

CHEM 3311-200
Exam 2 ANSWER KEY
October 23, 2012

Time: 2 Hours

Please **copy** and **sign** the Honor Pledge on the scantron sheet in the space below the double lines.

I pledge that

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

General Instructions

On the computer graded answer sheet (also known as a scantron), enter **your name** and **student identification number** in the appropriate boxes. Enter the number of your recitation section in the four columns at the upper left of the sheet. (Use a zero before the recitation section number - for example, section 237 is written as 0237.) Then **fill in the corresponding bubbles below your name, ID number, and recitation section.**

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 on this cover page. A Table of pK_a values is included here. Use the back of the exam pages as scratch paper. There are 6 exam pages (with 25 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 to the exam proctors. You may take the exam and scratch paper with you.

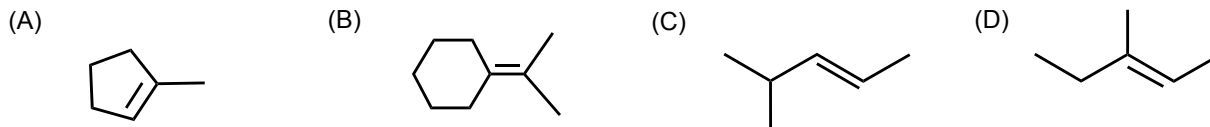
1 H	
3 Li	4 Be
11 Na	12 Mg

					2 He
5 B	6 C	7 N	8 O	9 F	10 Ne
13 Al	14 Si	15 P	16 S	17 Cl	18 Ar

Table of Acidities

<u>Acid</u>	<u>pK_a Value</u>
HI	-10.1
HCl	-3.9
H_3O^+	-1.7
CH_3COOH	4.7
NH_4^+	9.3
Phenol	10
H_2O	15.7
Alcohols	16-18
$HC\equiv CH$	26
NH_3	36
$H_2C=CH_2$	45
CH_4	60

1. Which compound forms acetone, $(\text{CH}_3)_2\text{C}=\text{O}$, as one of the products of its ozonolysis (reaction with O_3 , followed by treatment with H_2O)?

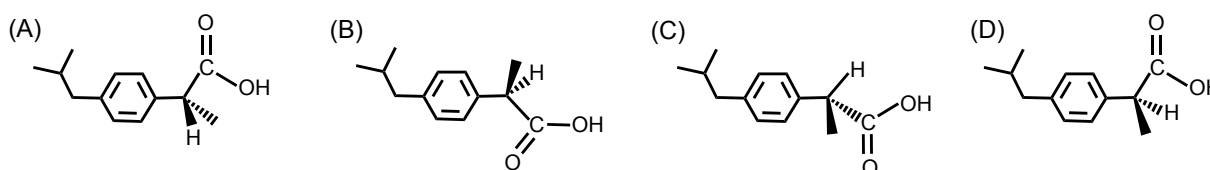


Correct Answer: B

2. Predict the number of stereoisomers possible for the compound $\text{CH}_3\text{CHBrCHBrCHClCH}_3$.

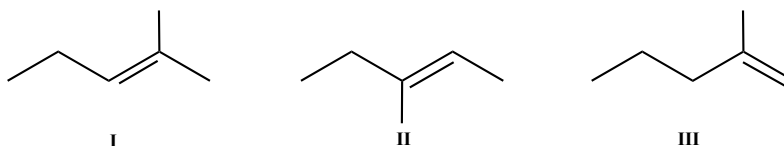


3. The *S* enantiomer of ibuprofen is responsible for its pain-relieving properties. Identify the structure of (*S*)-ibuprofen.

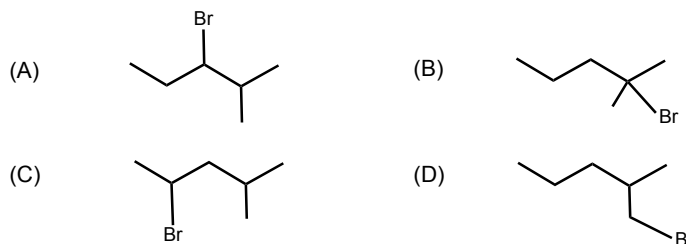


Correct Answer: D

4. Acid-catalyzed hydration of an unknown compound X, C_6H_{12} , yielded a racemic mixture Y, $\text{C}_6\text{H}_{14}\text{O}$, as the major product. Which (if any) of the following is/are (a) likely candidate(s) for X?



5. What is the major product of the reaction of 2-methyl-2-pentene with HBr ?

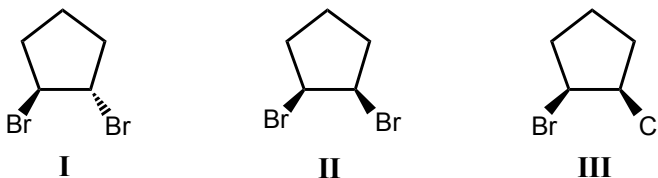


Correct Answer: B

6. What is/are the product(s) when 1-methylcyclobutene is reacted with BH_3/THF , followed by H_2O_2 in NaOH ?

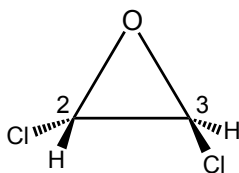
- (A) 1-methylcyclobutanol (B) *cis*-2-methylcyclobutanol
(C) *trans*-2-methylcyclobutanol (D) equal amounts of *cis*- & *trans*-2-methylcyclobutanol

7. Identify the chiral molecules.



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

8. Identify the configurations of carbons 2 and 3, respectively, in the structure shown below.



- (A) R and R **(B) S and S** (C) R and S (D) S and R

9. Select all the statements that *correctly* describe features of chiral and achiral molecules.

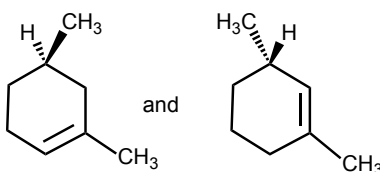
I. If a molecule has an internal plane of symmetry, it is achiral.

II. If a molecule has a center of symmetry, it is achiral.

III. If a molecule has one stereogenic center, it is chiral.

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

10. What is the relationship between the compounds shown below?

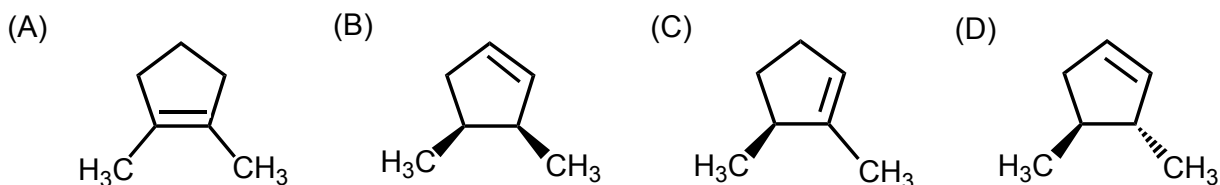


- (A) identical (B) enantiomers
 (C) diastereomers **(D) constitutional isomers**

11. The addition of Br_2 to (E)-3-hexene in CH_2Cl_2 produces:

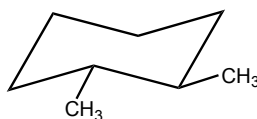
- (A) (3R,4R)-3,4-dibromohexane
 (B) (3S,4S)-3,4-dibromohexane
 (C) a racemic mixture of (3R,4R)-3,4-dibromohexane and (3S,4S)-3,4-dibromohexane
(D) meso-3,4- dibromohexane

12. Compound X, C_7H_{12} , is optically active. Hydrogenation of compound X produces two isomeric 1,2-dimethylcyclopentanes; one is optically active and the other is optically inactive. Identify the compound that fits the experimental data.



Correct Answer: C

13. Select the statement that *correctly* describes the structure shown below.



- (A) The methyl groups are anti to each other.
(B) The methyl groups are gauche to each other.
 (C) The methyl groups are eclipsed.
 (D) The conformation shown is the highest energy conformation for this molecule.

14. Consider the mechanism for each reaction listed below. For which reaction does the proposed mechanism include carbocations as intermediates?

- (A) Addition of Br_2 to an alkene
(B) Addition of HCl to an alkene
 (C) Addition of HBr to an alkene in the presence of H_2O_2
 (D) Oxymercuration-reduction of an alkene

15. The reaction of (E)-3-methyl-4-isopropyl-3-heptene with H_2 , using Pt as a catalyst, produces a

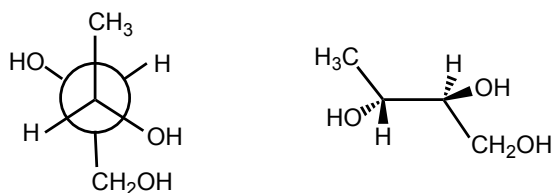
(A) racemic mixture of (3R,4S)-3-methyl-4-isopropylheptane & its enantiomer.

(B) racemic mixture of (3R,4R)-3-methyl-4-isopropylheptane & its enantiomer.

(C) meso compound.

(D) diastereomeric mixture.

16. How are these compounds related?



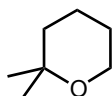
(A) constitutional isomers

(B) diastereomers

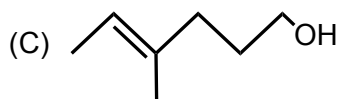
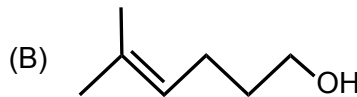
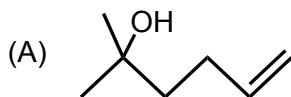
(C) enantiomers

(D) identical

17. Compound X when reacted with (1) $Hg(OAc)_2$ in THF- H_2O , followed by (2) reaction with $NaBH_4$ in NaOH yields the product shown below.

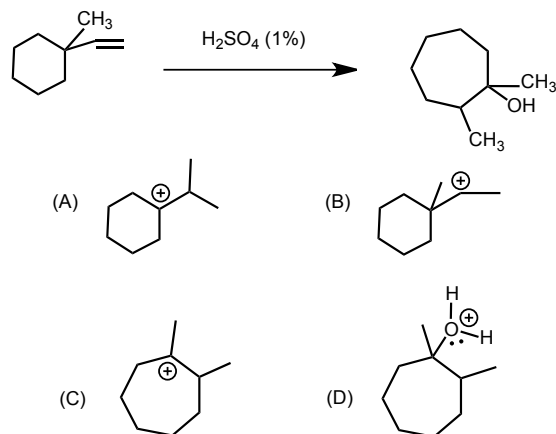


What is the identity of the starting material X?



Correct Answer: B

18. Draw a stepwise mechanism for the reaction shown below. Which of these intermediates will not lead to the product shown?



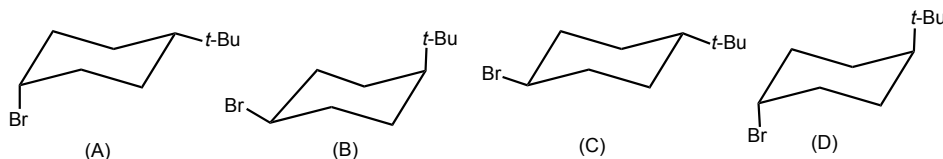
Correct Answer: A

19. The compound (5S)-1,5-dimethylcyclopentene is hydrogenated using Ni as a catalyst.

What are the products of this reaction?

- (A) A racemic mixture of (1R,2R)-1,2-dimethylcyclopentane & its enantiomer.
- (B) A racemic mixture of (1R,2S)-1,2-dimethylcyclopentane & its enantiomer.
- (C) A diastereomeric mixture of (1R,2R)-1,2-dimethylcyclopentane & a meso compound.
- (D) A diastereomeric mixture of (1S,2S)-1,2-dimethylcyclopentane & a meso compound.**

20. Which representation is the thermodynamically most stable conformation of *trans*-1-bromo-4-*tert*-butylcyclohexane?



Correct Answer: C

21. Which reaction will produce a single chiral product?

- (A) (S)-4-chloro-1-pentene + HBr \rightarrow
- (B) Hydroboration-oxidation of (S)-4-chloro-1-pentene \rightarrow**
- (C) (S)-4-chloro-1-pentene + peroxyacetic acid in $\text{CH}_2\text{Cl}_2 \rightarrow$
- (D) Oxymercuration-reduction of (S)-3-chloro-1-pentene \rightarrow

22. Which of these reactions produce a racemic mixture?

(I) (Z)-2-Butene + Br₂ in CCl₄

(II) (E)-2-Butene + Br₂ in CCl₄

(III) Hydroboration-oxidation of 1-methylcyclohexene

(A) III only

(B) I and II

(C) I and III

(D) II and III

23. Which reaction conditions would you select to convert 2-methyl-1-butene to 1-bromo-2-methylbutane?

(A) Br₂ in CH₂Cl₂

(B) Br₂ in CH₃OH

(C) HBr

(D) HBr, peroxides

24. Select the statement that *incorrectly* describes various aspects of free radical reactions.

(A) Peroxides are often used to initiate free radical reactions.

(B) Free radicals have unpaired electrons.

(C) Propagation steps are exothermic when HBr is added to alkenes in the presence of ROOR.

(D) Termination steps are always endothermic in free radical reactions.

25. Which cycloalkane has the lowest heat of combustion?

(A) Cyclopentane

(B) Methylcyclobutane

(C) *cis*-1,2-Dimethylcyclopropane

(D) *trans*-1,2-Dimethylcyclopropane