

**CHEM 3311**  
**Exam 2 ANSWER KEY**  
**March 11, 2014**

**Time: 2 Hours**

Please sign the Honor Pledge and hand in this sheet with your scantron.

I pledge that

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

\_\_\_\_\_  
PRINT YOUR FULL NAME

\_\_\_\_\_  
SIGN HERE

General Instructions

On the computer graded answer sheet, enter and bubble

- LAST NAME, FIRST, Middle Initial
- STUDENT ID
- RECITATION SECTION ID (Write a zero before the recitation section number - for example, section 227 is written as 0227.)

Answer all questions on the computer graded answer sheets by filling in the proper bubble with a No. 2 pencil. If you change an answer, erase the undesired mark thoroughly. Mark only the best answer to each question. Programmable calculators are not permitted during the exam.

A section of the Periodic Table with atomic numbers and masses is shown below. Use the back of the exam pages as scratch paper. There are 5 exam pages (with 25 questions), a cover page, and two blank pages (scratch paper). When instructed to begin the exam, please check that you have all pages. Good luck!

Please return the completed scantron sheet to the exam proctors. You may take the exam and scratch paper with you.

1 H					2 He
3 Li	4 Be				
11 Na	12 Mg				
5 B	6 C	7 N	8 O	9 F	10 Ne
13 Al	14 Si	15 P	16 S	17 Cl	18 Ar

Recitation Section #	Day of the Week	Time of the Day	TA
0113	Monday	12:00 - 12:50 PM	Cindy White
0115	Monday	1:00 - 1:50 PM	Cindy White
0123	Tuesday	12:00 - 12:50 PM	Cindy White
0125	Tuesday	1:00 - 1:50 PM	Cindy White
0127	Tuesday	4:00 - 4:50 PM	Cindy White
0213	Monday	12:00 - 12:50 PM	Zhenyi “Jensen” Hu
0215	Monday	1:00 - 1:50 PM	Zhenyi “Jensen” Hu
0223	Tuesday	12:00 - 12:50 PM	Tim Rochelle
0225	Tuesday	1:00 - 1:50 PM	Tim Rochelle
0227	Tuesday	4:00 - 4:50 PM	Tim Rochelle

1. Which alkene releases the *smallest* amount of heat on combustion?

- (A) 2-methyl-2-butene (B) 1-pentene  
(C) (Z)-2-pentene (D) (E)-2-pentene

2. Which of these constitutional isomers would produce one major product when reacted with HCl?

- (I) 2-methyl-1-butene  
(II) 3-methyl-1-butene  
(III) 2-methyl-2-butene

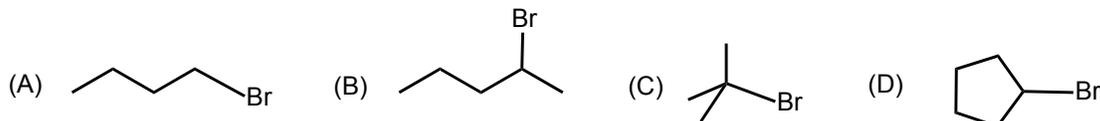
- (A) I and II (B) II and III (C) I and III (D) I, II, and III

3. For which constitutional isomer does a carbocation rearrangement account for the product distribution observed?

- (I) 2-methyl-1-butene  
(II) 3-methyl-1-butene  
(III) 2-methyl-2-butene

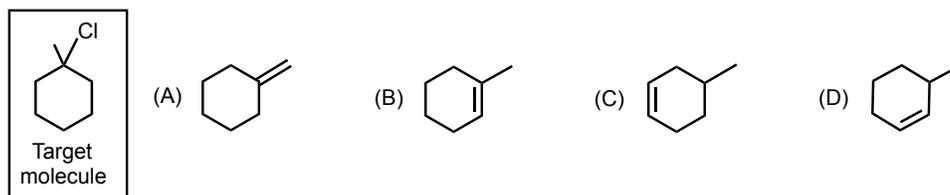
- (A) I (B) II (C) III (D) all of these

4. Which of these alkyl bromides cannot be synthesized using a Markovnikov addition of HBr to an alkene?



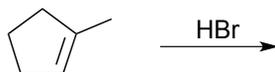
**Correct Answer: A**

5. Which alkene would not produce *any* of the target molecule (product) when reacted with HCl?



**Correct Answer: C**

6. What is the stereochemical outcome of the reaction shown below?

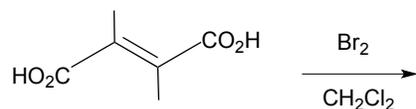


- (A) There is no reaction.  
(B) An achiral compound is the major product.  
(C) A racemic mixture is obtained.  
(D) A diastereomeric mixture is produced.

7. Compound X on reaction with  $\text{Br}_2$  in  $\text{CH}_2\text{Cl}_2$  produced *racemic* 1,2-dibromobutane as the product. What is compound X?

- (A) **1-Butene**      (B) (*E*)-2-Butene      (C) (*Z*)-2-Butene      (D) 2-methylpropene

8. What is the stereochemical outcome of the reaction shown below?

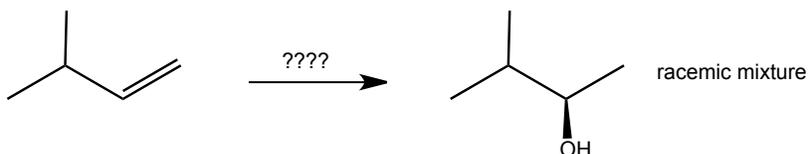


- (A) A racemic mixture is obtained.  
 (B) A diastereomeric mixture is produced.  
 (C) Constitutional isomers are formed.  
 (D) **The meso compound is formed.**

9. Each alkene listed below is reacted with  $\text{Cl}_2$  in  $\text{CH}_3\text{OH}$ . Which alkene reacts at the fastest rate?

- (A) (*E*)-2-pentene      (B) (*Z*)-2-pentene  
 (C) **2-methyl-2-butene**      (D) 1-pentene

10. Select the best reaction conditions to accomplish the transformation shown below.



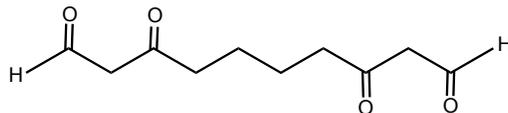
- (A) 1 M  $\text{HNO}_3$   
 (B) Hydroboration, followed by oxidation with  $\text{H}_2\text{O}_2$ ,  $\text{NaOH}$   
 (C) **(1)  $\text{Hg}(\text{OAc})_2$ ,  $\text{THF-H}_2\text{O}$ ; (2)  $\text{NaBH}_4$ ,  $\text{NaOH}$**   
 (D)  $\text{Br}_2$ ,  $\text{H}_2\text{O}$

11. Select the best reaction conditions to accomplish the transformation shown below.



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

12. Compound X is reacted with  $O_3$  in  $CH_2Cl_2$ , followed by hydrolysis in the presence of  $(CH_3)_2S$ . The structure of the only product formed is shown.

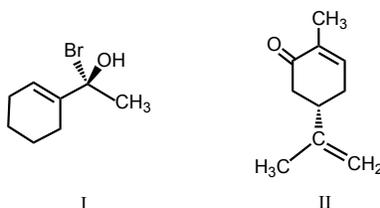


What is the structure of compound X?



**Correct Answer: D**

13. Assign the absolute configuration at each chiral center in compounds I and II.



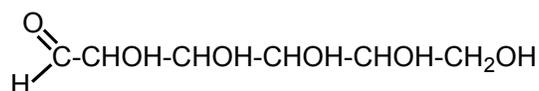
(A) (I) R, (II) R

(B) (I) S, (II) S

**(C) (I) R, (II) S**

(D) (I) S, (II) R

14. D-glucose is one of several stereoisomers with the structural formula shown below:



What is the maximum number of stereoisomers with this structural formula?

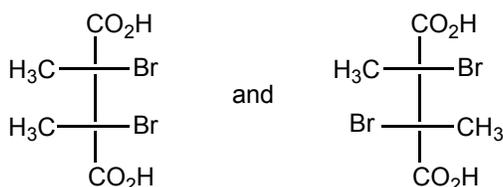
(A) 4

(B) 8

**(C) 16**

(D) 32

15. What is the relationship between the molecules shown?



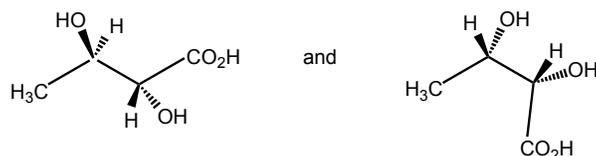
(A) Constitutional isomers

**(B) Diastereomers**

(C) Enantiomers

(D) Homomers (identical)

16. What is the relationship between the molecules shown?



(A) Constitutional isomers

(B) Diastereomers

**(C) Enantiomers**

(D) Homomers (identical)

17. What is the relationship between the molecules shown?



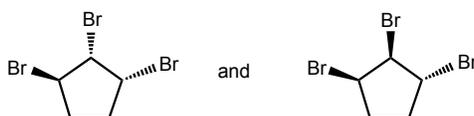
**(A) Constitutional isomers**

(B) Diastereomers

(C) Enantiomers

(D) Homomers (identical)

18. What is the relationship between the structures shown below?



(A) Constitutional isomers

(B) Diastereomers

(C) Enantiomers

**(D) Homomers (identical)**

19. Select all the statements that correctly describe enantiomers.

(I) Enantiomers of a compound rotate the plane of polarized light by the same amount; one clockwise and the other counterclockwise.

(II) An equimolar mixture of enantiomers is optically inactive.

(III) Enantiomers react with an achiral reagent at the same rate.

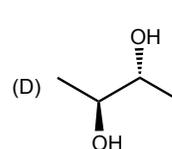
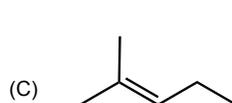
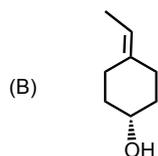
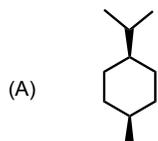
(A) I and II

(B) I and III

(C) II and III

**(D) I, II, and III**

20. Select the chiral molecule.



**Correct Answer: B**

21. Which reaction is best described by a concerted, one-step mechanism?

(I) Reaction of 2-methylpropene with 1M HNO<sub>3</sub>

(II) Reaction of 2-methylpropene with peroxyacetic acid

(III) Reaction of 2-methylpropene with HBr

(A) I

**(B) II**

(C) III

(D) none of these

22. Consider the mechanism for the reaction of 2-methyl-1-butene with HBr in the presence of peroxides. Classify the *intermediate* carbon-centered radical formed during propagation.

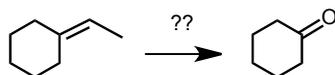
(A) Methyl radical

(B) 1° radical

(C) 2° radical

**(D) 3° radical**

23. Which reaction conditions would best facilitate the transformation shown below?



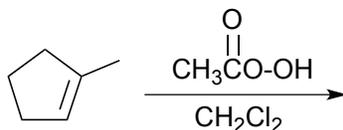
(A) CH<sub>3</sub>CO<sub>3</sub>H (peroxyacetic acid) in CH<sub>2</sub>Cl<sub>2</sub>

(B) Br<sub>2</sub> in H<sub>2</sub>O

**(C) Reaction with O<sub>3</sub>, followed by reaction with H<sub>2</sub>O<sub>2</sub>, H<sub>2</sub>O**

(D) Reaction with Hg(OAc)<sub>2</sub> in THF-H<sub>2</sub>O, followed by reaction with NaBH<sub>4</sub> and NaOH

24. Select the statement that correctly describes this reaction.



**(A) Enantiomers are formed in equal amounts.**

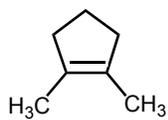
(B) Diastereomers are obtained in equal amounts.

(C) Diastereomers are obtained in unequal amounts.

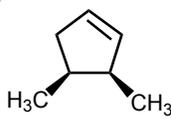
(D) An achiral compound is the major product.

25. Compound X, C<sub>7</sub>H<sub>12</sub>, is optically active. Hydrogenation of compound X produces a pure chiral product. Select the compound that best fits the experimental data.

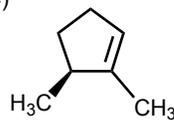
(A)



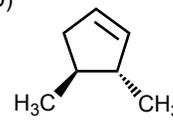
(B)



(C)



(D)



**Correct Answer: D**