

NAME (PRINT CLEARLY) \_\_\_\_\_

*I am on my honor that I will not discuss the contents of this exam with anyone until after 6:00 pm on Monday, November 25, and will notify Dr. Brush if I am made aware of any cases of academic dishonesty.*

I understand and agree to these conditions (signature) \_\_\_\_\_

**CHEM 243 ORGANIC CHEMISTRY I**  
**Exam III (version-1), Friday, November 22, 2024**

Answer all questions in the space provided, continuing on the back if necessary. **Read each question carefully and be sure to answer all parts to each question!** This exam is worth a total of 150 points.

Exams will be returned within one week. An answer key to this exam will be linked to the course web page.

(36) 1. \_\_\_\_\_

(19) 2. \_\_\_\_\_

(24) 3. \_\_\_\_\_

(20) 4. \_\_\_\_\_

(44) 5. \_\_\_\_\_

Sub-total (143) = \_\_\_\_\_ x 1.049 = \_\_\_\_\_

Total Points: \_\_\_\_\_ (150) = \_\_\_\_\_ %

Total Worksheet Points to date: \_\_\_\_\_ = \_\_\_\_\_ %

**Class Grade Estimate:**

Exam I \_\_\_\_\_ + Exam II \_\_\_\_\_ + Exam III \_\_\_\_\_ + (WS% x 1.5) \_\_\_\_\_ = \_\_\_\_\_ (SUM)

SUM / 6 = \_\_\_\_\_ % (raw class % - does not include project grade or lab grade)

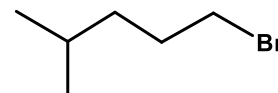
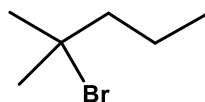
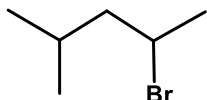
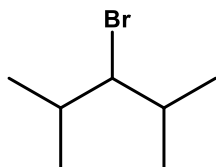
**IF YOU DO NOT UNDERSTAND A QUESTION, PLEASE ASK FOR AN EXPLANATION!**

1. (36 Points) Answer the following questions as indicated.

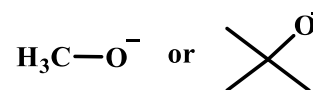
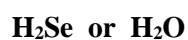
(a) For each of the following statements, indicate whether they are characteristics of **SN1**, **SN2**, **E1** or **E2** reactions. **Please note that some statements may have more than one answer.**

- |  |   |
|--|---|
| _____ these reactions have a carbocation intermediate  | _____ these reactions form alkenes as products                      |
| _____ for these reactions substrate reactivity = $3^\circ > 2^\circ > 1^\circ > \text{methyl}$ | _____ in this reaction the nucleophile can be a weak or strong base |
| _____ alcohol dehydration is an example of these two reactions                                 | _____ this reaction is known for forming racemic products           |
| _____ in this reaction the Lg and a $\beta$ -H must be anti                                    | _____ these reactions have a crowded transition state               |

(b) Rank the following alkyl bromides in order of their SN2 reactivity (**1 = fastest and 4 = slowest**).

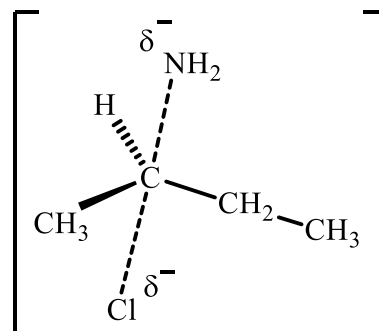


(c) Which nucleophile **in each pair** reacts **faster** in SN2 substitution reactions? Circle ONE choice in each pair.

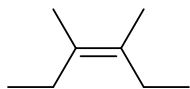


(d) Which of the following mechanistic characteristics are consistent with the transition state shown at the right? Circle your choice(s).

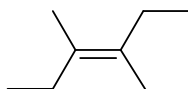
- |                     |                  |                    |                  |
|---------------------|------------------|--------------------|------------------|
| <b>SN1</b>          | <b>SN2</b>       | <b>E1</b>          | <b>E2</b>        |
| <b>racemization</b> | <b>acid/base</b> | <b>dehydration</b> | <b>inversion</b> |



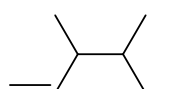
(e) Rank the following alkenes based on their stability. (1 = most stable and 4 = least stable)



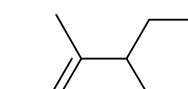
\_\_\_\_\_



\_\_\_\_\_



\_\_\_\_\_



\_\_\_\_\_

(f) Which of the following mechanistic characteristics are consistent with the transition state shown at the right? Circle your choice(s).

SN1

SN2

E1

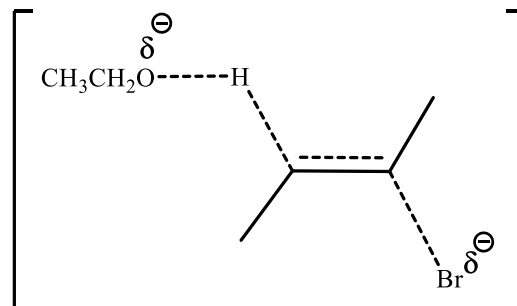
E2

racemization

acid/base

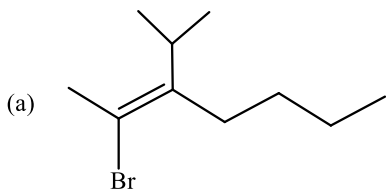
dehydration

inversion



## 2. (19 Points) Nomenclature.

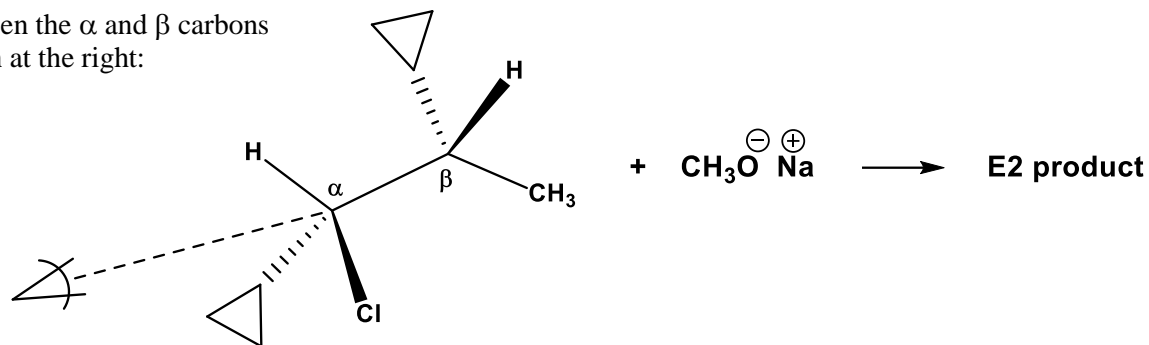
- If a name is given draw an accurate zig-zag structure (remember to use wedge and dash bonds for all chiral carbons, and draw the proper alkene geometry).
- If a structure is drawn, give an accurate IUPAC name (don't forget to assign configurations using the R/S prefix, and assign alkene geometry using the cis/trans or E/Z prefix).



(b) cis-(R)-2-bromo-6-cyclopentyl-3-hexene

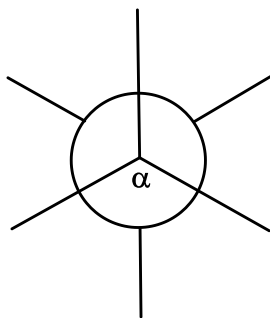
## 3. (24 Points) Reaction Stereochemistry.

(a) (16 Points). Consider the E2 elimination reaction occurring between the  $\alpha$  and  $\beta$  carbons of the alkyl halide drawn at the right:

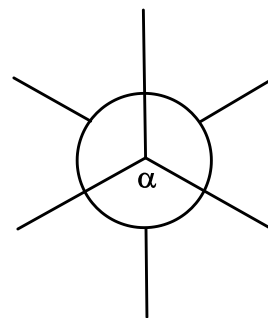


(i) In the structure drawn above, **CIRCLE** the **Leaving Group** and the  **$\beta$ -H** in the reactant that will produce the elimination product.

(ii) Looking directly at the  $\alpha$ -carbon, draw a Newman Projection looking back toward the  $\beta$ -carbon. Then **circle the Leaving Group and the  $\beta$ -H**:

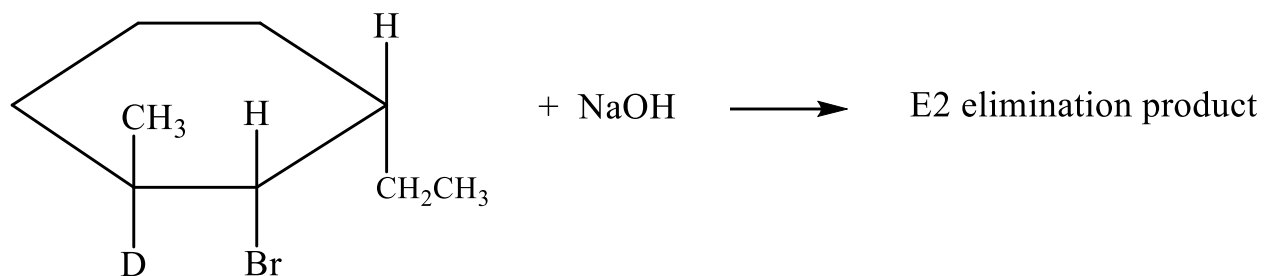


(iii) Rotate such that the leaving group and  $\beta$ -H are "anti". Draw a **dotted line** through the Lg and  $\beta$ -H:



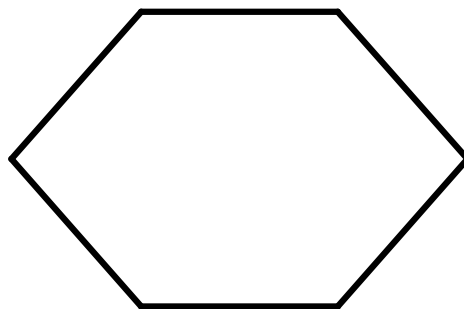
(iv) Based on your Newman Projections, draw the structure of the **major E2 product** expected from this reaction:

**(b) (8 Points) E2 Elimination Stereochemistry.** Consider the **E2 elimination** reaction of this cycloalkyl bromide using NaOH. "D" represents deuterium, an isotope of hydrogen.

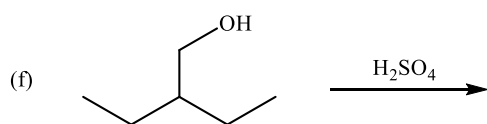
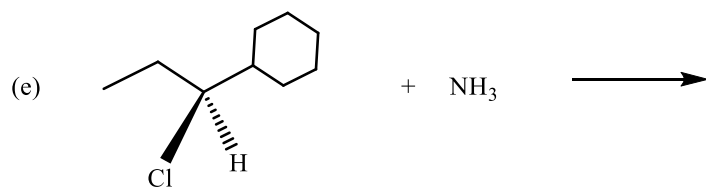
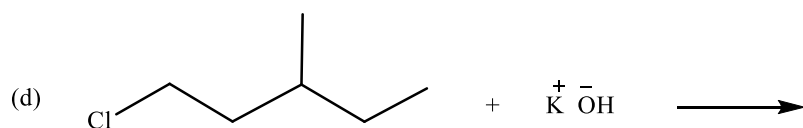
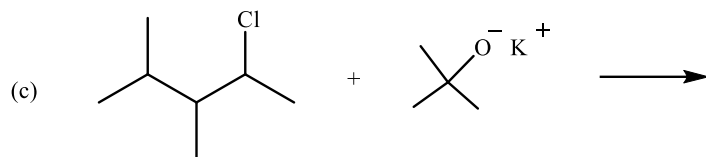
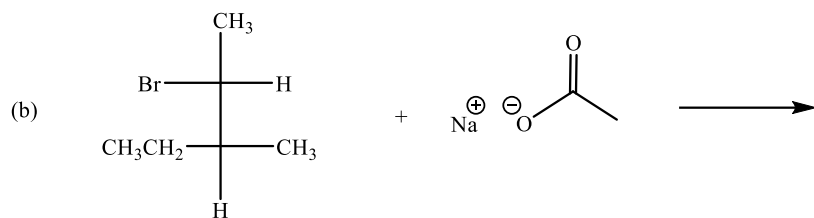
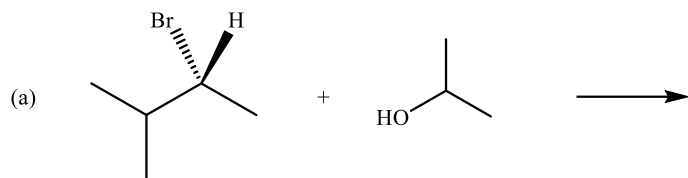


(i) In the structure drawn above, **CIRCLE** the **Leaving Group (Lg)** and the  **$\beta$ -H and/or  $\beta$ -D** that will lead to E2 elimination.

(ii) (b) Based on your answer in part (i), use the 2D template below to draw the **major E2 elimination product**:

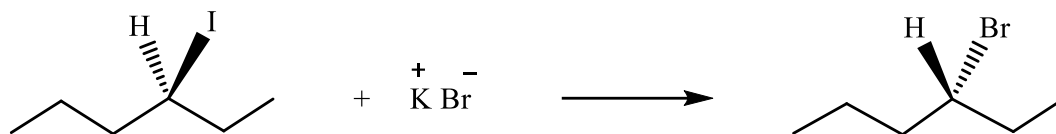


4. (20 Points) **Reactions.** The reaction products below may include: **SN1 & E1, SN2 & E2, SN2 only, E2 only, or dehydration.** Complete the reactions shown below by drawing the structure of the **major, neutral organic products**. Draw the proper stereochemistry, if relevant. It is **NOT** necessary to balance these reactions or write the mechanism.



## 5. (44 points) Mechanisms.

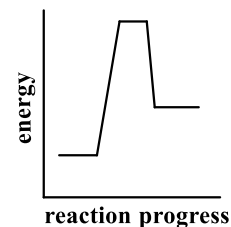
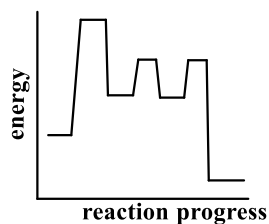
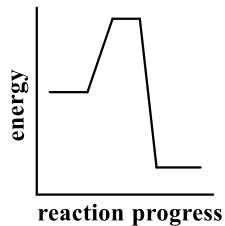
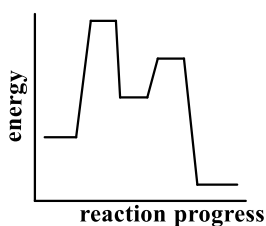
(a) **SN2 Substitution Reaction Theory.** Answer each of the following questions based on the partial, SN2 substitution reaction drawn below:



(i) **SN2 Mechanism (1 step).** Complete the 1-step SN2 mechanism above by:

- (1) drawing the curved arrow(s) for the reactants **directly** in the reaction above, and
- (2) balancing the products

(ii) Of the four potential energy diagrams shown below, **CIRCLE** the **one** that is most consistent with this exothermic SN2 reaction:

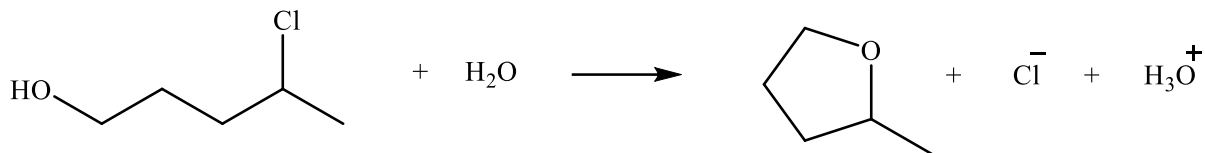


(iii) In the brackets at the right, draw the structure of the **transition state** for this SN2 reaction above.

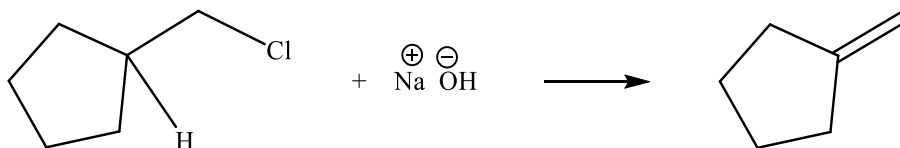


(iv) Using your transition state, **explain** the observed stereochemistry in comparing the reactants to products in your balanced equation above.

(b) **Intramolecular SN1 Mechanism (3 steps).** Write a complete mechanism that explains the balanced net reaction shown below. Your mechanism must consist of a series of individual, balanced chemical equations, and curved arrows to show electron pair movement.



(c) **E2 Mechanism (1 step).** Complete the mechanism below by:  
 (1) drawing the curved arrow(s) for the reactants **directly** in the reaction below, and  
 (2) balancing the products





(c) **E1 Alcohol Dehydration Mechanism (3 steps).** Write a complete mechanism that explains the formation of all products in the balanced net reaction shown below. Your mechanism must consist of a series of individual, balanced chemical equations, and curved arrows to show electron pair movement.

