Methyl-1-butene (B) 3-Methyl-1-butene
(C) 2-Methyl-2-butene (D) 1-Pentene

(V) Which dichlorobutane has a meso form?

- (A) 1,2-Dichlorobutane (B) 1,3-Dichlorobutane
(C) 1,4-Dichlorobutane (D) 2,3-Dichlorobutane

Question 4B (20 points)**Multiple Choice** (5 points each): Select the best answer to each question.

(VI) Compound X, $C_5H_{10}O$, is optically active. This compound reacts with one equivalent of H_2 in the presence of Pt/C and the hydrogenation product is optically active. What is the structure of compound X?

- (A) $CH_3CH(OH)CH_2CH=CH_2$ (B) $H_2C=CHCH_2CH_2CH_2OH$
(C) *cis*- $CH_3CH=CHCH_2CH_2OH$ (D) $CH_3CH_2CH(OH)CH=CH_2$

(VII) Which reaction conditions would you select to convert 2-methyl-2-butene to 3-bromo-2-methylbutane?

- (A) Br_2 in CH_2Cl_2 (B) Br_2 in CH_3OH
(C) HBr (D) HBr , peroxides

(VIII) Which reaction gives a single enantiomer of a chiral product?

- (A) (R)-4-methyl-1-hexene with HBr in the presence of peroxides
(B) 1-methylcyclopentene on hydroboration, followed by H_2O_2 , OH^-
(C) 1-methylcyclopentene with HBr
(D) 1-methylcyclopentene with Br_2 in CH_2Cl_2

(IX) Which reaction produces an achiral product?

- (A) (R)-4-methyl-1-hexene with HBr in the presence of peroxides
(B) 1-methylcyclopentene on hydroboration, followed by H_2O_2 , OH^-
(C) 1-methylcyclopentene with HBr
(D) 1-methylcyclopentene with Br_2 in CH_2Cl_2

Question 5 (11 points)

Write the DETAILED mechanism for the **PROPAGATION STEPS** when 2-methyl-1-butene reacts with HBr in the presence of RO-OR. Please label your steps as **Step 1** and **Step 2**. Show the accepted arrow formalism and show all lone pairs, unpaired electrons, etc. as relevant, and the **stereochemistry of final product(s) using wedges and dashes**.

Use the data shown below and classify Steps 1 and 2 as **exothermic** or **endothermic**. Enter your answers in the grid provided.

| Bond of Interest | Bond Energy (kJ/mol) |
|---|----------------------|
| H ₂ C=CH ₂ (double bond) | 728 |
| H ₂ C=CH ₂ (π -bond) | 243 |
| (CH ₃) ₃ C-H | 404 |
| C-Cl | 350 |
| C-Br | 302 |
| C-I | 241 |
| H-Cl | 431 |
| H-Br | 368 |
| H-I | 297 |

| Reaction with | STEP 1 | STEP 2 |
|---------------|--------|--------|
| HCl | | |
| HBr | | |
| HI | | |

Why does HBr react with 2-methyl-1-butene in the presence of peroxides while HCl and HI do not react under the exact same conditions? Your answer should be consistent with the results in your grid.

