

Name: _____

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Multiple Choice (Choose the one best answer for each of the following. Using a #2 pencil, record this answer on the scantron provided.)

1. A molecule has the chemical formula $C_{10}H_{16}Cl_2$. How many degrees of unsaturation in this molecule?

$C_{10}H_{16}$ $DU = \frac{2 \cdot 10 - 16}{2} = \frac{14}{2} = 7$

- A. three B. five **C. seven**
D. one E. two

2. Calculate the number of degrees of unsaturation in the molecule C_4H_5N . Based on this number, which of the following combination CAN be present in C_4H_5N ?

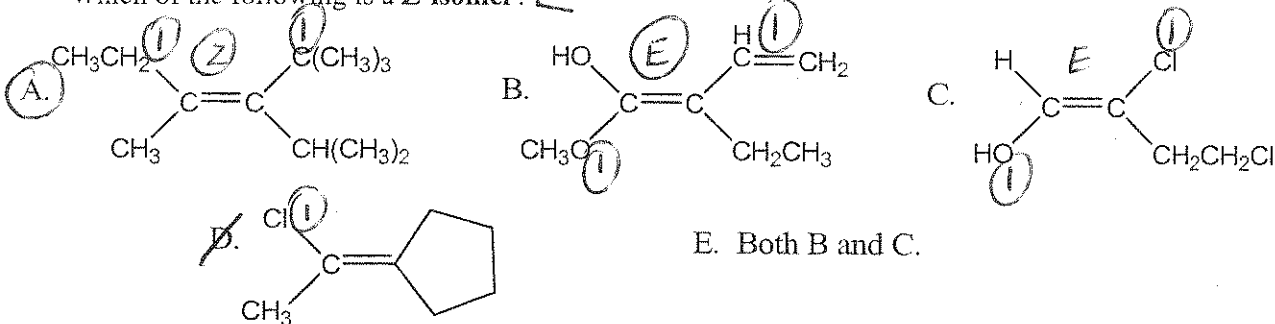
C_4H_{10+1}
 $DU = \frac{11 - 5}{2} = \frac{6}{2} = 3$

	# double bonds	# triple bonds	# rings	DU
A.	2	1	0	7
B.	1	1	2	5
C.	3	0	1	4
D.	2	0	1	3
E.	0	1	0	2

3. **Cis/trans isomers** are possible for which of the following?

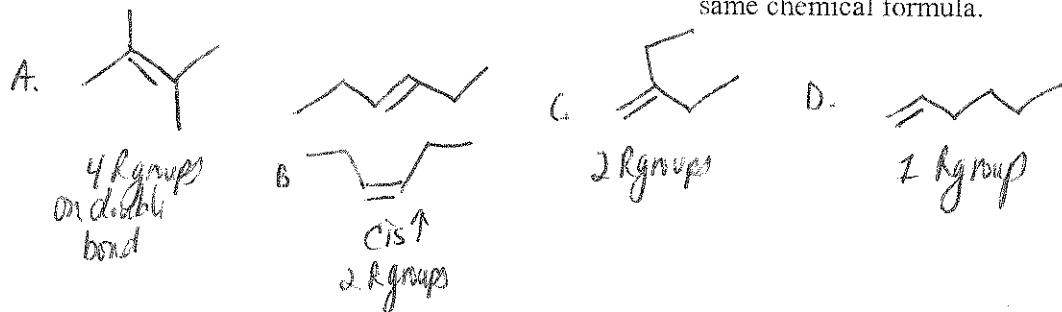
- A. 1-methylcyclopentene **B. 3-heptene** C. propene
D. 3-ethyl-2-pentene E. all of the above.

4. Which of the following is a **Z-isomer**?



5. Which of the following C_6H_{12} **alkenes** is the most stable? Draw structures to decide.

- A. 2,3-dimethyl-2-butene** B. cis-3-hexene C. 2-ethyl-1-butene
D. 1-hexene E. All are equally stable since all have the same chemical formula.



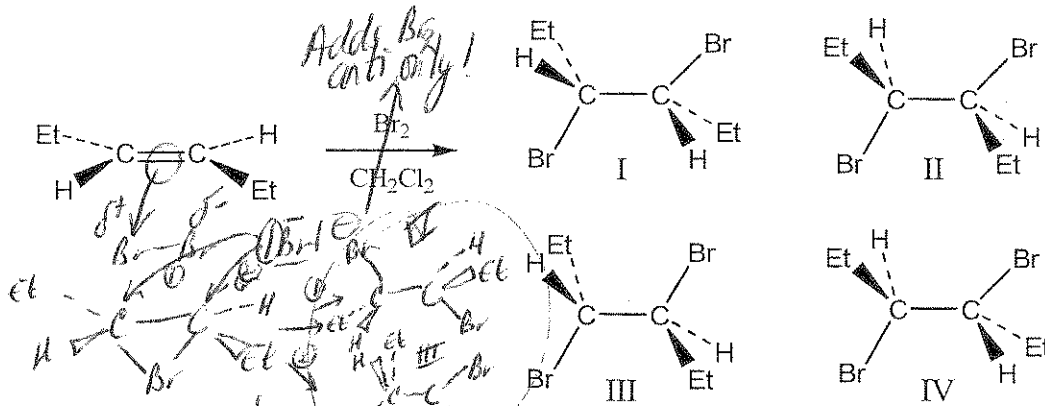
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8. Which of the following stereoisomer products will be formed in the reaction shown below?



31%

- A. I and II
B. I and III
C. II and IV
D. III only (III and IV are identical)
E. I, II, III, and IV

9. Which of the following bases will cause an E2 reaction to proceed the slowest?

- A. NaCN (pK_A = 9.1)
B. NaI (pK_A = -10.0)
C. NaOCH₃ (pK_A = 15.5)
D. NaNH₂ (pK_A = 36)
E. E2 reaction rate is independent of base strength.

Rate_{E2} = k [RX] [B] as base strength
Rate E2 ↓ as base strength ↓
Weak base will cause rxn to go slowest!
Strong acid → weak conjugate base

10. Which one of the following compounds has the highest boiling point?

- A. cycloheptene
B. 1-propoxypropane
C. heptane
D. 2,2-dimethyl-1-butanol
E. 1-hexanol

As strength IMF BPT

27%

58%

11. What are the two most likely mechanisms for the following reaction?



iodocyclopentane



- A. E1/S_N2
B. E2/S_N2
C. E2/S_N1
D. E1/S_N1
E. S_N1/S_N2

14%

12. Which of the following statements pertaining to an E1 elimination is correct?

- A. Base strength has no effect on the rate of an E1 mechanism. TRUE
B. The leaving group and β-hydrogen need to be anti-periplanar for elimination to occur.
C. The reaction mechanism involves one step. No 2 steps
D. The major product is usually the anti-Zaitsev product. No-Zaitsev product
E. None of the above are correct.

22%

Rate_{E1} = k [RX] true base not involved in E1 rxn mechanism. No

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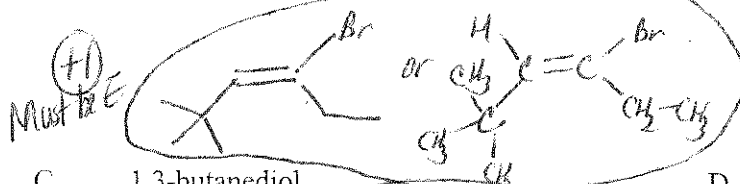
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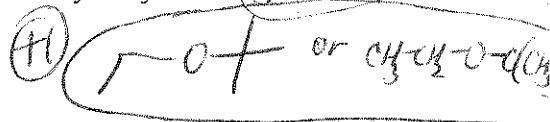
Partial Credit (Fill out the remaining questions on the exam itself. Show all work, provide complete explanations, and circle the answer(s) to be graded.)

16. Give a structure (line or structural) for each of the following compounds. Show cis/trans, E/Z, or R/S stereochemistry (3-D directionality) where appropriate.

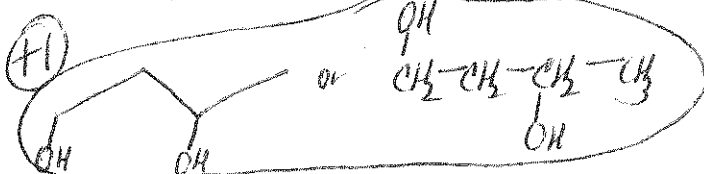
A. (E)-4-bromo-2,2-dimethyl-3-hexene



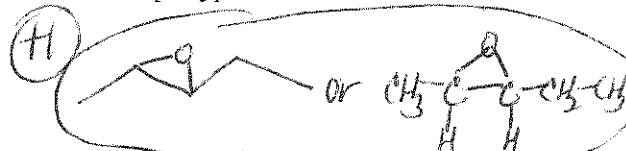
B. t-butyl ethyl ether



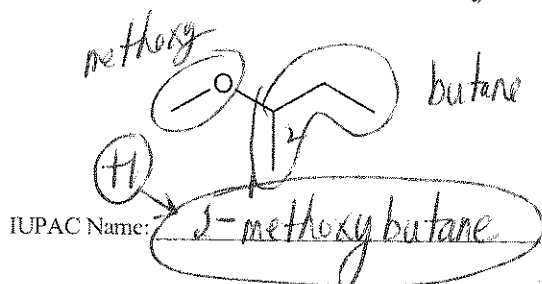
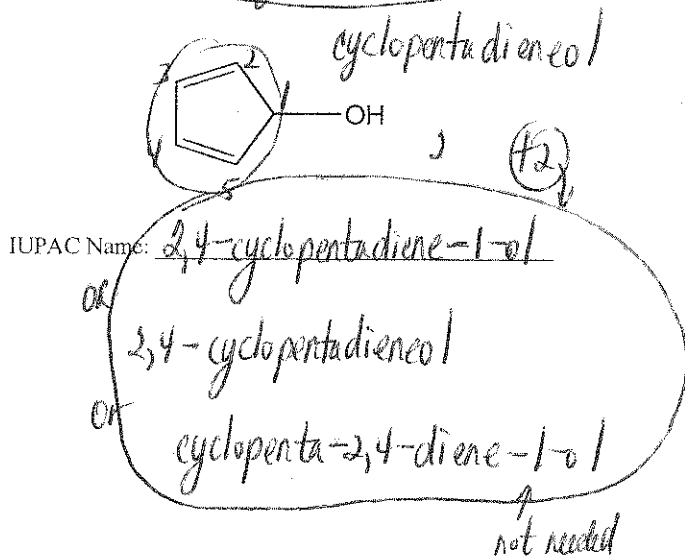
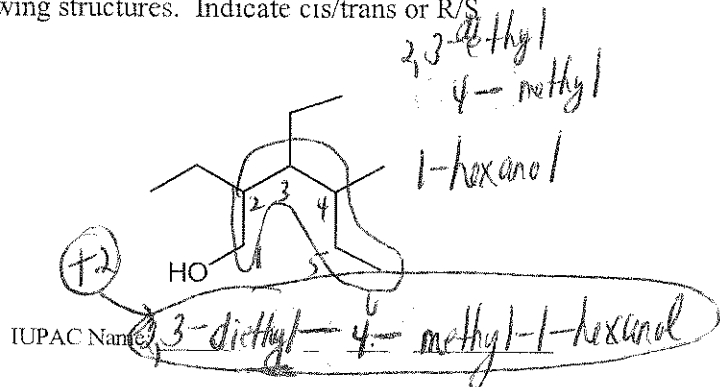
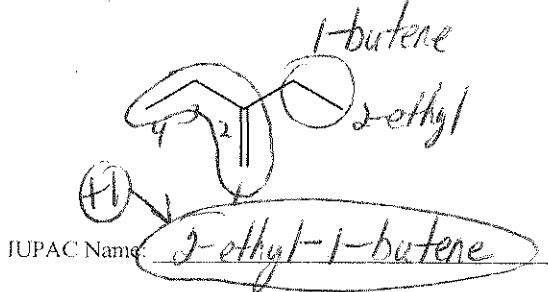
C. 1,3-butanediol



D. 2,3-epoxypentane



17. Give a correct IUPAC name for each of the following structures. Indicate cis/trans or R/S stereochemistry where appropriate.



Rate E2+E1: 3° > 2° > 1°

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18. Circle which one of each of the following pairs will give a higher yield of elimination product relative to substitution product.

(4)

A. bromocyclohexane + NaOCH₃ (run at T=50°C) vs. bromocyclohexane + NaOCH₃ (run at T=25°C)

B. (CH₃)₂CHCH₂CH₂I + NaOCH₃ vs. (CH₃)₂CHCH(I)CH₃ + NaOCH₃

C. CH₃CH₂Br + NaSCH₃ vs. (CH₃)₃CCH₂Br + NaSCH₃ → *bulky base favors elimination*

D. 2-chloro-3-methylbutane + KOC(CH₃)₃ vs. 2-chloro-3-methylbutane + KOCH₃

+1 each

19. There are two potential routes to prepare the ether, methoxycyclohexane, via a **Williamson synthesis**. Show both potential routes and indicate the preferred route. Give an explanation for your choice of preferred route. Potential reagents for use are: cyclohexanol, bromocyclohexane, cyclohexane, methanol, bromomethane, methane, and NaH.

Williamson synthesis → alcohol + alkyl halide → ether (Rxn occurs in 2 steps)

Route 1: Cyclohexanol + CH₃Br $\xrightarrow{\text{NaH}}$ Methoxycyclohexane

Route 2: Bromocyclohexane + CH₃OH $\xrightarrow{\text{NaH}}$ Methoxycyclohexane

Preferred route because second step is S_N2 and methyl undergoes S_N2 faster than 2° alkyl bromide

2° undergoes S_N2 but not as fast as methyl bromide

Need BH to do elim + no β-H's

20. Give structural formulas for ALL possible elimination products (Zaitsev, anti-Zaitsev, cis/trans, etc.) for the following reactions. Circle the major elimination product.

A. CC(C)C(Br)C $\xrightarrow[\text{heat (E1)}]{\text{:B (weak base)}}$ CC(C)=CC + CC(C)C=C + CC=C(C)C

Carbocation intermediate!

+3 pts -1 each error to max of 3

B. CC1(C)C(Br)CCCC1 $\xrightarrow[\text{heat (E2)}]{\text{:B}^- \text{ (strong base)}}$ CC1=CCCCC1 + CC1(C)C=CCCC1

A-H is NOT anti-periplanar to Br!

Do NOT get any CC1=CC=CC1

+2 pts -1 each error to max of 2

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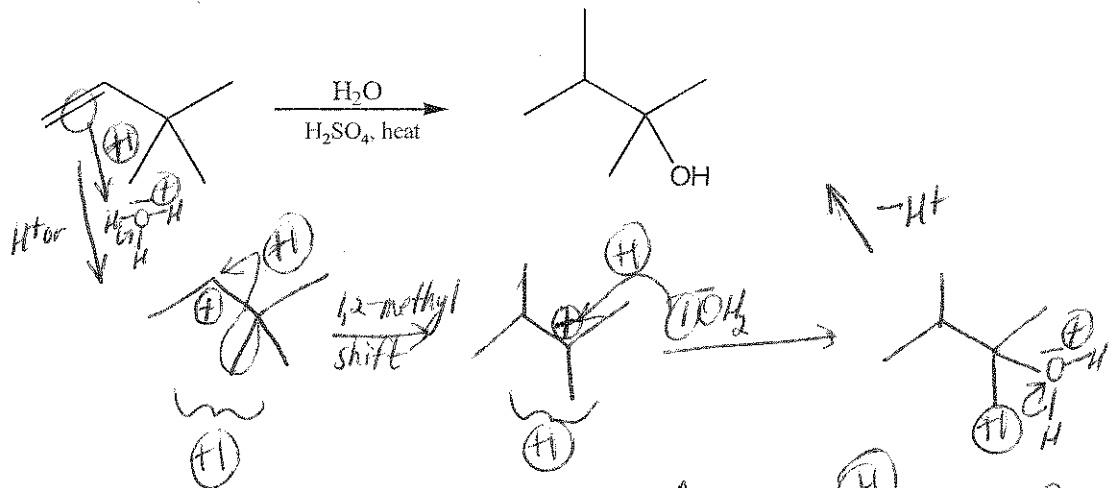
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21. Predict major organic product(s) for B and C, and show detailed step-by-step mechanisms for obtaining the product(s) in A-C. Give as much information as possible and be sure to show movement of electrons using curved arrows, positive or negative formal charges, intermediates, etc. For any E2 mechanisms, show the transition state species. Don't skip any steps in the mechanism.

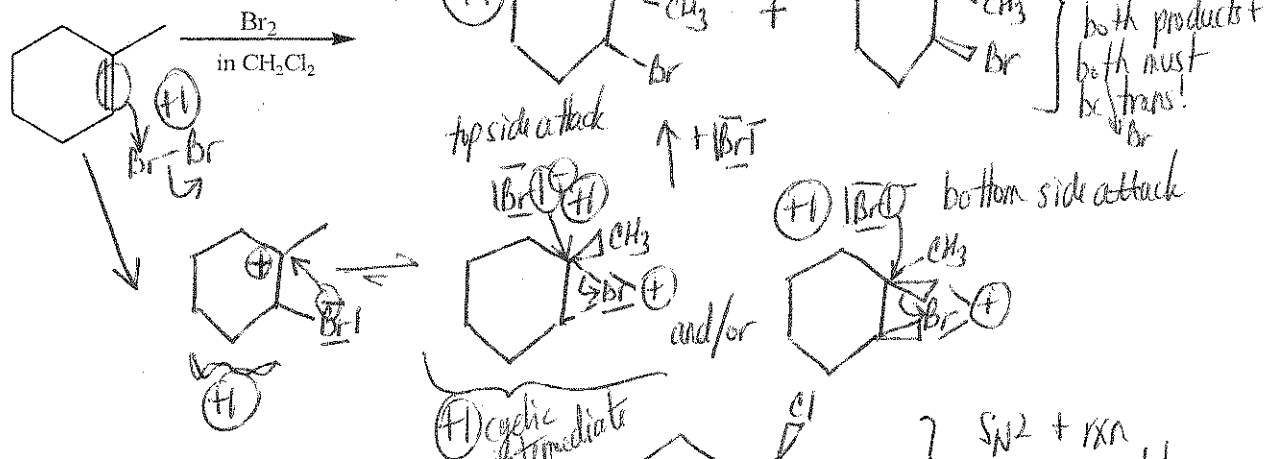
A.

+6pts



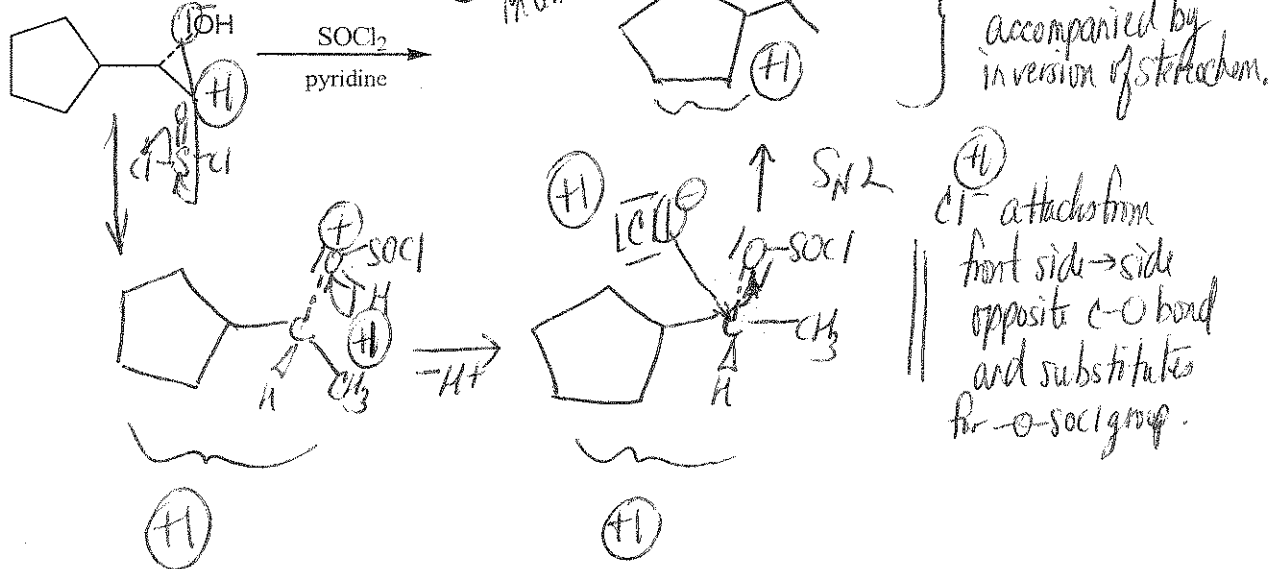
B.

+6pts



C.

+6pts



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22. Give the major organic product(s) for each of the following reactions. If applicable, show the cis/trans or R/S nature. Show enantiomeric sets, Zaitsev/antiZaitsev products, and products due to carbocation rearrangement and non-rearrangement. For constitutional isomer products, circle the major product.

All worth 1pt except A, E+H worth 2pts each

