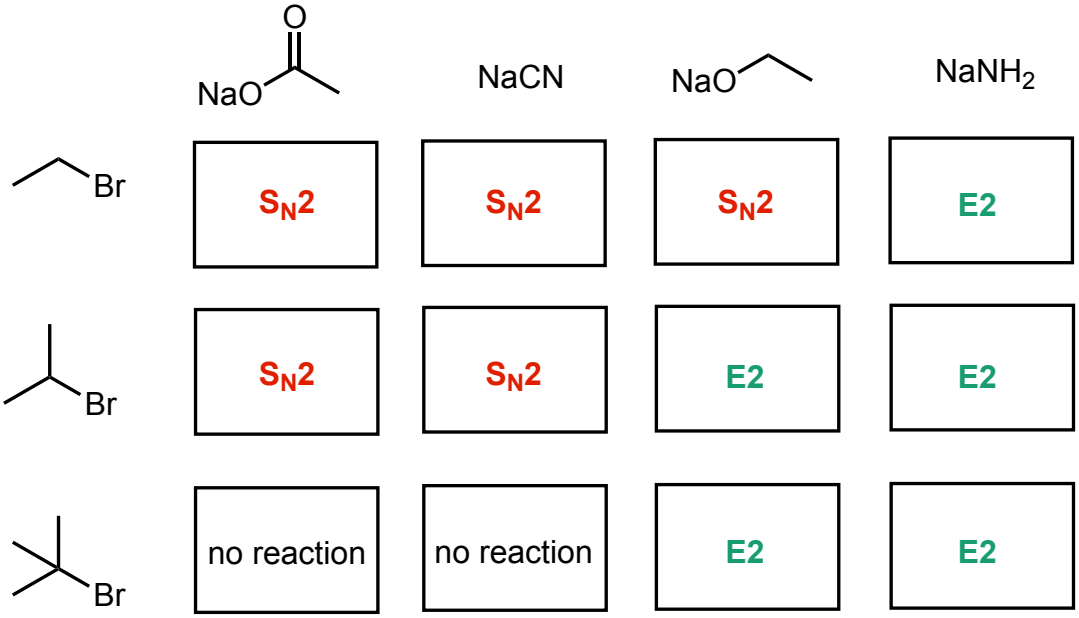
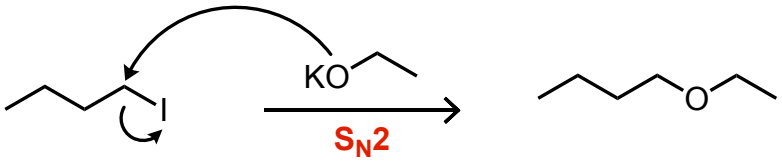
Substitution and Elimination

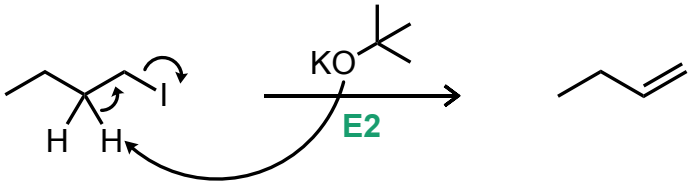
1. A. **Classify each alkyl halide** as being primary, secondary, or tertiary
   B. **Identify the weakest Lewis base** and **strongest Lewis base**
   C. In the boxes provided, **predict** if a **S_N2, E2,** or **no reaction** will proceed between each alkyl halide and Lewis base pair



2. A. Draw the curved arrow mechanism for each reaction below.
   B. Explain why S_N2 occurs in the top reaction, but E2 occurs in the bottom reaction.

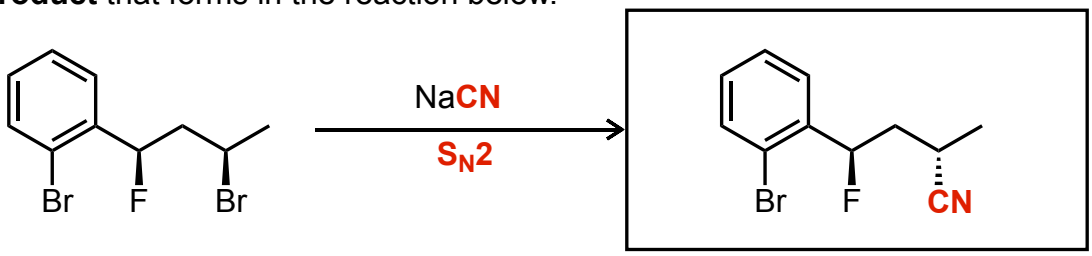


Primary leaving groups will undergo S_N2 reactions with sterically unhindered alkoxides

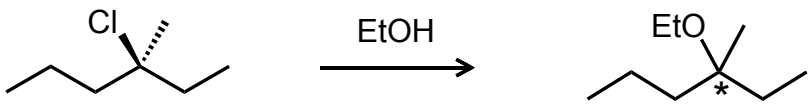


Tertiary leaving groups cannot undergo S_N2 reactions and the alkoxide is very sterically hindered, so E2 predominates

3. **Draw the product** that forms in the reaction below.



4. The reaction below is deliberately excluded from the Core Concept's flowchart. Answer the questions below to help you classify the reaction as S_N2, E2, S_N1, or E1.

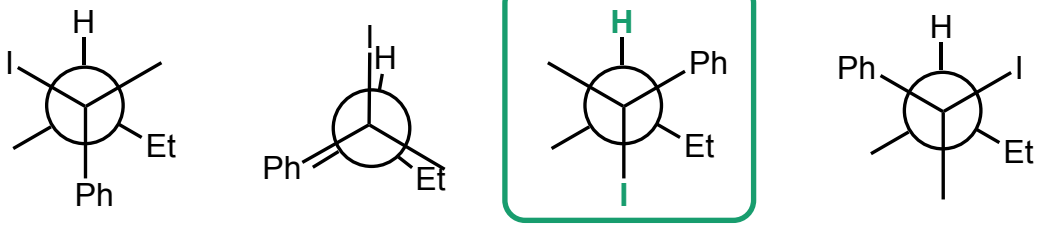


A. **Do we observe inversion, retention, or racemization of chirality** when comparing the product to the starting material?

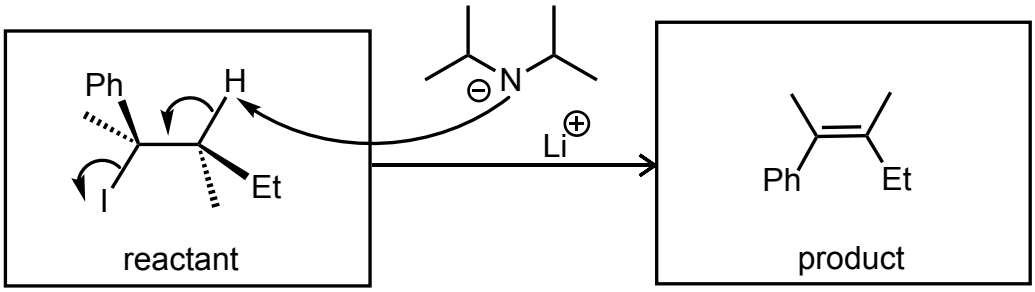
B. Is this process **stepwise** or **concerted**? Consider the reagents used in stepwise reactions versus the types of Lewis bases used in concerted reactions.
A tertiary carbocation is the key intermediate in this reaction

C. What **type of reaction** occured above? S_N2, E2, **S_N1**, or E1?

5. A. Shown below are various conformations of the same molecule (conformers). **Place a box around the Newman projection** that is in a **reactive conformation** for an **E2 elimination reaction.**

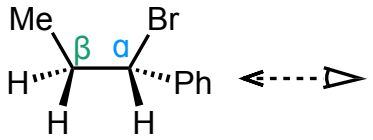


B. **Draw the bond line structure of the boxed conformation from part A** in the reactant space below. Then, show the curved-arrow mechanism and product for its subsequent E2 reaction with the shown base.



6. The alkyl halide below can participate in an **E2 reaction** in the presence of a suitable base **to yield two diastereomeric alkene products**.

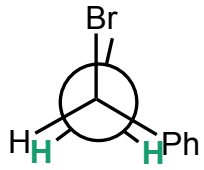
A. **Label the α carbon and β carbon(s)** relative to the leaving group in the molecule below.



E2 base → two diastereomeric alkene products

Conjugate acid

B. **Draw the Newman projection** of the molecule above **given the indicated perspective.**



unreactive for E2

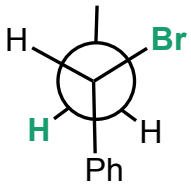
In the Newman projection you drew to the left, the **molecule is not in a reactive conformation for** an **E2** elimination reaction. **Why not**?

E2 reactions require an anti-periplanar relationship between the β-H and leaving group (not possible in an eclipsed conformation)

C. **Rotate the front carbon** of the Newman projection in part B **to provide two different Newman projections that are in a reactive conformation for an E2 reaction.**

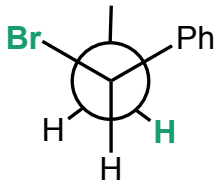
rotate front C

reactive Newman projection 1



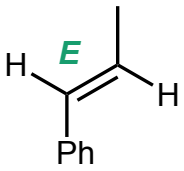
rotate front C

reactive Newman projection 2

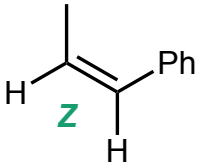


D. **Draw the alkene product** that would result f**rom each of the reactive Newman projections** from part C. Then **assign them** as ***E*** or ***Z*** and **circle the major product.**

product from reactive Newman projection 1

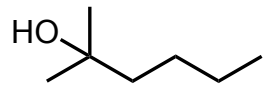


product from reactive Newman projection 2



7. **Identify the reaction taking place** (S_N1, S_N2, E1, or E2). Then, **provide the missing starting material, reactant, or major product**.
Consider that carbocation rearrangements are possible in S_N1 and E1 reactions if the shift results in a more stable carbocation.

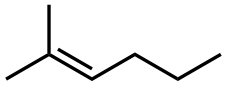
A.



H_2SO_4

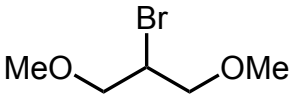
H_2O

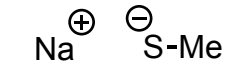
E1



+ H_2O

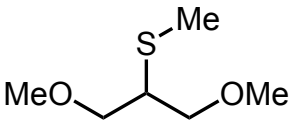
B.





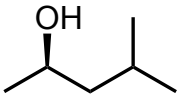
DMSO

S_N2



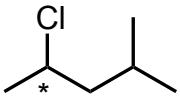
+ NaBr

C.



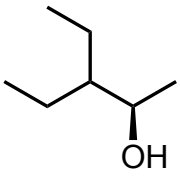
HCl

S_N1



+ H_2O

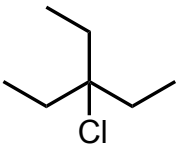
D.



HCl

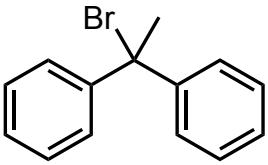
S_N1

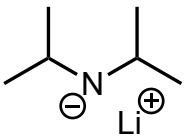
with 1,2-hydride shift



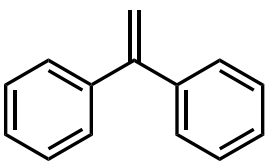
+ H_2O

E.



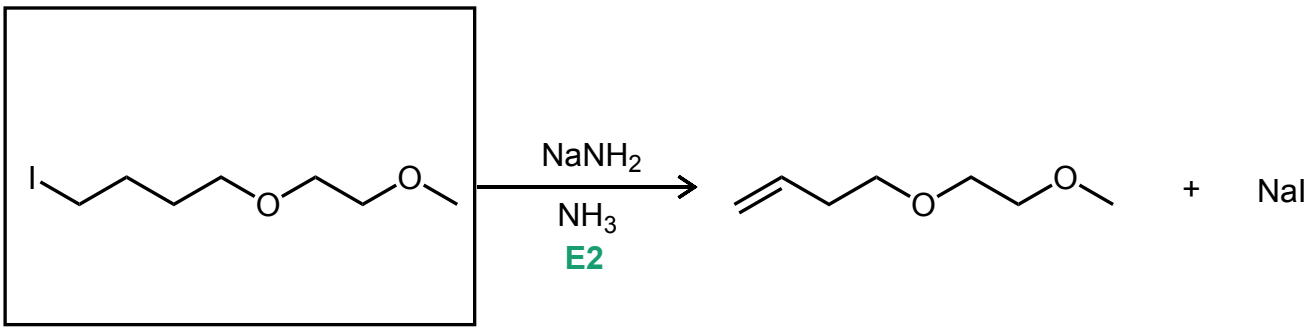


E2

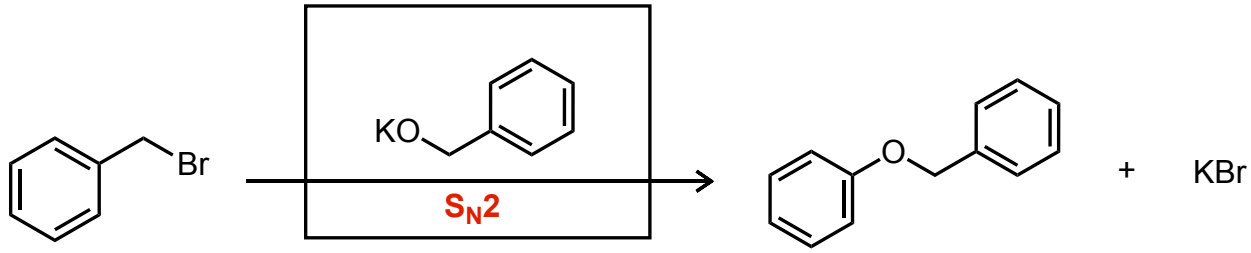


+ LiBr

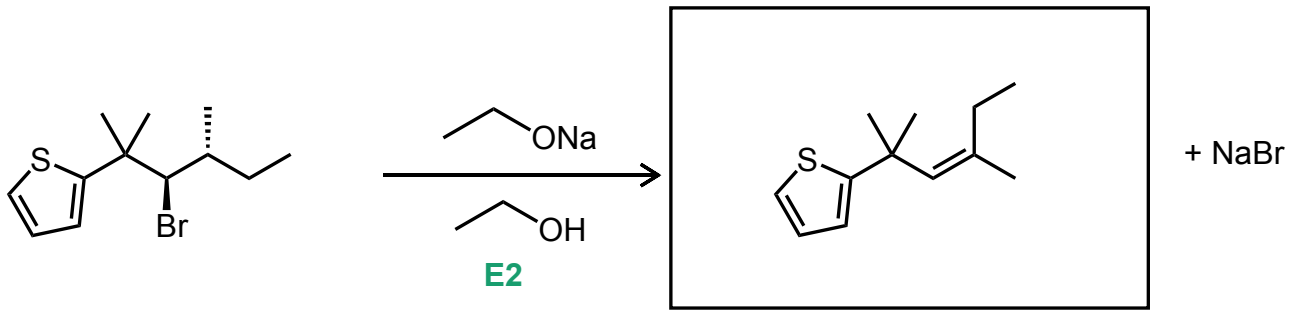
F.



G.

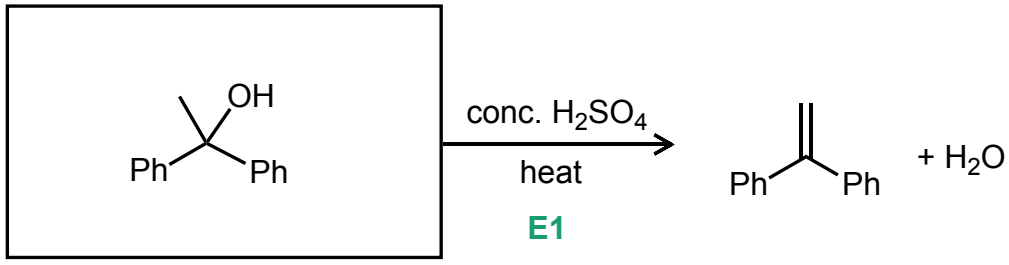


H.



rotation required (similar to question #6)

I.



J.