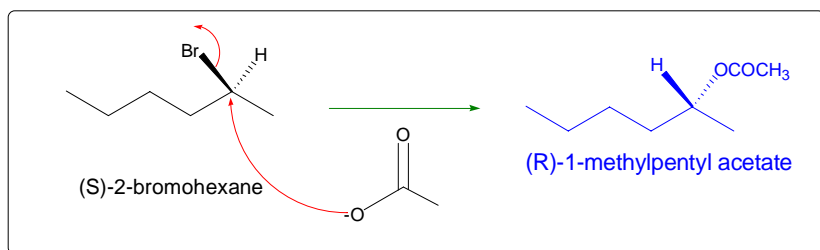


Chapter 11

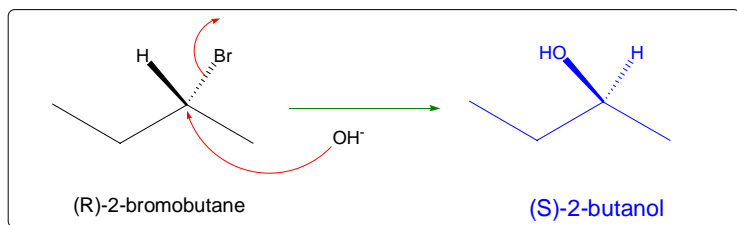
11.1 What product would you expect to obtain from a nucleophilic substitution reaction of (S)-2-bromohexane with acetate ion, CH_3CO_2^- ? Assume that inversion of configuration occurs, and show the stereochemistry of both reactant and product.

Solution:

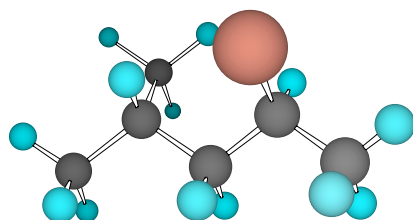


11.2 What product would you expect to obtain from $\text{S}_{\text{N}}2$ reaction of OH^- with (R)-2-bromobutane? Show the stereochemistry of both reactant and product.

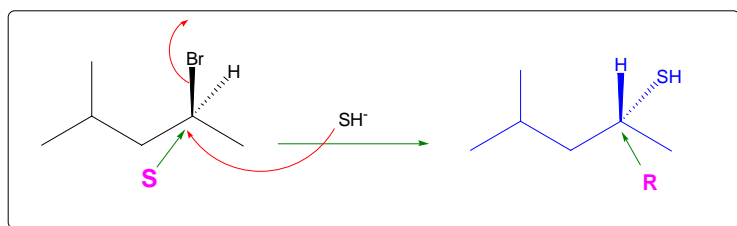
Solution:



11.3 Assign configuration to the following substance, and draw the structure of the product that would result on the nucleophilic substitution reaction with HS^- . (reddish-brown = Br^-)



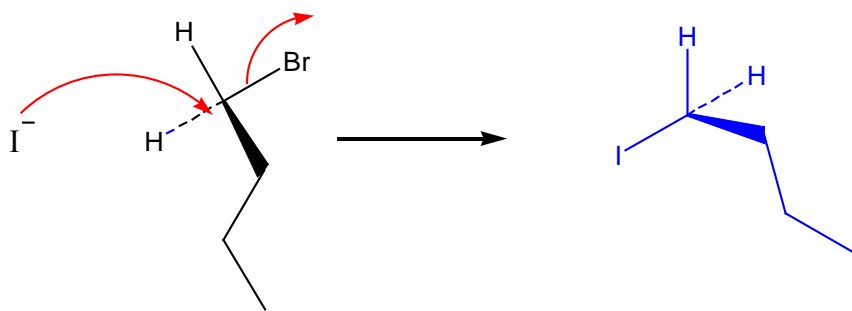
Solution:



11.4 What product would you expect from $\text{S}_{\text{N}}2$ reaction of 1-bromobutane with each of the following?

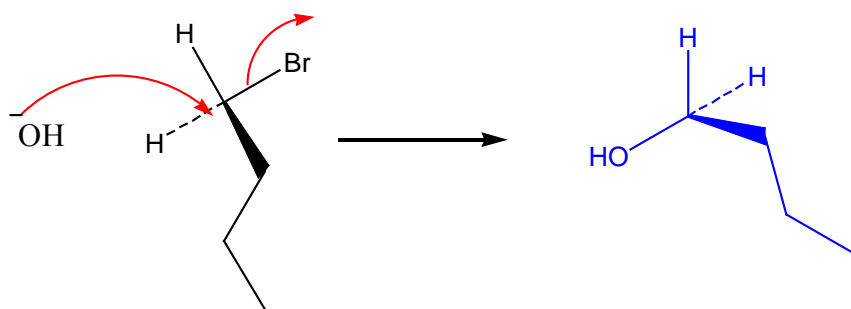
(a) NaI

Solution:



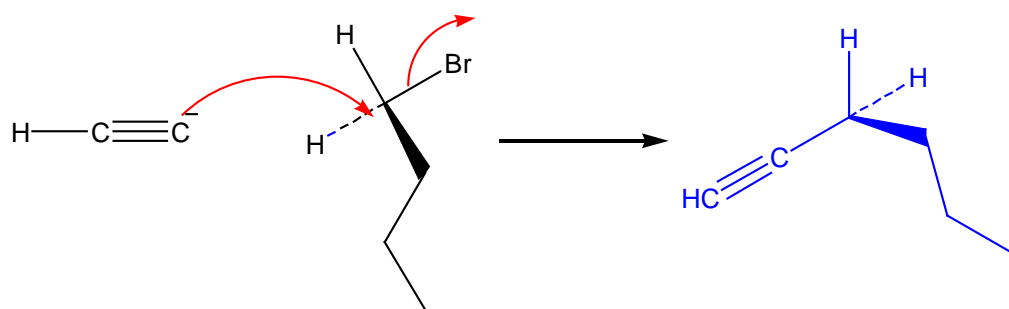
(b) KOH

Solution:



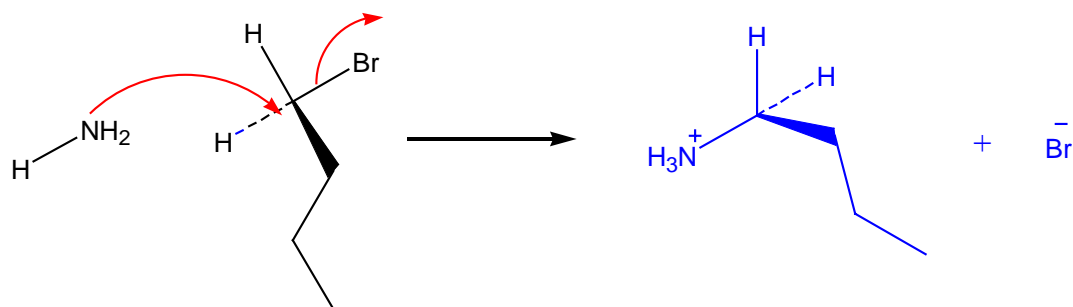
(c) $\text{H}-\text{C}\equiv\text{C}-\text{Li}$

Solution:

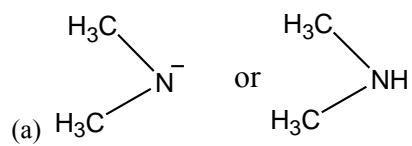


(d) NH_3

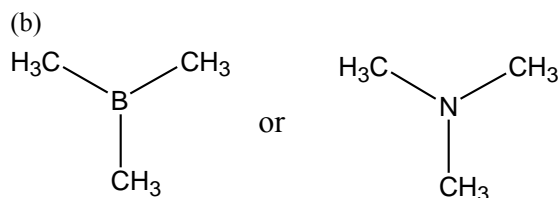
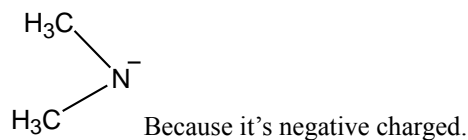
Solution:



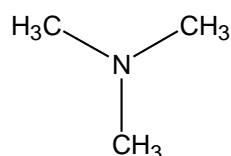
11.5 Which substance in each of the following pairs is more reactive as a nucleophile? Explain.



Solution:



Solution:



Because the N atom has a lone pair electron, so it's more likely to donate electron. As a result, it has higher basicity and is more reactive as a nucleophile. What's more, the N is below the B in a column of the periodic table.

(c) H₂O or H₂S

Solution:

H₂S

Because the S is below the O in a column of the periodic table, so it is more reactive as a nucleophile.

11.6 Rank the following compounds in order of their expected reactivity toward S_N2 reaction:

CH₃Br, CH₃OTos, (CH₃)₃CCl, (CH₃)₂CHCl

Solution:

Reactivity toward S_N2 reaction:

CH₃OTos > CH₃Br > (CH₃)₂CHCl > (CH₃)₃CCl

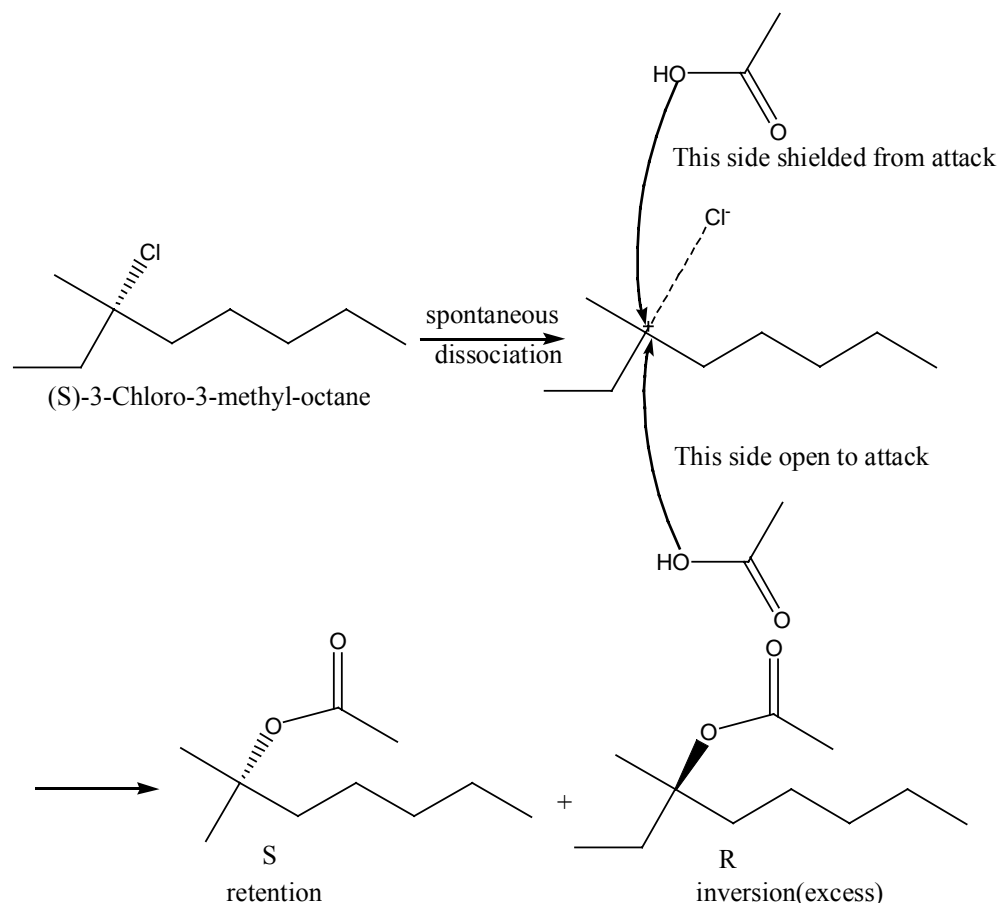
11.7 Organic solvents such as benzene, ether, and chloroform are neither protic nor strongly polar. What effect would you expect these solvents to have on the reactivity of a nucleophile in S_N2 reactions?

Solution:

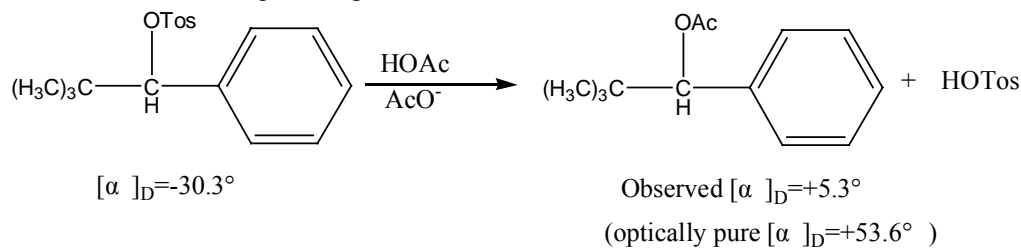
Organic solvents such as benzene, ether, and chloroform are not suitable solvents for typical S_N2 reactions.

11.8 What products would you expect from reaction of (S)-3-chloro-3-methyloctane with acetic acid? Show the stereochemistry of both reactant and product.

Solution:



11.9 Among the numerous examples of S_N1 reactions that occur with incomplete racemization is one reported by Winstein in 1952. The optically pure tosylate of 2,2-dimethyl-1-phenyl-1-propanol ($[\alpha]_D = -30.3^\circ$) was heated in acetic acid to yield the corresponding acetate ($[\alpha]_D = +5.3^\circ$). If complete inversion had occurred, the optically pure acetate would have had $[\alpha]_D = +53.6^\circ$. What percentage racemization and what percentage inversion occurred in this reaction?



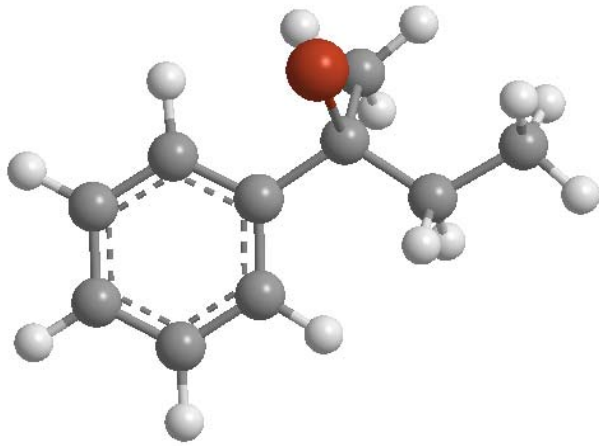
We assume that the enantiomer of $[\alpha]_D = 53.6^\circ$ make up of the mixture by x percent, so the one of $[\alpha]_D = -53.6^\circ$ constitutes by $(1-x)$, we get:

$$53.6x - 53.6(1-x) = 5.3$$

so $x = 9.888\%$,

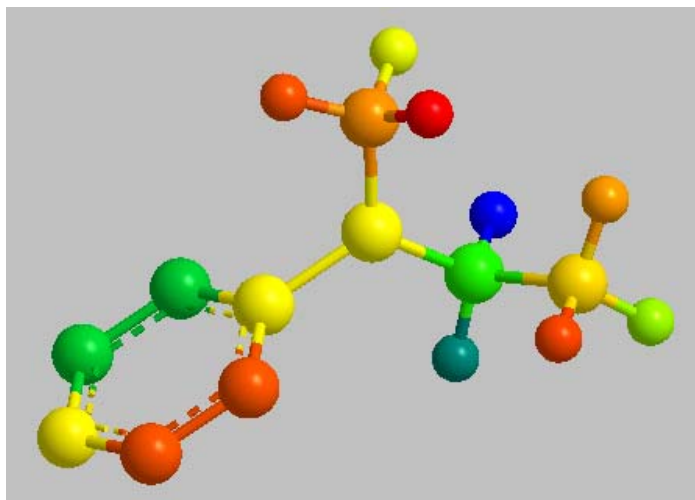
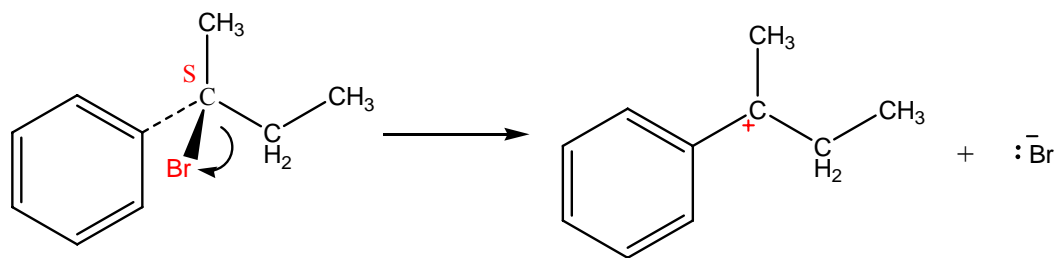
than we get the conclusion that there is $x - (1-x) = 2x - 1 = 9.888\%$ that occurred inversion of its configuration, and there is $2(1-x) = 1 - (2x - 1) = 2 - 2x = 90.112\%$ percentage takes place in the racemization.

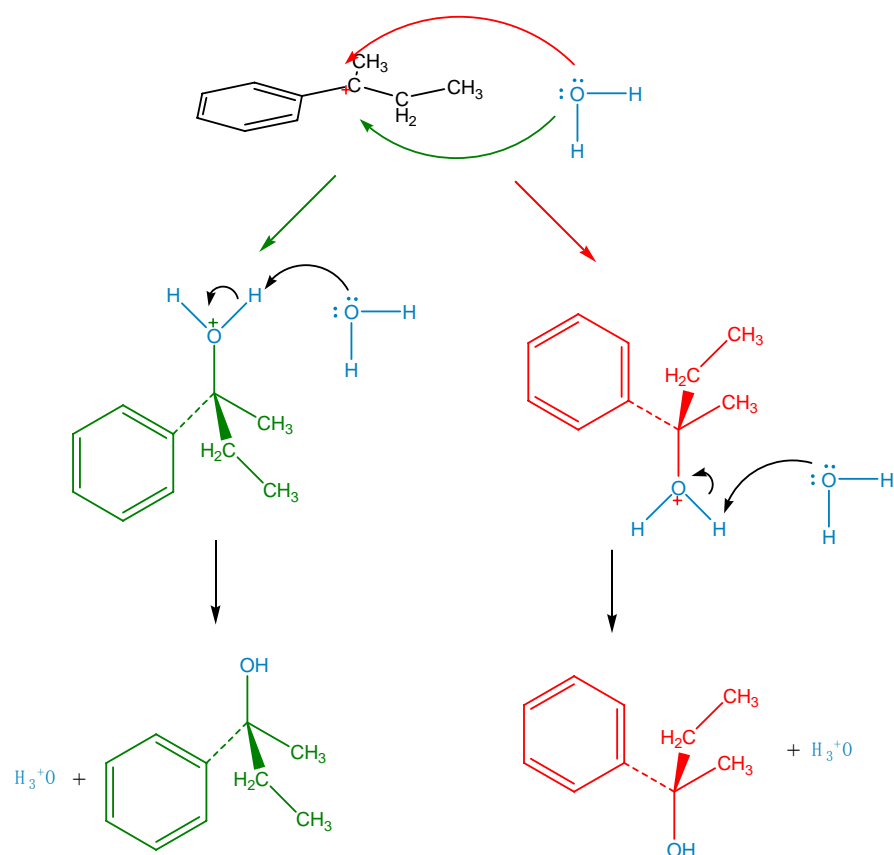
11.10 Assign configuration to the following substrate, and show the stereochemistry and identity of the product you would obtain by S_N1 reaction with water (reddish-brown = Br)



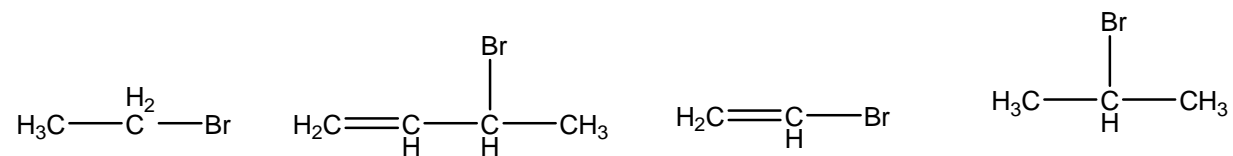
Solution:

The first step(rate limiting step)

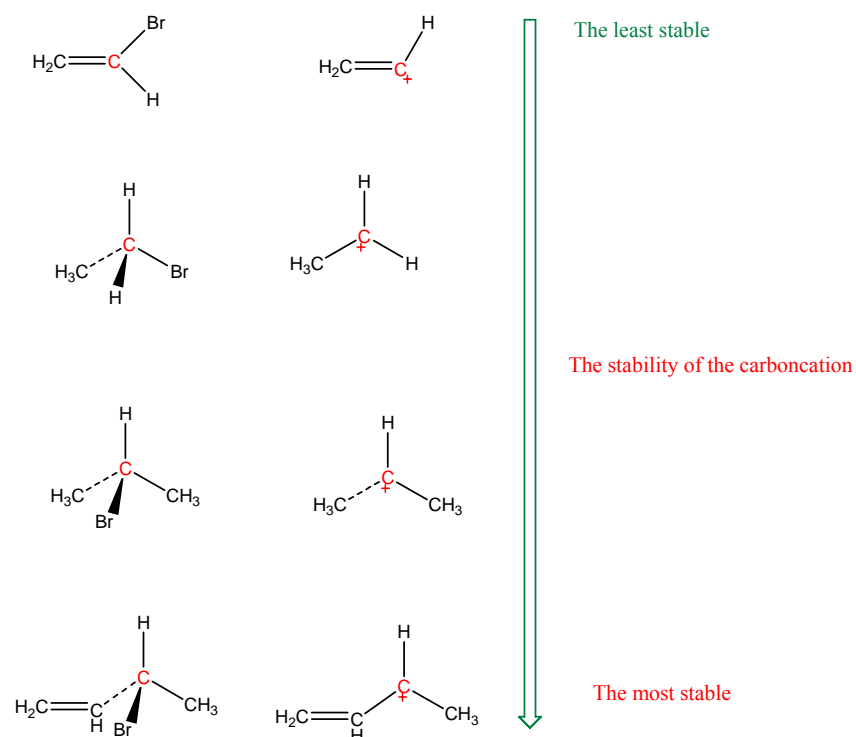




11.11 Rank the following substances in order of their expected S_N1 reactivity.

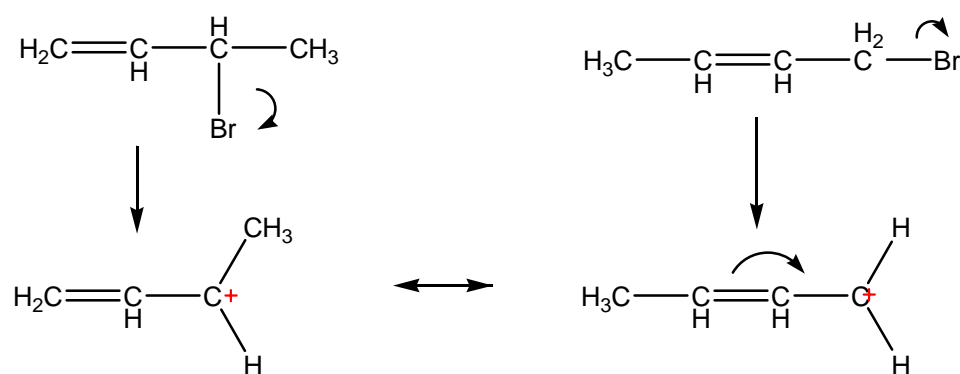


Solution:



11.12 3-Bromo-1-butene and 1-bromo-2-butene undergo S_N1 reaction at nearly the same rate even though one is a secondary halide and the other is primary. Explain.

Solution:

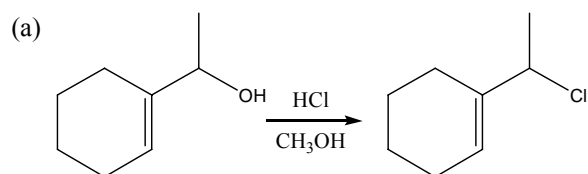


The starting materials are different definitely, however, you can see clearly in the diagram above that the same allylic carbocation is formed by resonance. And so the rate of the reaction is same.

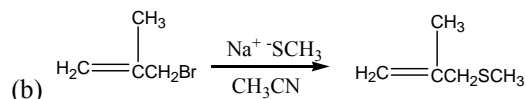
11.13 1-Chloro-1,2-diphenylethane reacts with the nucleophiles fluoride ion and triethylamine at the same rate, even though one is charged and one is neutral. Explain.

Solution: Because it is a S_N1 reaction. The rate of S_N1 reaction is only depending on the concentration of the substrate. And it is not related to the nucleophiles.

11.14 Predict whether each of the following substitution reactions is likely to be S_N1 or S_N2.

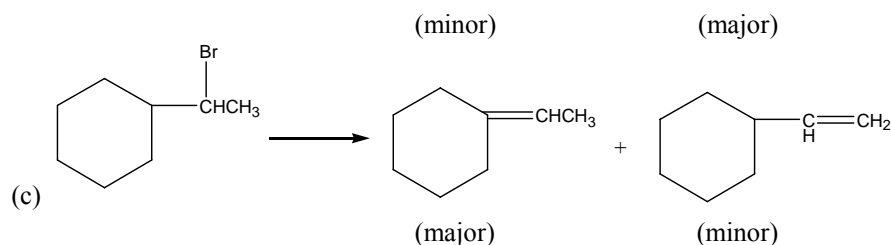
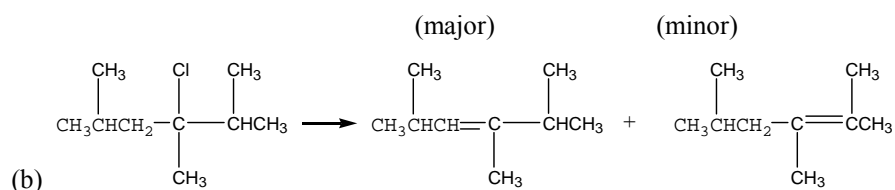
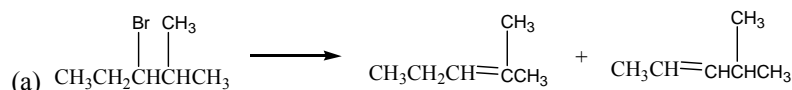


It is likely to be an S_N1 reaction. The substrate is secondary and the nucleophile is weakly basic and the solvent is acidic.



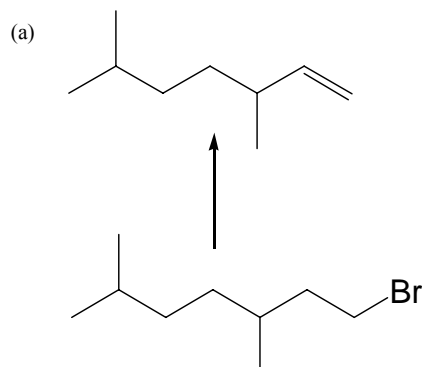
It is likely to be an S_N2 reaction. The substrate is primary and the nucleophile is a reasonably good one and the solvent is polar aprotic.

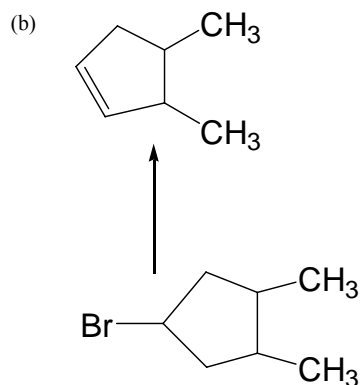
11.15 Ignoring double-bond stereochemistry, what products would you expect from elimination reaction of the following alkyl halides? Which product will be major in each case.



11.16 What alkyl halides might the following alkenes have been made from?

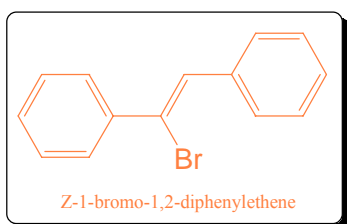
Solution:



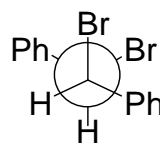


11.17 What stereochemistry do you expect for the alkene obtained by E2 elimination of (1R,2R)-1,2-dibromo-1,2-diphenylethane? Draw a Newman projection of the reacting conformation.

Solution: The product of this E2 elimination is Z-1-bromo-1,2-diphenylethene. The structure of it as

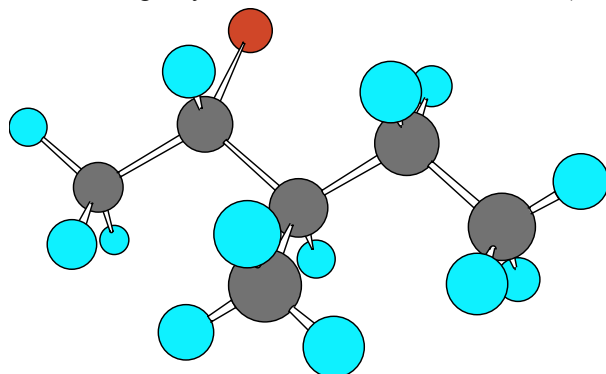


following:



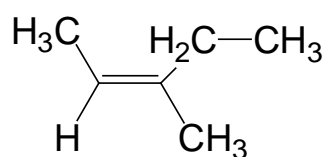
The Newman projection of the reacting conformation:

11.18 What stereochemistry do you expect for the trisubstituted alkene obtained by E2 elimination of the following alkyl halide on treatment with KOH? (Reddish-brown = Br)



Solution:

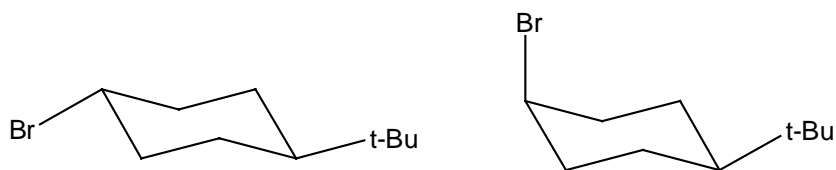
We will get



11.19 Which isomer would you expect to undergo E2 elimination faster, trans-1-bromo-4-tert-butylcyclohexane or cis-1-bromo-4-tert-butylcyclohexane? Draw each molecule in its more stable

chair conformation, and explain your answer.

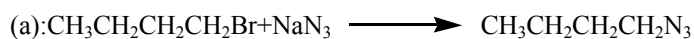
Solution:



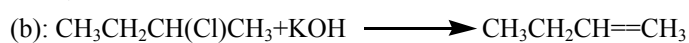
The right (cis) one is more faster to undergo E2. Because Br is axial. It does not need to flip over like the left one (trans).

11.20: Tell whether each of the following reaction is likely to be S_N1 , S_N2 , E1, E2.

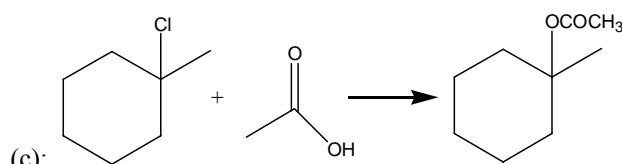
Solution:



S_N2



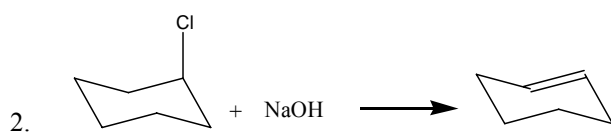
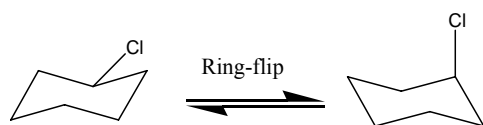
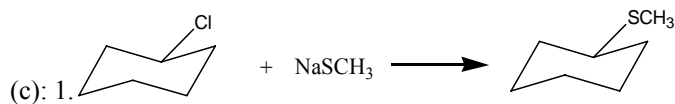
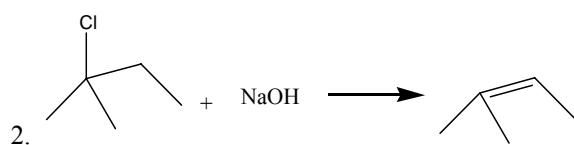
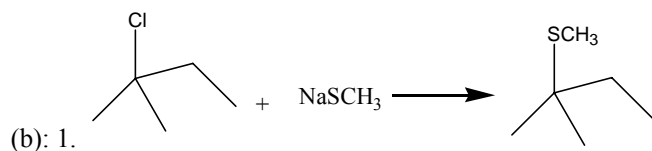
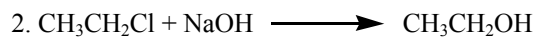
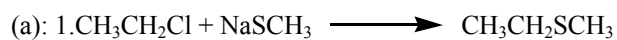
E2



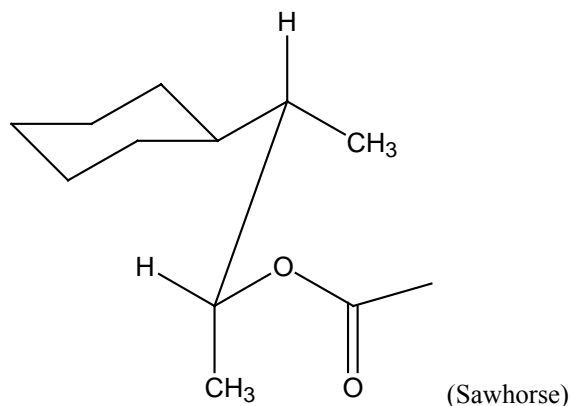
S_N1

11.21: Write the product you would expect from those reactions.

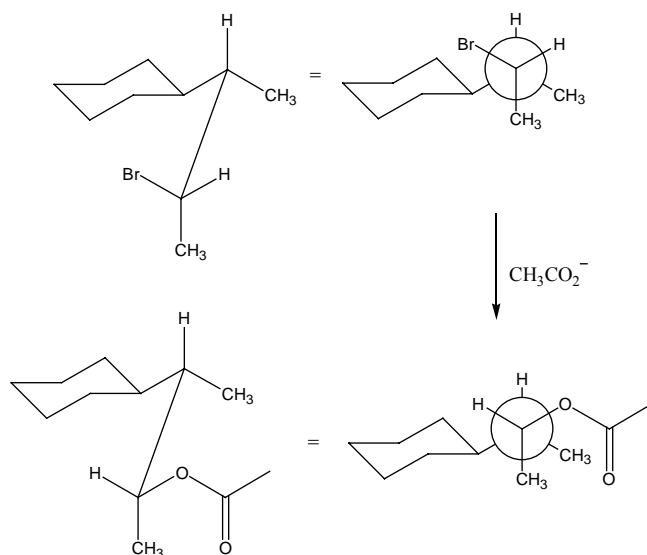
Solution:



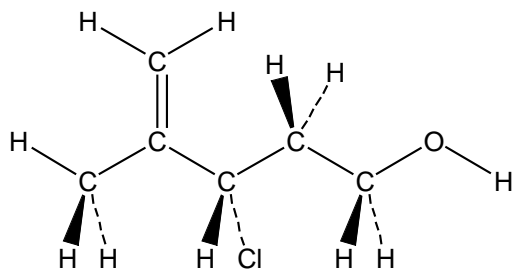
11.22 From what alkyl bromide was the following alkyl acetate made by S_N2 reaction? Write the reaction, showing all stereochemistry.



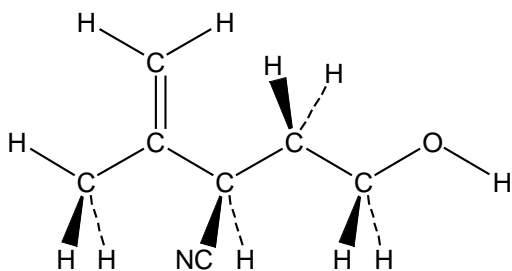
Solution:



11.23 Assign R or S configuration to the following molecule, write the product you would expect from S_N2 reaction with NaCN, and assign R or S configuration to the product:



Solution: The configuration of the molecule above is S. The product of S_N2 reaction with NaCN is that

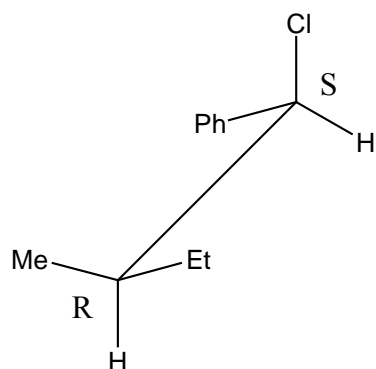


following:

configuration is R.

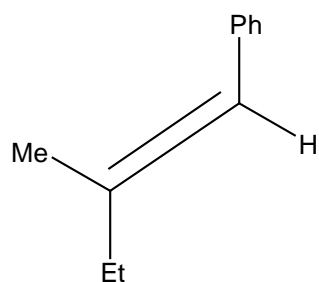
. It experiences a Walden Inversion and the

11.24: Draw the structure and assign Z or E stereochemistry to the product you expect from E2 reaction of the following molecule with NaOH:



Strategy: The reaction should follow the anti-co-planar.

Solution: The stereochemistry of the product should be E:



11.25: Describe the effects of each of the following variables on both S_N2 and S_N1 reaction:

(a): Solvent (b): Leaving group (c): Nucleophile (d): Substrate

Solution:

(a): solvent:

S_N1 : The good solvent will due largely to stabilize carbocation.

S_N2 : The good solvent will due largely to stabilize the transition state.

(b): Leaving group:

S_N1 : The good leaving group should be weaker base.

S_N2 : The good leaving group should be weaker base.

(c): Nucleophile:

S_N1 : No relation to the reaction rate.

S_N2 : The strong nucleophile will benefit for S_N2 .

(d): Substrate:

S_N1 : The good substrate will yield the more stable carbocation intermediates.

S_N2 : The good substrate will be primary, allylic and benzylic halides.

11.26 Which choice in each of the following pairs will react faster in an S_N2 reaction with OH^- ?

- (a) CH_3Br or CH_3I (b) $\text{CH}_3\text{CH}_2\text{I}$ in ethanol or in dimethyl sulfoxide
(c) $(\text{CH}_3)_3\text{CCl}$ or CH_3Cl (d) $\text{H}_2\text{C}=\text{CHBr}$ or $\text{H}_2\text{C}=\text{CHCH}_2\text{Br}$

Solution: (a) CH_3I will react faster in an S_N2 reaction with OH^- . Because as a leaving group, I^- is more reactive than Br^- .

(b) $\text{CH}_3\text{CH}_2\text{I}$ in dimethyl sulfoxide will react faster in an S_N2 reaction with OH^- . Because S_N2 reactions react faster in polar aprotic solvents than in protic solvents.

(c) CH_3Cl will react faster in an S_N2 reaction with OH^- . Because methyl halides is a more reactive substrates than tertiary halides.

(d) $\text{H}_2\text{C}=\text{CHCH}_2\text{Br}$ will react faster in an S_N2 reaction with OH^- . Because vinylic halides are unreactive toward S_N2 reaction.

11.27 What effect would you expect the following changes to have on the rate of the S_N2 reaction of 1-iodo-2-methylbutane with cyanide ion?

- (a) The CN^- concentration is halved, and the 1-iodo-2-methylbutane concentration is doubled.
(b) Both the CN^- and the 1-iodo-2-methylbutane concentrations are tripled.

Solution: (a) The rate of the S_N2 reaction will not be changed.

(b) The rate of the S_N2 reaction will be as 9 times as before.

11.28 What effect would you expect the following changes to have on the rate of the reaction of ethanol with 2-iodo-2-methylbutane?

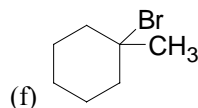
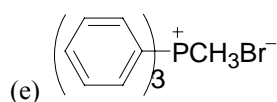
- (a) The concentration of the halide is tripled?
(b) The concentration of the ethanol is halved by adding diethyl ether as an inert solvent.

Solution: (a) The rate will also be tripled

(b) It would not be changed.

11.29 How might you prepare each of the following molecules using a nucleophilic substitution reaction at some step?

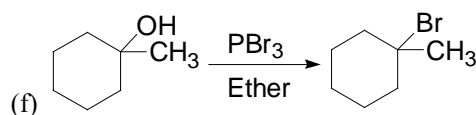
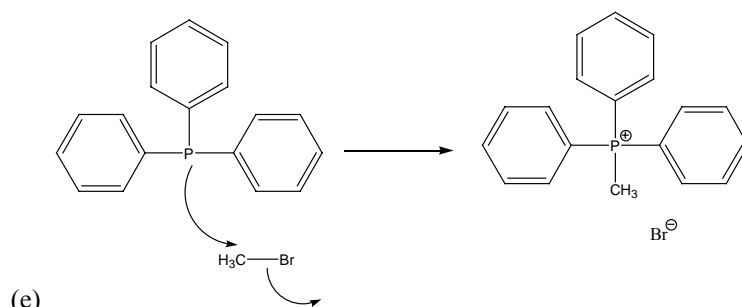
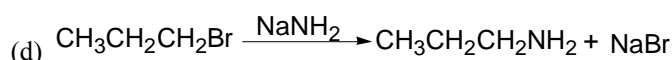
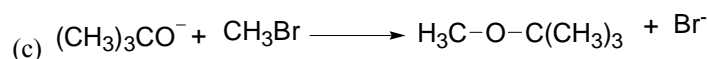
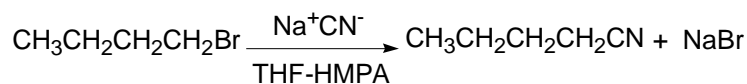
- (a) $\text{H}_3\text{C}\text{C}\equiv\text{CCH}(\text{CH}_3)_2$ (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CN}$
(c) $\text{H}_3\text{C}-\text{O}-\text{C}(\text{CH}_3)_3$ (d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$



Solution: (a)



(b)



11.30 Which reaction in each of the following pairs would you respect to be faster?

- (a) The $\text{S}_{\text{N}}2$ displacement by I^- on CH_3Cl or on CH_3OTos

Solution: On CH_3OTs .

- (b) The $\text{S}_{\text{N}}2$ displacement by CH_3CO_2^- on bromoethane or on bromocyclohexane

Solution: On bromoethane.

- (c) The $\text{S}_{\text{N}}2$ displacement on 2-bromopropane by $\text{CH}_3\text{CH}_2\text{O}^-$ or by CN^-

Solution: By CN^- .

- (d) The $\text{S}_{\text{N}}2$ displacement by $\text{HC}\equiv\text{C}^-$ on bromoethane in benzene or in hexamethylphoramide

Solution: By hexamethylphoramide.

11.31 What products would you expect from the reaction of 1-bromopropane with each of the following?

- (a) NaNH_2

- (b) $\text{KOC}(\text{CH}_3)_3$

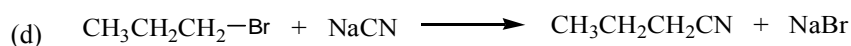
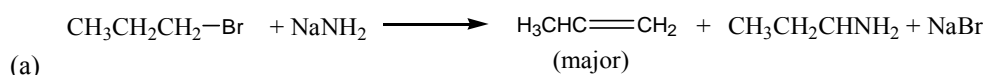
- (c) NaI

- (d) NaCN

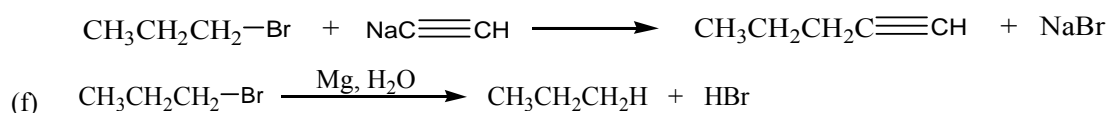
- (e) $\text{NaC}\equiv\text{CH}$

- (f) Mg , then H_2O

Solution:



- (e)



11.32 Which reactant in each of the following pairs is more nucleophilic? Explain.

(a) -NH_2 or NH_3

Solution: The first one is more nucleophilic. Because it has a lone pair electrons and it can attack the nucleons.

(b) H_2O or CH_3CO_2^-

Solution: The second one is more nucleophilic. Because it is more basic than water and nucleophilicity roughly parallels basicity, it is more nucleophilic.

(c) BF_3 or F^-

Solution: The second one is more nucleophilic. It has a lone pair electrons while BF_3 has a empty orbital(it is electronic)

(d) $(\text{CH}_3)_3\text{P}$ or $(\text{CH}_3)_3\text{N}$

Solution: The first one is more nucleophilic. Its polarization is stronger than the second one's.

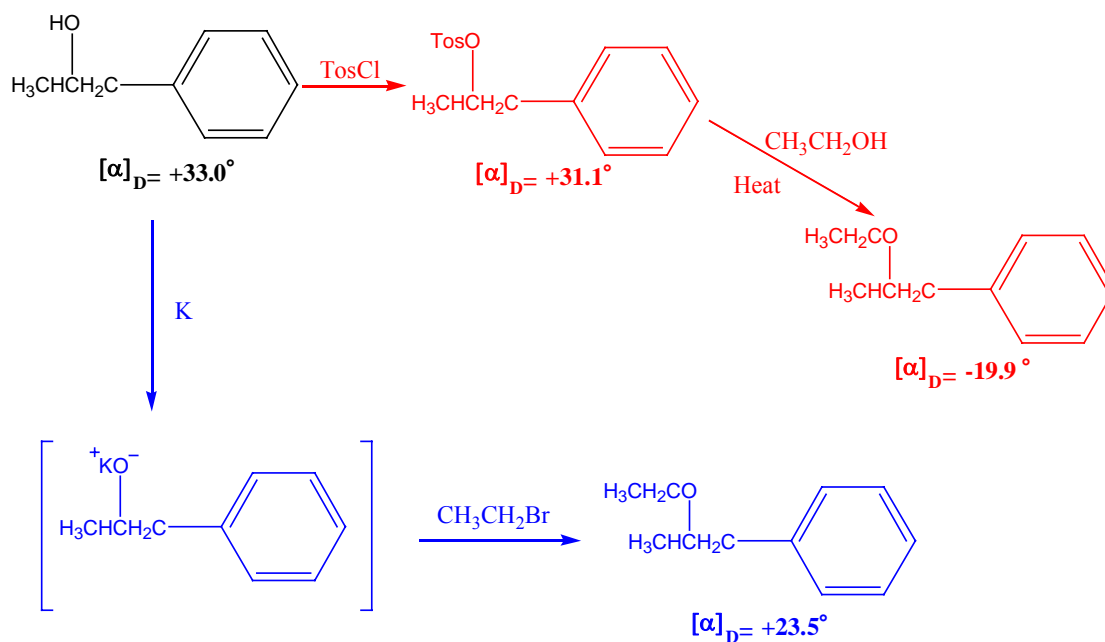
(e) I^- or Cl^-

Solution: The first one is more nucleophilic. Nucleophilicity usually increases going down a column of the periodic table. The first one's capacity of controlling electrons is weaker(Diameter is longer) and it can be polarized easily than the second one.

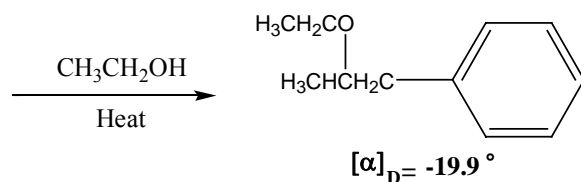
(f) $\text{C}\equiv\text{N}^-$ or -OCH_3

Solution: The second one is more nucleophilic. The acidity of its conjugate acid (CH_3OH) is weaker than HCN . So the second one's basicity is stronger.

11.33 Among the Walden cycles carried out by Kenyon and Phillips is the following series of reaction reported in 1923. Explain the results, and indicate where Walden inversion is occurring.

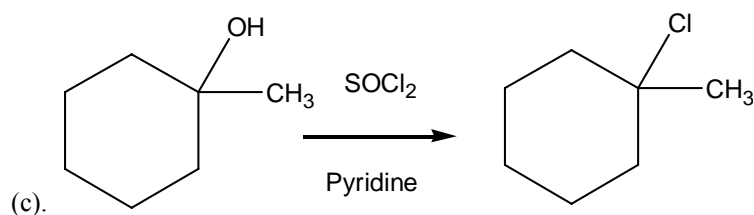
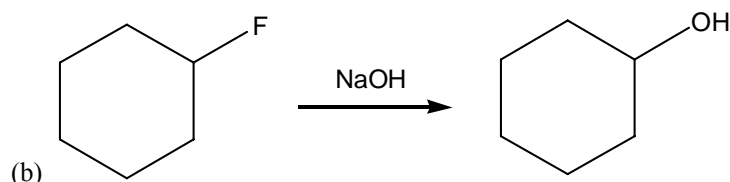
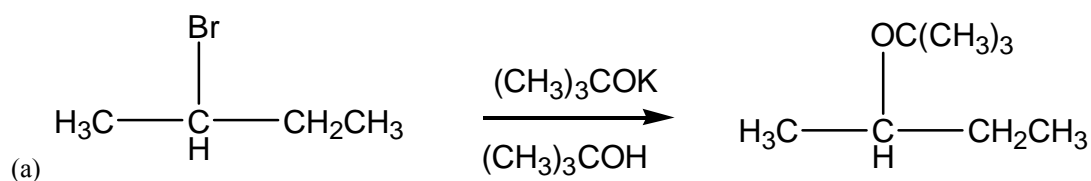


Solution: The reaction which is written in red shows that the configuration changes from retention to inversion. But the configuration in the reaction which is written in blue doesn't. The products in two reactions are enantiomers. The amounts of their rotation should be same. But here is not. Maybe the products are not pure. Walden inversion is occurring in the following step.



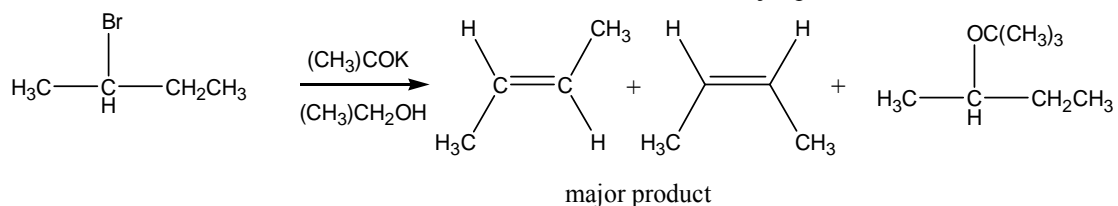
(The product show in red is not pure, but the blue one contains only one enantiomer.)

11.34 The synthetic sequences shown below are unlikely to occur as written. Tell what is wrong with each, and predict the true product.

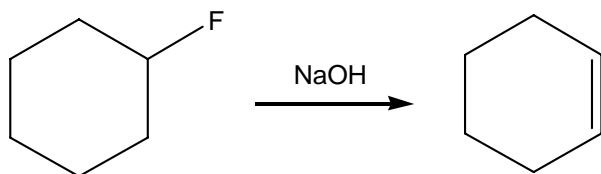


Solution:

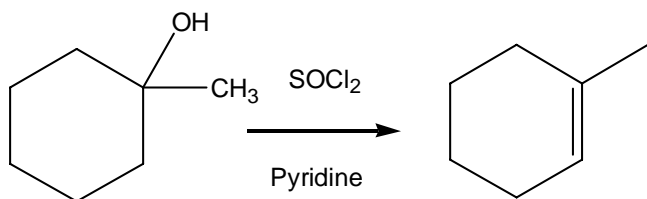
(a). The $(\text{CH}_3)_3\text{CO}^-$ is a kind of strong base which is good of the E2 elimination in the polar aprotic solvent, and at the same time, $\text{S}_\text{N}2$ substitution also occurs, but the major product is alkene.



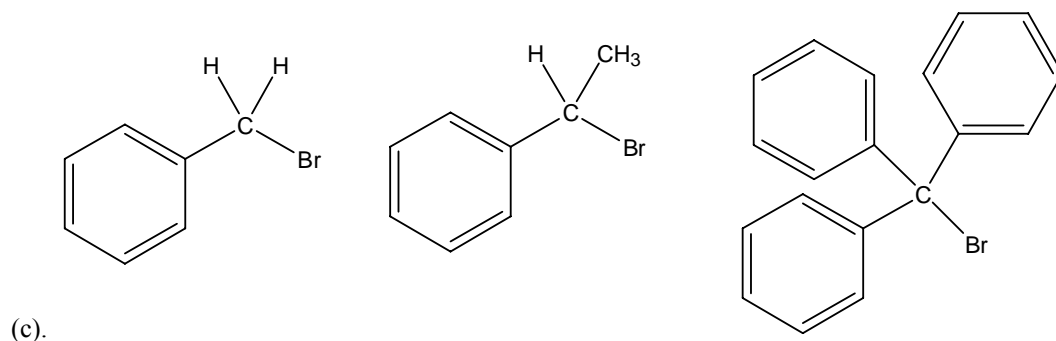
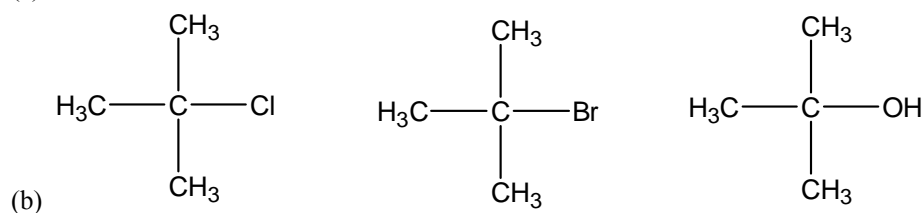
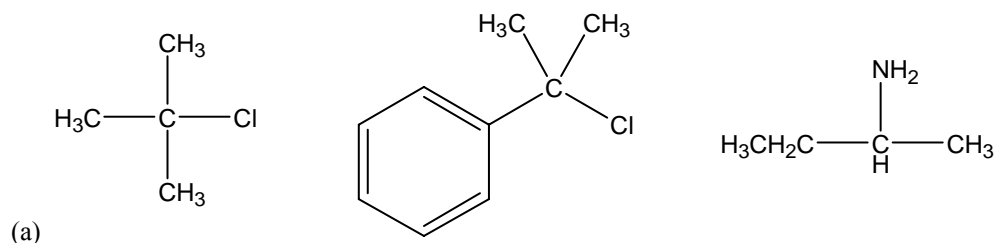
(b). The F-C bond is too strong for break so it is not good for the $\text{S}_\text{N}1$ substitution and $\text{S}_\text{N}2$ substitution, and the OH^- is a kind of strong base which is good for E2 elimination not E1 elimination.



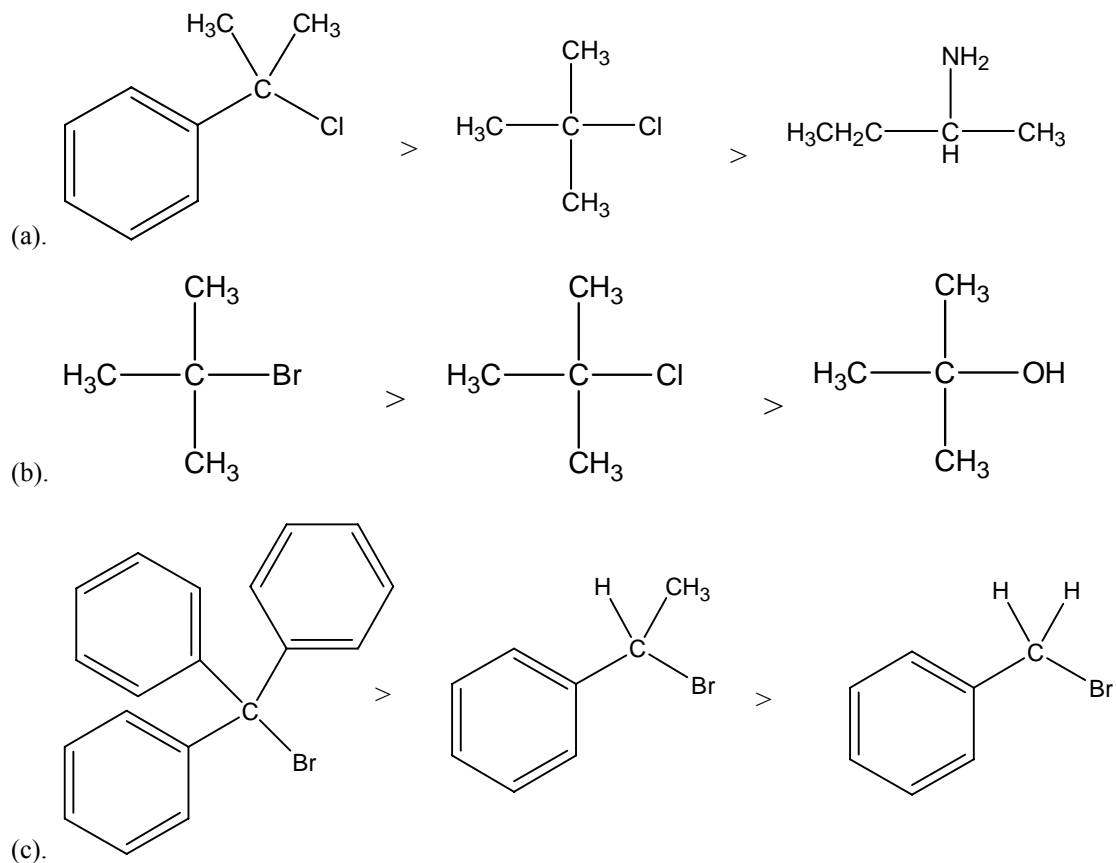
(c). The substrate is a Tertiary alkyl alcohol, so the reaction is not good for $\text{S}_\text{N}2$ and E2 reactions, and the solvent pyridine is a kind of base which means that it is a strong nucleophilic good for the E1 elimination, not $\text{S}_\text{N}1$ substitution.



11.35 Order each of the following sets of compounds with respect to $\text{S}_\text{N}1$ reaction

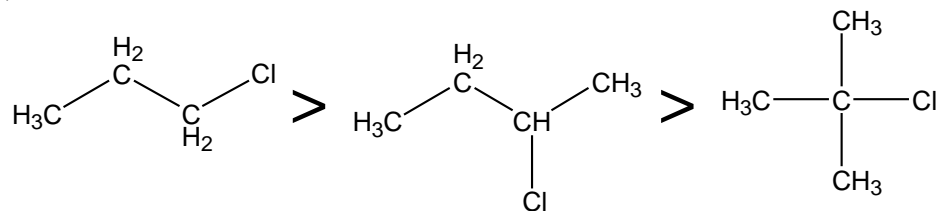


Solution:

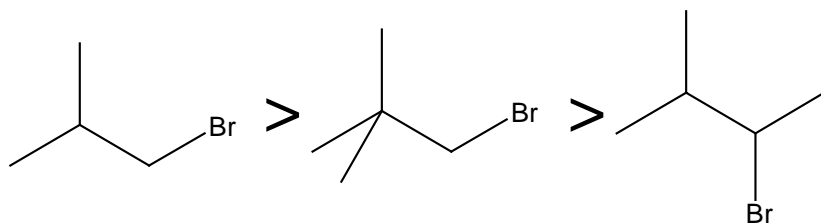


11.36 Order each of the following sets of compounds with respect to S_N2 reactivity.

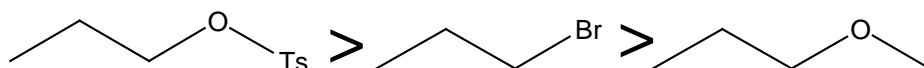
(a)



(b)

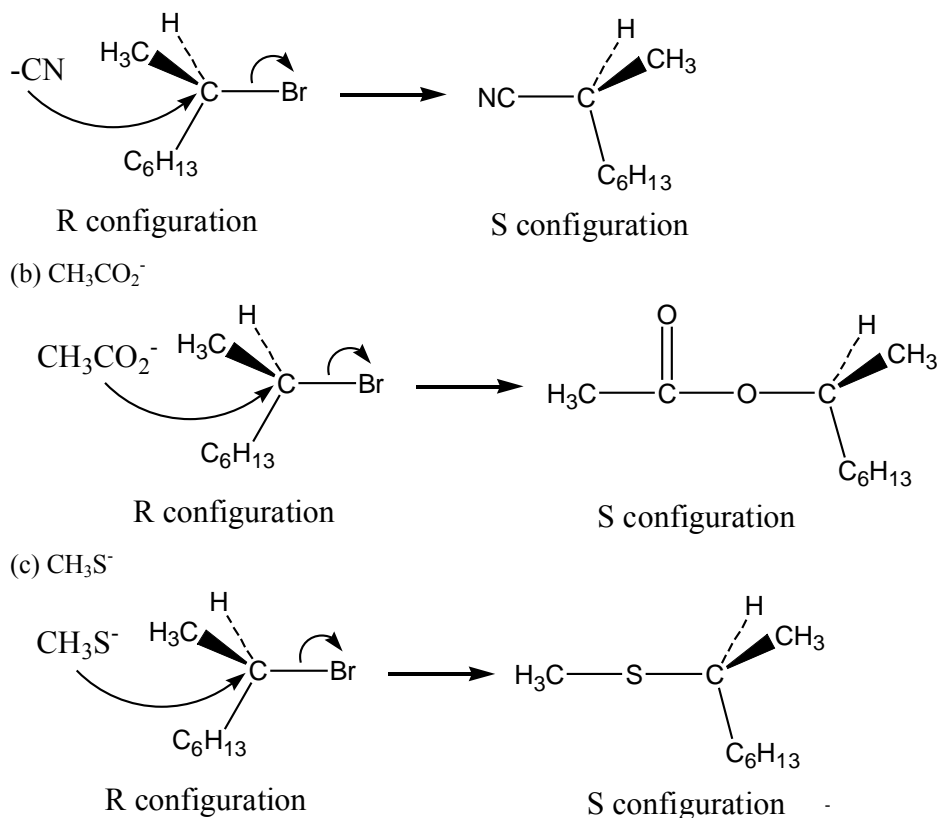


(c)



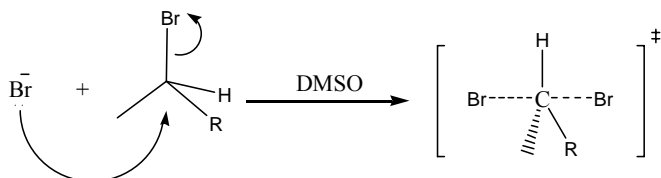
11.37 Predict the product and give the stereochemistry resulting from reaction of each of the following nucleophiles with (R) -2-bromooctane:

(a) ^-CN



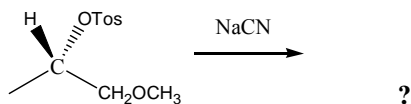
11.38 (R)-2-bromooctane undergoes racemization to give (+)-2-bromooctane when treated with NaBr in dimethyl sulfoxide. Explain.

Solution: In DMSO, $\text{S}_{\text{N}}2$ is proper to happen, the mechanism will be following:

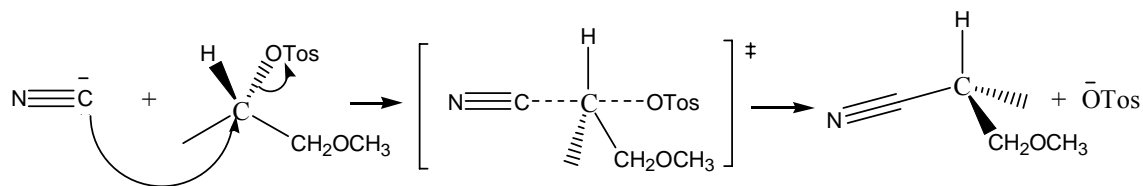


Because the nucleophiles are the same, so it will be equal to yield S and R product.

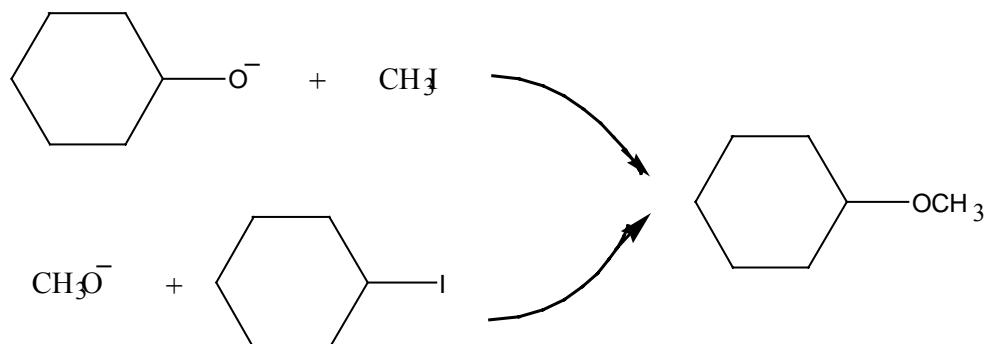
11.39 Reaction of the following S tosylate with cyanide ion yields a nitrile product that also has S stereochemistry. Explain.



Solution: The TosO^- is quite a good leaving group for $\text{S}_{\text{N}}2$ reaction, and the substrate is secondary, so it will be not very stable to form carbocation, and it is easy to undergo $\text{S}_{\text{N}}2$ reaction. The mechanism will be follow:



11.40 Ethers can often be prepared by S_N2 reaction of alkoxide ions, RO^- , with alkyl halides. Suppose you wanted to prepare cyclohexyl methyl ether, which of the two possible routes shown below would you choose? Explain.

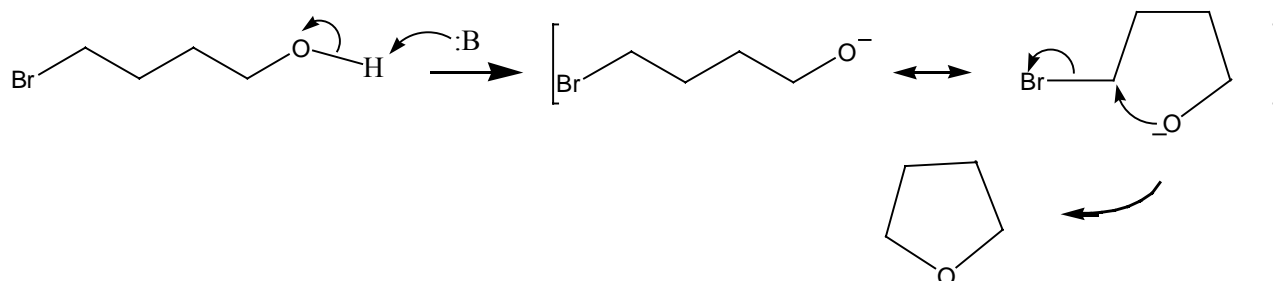


Solution:

The route above is better. Cyclohexoxide anion is a good nucleophile for S_N2 reaction and methyl iodide is a good substrate for S_N2 reaction, so S_N2 reaction is favored in the above route and the very product will be obtained. In the route below, methoxide anion is also a good nucleophile, but the substrate, iodo cyclohexane, is not good for S_N2 reaction because of the steric effect, and then the methoxide anion will act as a strong base and the elimination will occur, so the product is not that we want.

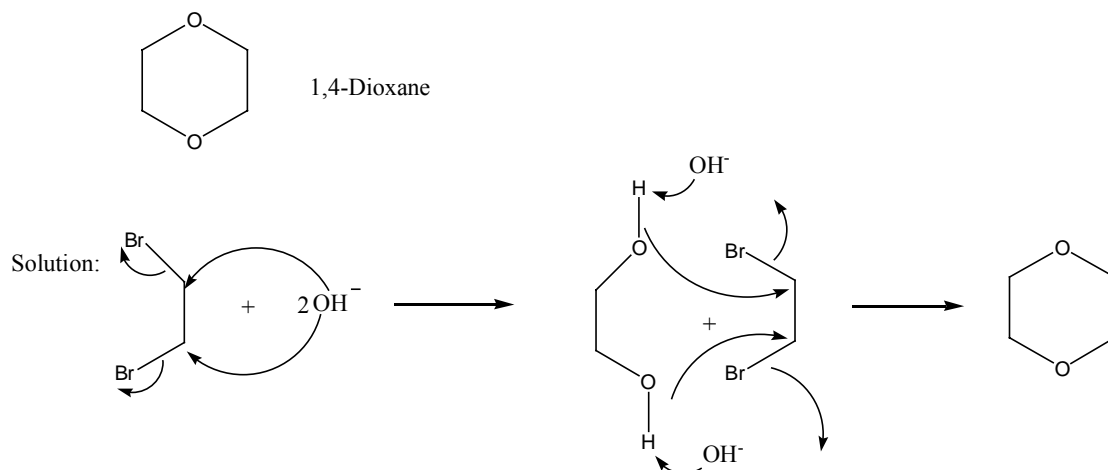
11.41 The S_N2 reaction can occur intramolecularly (within the same molecule). What product would you expect from treatment of 4-bromo-1-butanol with base?

Solution:

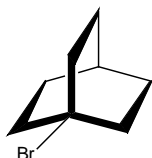


The base will be more likely to react with the proton of $-OH$ than to react with the carbon next to the bromine. The reaction shown above will be favored; especially the concentration of the substrate is low.

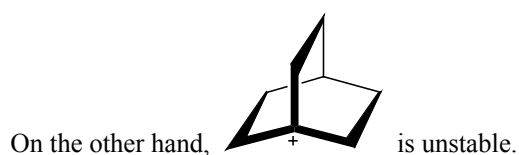
11.42: In light of your answer to problem 11.41, propose a synthesis of 1,4-dioxane starting only with 1,2-dibromoethane.



11.43: The following tertiary alkyl bromide does not undergo a nucleophilic substitution reaction by either S_N1 or S_N2 mechanisms. Explain.



Solution: Steric effects in the S_N2 reaction.



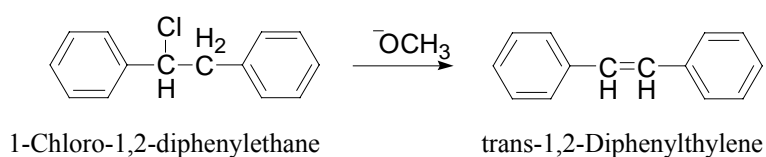
11.44 In addition to not undergoing substitution reactions, the alkyl bromide shown in Problem 11.43 also fails to undergo an elimination reaction when treated with base. Explain.

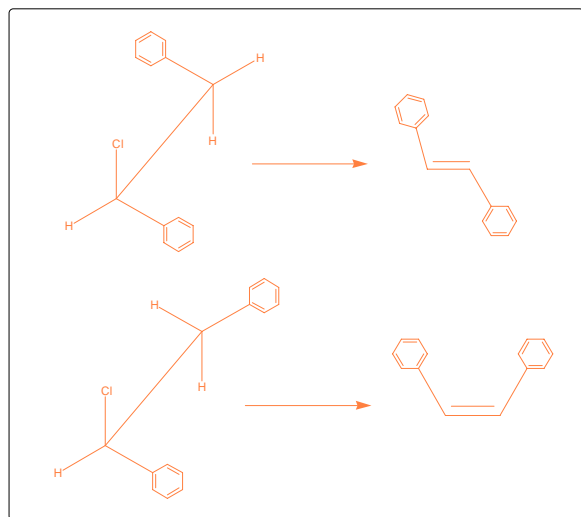


Solution: There is no appropriate H for E2 elimination.



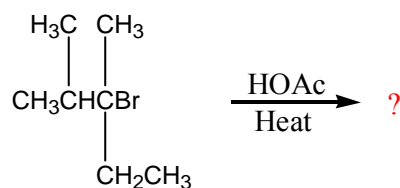
11.45 1-Chloro-1,2-diphenylethane can undergo E2 elimination to give either cis- or trans-1,2-diphenylethylene (stilbene). Draw Newman projections of the reactive conformations leading to both possible products, and suggest a reason why the trans alkene is the major product.



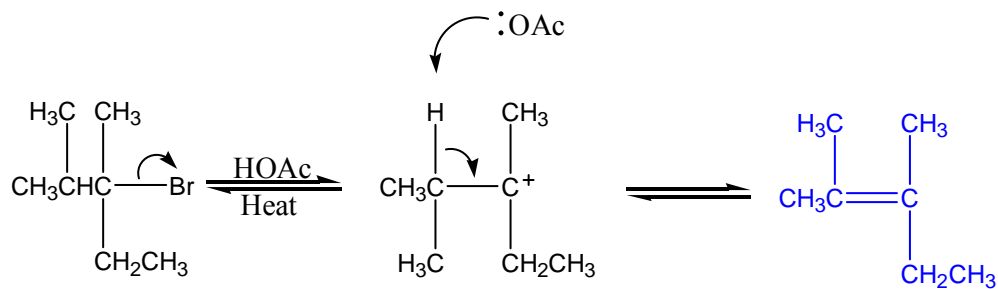


As we can see, to (a) the product will be trans alkene; to (b) it will be cis-alkene. Treat with (b) the transition state of the reaction will have a high energy which does not favor the reaction, so the trans will be major.

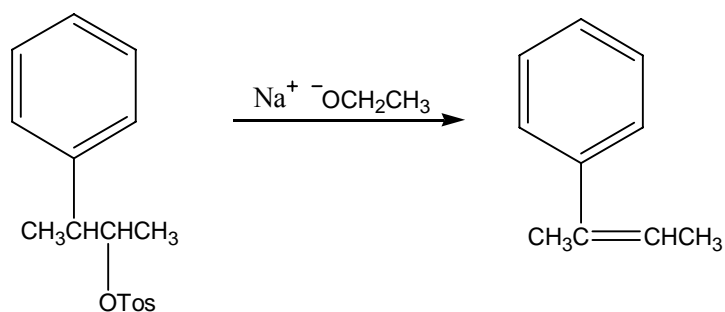
11.46 Predict the major alkene product of the following E1 reaction:



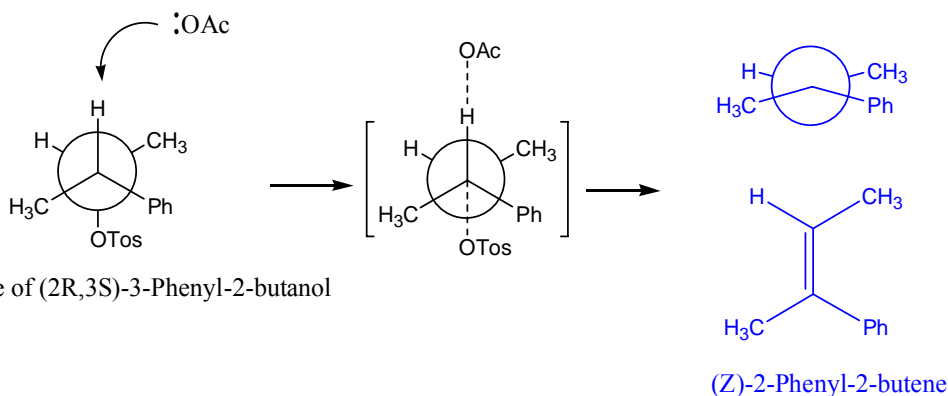
Solution:



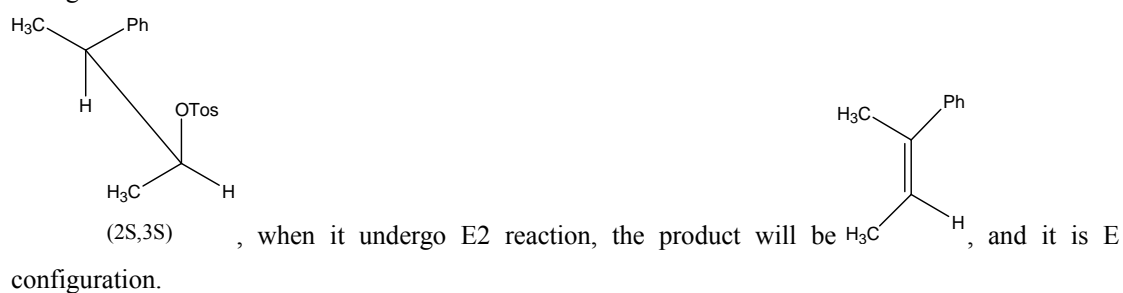
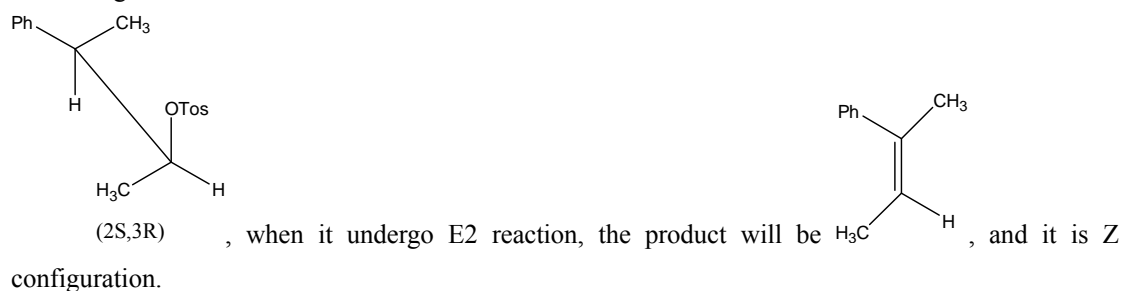
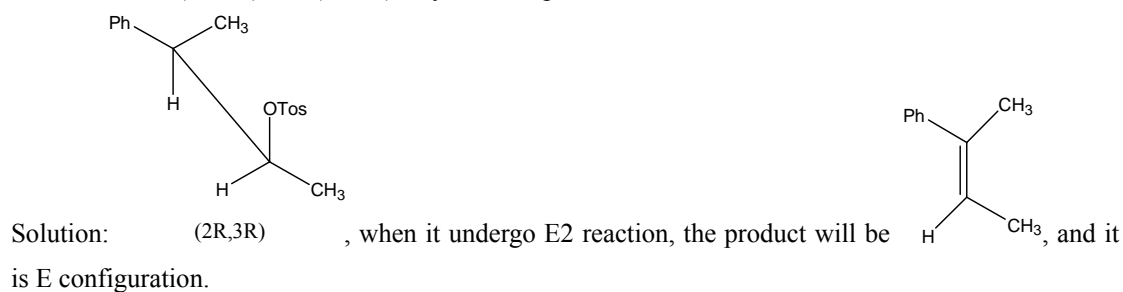
11.47 The tosylate of (2R, 3S)-3-phenyl-2-butanol undergoes E2 elimination on treatment with sodium ethoxide to yield (Z)-2-phenyl-2-butene. Explain, using Newman projections.



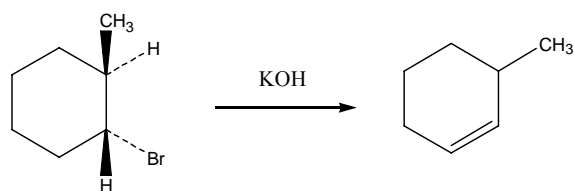
Solution:

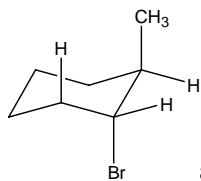


11.48 In light of your answer to Problem 11.47, which alkene, E or Z, would you expect from an E2 reaction on the tosylate of (2R,3R)-3-phenyl-2-butanol? Which alkene would you result from E2 reaction on the (2S,3R) and (2S,3S) tosylates? Explain.



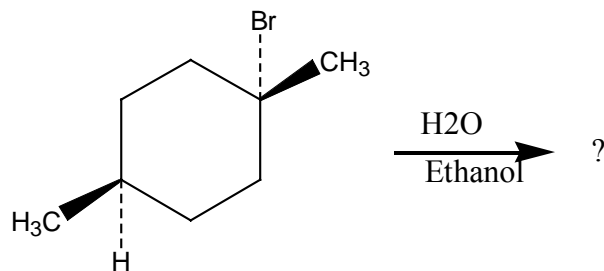
11.49 How can you explain the fact that trans-1-bromo-2-methylcyclohexane yields the non-Zaitsev elimination product 3-methylcyclohexene on the treatment with base?



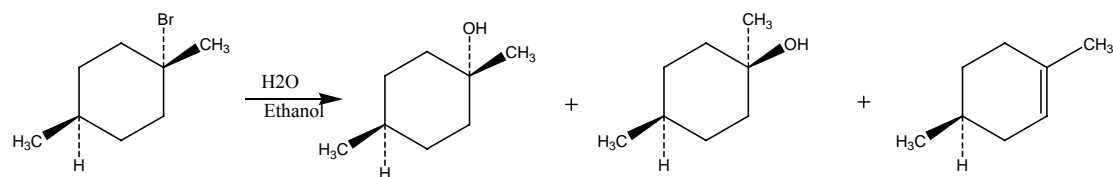


Solution: as we see in the structure, the elimination reaction can happen when both the C-Br bond and C-H bond are anti-coplanar, but in this molecular, the C-H bond on the more substitutive carbon is equatorial, so it doesn't follow the Zaitsev's rule.

11.50. Predict the products of the following reaction, indicating stereochemistry where necessary



Solution:

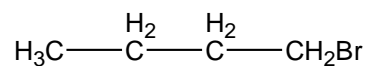


11.51. Draw all isomers of C_4H_9Br , name them, and arrange them in order of decreasing reactivity in the S_N2 reaction.

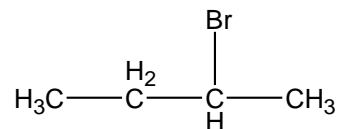
Solution:

The isomers of C_4H_9Br :

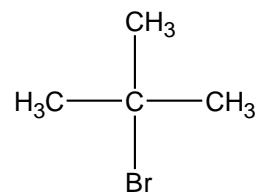
- 1-Bromobutane



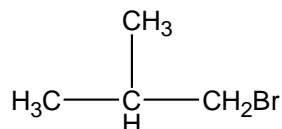
- 2-Bromobutane



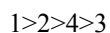
- 2-Bromo-2-methylpropane



- 1-Bromo-2-methylpropane

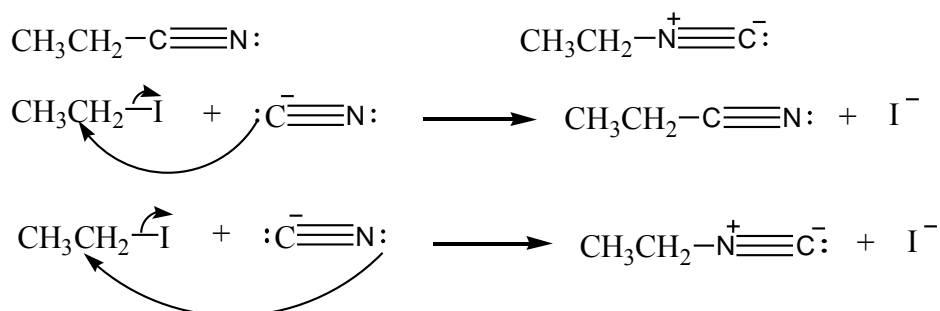


The order of decreasing reactivity in the SN2 reaction:



11.52 reaction of iodoethane with CN^- yields a small amount of isonitrile, $\text{CH}_3\text{CH}_2\text{NC}$, along with the nitrile, $\text{CH}_3\text{CH}_2\text{CN}$ as the major product. Write Lewis structure for both products, assign formal charges as necessary, and propose mechanism to account for their formation.

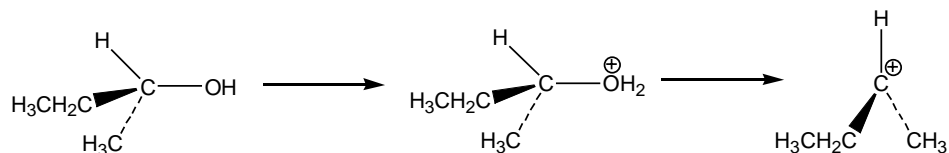
Solution:



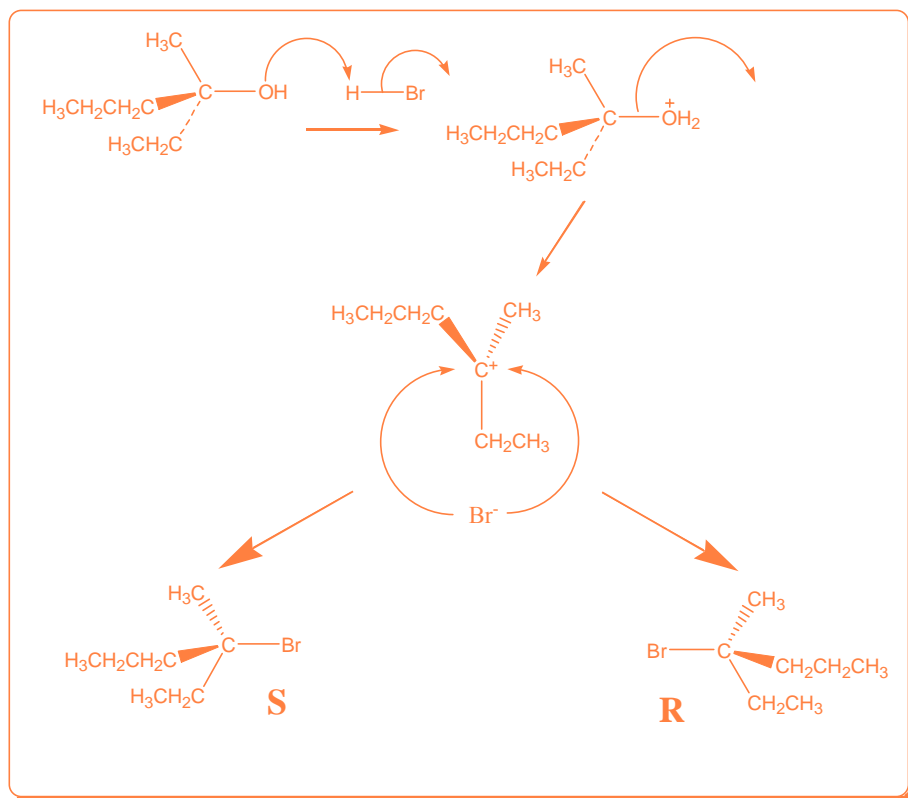
11.53 alkynes can be made by dehydrohalogenation of vinylic halides in a reaction that is essentially an E2 process. In studying the stereochemistry of this elimination, it was found that (Z)-2-chloro-2-butenedioic acid reacts 50 times as fast as the corresponding E isomer. What conclusion you can draw about the stereochemistry of eliminations in vinylic halides? How does this result compare with eliminations of alkyl halides?

Solution: Similar to elimination of alkyl halides, elimination in vinylic halides is more favored when the X and the H are on opposite sides of the molecule—anti periplanar geometry.

11.54 (S)-2-Butanol slowly racemizes on standing in dilute sulfuric acid. Explain.

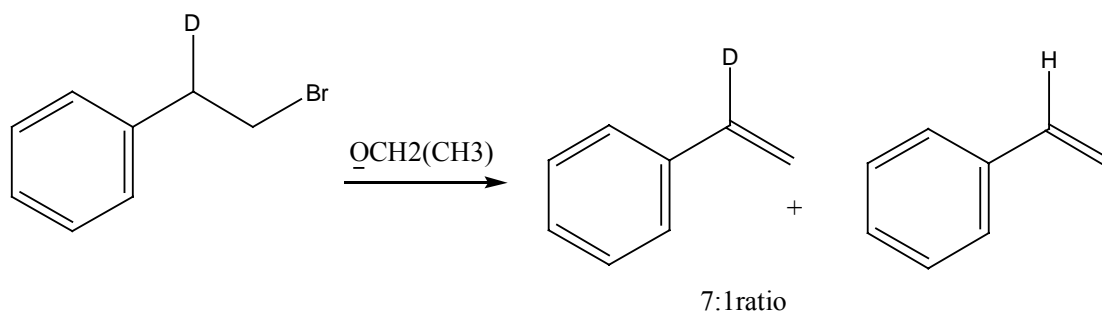


11.55 Reaction of HBr with (R)-3-methyl-3-hexanol leads to (±)-3-bromo-3-methyl-hexane. Explain.



11.56

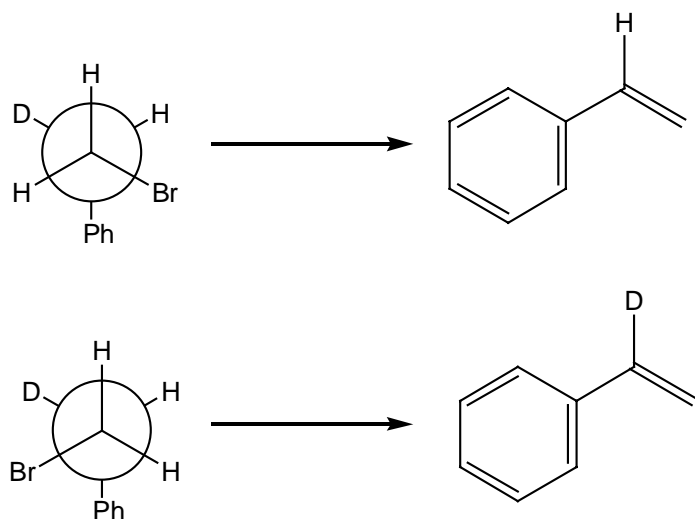
Treatment of 1-bromo-2-deuterio-2-phenylethane with strong base leads to a mixture of deuterated and nondeuterated phenylethylenes in an approximately 7:1 ratio. Explain.



Solution:

The mechanism of this reaction as follows:

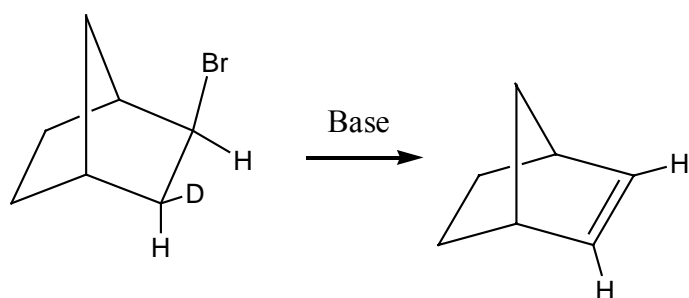
(a)



Two reasons: conformation favored and isotope effect.

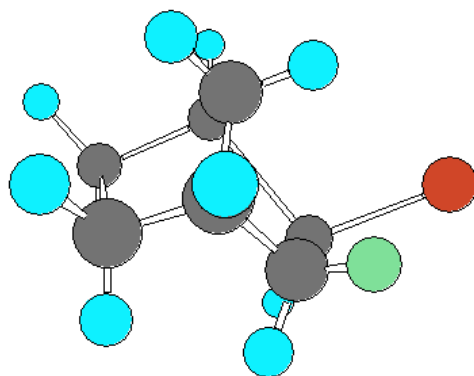
11.57

Although anti periplanar geometry is preferred for E2 reactions, it isn't absolutely necessary. The deuterated bromo compound shown here reacts with strong base to yield an undeuterated alkene. Clearly, a syn elimination has occurred. Make a molecular model of reactant, and explain the result.



Solution:

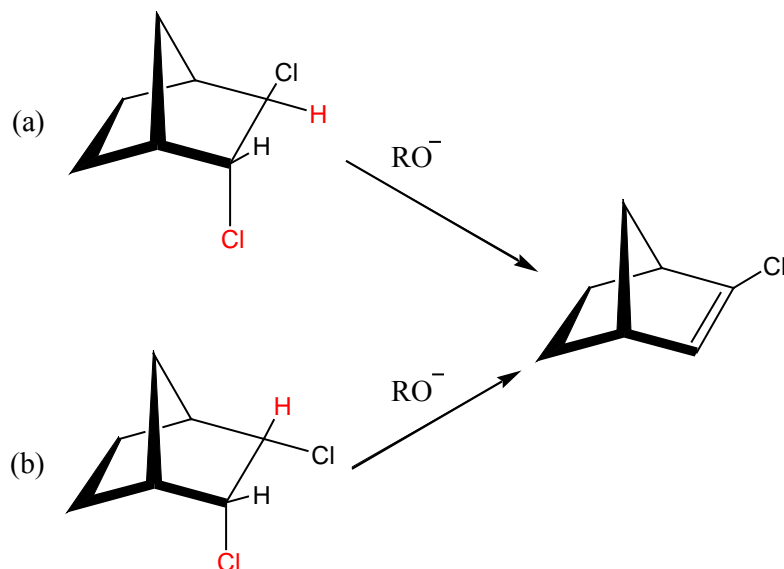
The molecular model as follow:



from the figure we can see only the D atom is in the same plan with the Br atom, so only D and Br

could be eliminated together to yield an undeuterated alkene.

11.58 In light of your answer to Problem 11.57, explain why one of the following isomers undergoes E2 reaction approximately 100 times as fast as the other. Which isomer is more reactive, and why?

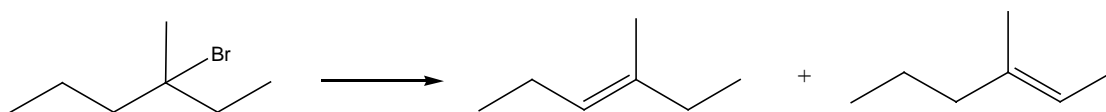


Solution: (a) is more reactive, because Cl and H lie in the same plane in the (a) isomer, which is more favored in E2 reaction, whereas in the (b) isomer, Cl and H are without a periplanar geometry, they can be in the same plane by ringflip, but it is hard to occur.

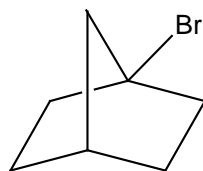
11.59 Propose structures for compounds that fit the following descriptions:

- An alkyl halide that gives a mixture of three alkenes on E2 reaction
- An organohalide that will not undergo nucleophile substitution
- An alkyl halide that gives the non-Zaitsev product on E2 reaction
- An alcohol that reacts rapidly with HCl at 0°C

Solution: (a)



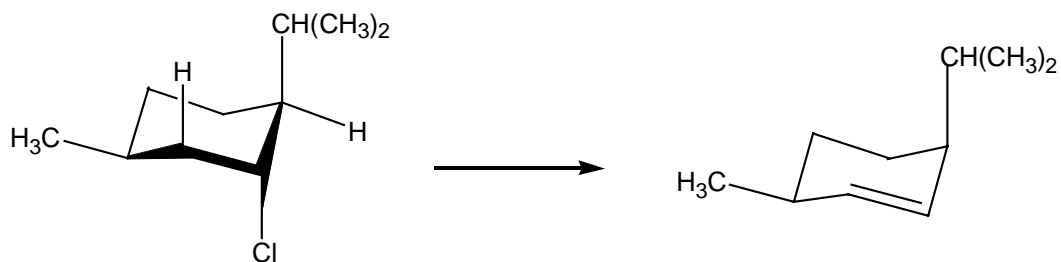
(b)



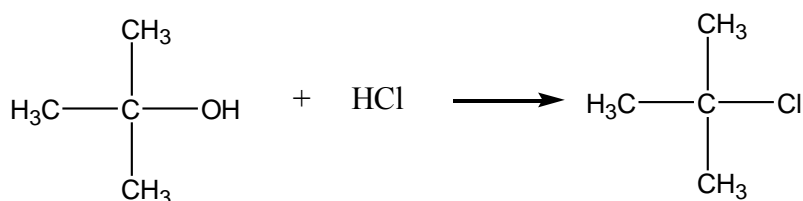
The carbocation is hard to form plane structure, so it is hard to undergo $\text{S}_{\text{N}}1$.

The carbon is tertiary, so it can't undergo $\text{S}_{\text{N}}2$.

(c)



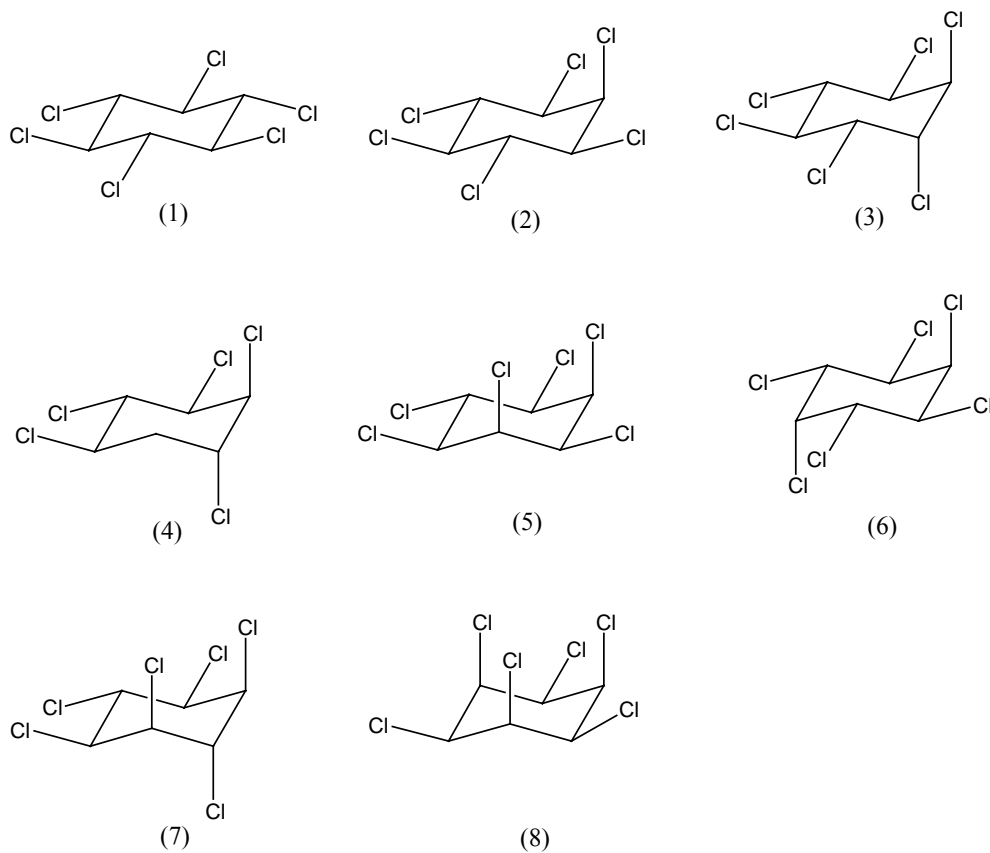
(d)



Tertiary carbocation is much stable, so even at 0°C the alcohol reacts with HCl rapidly.

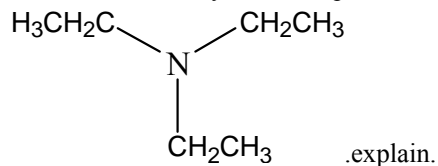
11.60 There are eight diastereomers of 1,2,3,4,5,6-hexachlorocyclohexane. Draw each in its more stable chair formation. One isomer loses HCl in an E2 reaction nearly 1000 times more slowly than the others. Which isomer reacts so slowly, and why?

Solution:

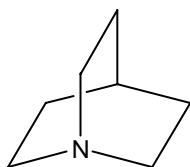


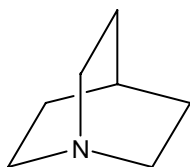
Isomer (1) reacts so slowly because there is no anti-planar hydrogen.

11.61 The tertiary amine quinuclidine reacts with CH_3I 50 times as fast as triethylamine,

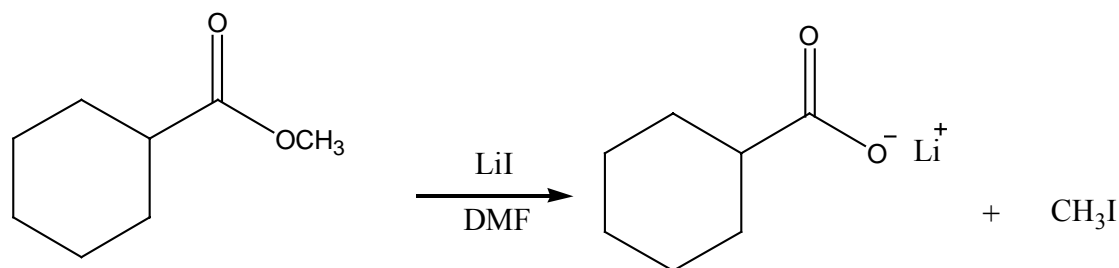


Solution:



The lone pair electrons of  is more outwards, and the C-N bonds cannot freely rotate, so it is stronger nucleophile.

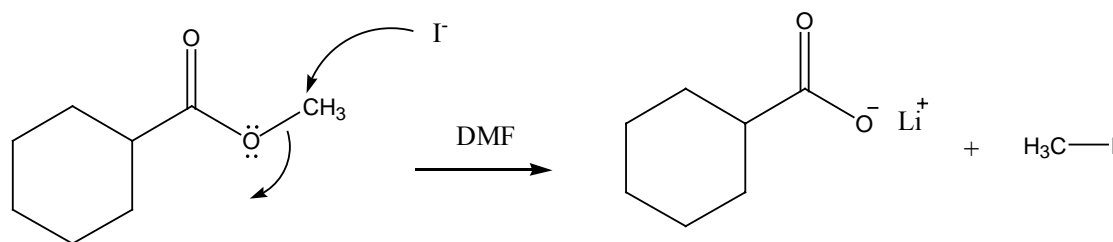
11.62 Methyl esters (RCO_2CH_3) undergo a cleavage reaction to yield carboxylate ions plus iodomethane on heating with LiI in dimethylformamide:



The following evidence has been obtained: (1) The reaction occurs much faster in DMF than in ethanol. (2) The corresponding ethyl ester ($\text{RCO}_2\text{CH}_2\text{CH}_3$) cleaves approximately 10 times more slowly than the methyl ester. Propose a mechanism for the reaction. What other kinds of experimental evidence could you gather to suppose your hypothesis?

Solution:

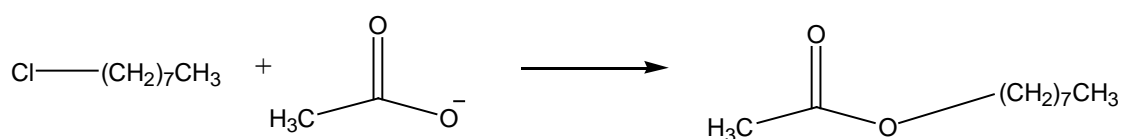
Mechanism:



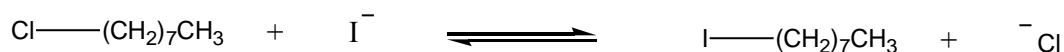
The mechanism is $\text{S}_{\text{N}}2$

11.63 The reaction of 1-chlorooctane with CH_3CO_2^- to give octyl acetate is greatly accelerated by adding a small quantity of iodide ion. Explain.

Solution:



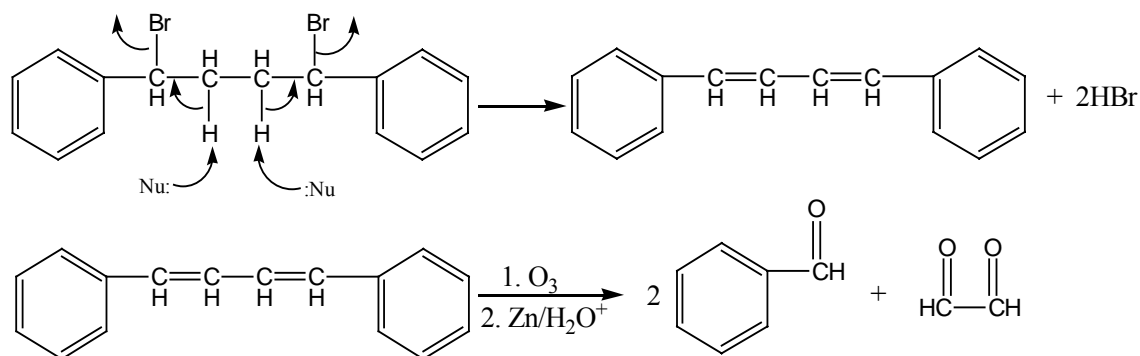
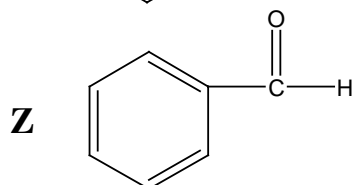
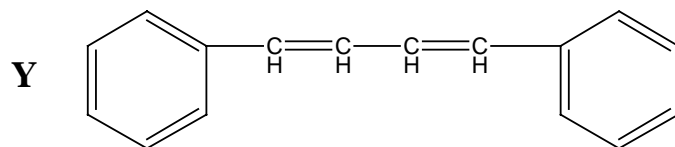
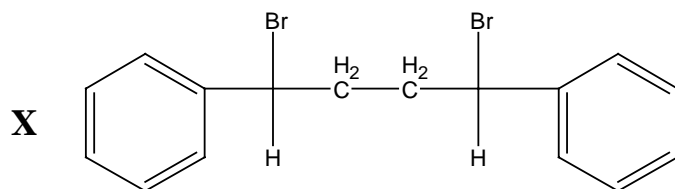
After adding a small quantity of iodide ion,



This reaction is more favored than the former, because 1-Iodoctane is more reactive than 1-chlorooctane.

11.64 Compound X is optically inactive and has the formula $\text{C}_{16}\text{H}_{16}\text{Br}_2$. On treatment with strong base, X gives hydrocarbon Y, $\text{C}_{16}\text{H}_{14}$. Compound Y absorbs 2 equivalents of hydrogen when reduced over a palladium catalyst and reacts with ozone to give two fragments. One fragment, Z, is an aldehyde with formula $\text{C}_7\text{H}_6\text{O}$. The other fragment is glyoxal, $(\text{CHO})_2$. Write the reactions involved, and suggest structures for X, Y, and Z. What is the stereochemistry of X?

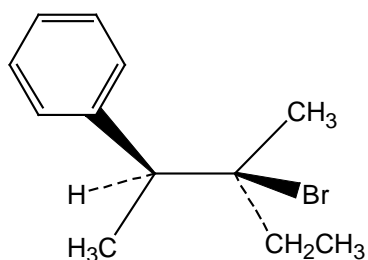
Solution:



X is a Meso compound.

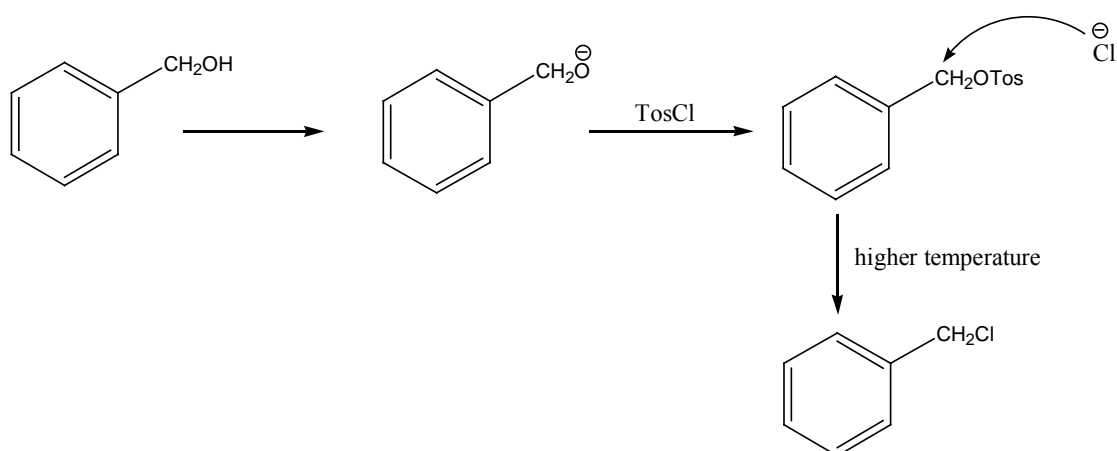
11.65 Propose a structure for an alkyl halide that gives only (E)-3-methyl-2-phenyl-2-pentene on E2 elimination. Make sure you indicate the stereochemistry.

Solution:



11.66 When primary alcohols are treated with p-toluenesulfonyl chloride at room temperature in the presence of an organic base such as pyridine, a tosylate is formed. When the same reaction is run at higher temperature, an alkyl chloride is often formed. Propose a mechanism.

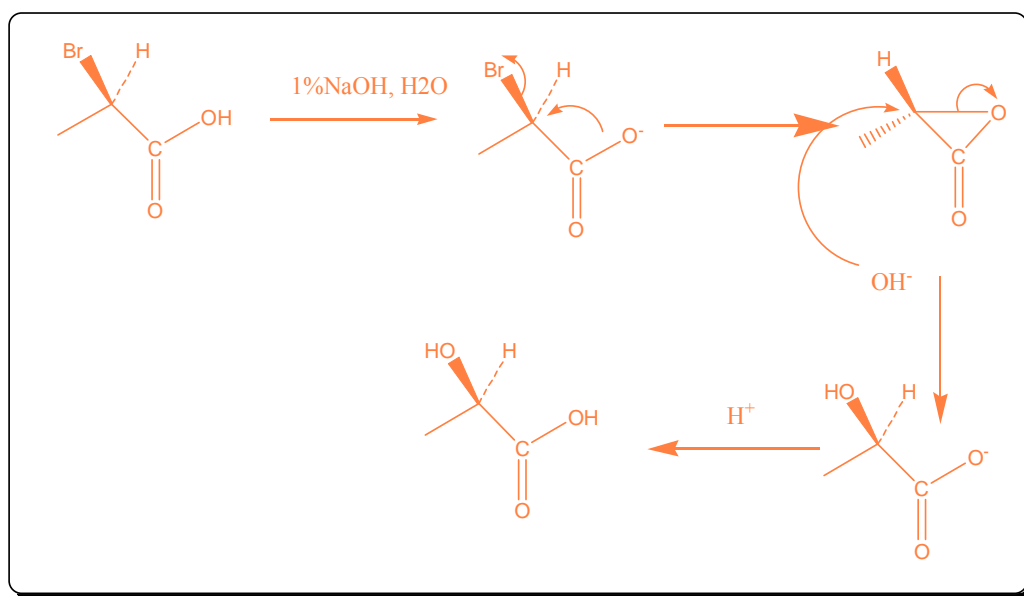
Solution:



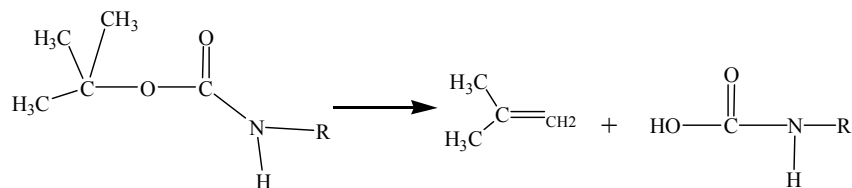
11.67 S_N2 reactions take place with inversion of configuration, and S_N1 reactions take place with racemization. The following substitution reaction, however, occurs with complete retention of configuration. Propose a mechanism.

Solution:

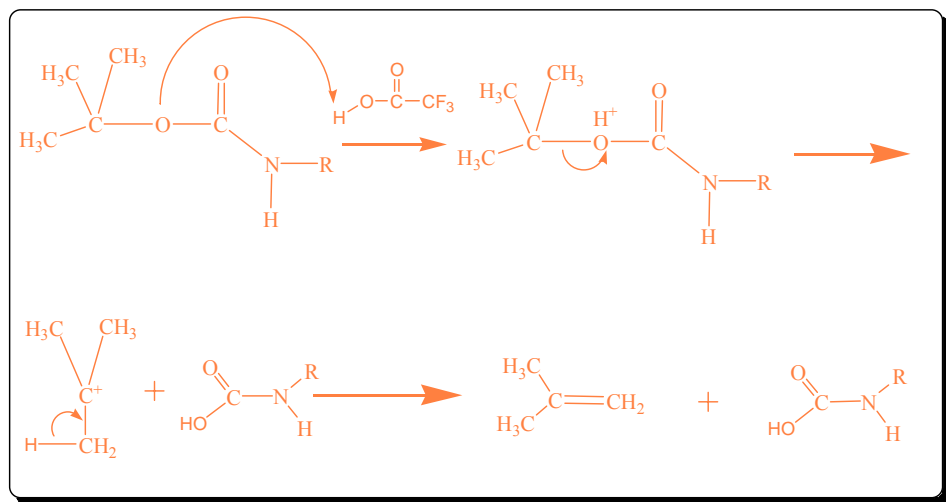
By neighboring group participation:



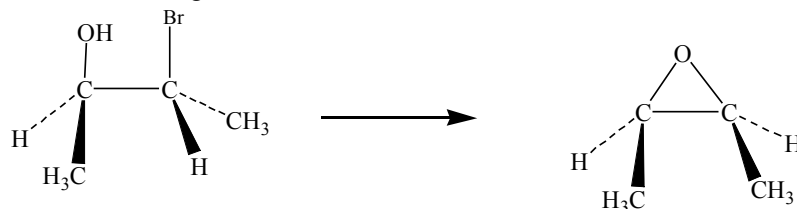
11.68 Propose a mechanism for the following reaction, an important step in the lab to synthesis proteins:



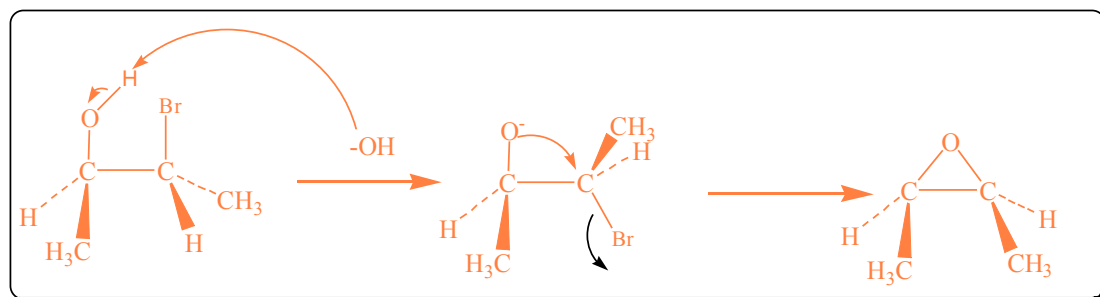
Solutions: Cause the $\text{CF}_3\text{CO}_2\text{H}$ is a strong acid, there will be E1 elimination, and yield carbocation.



11.69 Bromohydrins are converted to cyclic ethers called epoxides when treated with base. Propose a mechanism, using curved arrows to show the electron flow.

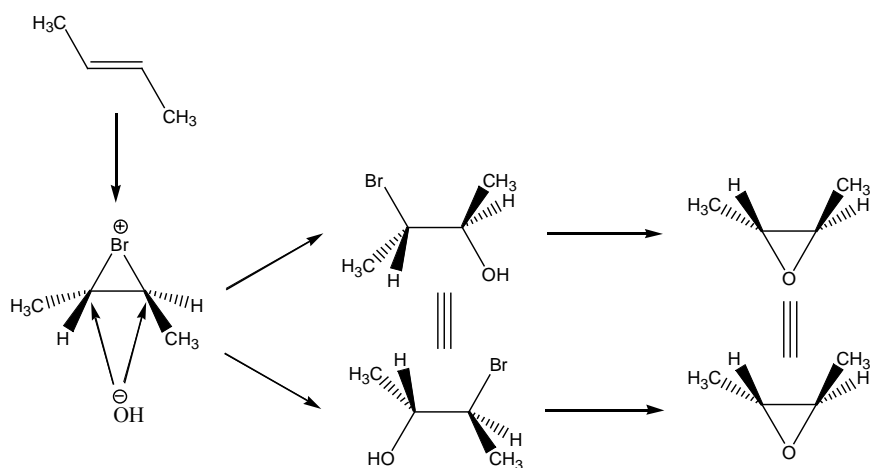


Solutions:

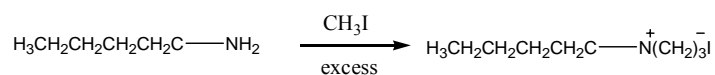


11.70 Show the stereochemistry of the epoxide (see Problem 11.69) you would obtain by formation of a bromohydrin from trans-2-butene, followed by treatment with base.

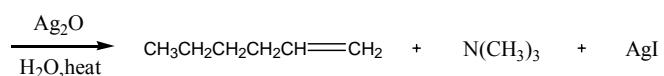
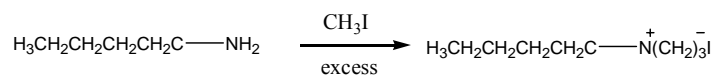
Solution:



11.71 Amines are converted into alkenes by a two-step process called the Hofmann elimination. Reaction of the amine with excess CH_3I in the first step yields intermediate that undergoes E2 reaction when treated with basic silver oxide. Pentylamine, for example, yields 1-pentene. Propose a structure for the intermediate, and explain why it undergoes ready elimination.



Solution:



$-\text{NH}_2$ is a kind of poor leaving group. When it reacts with CH_3I , it could be converted into $-\overset{+}{\text{N}}(\text{CH}_3)_3$, which is a quaternary ammonium, a better leaving group. Thus the substrate can undergo elimination.