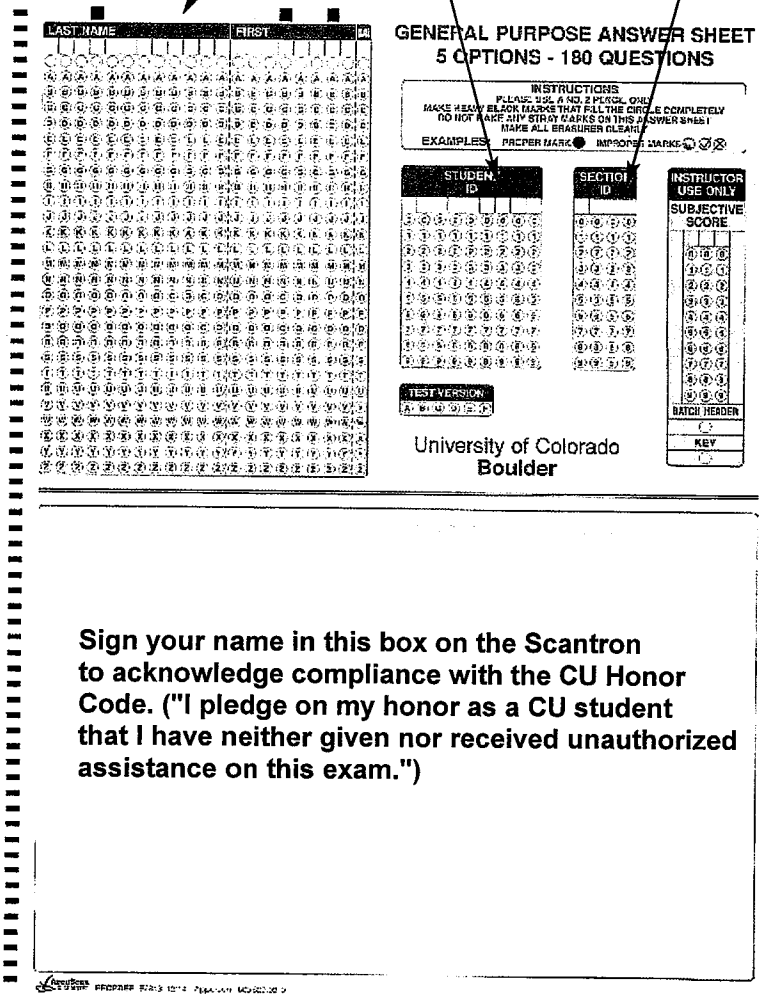
CHEM 3311
Dr. Minger

Exam #3 **Name** Key
June 26, 2018

On your Scantron:

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



Recitation Sections

0111 Chance
0112 Matthew
0113 Will
0114 Zepeng
0115 Mitch (3 pm)
0121 Thomas (11 am)
0122 Allie
0123 Eunsol
0124 Dayan
0125 Mitch (11 am)
0141 Thomas (4 pm)
0142 Mohamed Eid

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.")

Instructions continue on the next page.

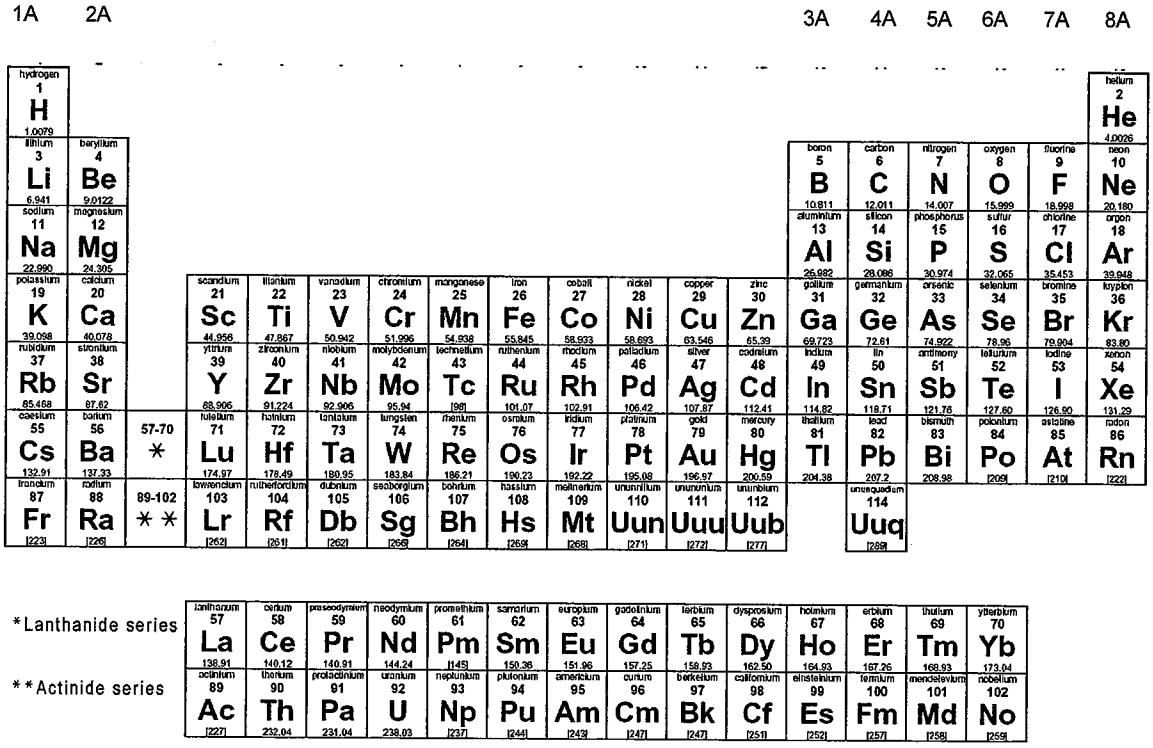
General Instructions

There are 25 questions. Be sure you have them all. Read each question carefully so that you know exactly what is being asked.

Each multiple choice question (1-25) is worth **4 points and has only one correct answer.** Bubble in your answers to these questions on the Scantron provided. **Only the Scantron will be graded, not anything that you write on the exam.**

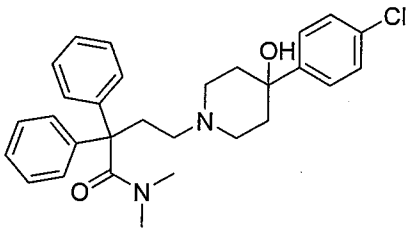
At the end of the exam, turn in only your Scantron. Remember to sign the Scantron to acknowledge compliance with the Honor Code. You may keep the exam to check your answers against the key later.

Good luck!

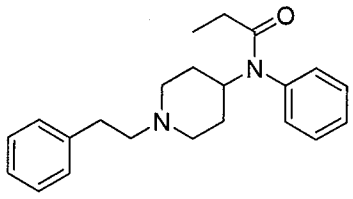


1. Opioids are drugs that are used for pain relief. They can include compounds that occur naturally (e.g. morphine, which is isolated from the opium poppy) or synthesized in the lab (e.g. tramadol). Unfortunately, opioids also carry a high risk of addiction and overdose, and deaths from opioid overdoses have increased dramatically in the last several years.

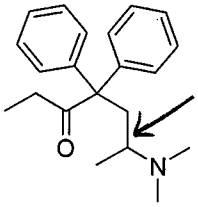
Which of these opioids contain(s) at least one asymmetric carbon atom?



Loperamide
used to treat diarrhea



Fentanyl
50-100x more potent than morphine

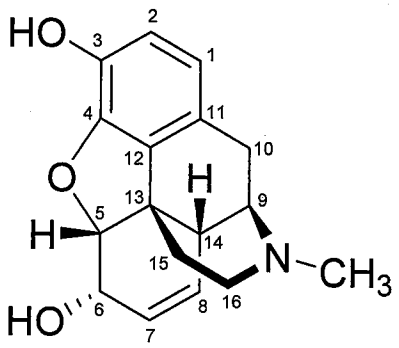


Methadone
used to treat opioid addiction

a. Only Loperamide
b. Only Fentanyl
c. Loperamide and Fentanyl
d. Loperamide and Methadone
e. Loperamide, Fentanyl and Methadone

Only methadone has an asymmetric C, so the problem is thrown out since the correct answer was not one of the choices.

2. Another opioid is morphine. Here is the structure of morphine with the carbon atoms numbered for reference.



Morphine

What is the absolute configuration of C6?

a. *R*
b. *S*

1. Opioids are drugs that are used for pain relief. They can include compounds that occur naturally (e.g. morphine, which is isolated from the opium poppy) or synthesized in the lab (e.g. tramadol). Unfortunately, opioids also carry a high risk of addiction and overdose, and deaths from opioid overdoses have increased dramatically in the last several years.

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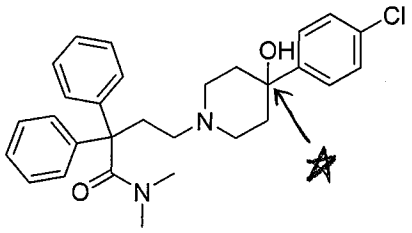
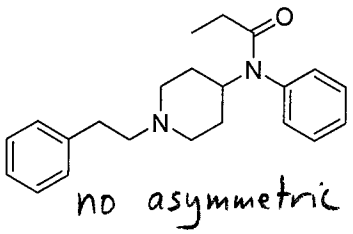
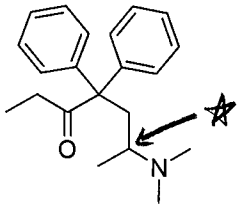


Loperamide
used to treat diarrhea



no asymmetric C's

Fentanyl
50-100x more potent than morphine



Methadone
used to treat opioid addiction

a. Only Loperamide
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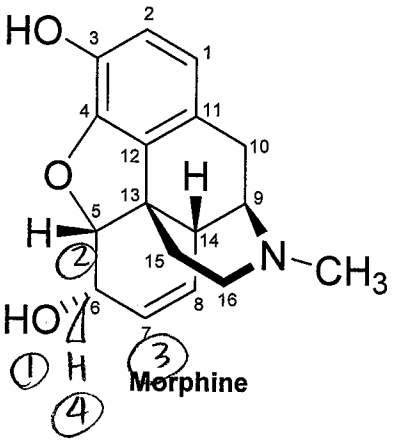
B



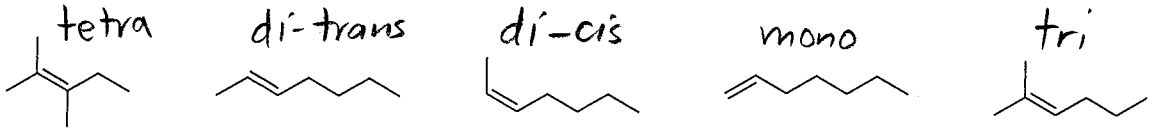
Morphine

What is the absolute configuration of C6?

a. *R*
b. *S*

3. Here is a set of C7 alkene isomers. Select the molecule that releases the most energy on formation from its elements.

A

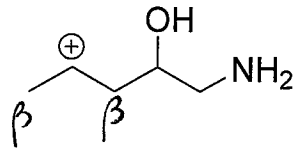


(A) B C D E

Formation of the most stable alkene releases the most E.

4. Here is the structure of a carbocation. Which of these orbitals overlaps with a *p* orbital to help stabilize this carbocation by hyperconjugation?

D



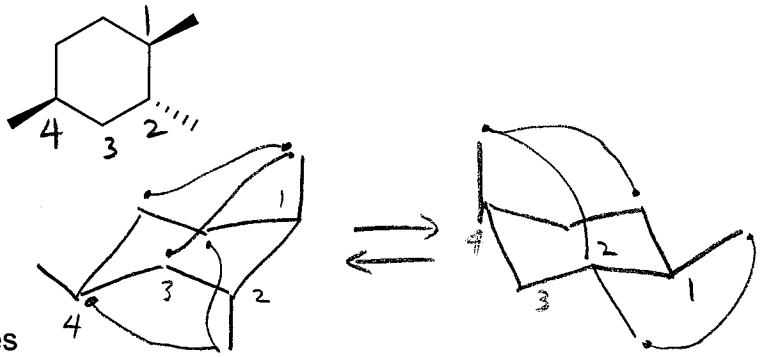
a. O-H σ
b. C-H σ*
c. C-N σ
(d.) C-C σ
e. None of these orbitals is involved in hyperconjugation in this cation

empty p with C-H σ and C-C σ

5. The strain energy associated with a gauche butane interaction is 0.8 kcal/mol. What is the difference in energy, in kcal/mol, between the two chair conformations of this molecule?

A

(a.) 0.8 kcal/mol
b. 1.6 kcal/mol
c. 2.4 kcal/mol
d. 3.2 kcal/mol
e. None of these values



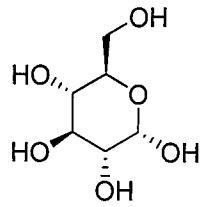
4 gb 3 gb

6. Which of these terms correctly describes a racemic mixture?

E

a. Achiral
b. Chiral
c. Meso
d. Optically active
(e.) Optically inactive

7. The structure of D-glucose is shown:

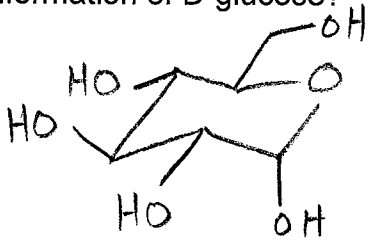


D-glucose

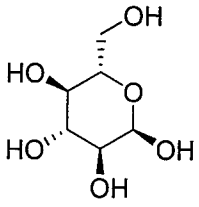
How many OH groups (not CH_2OH) occupy equatorial positions in the most stable chair conformation of D-glucose?

D

a. 0
b. 1
c. 2
(d.) 3
e. 4



8. D-glucose has a specific rotation of +98° at 25°C. What is the specific rotation of this isomer of D-glucose?



An isomer of D-glucose

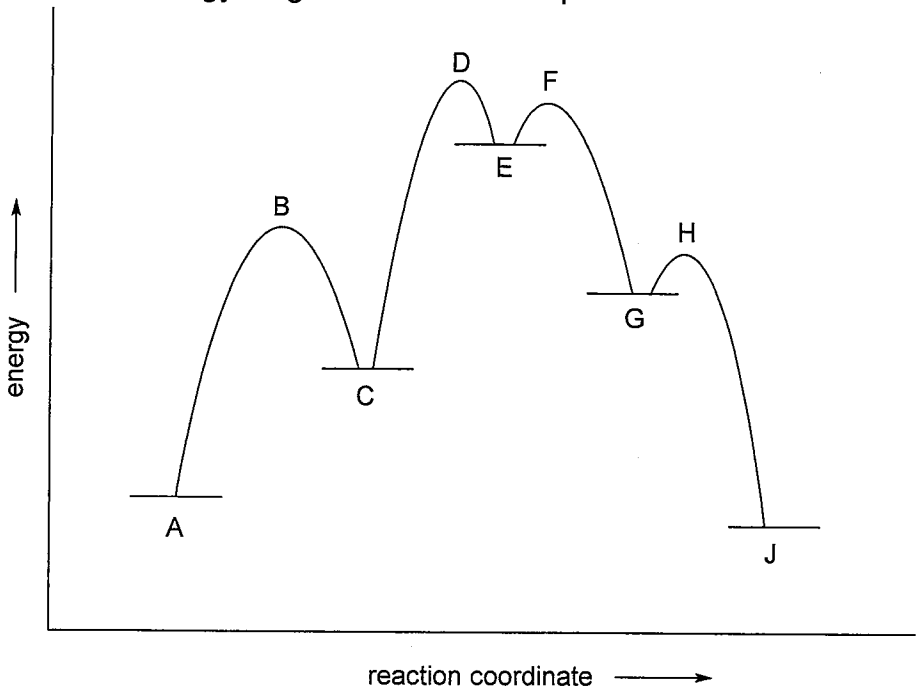
B

This is the enantiomer of D-glucose (all absolute configurations are opposite those in D-glucose)

a. +98°
(b.) –98°
c. 0 (this isomer does not rotate plane polarized light)
d. Cannot be determined with the information provided. We would need to run a polarimetry experiment.

9. Here is an energy diagram for a multi-step reaction:

A



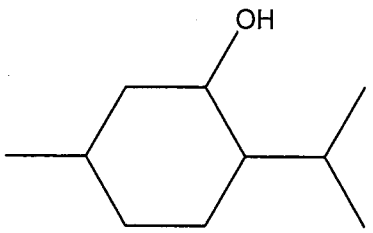
Which two states cannot be compared using the Hammond postulate?

(a.) E and G not consecutive states
b. H and J
c. A and B
d. C and D
e. All of these may be compared using the Hammond postulate

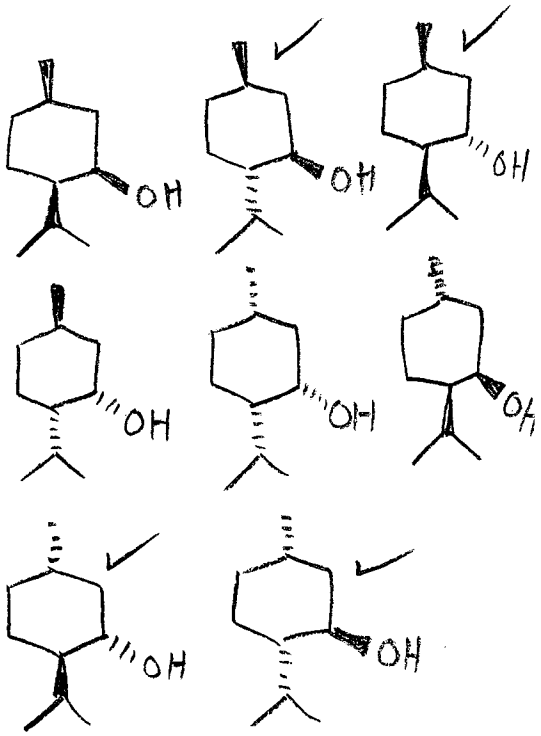
10. Menthol is 2-isopropyl-5-methylcyclohexanol. Its constitution is shown. How many stereoisomers of menthol have the isopropyl group trans to the hydroxyl group?

B

$2^3 = 8$ possible stereoisomers



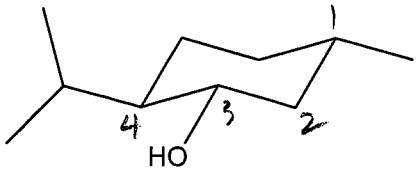
Menthol
2-isopropyl-5-methylcyclohexanol

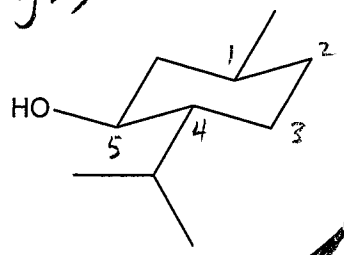


a. 2
(b.) 4
c. 6
d. 8
e. Some other number

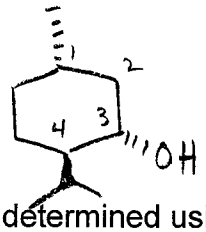
11. Here are two chair conformations based on the constitution of menthol. What is the stereochemical relationship between these two molecules?

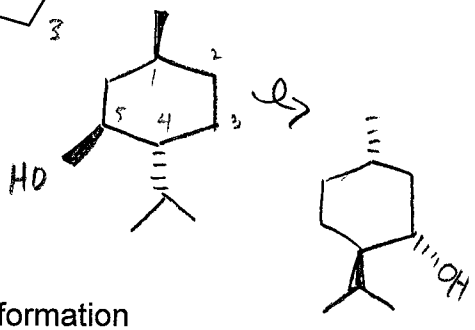
(Not IUPAC numbering!)





A

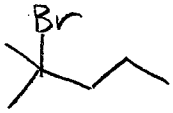




(a.) They are identical
b. They are enantiomers
c. They are diastereomers
d. The relationship cannot be determined using the information provided

12. You want to synthesize 2-bromo-2-methylpentane by reacting an alkene with HBr. You go to the chemical cabinet and find these three alkenes:

A. 4-methyl-1-pentene
B. 2-methyl-1-pentene
C. 2-methyl-2-pentene

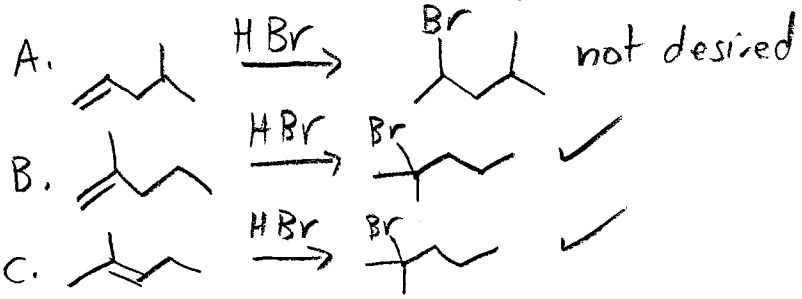


= desired product

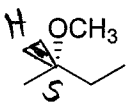
D

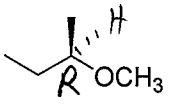
From which of these alkenes can you make the desired alkyl bromide using HBr?

a. A only
b. B only
c. C only
(d.) B and C
e. A, B, and C



13. Which term correctly describes the relationship between the two structures?

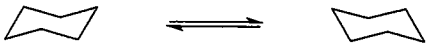




C

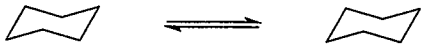
a. Constitutional isomers
b. Diastereomers
(c.) Enantiomers
d. Identical

14. "Chair flips", or "ring flips", are often conventionally drawn like this:

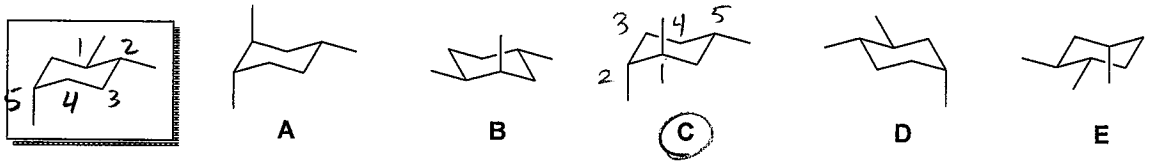


However, as long as the bonds to any substituents reflect the proper orientations based on the original chair, you can also draw the ring flip just like your original chair, like so:

C

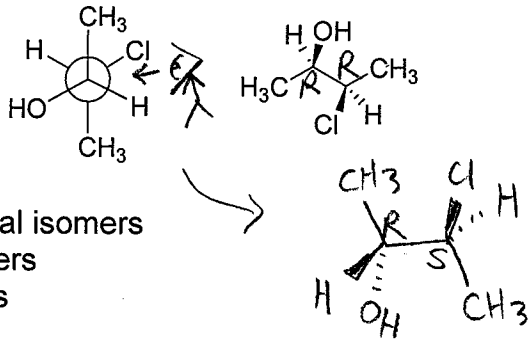


Which of these chair conformations is the ring flip of the chair shown in the box?



15. Which term correctly describes the relationship between the two structures?

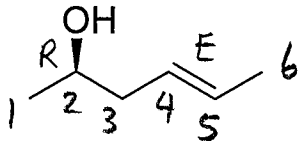
B



a. Constitutional isomers
b. Diastereomers
c. Enantiomers
d. Identical

16. Select the correct name of this molecule.

A



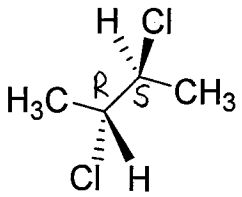
a. (2*R*,4*E*)-4-hexen-2-ol
b. (2*S*,4*E*)-4-hexen-2-ol
c. (2*S*,4*Z*)-4-hexen-2-ol
d. (2*R*,4*Z*)-4-hexen-2-ol
e. None of these names is correct

17. Which of these statements is true about the chair conformation shown?

B

a. The two methyl groups are anti.
b. The two methyl groups are gauche.
c. The two methyl groups are eclipsed.
d. There is no relationship between the two methyl groups.

18. Consider the following statements about this molecule.



Achiral and meso

D

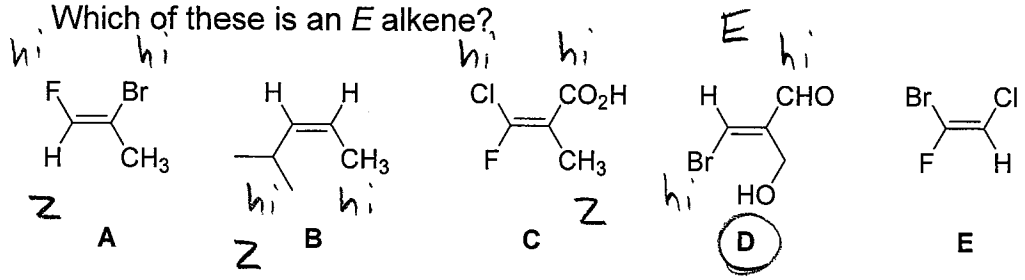
I. This molecule has an enantiomer. X it's achiral
II. This molecule has at least one diastereomer.
III. This molecule is chiral. X it's achiral
IV. A pure sample of this molecule will not rotate plane polarized light.

Select any and all **true** statements from the set.

a. I, II, III and IV
b. I only
c. I and II
d. I and IV
e. II and III

19. Which of these is an *E* alkene?

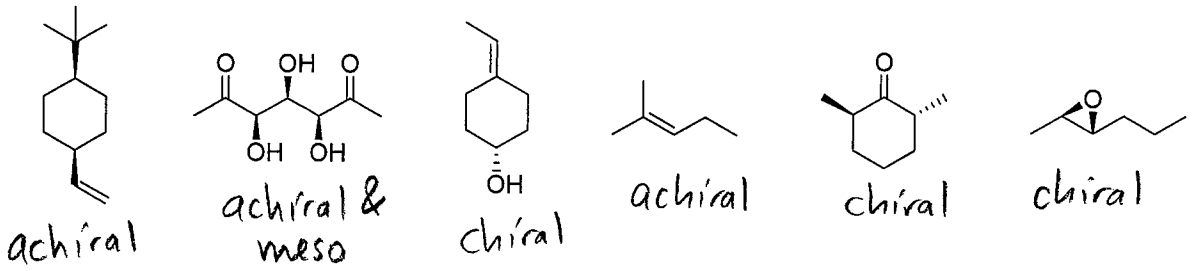
D



20. Several years ago, Kim Kardashian proposed a TV show called "The Kardashians Go Khiral!" Kim planned to have different chiral molecules on the show each week as guest stars. However, after one episode, the show was canceled. Later, the tabloids reported that Kim really didn't have the first clue about what chirality was and that some of the molecules that starred in the first (and only) episode were not even chiral, much less good actors.

Here is the cast of Kim's first show. How many of the molecules in this group are chiral?

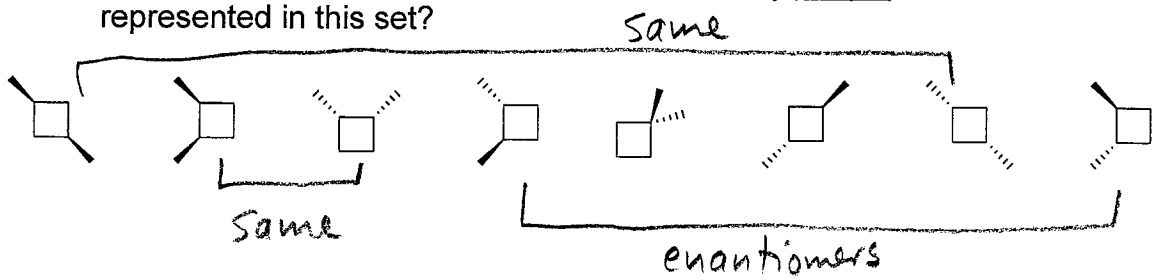
D



a. All are chiral
b. None are chiral
c. 1
(d.) 3
e. 5

21. Dimethylcyclobutane has a number of constitutional and stereoisomers. Consider this set of structures, where some of the molecules are drawn more than once but in different ways. How many <u>unique</u> molecules are represented in this set?

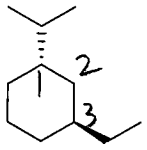
E

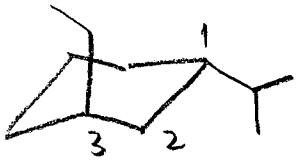


a. 2
b. 3
c. 4
d. 5
(e.) 6

22. The "A" value describes the preference for a group to occupy an equatorial bond. For an isopropyl group, the "A" value is about 2.61 kcal/mol and for an ethyl group, the "A" value is about 1.79 kcal/mol. Which statement correctly describes the lowest energy chair conformation of this molecule?

A



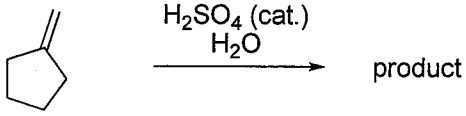


a. The ethyl group will be axial and the isopropyl group will be equatorial.
b. The ethyl group will be equatorial and the isopropyl group will be axial.
c. Both the ethyl group and the isopropyl group will be axial.
d. Both the ethyl group and the isopropyl group will be equatorial.

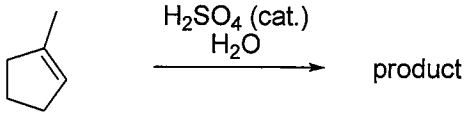
23. Consider these two hydration reactions:

B

Reaction 1:



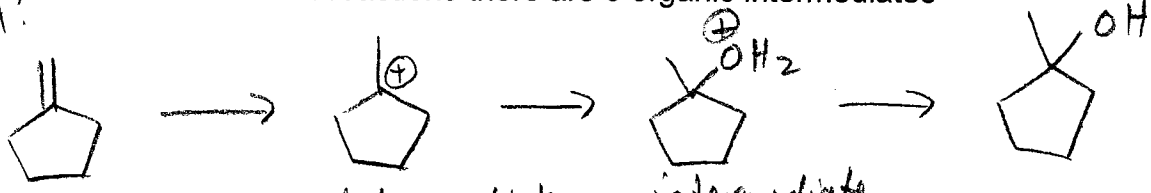
Reaction 2:



How many <u>organic</u> (carbon-containing) intermediates are there in each reaction?

a. In both reactions there is 1 organic intermediate
b. In both reactions there are 2 organic intermediates
c. Reaction 1 has 2 organic intermediates and Reaction 2 has 1 organic intermediate
d. Reaction 1 has 1 organic intermediate and Reaction 2 has 2 organic intermediates
e. In both reactions there are 3 organic intermediates

for A:



(same pattern for B)

24. Referring to #23, which reaction is faster?

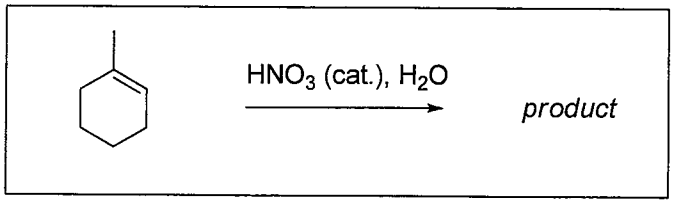
A

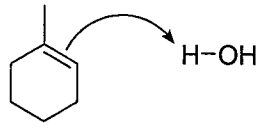
a. Reaction 1 is faster
b. Reaction 2 is faster
c. The two reactions occur at the same rate
d. There is not enough information to make a determination about relative rates of the two reactions.

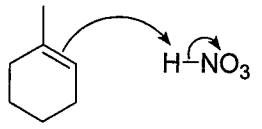
Rate-limiting step has lower Ea because Reaction 1's alkene is higher in E (see below)

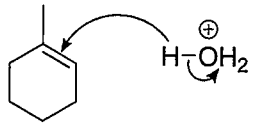
25. Which of these choices shows the correct way to draw the first step of the mechanism for the reaction in the box? (Lone pairs are omitted for clarity.)

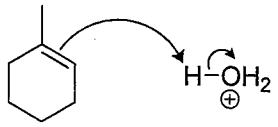
D

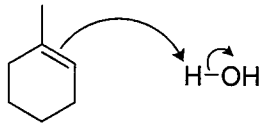


A 

B 

C 

D 

E 

Both alkenes form the same carbocation, thus go through the same transition state:

24.