NAME (PRINT CLEARLY) Answer Key V1

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.**

SN1+E1 these reactions have a carbocation intermediate

SN1+E1 for these reactions substrate reactivity = 3°>2°>1°>methyl

E1+E2 alcohol dehydration is an example of these two reactions

E2 in this reaction the Lg and a β-H must be anti

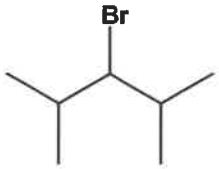
E1+E2 these reactions form alkenes as products

SN2 in this reaction the nucleophile can be a weak or strong base

SN1 this reaction is known for forming racemic products

SN2+E2 these reactions have a crowded transition state

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



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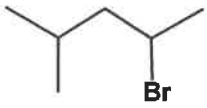

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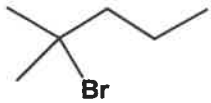

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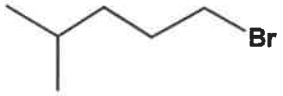


1

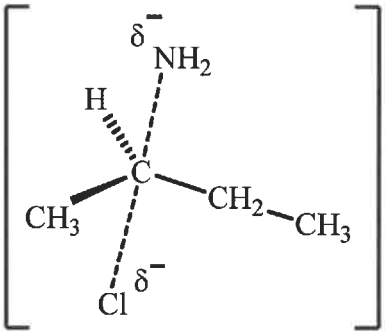
(c) Which nucleophile **in each pair** reacts **faster** in SN2 substitution reactions? Circle ONE choice in each pair.

NH_3 or $Na^+ {}^-NH_2$ Cl^- or PH_2^- H_2Se or H_2O $H_3C{-}O^-$ or 

(d) 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**

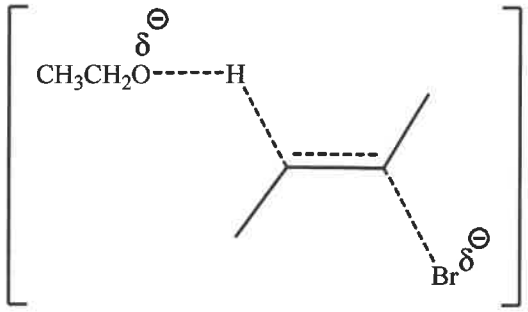


(e) Rank the following alkenes based on their stability. (1 = most stable and 4 = least stable)

(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**

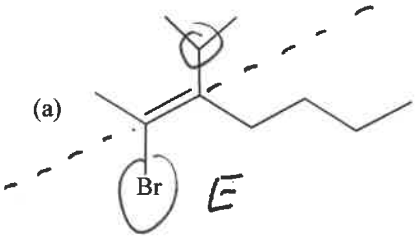
racemization **acid/base** **dehydration** **inversion**



2. (19 Points) Nomenclature.

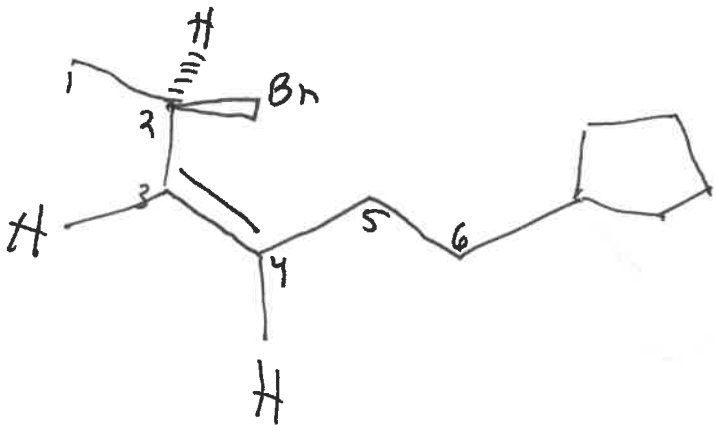
- If a name is given draw an accurate zig-zag structure (remember to use wedge and dash bonds for all chiral carbons, and draw the proper alkene geometry).
- If a structure is drawn, give an accurate IUPAC name (don't forget to assign configurations using the R/S prefix, and assign alkene geometry using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

(a)



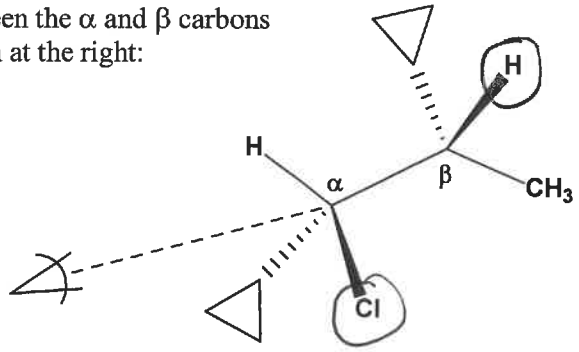
(E)-2-bromo-3-isopropyl-2-heptene

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



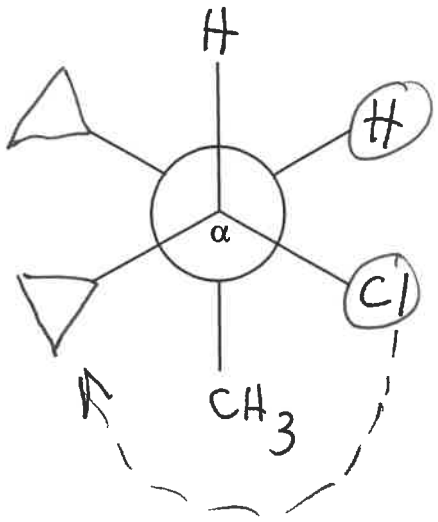
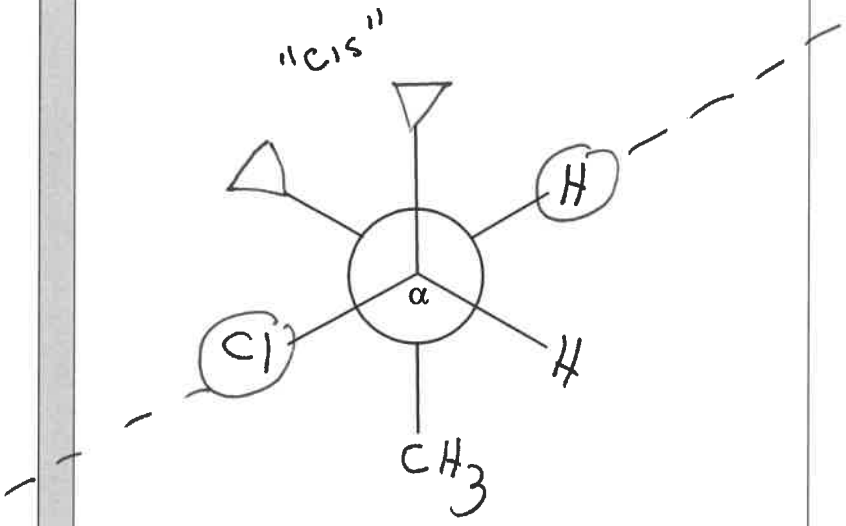
3. (24 Points) Reaction Stereochemistry.

(a) (16 Points). Consider the E2 elimination reaction occurring between the α and β carbons of the alkyl halide drawn at the right:

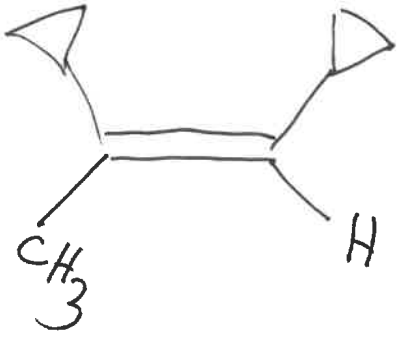


+ $CH_3O^{\ominus}\ Na^{\oplus}$ ⟶ **E2 product**

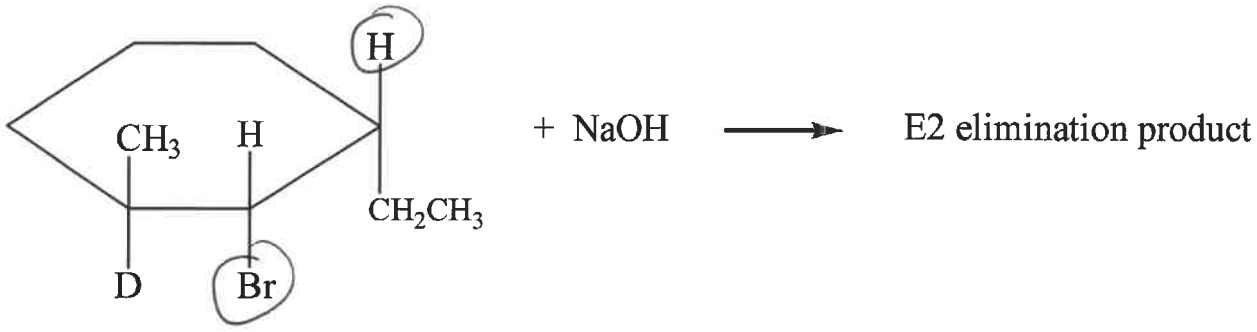
(i) In the structure drawn above, **CIRCLE** the **Leaving Group** and the **β-H** in the reactant that will produce the elimination product.

(ii) Looking directly at the **α**-carbon, draw a Newman Projection looking back toward the **β**-carbon. **Then circle the Leaving Group and the β-H:**	(iii) Rotate such that the leaving group and β-H are "anti". **Draw a dotted line through the Lg and β-H:**
	

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



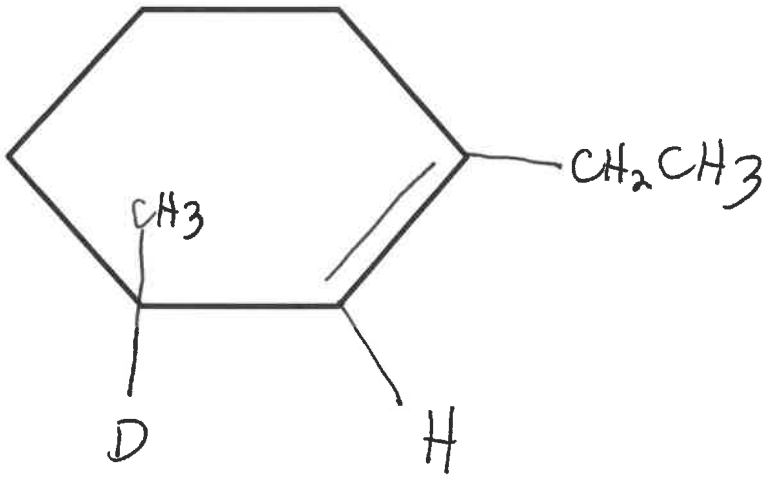
(b) (8 Points) E2 Elimination Stereochemistry. Consider the **E2 elimination** reaction of this cycloalkyl bromide using NaOH. "D" represents deuterium, an isotope of hydrogen.



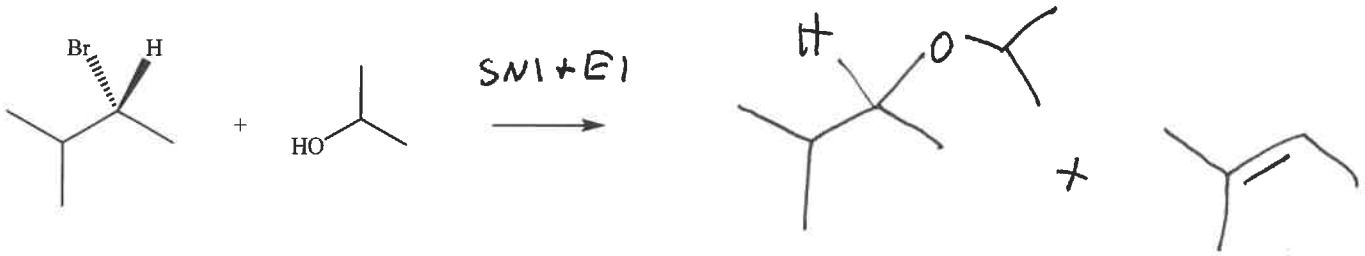
(must be anti / trans)

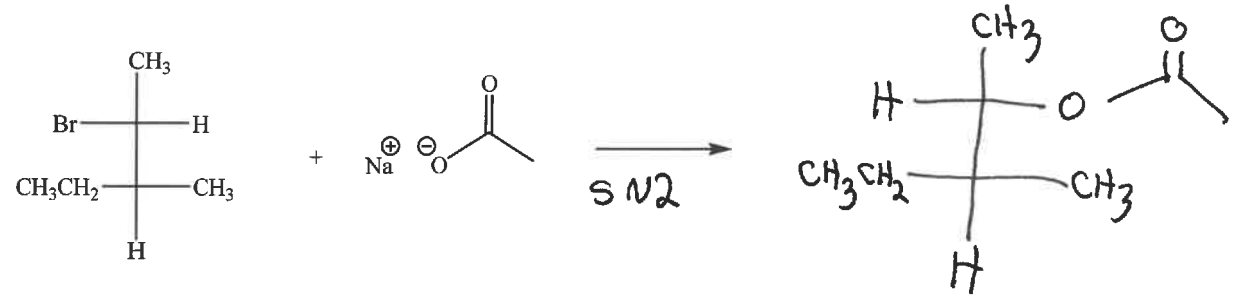
(i) In the structure drawn above, **CIRCLE** the **Leaving Group** (Lg) and the **β-H and/or β-D** that will lead to E2 elimination.

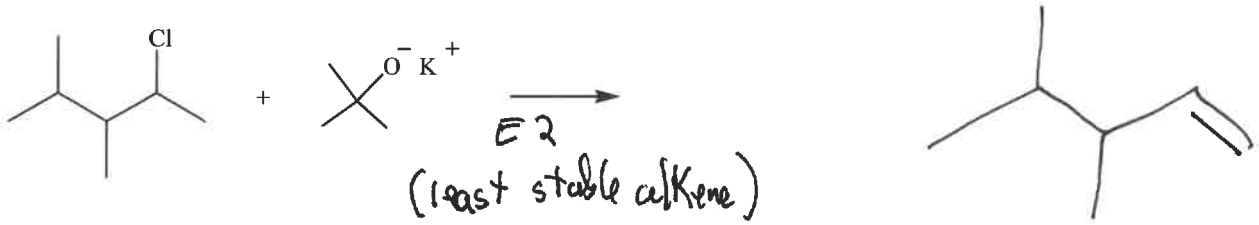
(ii) (b) Based on your answer in part (i), use the 2D template below to draw the **major E2 elimination product:**

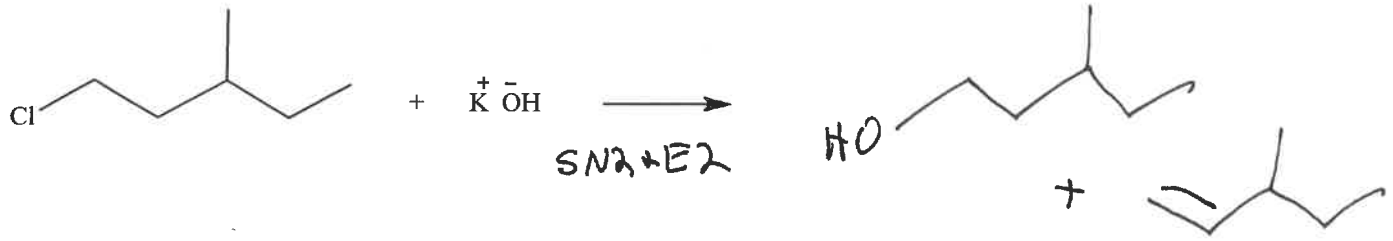


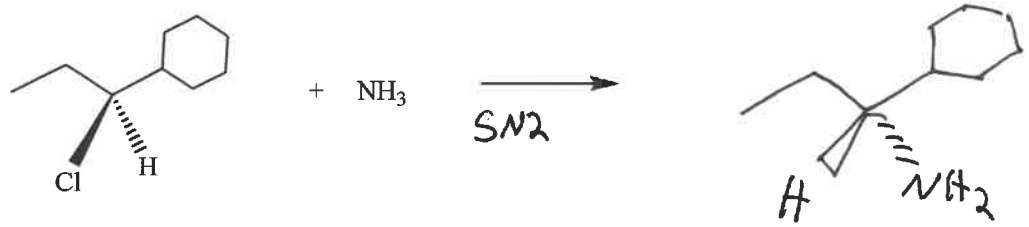
4. (20 Points) Reactions. The reaction products below may include: **SN1 & E1, SN2 & E2, SN2 only, E2 only, or dehydration.** Complete the reactions shown below by drawing the structure of the **major, neutral organic products.** Draw the proper stereochemistry, if relevant. It is **NOT** necessary to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

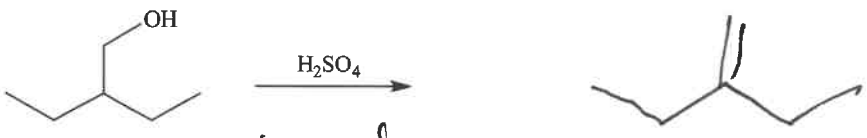
(a) 

(b) 

(c) 

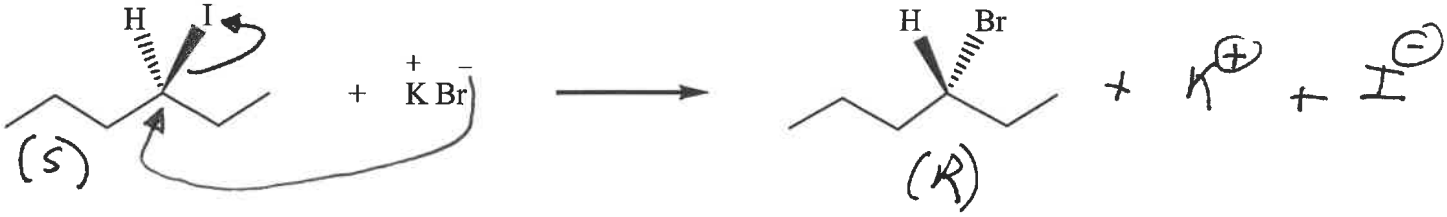
(d) 

(e) 

(f) 

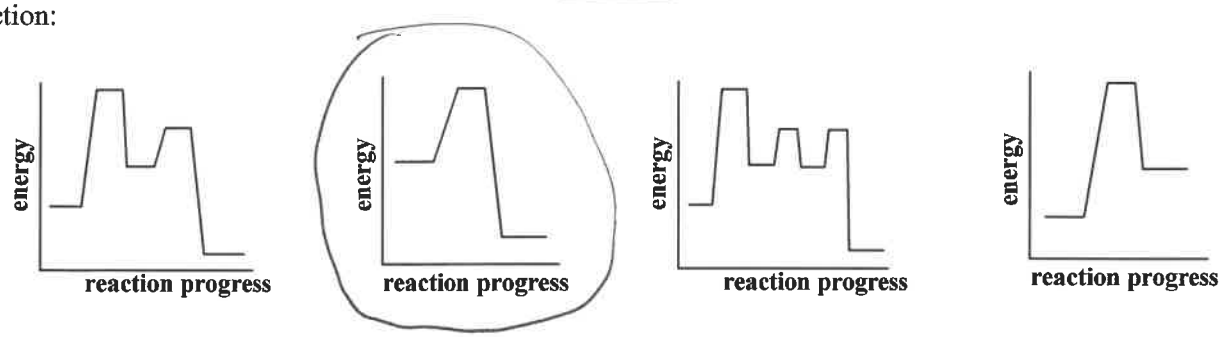
5. (44 points) Mechanisms.

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

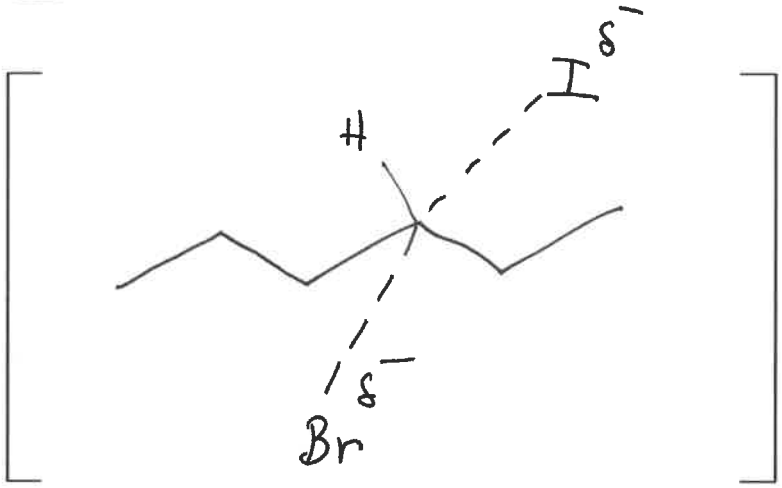


(i) SN2 Mechanism (1 step). Complete the 1-step SN2 mechanism above by:
(1) drawing the curved arrow(s) for the reactants **directly** in the reaction above, and
(2) balancing the products

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



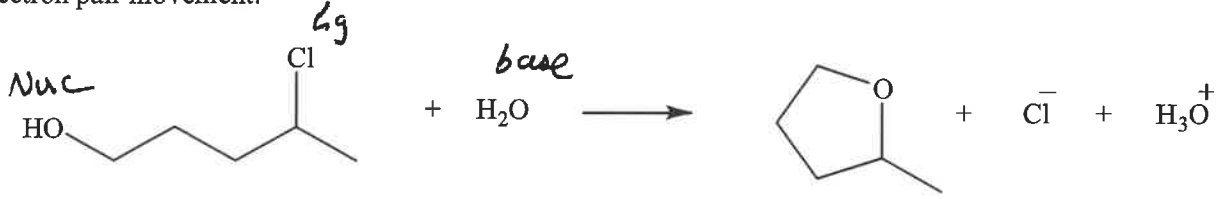
(iii) In the brackets at the right, draw the structure of the **transition state** for this SN2 reaction above.



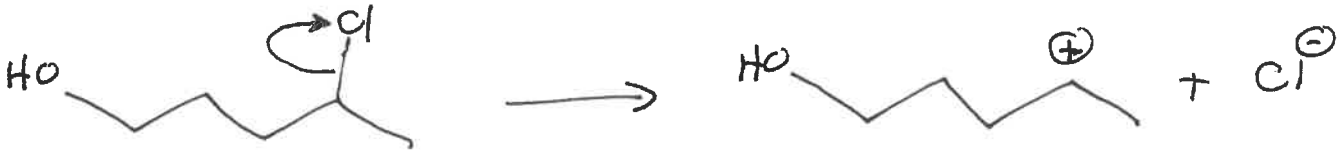
(iv) Using your transition state, **explain** the observed stereochemistry in comparing the reactants to products in your balanced equation above.

The R → P configuration switched from S → R. This is due to inversion of configuration in the transition state with the nucleophile coming in 180° opposite the leaving group.

(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.



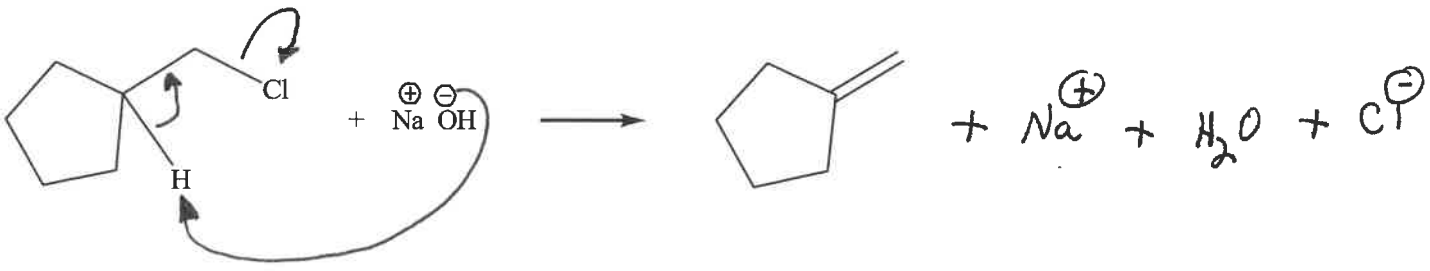
1)



2)

3)

(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.