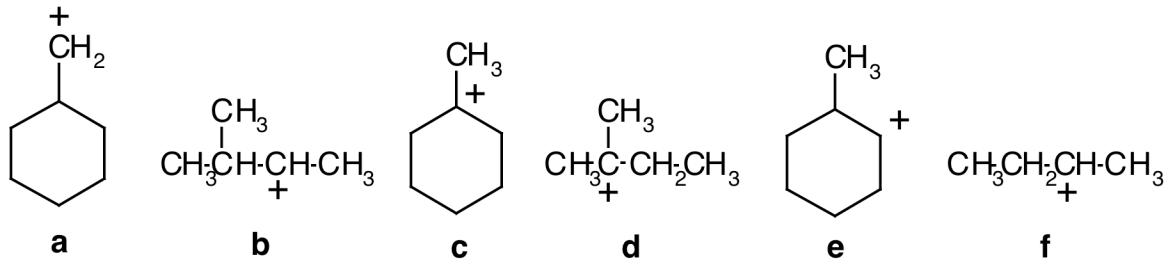
"Grade or Education" = 1

CHEM 2261/01
Summer 09
Final Exam
Chapters 1-11, 14

1. Which of the cations whose structures are shown below **WOULD** be expected to rearrange?



a **b** **c** **d** **e** **f**

__ A. Only the cation labelled **d** would be expected to rearrange.

__ B. Only the cation labelled **b** would be expected to rearrange.

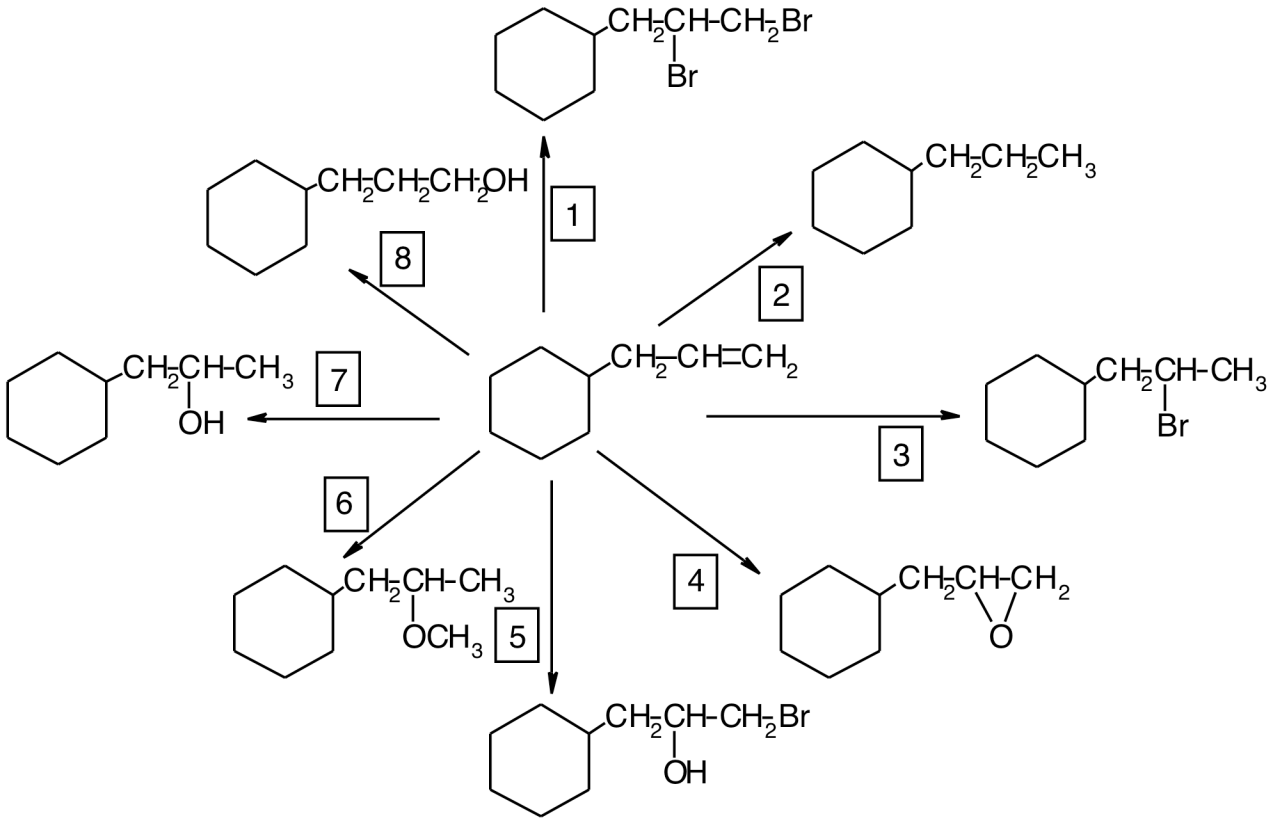
__ C. The cations labelled **a**, **b**, and **e** would be expected to rearrange.

__ D. The cations labelled **c**, **d**, and **f** would be expected to rearrange.

__ E. All of these cations would be expected to rearrange.

Rationale:
Chapter 4 Problem 15

2. The compound whose structure is shown in the center of the figure following can be converted into all of the other outer compounds whose structures are shown. Conversion number 1 transforms the center compound into the topmost compound in the figure (see boxed number 1). Conversion number 2 transforms the center compound into the outer compound one position clockwise from the topmost compound, etc. (ie. the conversion numbers are arranged in a clockwise pattern). Use this information to find the multiple choice answer which is **WRONG**.



__ A. Conversion number 5 can be carried out using Br_2 and H_2O.

__ B. Conversion number 3 can be carried out using HBr and peroxide.

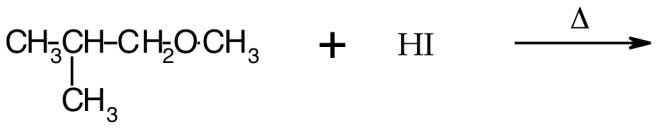
__ C. Conversion number 8 can be carried out using BH_3 followed by H_2O_2 and base (OH^-).

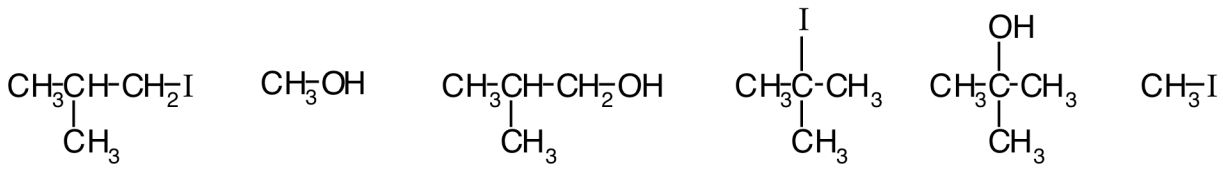
__ D. Conversion number 2 can be carried out using H_2/Pt.

__ E. Conversion number 6 can be carried out using acid (H^+) and CH_3OH.

Rationale:
similar to Chapter 4 Problem 47

3. Select the answer which refers to the **CORRECT** structure(s) of the product(s) of the reaction shown below.





1 **2** **3** **4** **5** **6**

__ A. This reaction gives products with structures **1** and **2**.

__ B. This reaction gives products with structures **2** and **4**.

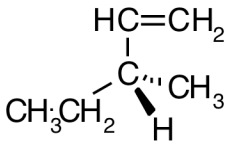
__ C. This reaction gives only the product with structure **4**.

__ D. This reaction gives products with structures **5** and **6**.

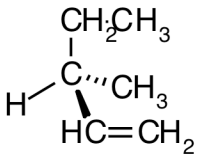
__ E. This reaction gives products with structures **3** and **6**.

Rationale:
Chapter 10 Problem 38b

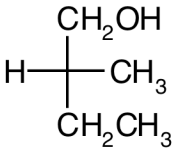
4. Figure out whether each of the following pairs of compounds are identical, or are enantiomers, diastereomers, or constitutional isomers. Pairs of compounds share the same letter, like **a1** and **a2**. Choose the **CORRECT** statement from the multiple choices.



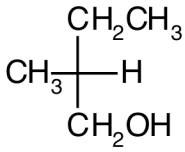
a1



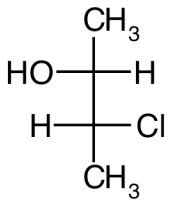
a2



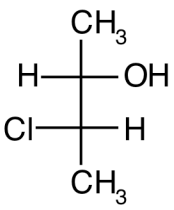
b1



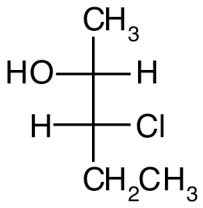
b2



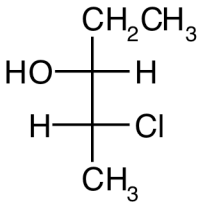
c1



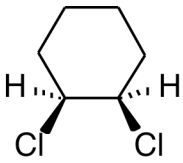
c2



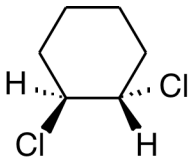
d1



d2



f1



f2

__ A. **d1** and **d2** are diasteriomers.

__ B. **f 1** and **f 2** are enantiomers.

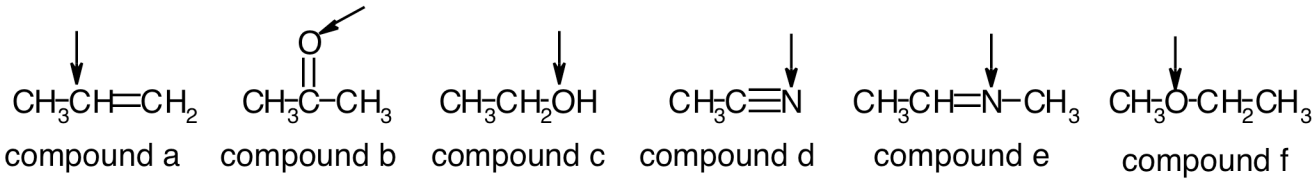
__ C. **c1** and **c2** are diasteriomers.

__ D. **a1** and **a2** are identical.

__ E. **b1** and **b2** are enantiomers.

Rationale:
similar to Chapter 5 Problem 76(a,b,c,d,f)

5. Choose the answer which correctly gives the hybridization of the indicated atoms in the compounds below.



__ A. sp^2 in compound a, sp in compound b, sp^2 in compound c, sp in compound d, sp^2 in compound e, and sp^2 in compound f

__ B. sp^2 in compound a, sp in compound b, sp in compound c, sp in compound d, sp in compound e, and sp in compound f

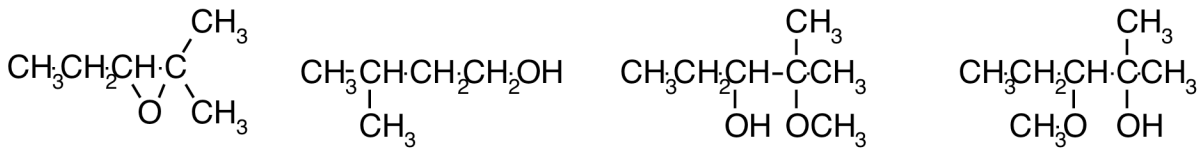
__ C. sp^2 in compound a, sp^2 in compound b, sp^3 in compound c, sp in compound d, sp^2 in compound e, and sp^3 in compound f

__ D. sp^3 in compound a, sp in compound b, sp^2 in compound c, sp in compound d, sp^2 in compound e, and sp^2 in compound f

__ E. sp^3 in compound a, sp^3 in compound b, sp^4 in compound c, sp^2 in compound d, sp^3 in compound e, and sp^4 in compound f

Rationale:
Chapter 1 Problem 82

6. By looking at the numbered structures below figure out which of the multiple choices specifies the **CORRECT** product of a reaction.



__ A. **1** + $H^+/CH_3OH \rightarrow$ **2**

__ B. **1** + $CH_3O^-/CH_3OH \rightarrow$ **2**

__ C. **1** + $CH_3O^-/CH_3OH \rightarrow$ **3**

__ D. **1** + $H^+/CH_3OH \rightarrow$ **4**

__ E. **1** + $CH_3O^-/CH_3OH \rightarrow$ **4**

Rationale:
Chapter 10 Problem 33(d,e)

7. Draw the two chair conformers of trans-1-ethyl-3-methylcyclohexane. Circle the most stable conformer. Choose the statement which is **TRUE** about the structure of the **MOST STABLE** conformer of this compound.

__ A. The ethyl group is equatorial and the methyl group is axial.

__ B. Both the ethyl group and the methyl group are axial.

__ C. Both the ethyl group and the methyl group are equatorial.

__ D. The ethyl group is axial and the methyl group is equatorial.

__ E. Both conformers of this compound are equally stable.

Rationale:
similar to Chapter 2 Problem 67

8. In each of the following pairs of reactions circle the reaction which will take place **more rapidly**. Pairs of reactions share the same line and the same letter, like **a1** and **a2**. Now use your work to select the **CORRECT** statement from the multiple choices.

a1: $CH_3Br + HO^- \rightarrow CH_3OH + Br^-$ **a2**: $CH_3Br + H_2O \rightarrow CH_3OH + HBr$

b1: $CH_3I + HO^- \rightarrow CH_3OH + I^-$ **b2**: $CH_3Cl + HO^- \rightarrow CH_3OH + Cl^-$

c1: $CH_3Br + NH_3 \rightarrow CH_3NH_3^+ + Br^-$ **c2**: $CH_3Br + H_2O \rightarrow CH_3OH + HBr$

d1: $CH_3Br + HO^- \xrightarrow{DMSO} CH_3OH + Br^-$ **d2**: $CH_3Br + HO^- \xrightarrow{EtOH} CH_3OH + Br^-$

e1: $CH_3Br + NH_3 \xrightarrow{EtOEt} CH_3NH_3^+ + Br^-$ **e2**: $CH_3Br + NH_3 \xrightarrow{EtOH} CH_3NH_3^+ + Br^-$

__ A. Reaction **a2** will take place more rapidly than reaction **a1**.

__ B. Reaction **c2** will take place more rapidly than reaction **c1**.

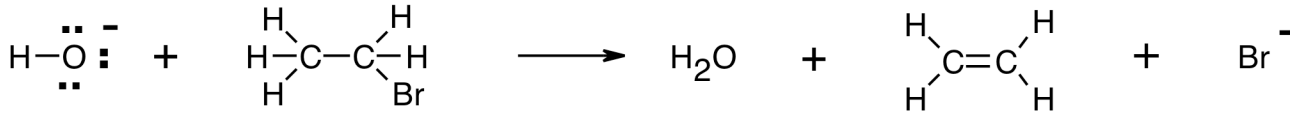
__ C. Reaction **b2** will take place more rapidly than reaction **b1**.

__ D. Reaction **e2** will take place more rapidly than reaction **e1**.

__ E. Reaction **d2** will take place more rapidly than reaction **d1**.

Rationale:
Chapter 8 Problem 30

9. Draw curved arrows to show the flow of electrons responsible for the conversion of reactants into products in the reaction shown below. Draw three curved arrows right on the figure below and choose the statement which gives a **WRONG** description of the attributes of one of these arrows.



__ A. The tail of the leftmost arrow originates at one of the lone pairs on the oxygen of the hydroxide ion.

__ B. The point of the leftmost arrow points to one of the two hydrogens attached to the same carbon that the bromine is attached to in the bromoethane molecule.

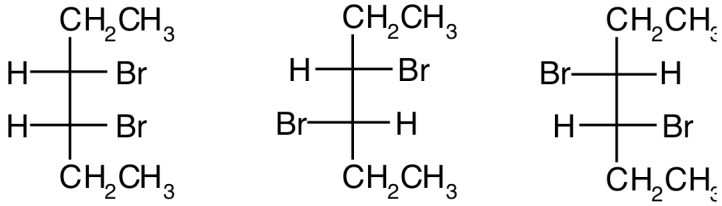
__ C. The point of the middle arrow points to the bonding area between the two carbon atoms in the bromoethane molecule.

__ D. The tail of the rightmost arrow originates at the bond betwen carbon and bromine in the bromoethane molecule.

__ E. the point of the rightmost arrow points to the valence shell on the outside of the bromine atom in the bromoethane molecule.

Rationale:
Chapter 3 Problem 42

10. Find the structures of the products of the reactions given in the multiple choices among the Fisher projections numbered **1**, **2**, and **3** below. Pick the choice which indicates the **CORRECT** product(s) of the reaction given.



1 **2** **3**

__ A. cis-3-hexene + Br_2/CH_2Cl_2 → product **1** and **3**

__ B. trans-3-hexene + Br_2/CH_2Cl_2 → product **1**

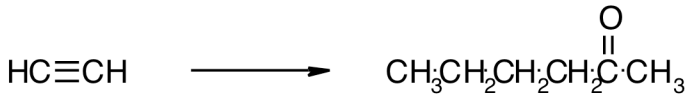
__ C. cis-3-hexene + Br_2/CH_2Cl_2 → product **1**

__ D. trans-3-hexene + Br_2/CH_2Cl_2 → product **3**

__ E. trans-3-hexene + Br_2/CH_2Cl_2 → products **2** and **3**

Rationale:
Chapter 5 Problem 82(e,f)

11. Pick the choice which describes **CORRECTLY** how the conversion shown below can be accomplished



__ A. First react the starting material with $NaNH_2$ followed by $CH_3CH_2CH_2CH_2Br$. Next treat the product of these reactions with H_2SO_4, H_2O, and $HgSO_4$ to generate the desired product.

__ B. First react the starting material with $NaNH_2$ followed by $CH_3CH_2CH_2CH_2Br$. Next treat the product of these reactions with H_2 and Lindlar's catalyst. Finally treat the product of the previous reactions with disiamylborane followed by OH^- and H_2O_2 to generate the desired product.

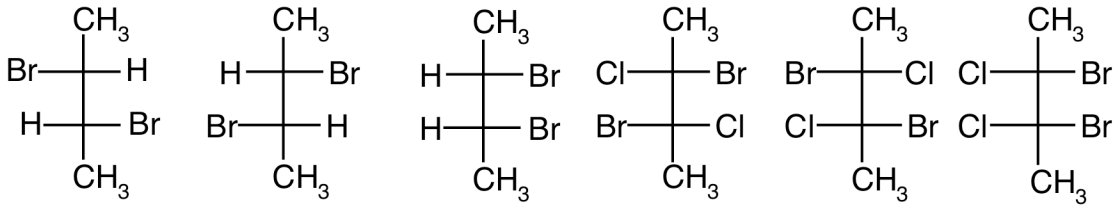
__ C. First react the starting material with $NaNH_2$ followed by $CH_3CH_2CH_2CH_2Br$. Next treat the product of these reactions with BH_3/THF followed by OH^- and H_2O_2 to generate the desired product.

__ D. First react the starting material with $NaNH_2$ followed by $CH_3CH_2CH_2CH_2Br$. Next treat the product of these reactions with H_2 and Lindlar's catalyst. Finally treat the product of the previous reactions with H_2SO_4, H_2O, and $HgSO_4$ to generate the desired product.

__ E. First react the starting material with $NaNH_2$ followed by $CH_3CH_2CH_2CH_2Br$. Next treat the product of these reactions with disiamylborane followed by OH^- and H_2O_2 to generate the desired product.

Rationale:
Chapter 6 Problem 46a

12. Examine the Fischer projections below. Which of the multiple choices gives the number(s) associated with the Fischer projection(s) of the **CORRECT** stereoisomer(s) obtained from the reaction of 2-butyne with the reagents specified?



1 **2** **3** **4** **5** **6**

__ A. Reaction with, 1. Cl_2/CH_2Cl_2, followed by 2. Br_2/CH_2Cl_2 gives the products with structures **4** and **5** only.

__ B. Reaction with, 1. Na/NH_3(liq), followed by 2. Br_2/CH_2Cl_2 gives the products with structures **4** and **5** only.

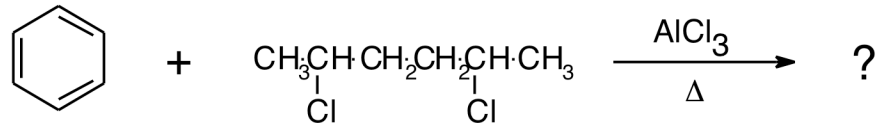
__ C. Reaction with, 1. Na/NH_3(liq), followed by 2. Br_2/CH_2Cl_2 gives the products with structures **1** and **2** only.

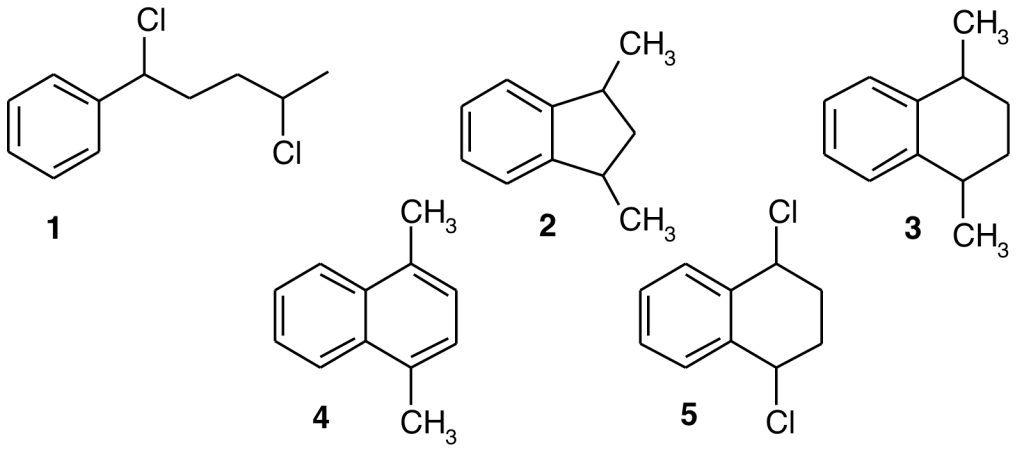
__ D. Reaction with, 1. Na/NH_3(liq), followed by 2. Br_2/CH_2Cl_2 gives the product with structure **6** only.

__ E. Reaction with, 1. H_2/Lindlar catalyst, followed by 2. Br_2/CH_2Cl_2 gives the products with structures **1** and **2** only.

Rationale:
Chapter 6 Problem 44

13. Choose the **CORRECT** structure of the product of the reaction shown below.





__ A. **4**

__ B. **3**

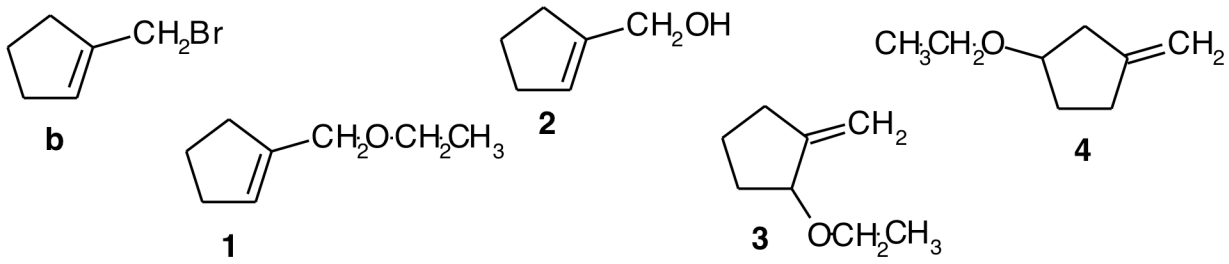
__ C. **1**

__ D. **5**

__ E. **2**

Rationale:
moved to Chapter 16

14. Find **ALL** of the **CORRECT** structures of the products obtained from the solvolysis of the compound with structure **b** (shown below) in ethanol. Choose the answer which gives all of the correct product structures and no wrong structures.



__ A. The products have structures **2** and **4**.

__ B. The products have structures **1** and **4**.

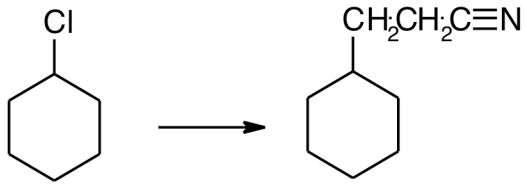
__ C. The products have structures **2** and **3**.

__ D. The products have structures **1** and **2**.

__ E. The products have structures **1** and **3**.

Rationale:
Chapter 8 Problem 46b

15. Using the starting material with the structure shown in the figure below, any necessary inorganic reagents, and any carbon-containing compounds with no more than two carbon atoms, figure out how to synthesize the product having the structure shown in the figure. Pick the choice which **CORRECTLY** describes how this synthesis might be accompliched.



__ A. First treat the starting compound with $CH_2{=}CH_2C{\equiv}N$ and $(Ph_3P)_4Pd/Et_3N$. Then treat the resulting compound with excess $H_2/Pd/C$.

__ B. First treat the starting compound with Mg and Et_2O. Next treat the resulting compound with TsCl. Next react with: 1. ethylene oxide, followed by 2. H^+. Finally react with $^-C{\equiv}N$.

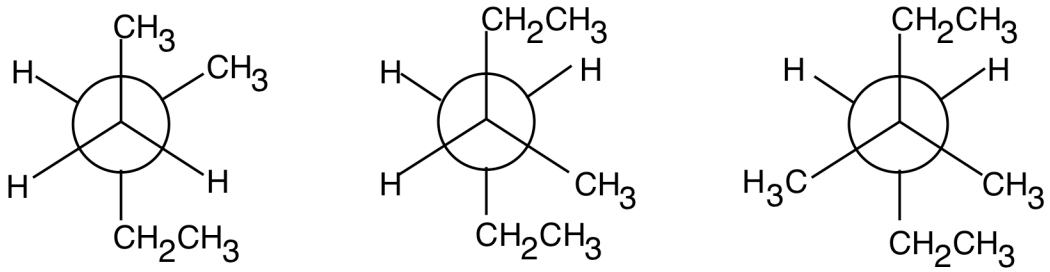
__ C. First treat the starting compound with ^-OH. Next react with TsCl. Next react with: 1. ethylene oxide, followed by 2. H^+. Finally react with $^-C{\equiv}N$.

__ D. First treat the starting compound with Mg and Et_2O. Next treat the resulting compound with: 1. ethylene oxide, followed by 2. H^+. Next react with TsCl. Finally react with $^-C{\equiv}N$.

__ E. First treat the starting compound with tert-butoxide. Next react with H_2O/H_2SO_4. Next react with TsCl. Next react with $NaC{\equiv}CH$. Finally react with HCN.

Rationale:
similar to Chapter 11 Problem 25d

16. Look at the three Newman projections below labelled **a**, **b**, and **c**. Choose the statement which is completely **CORRECT** about one of these projections.



__ A. Structure **b** is the most stable conformation of 3-methylhexane, viewed along the C3-C4 bond.

__ B. Structure **a** is the most stable conformation of 3,3-dimethylhexane, viewed along the C3-C4 bond.

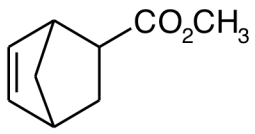
__ C. Structure **a** is the most stable conformation of 3-methylhexane, viewed along the C3-C4 bond.

__ D. Structure **c** is the most stable conformation of 3-methylpentane, viewed along the C2-C3 bond.

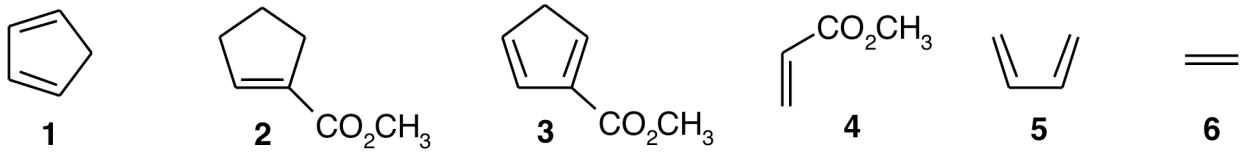
__ E. Structure **b** is the most stable conformation of 3,3-dimethylhexane, viewed along the C3-C4 bond.

Rationale:
Chapter 2 Problem 36

17. How could the compound below be synthesized using a Diels-Alder reaction? Choose the **CORRECT** structures of the two substances which react with one another to form this Diels-Alder product.



product



__ A. **1** and **2**

__ B. **5** and **2**

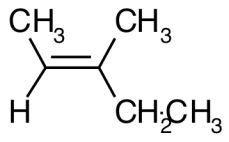
__ C. **3** and **4**

__ D. **1** and **4**

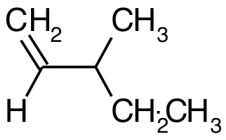
__ E. **3** and **6**

Rationale:
Chapter 7 Problem 64b

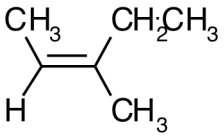
18. Find the elimination product(s) of (2S,3S)-2-chloro-3-methylpentane + high concentration of CH_3O^- among the numbered structures below. Choose the **CORRECT** product(s) of this reaction.



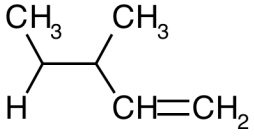
1



2



3



4

__ A. **1** and **3** are both products of this reaction.

__ B. **1** is the product of this reaction.

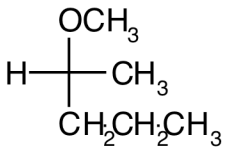
__ C. **4** is the product of this reaction.

__ D. **3** is the product of this reaction.

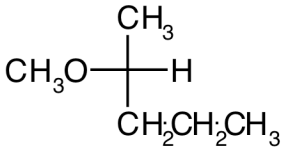
__ E. **2** is the product of this reaction.

Rationale:
Chapter 9 Problem 48a

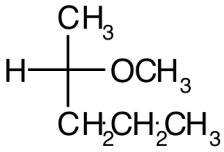
19. Examine the Fischer projections shown below. Choose the one which **CORRECTLY** shows the structure of the product of the reaction of (R)-2-bromopentane + high concentration of CH_3O^-.



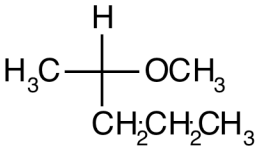
a1



a2



a3



a4

__ A. Structure **a3** is correct.

__ B. Structure **a4** is correct.

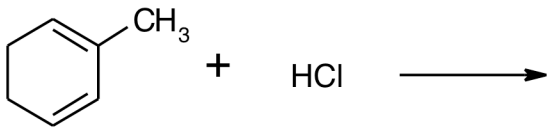
__ C. Structure **a1** is correct.

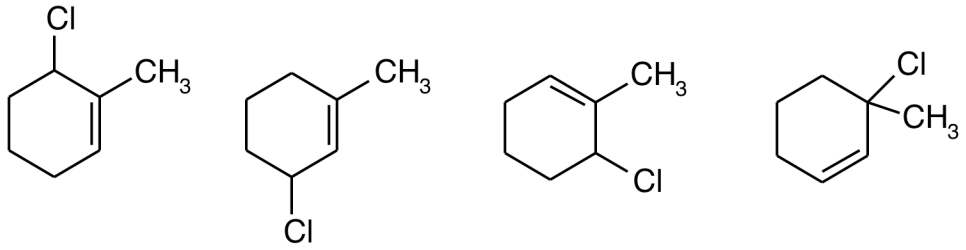
__ D. None of these structures is correct.

__ E. Structure **a2** is correct.

Rationale:
Chapter 8 Problem 45a

20. For the reaction shown below find the major 1,2- and 1,4-addition products and determine which is the kinetic product and which is the thermodynamic product. Pick the **CORRECT** statement from the multiple choices.





1 **2** **3** **4**

__ A. The 1,2-addition product is **3** and the 1,4-addition product is **1**; the predominant kinetic product is **3**, and the predominant thermodynamic product is **1**.

__ B. The 1,2-addition product is **3** and the 1,4-addition product is **1**; the predominant kinetic product is **1**, and the predominant thermodynamic product is **3**.

__ C. The 1,2-addition product is **4** and the 1,4-addition product is **2**; the predominant kinetic product is **2**, and the predominant thermodynamic product is **4**.

__ D. The 1,2-addition product is **2** and the 1,4-addition product is **4**; the predominant kinetic product is **4**, and the predominant thermodynamic product is **2**.

__ E. The 1,2-addition product is **4** and the 1,4-addition product is **2**; the predominant kinetic product is **4**, and the predominant thermodynamic product is **2**.

Rationale:
Chapter 7 Problem 31c

21. Use the pKa table below to figure out which of the reactions shown below is written so that the equilibrium does **NOT** lie in the direction indicated (ie. the equilibrium favors reactants rather than products).

ACID	pK_a	ACID	pK_a
CH_3OH	15.5	$CH_3OH_2^+$	–2.5
H_2O	15.7	CH_3NH_2	40
H_3O^+	–1.7	$CH_3NH_3^+$	10.7
NH_4^+	9.4	HCl	–7

__ A. $CH_3OH + HO^- \rightarrow CH_3O^- + H_2O$

__ B. $CH_3NH_2 + H_3O^+ \rightarrow CH_3NH_3^+ + H_2O$

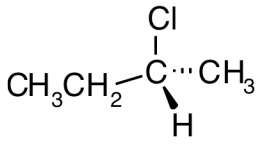
__ C. $NH_3 + H_2O \rightarrow NH_4^+ + HO^-$

__ D. $CH_3OH_2^+ + H_2O \rightarrow CH_3OH + H_3O^+$

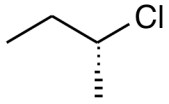
__ E. $CH_3NH^- + H_2O \rightarrow CH_3NH_2 + HO^-$

Rationale:
Chapter 1 Problem 48

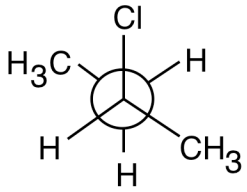
22. Which of the structures below is/are (S)-2-chlorobutane?



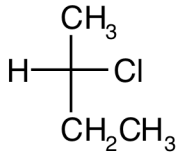
a



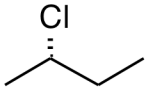
c



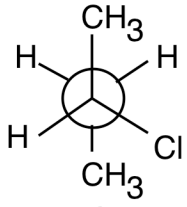
e



b



d



f

__ A. Only **b** is (S)-2-chlorobutane.

__ B. Structures **a**, **c**, and **d** are (S)-2-chlorobutane.

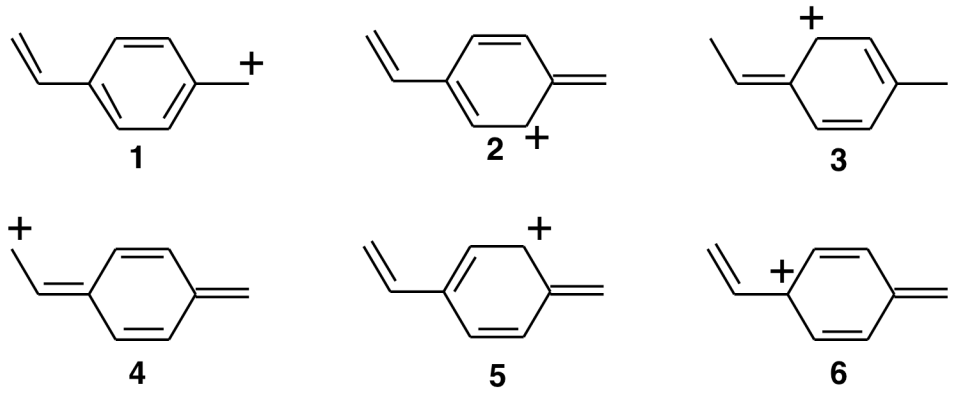
__ C. Only **c** is (S)-2-chlorobutane.

__ D. Structures **b**, **d** and **f** are (S)-2-chlorobutane.

__ E. Structures **b** and **c** are (S)-2-chlorobutane.

Rationale:
Chapter 5 Problem 78

23. Pick the number of the structure which is **NOT** a correct resonance contributor for the ion labelled **1**, shown below.



__ A. **5**

__ B. **3**

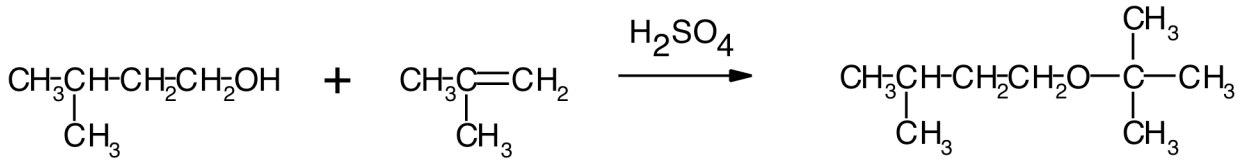
__ C. **6**

__ D. **4**

__ E. **2**

Rationale:
Chapter 7 Problem 44b

24. Draw out the mechanism for the reaction shown below using curved arrows to depict electron movement. Use the letter "R" to represent the isopentyl group of the alcohol in order to save time. Use your drawing to choose the statetement from the multiple choices which is **WRONG** about this mechanism.



__ A. The second intermediate in this mechanism is an ion containing a positively-charged oxygen atom.

__ B. There are two intermediates and three steps in this mechanism.

__ C. In the first step of this mechanism a hydrogen cation attacks a double bond. This is represented by a curved arrow originating at the hydrogen and pointing toward the double bond.

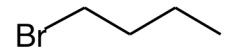
__ D. In the third step of this mechanism a protonated oxygen atom loses a hydrogen cation. This is represented by drawing a curved arrow which originates at the bond between the oxygen atom and the hydrogen atom being lost. This curved arrow points toward the middle of the positively-charged oxygen atom.

__ E. In the second step of this mechanism a lone pair of electrons located on the oxygen atom of the alcohol molecule attacks a tertiary carbocation. This is represented by a curved arrow with its tail at the lone pair of electrons and its point directed toward the positive charge.

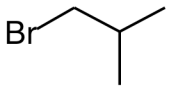
Rationale:
Chapter 4 Problem 14

25. Indicate whether the alkyl halides listed in the table below will give primarily substitution products (S), only elimination products (E), both substitution and elimination products (S & E), or no products (X) when they are treated with the reagents under the reaction conditions shown in the table below. Put the correct abbreviations for substitution (S), Elimination (E) or no reaction (X) in the product column of the table for each reaction shown. These reactions are designated **a1** through **b4** in the multiple choices as presented in the table. Pick the **CORRECT** statement from the multiple choices.

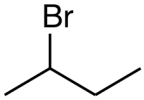
Rxn	Alkyl Halide	Reaction Conditions	Products
a1	1-bromobutane	methanol under $S_N1/E1$	
a2	1-bromo-2-methylpropane	methanol under $S_N1/E1$	
a3	2-bromobutane	methanol under $S_N1/E1$	
a4	2-bromo-2-methylpropane	methanol under $S_N1/E1$	
b1	1-bromobutane	sodium methoxide under $S_N2/E2$	
b2	1-bromo-2-methylpropane	sodium methoxide under $S_N2/E2$	
b3	2-bromobutane	sodium methoxide under $S_N2/E2$	
b4	2-bromo-2-methylpropane	sodium methoxide under $S_N2/E2$	



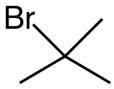
1-bromobutane
1



1-bromo-2-methylpropane
2



2-bromobutane
3



2-bromo-2-methylpropane
4

__ A. Reaction **a2** gives both substitution and elimination products.

__ B. Reaction **a4** gives no products.

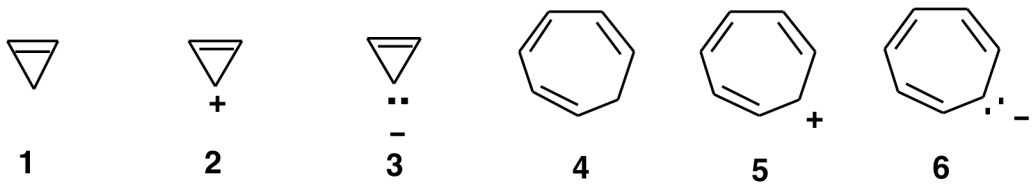
__ C. Reaction **b3** gives only elimination products.

__ D. Reaction **a1** gives no products.

__ E. Reaction **b4** gives primarily substitution products.

Rationale:
Chapter 9 Problem 22

26. Which of the numbered structures below is/are aromatic?



__ A. All of the structures shown are aromatic.

__ B. **1** and **4** only

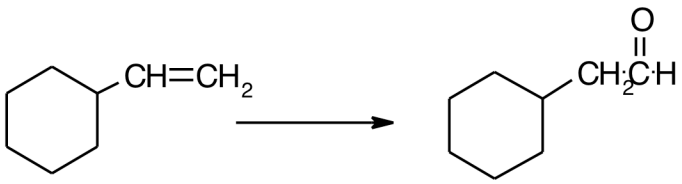
__ C. **2** and **5** only

__ D. **1**, **2**, **4**, and **5** only

__ E. **3** and **6** only

Rationale:
Chapter 15 Problem 3

27. For the target compound whose structure is shown below choose the multistep synthesis which could be used to prepare it from the given starting material.



__ A. First: Br_2/CH_2Cl_2; Next: excess $^{-}NH_2$; Finally: 1. disiamylborane and 2. HO^{-}, H_2O_2, H_2O

__ B. First: HBr/CH_2Cl_2; Next: $^{-}NH_2$; Finally: 1. BH_3/THF and 2. HO^{-}, H_2O_2, H_2O

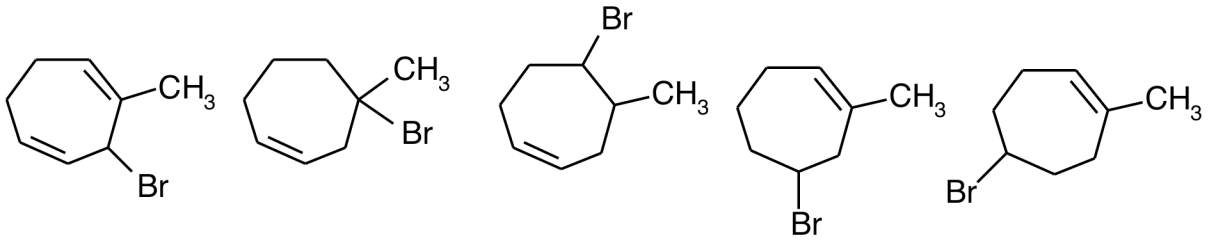
__ C. First: Br_2/CH_2Cl_2; Next: excess $^{-}NH_2$; Finally: H_2SO_4/H_2O

__ D. First: Br_2/H_2O; Next: $^{-}NH_2$

__ E. First: Br_2/CH_2Cl_2; Next: excess $^{-}NH_2$; Finally: $H_2SO_4/HgSO_4$

Rationale:
Chapter 9 Problem 31b

28. Choose structure of the **MAJOR** product of the reaction shown below.



1 **2** **3** **4** **5**

__ A. **3**

__ B. **1**

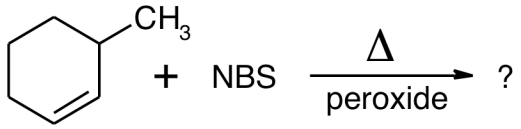
__ C. **4**

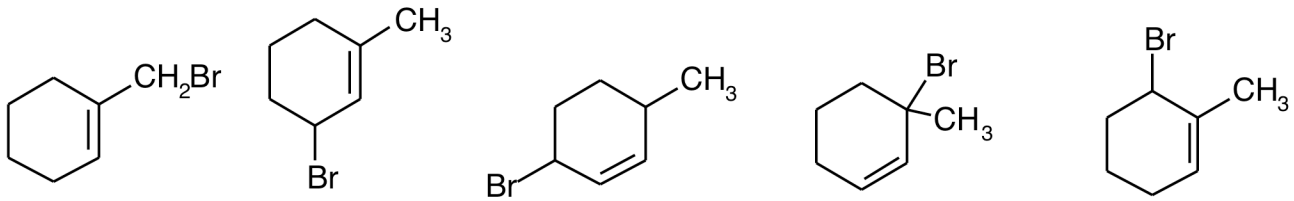
__ D. **5**

__ E. **2**

Rationale:
Chapter 12 Problem 32e

29. Find the major product(s) of the reaction shown below. Ignore stereochemistry.





1 **2** **3** **4** **5**

__ A. **1**, **2**, and **5** are the major products of this reaction.

__ B. **3** is the major product of this reaction.

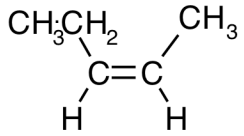
__ C. **3** and **4** are the major products of this reaction.

__ D. **2** and **4** are the major products of this reaction.

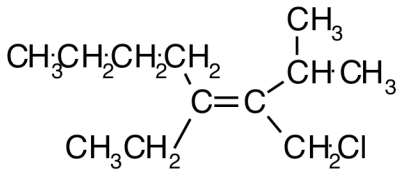
__ E. **1**, **3**, and **5** are the major products of this reaction.

Rationale:
Chapter 12 Problem 26c

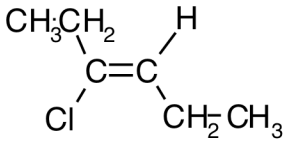
30. Which of the compounds whose structures are shown below have the Z configuration?



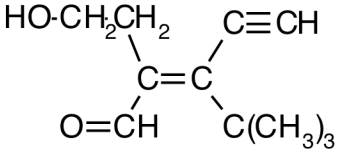
structure A



structure C



structure B



structure D

__ A. The compounds with structures B and C have the Z configuration.

__ B. Only the compound with structure D has the Z configuration.

__ C. The compounds with structures C and D have the Z configuration.

__ D. The compounds with structures A and B have the Z configuration.

__ E. The compounds with structures A and D have the Z configuration.

Rationale:
Chapter 3 Problem 12

Answer Key

"Grade or Education" = 1

CHEM 2261/01
Summer 09
Final Exam
Chapters 1-11, 14

1. C
2. B
3. E
4. D
5. C
6. E
7. A
8. D
9. B
10. B
11. A
12. E
13. B
14. E
15. D
16. A
17. D
18. B

19. A

20. E

21. C

22. D

23. B

24. C

25. D

26. C

27. A

28. A

29. D

30. D