

Homework - Review of Chem 2310

Chapter 1 - Atoms and Molecules

Name _____

1. What is organic chemistry?
2. Why is there an entire one year course devoted to the study of organic compounds?
3. Give 4 examples of areas of study that organic chemistry prepares you for, or industries that depend on knowledge of organic chemistry.
4. Which elementary particles are involved in chemical reactions? Why?
5. Fill in the following partial Periodic Table of Elements. Do as much as you can from memory. (The squares with dotted lines around them are ones you don't need to know.)

6. What are the two most important ways that 3rd period elements are different from 2nd period elements?
- 1)
- 2)

7. If you want to know how the following elements behave, what other element would be best to look at?

a) sulfur

b) phosphorus

c) silicon

d) bromine

8. What is electronegativity?

9. For each of the following pairs of atoms, determine whether size or electronegativity will be the most important factor. Then circle the one which is larger OR which is more electronegative.

a) nitrogen vs. oxygen

b) bromine vs. iodine

10. Give the number of protons and neutrons in each of the following isotopes. Circle the more common isotope of each element.

a) ^{12}C

c) ^1H

e) ^{18}O

b) ^{13}C

d) $^2\text{H} = \text{D}$

f) ^{16}O

11. Why are isotopes useful in organic chemistry?

12. Draw a Lewis structure for each of the following elements, and write how many covalent bonds it will form if (if it is uncharged).

a) carbon

c) oxygen

e) bromine

g) sulfur

b) nitrogen

d) hydrogen

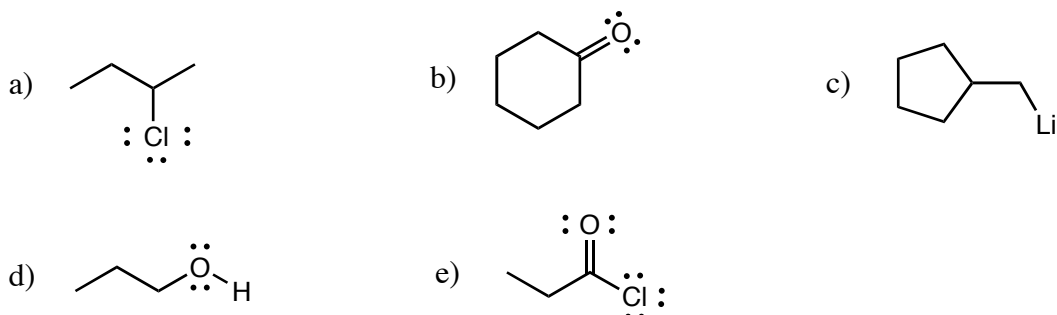
f) phosphorus

h) chlorine

13. Draw complete Lewis structures for three different compounds with the formula C_2H_5NO (and no charged atoms).

14. Draw a correct Lewis structure for CH_3CH_2ONa . How many covalent bonds does it contain? How many ionic bonds?

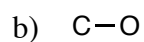
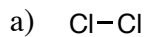
15. Label all polar bonds in each of the following molecules except C-H bonds using partial charges or polarity arrows.



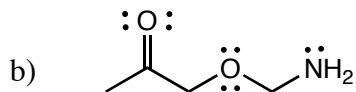
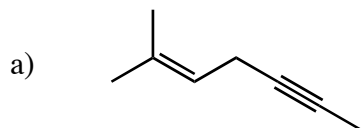
16. Which bond is weaker (more reactive) in each of the following pairs? Briefly explain your answer.



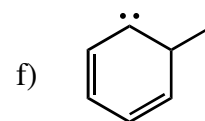
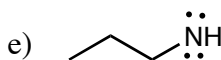
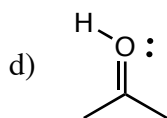
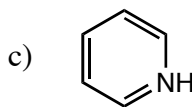
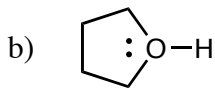
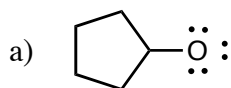
17. Are the following bonds more likely to break homolytically or heterolytically? Explain why. What kinds of reactive species result?



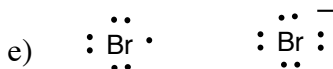
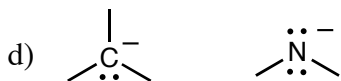
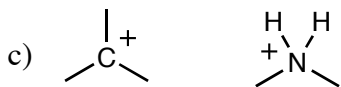
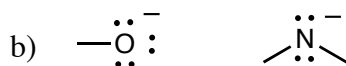
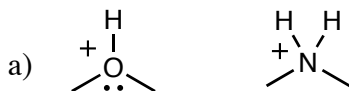
18. Give the geometry of all appropriate atoms in each of the following compounds.



19. Give the charge next to each atom in the following compounds which has a charge.

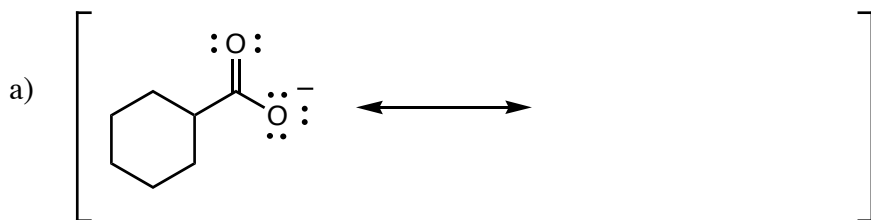


20. Circle the species which is more reactive in each pair, and briefly explain your answer using octets and electronegativity.

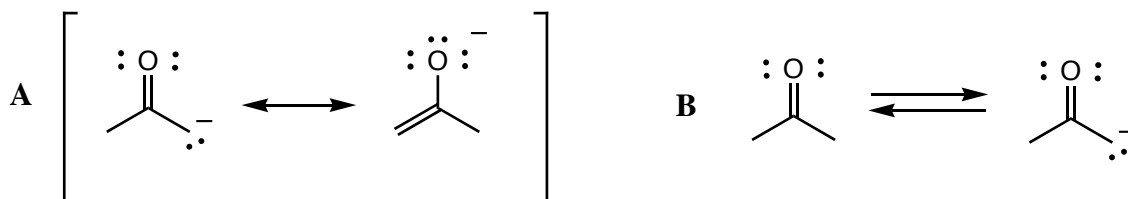


21. When are resonance structures most commonly needed to represent a molecule?

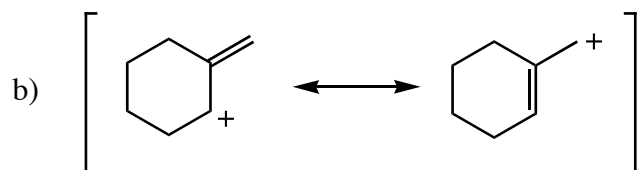
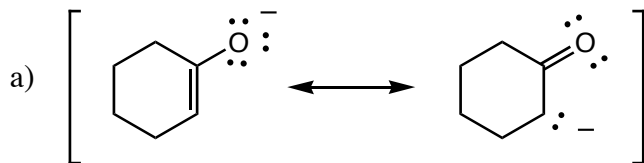
22. Draw resonance structures for the following compounds, using arrows to show where the electrons go.



23. What is the difference between the two structures in A and the two structures in B? Explain in detail.

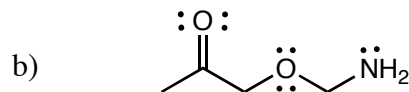
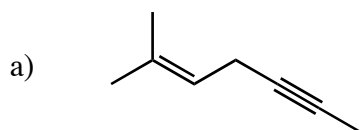


24. Circle the greater resonance contributor in each pair and briefly explain your answer.

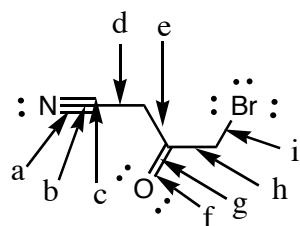


25. Does having resonance structures make a compound more stable or less stable? Why?

26. Give the hybridization of each atom (except hydrogen) in the following compounds.



27. Label each molecular orbital and give the atomic orbitals that it came from in the following compound.

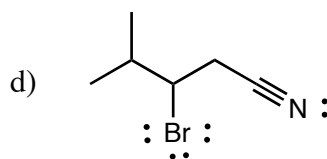
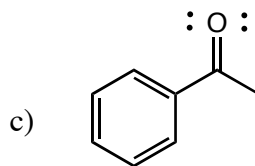
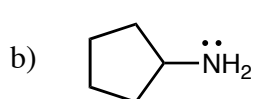
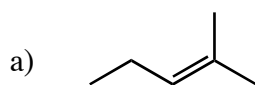


(a,b,c and f,g
are interchangeable)

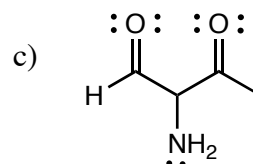
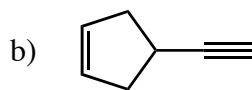
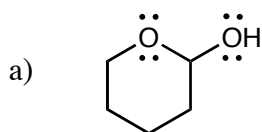
- | | |
|----|----|
| a) | f) |
| b) | g) |
| c) | h) |
| d) | i) |
| e) | |

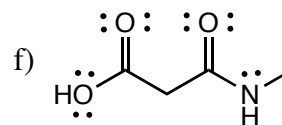
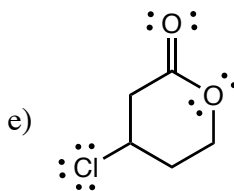
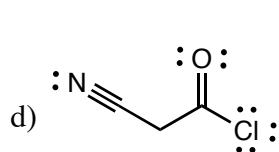
Chapter 2 - Intro to Organic Compounds

28. Give the molecular formula for the following line structures.



29. Give all functional groups which the following compounds contain.

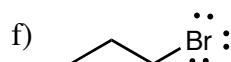
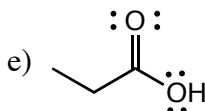
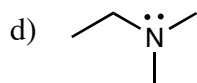
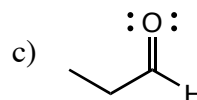
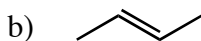
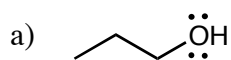




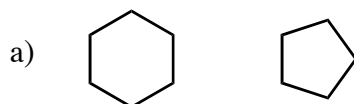
30. What functional groups do the following compounds contain?

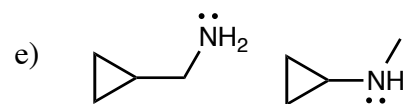
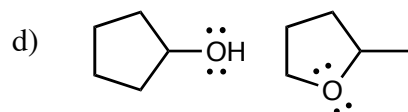
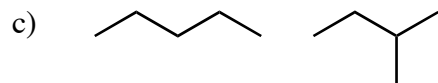
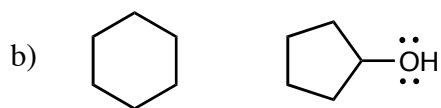
- a) 2-pentyne
- b) 2-pentanone
- c) trans-2-pentene
- d) methyl pentanoate
- e) pentanal
- f) 2-cyanopentanoic acid
- g) 2-pentanol
- h) 2-pentanamine

31. Which intermolecular force will be the most important in the the following compounds?

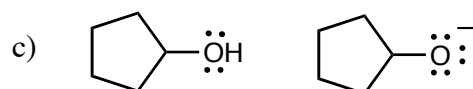
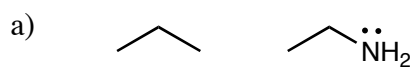


32. Choose the compound in each pair which will have the highest boiling point, and briefly explain your choice.





33. Choose the compound in each pair which will be the most soluble in water, and briefly explain your choice.

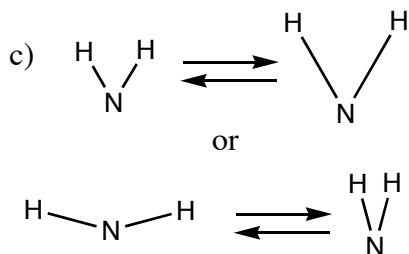


Chapter 3 - IR Spectroscopy

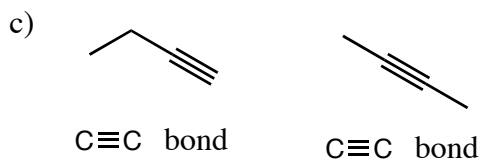
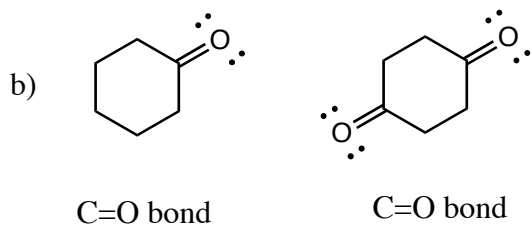
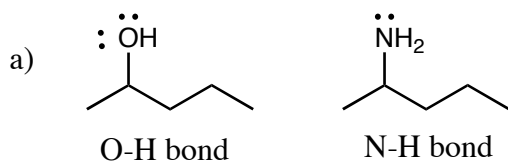
34. What does IR spectroscopy tell you about a compound?

35. Why do organic molecules absorb infrared light?

36. Which of the following bands will absorb light at a higher frequency, and why?



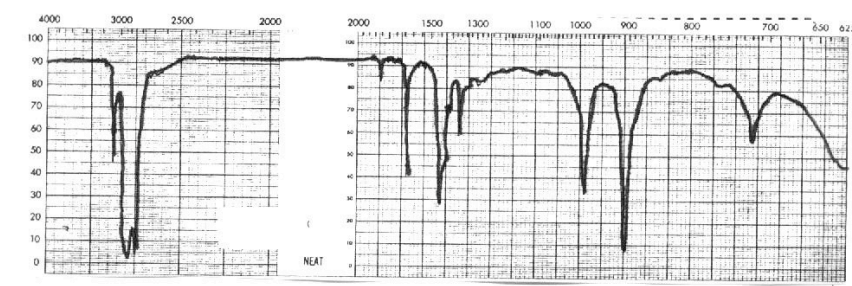
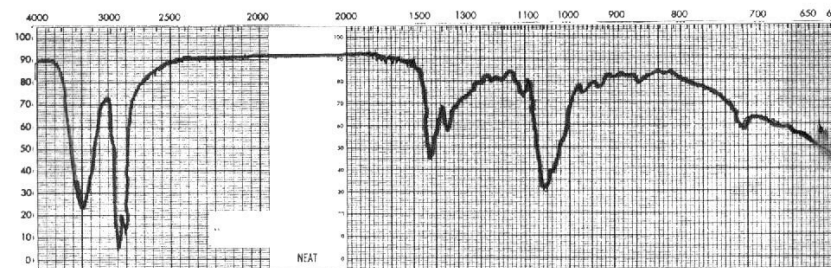
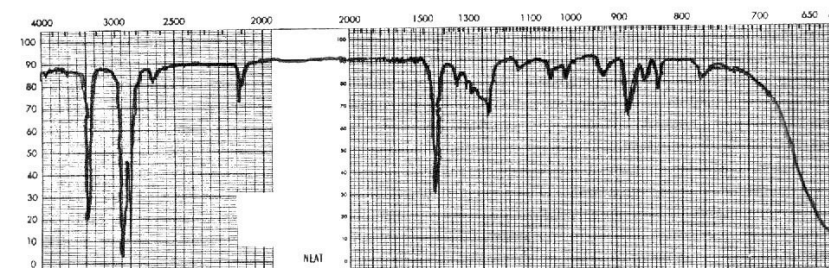
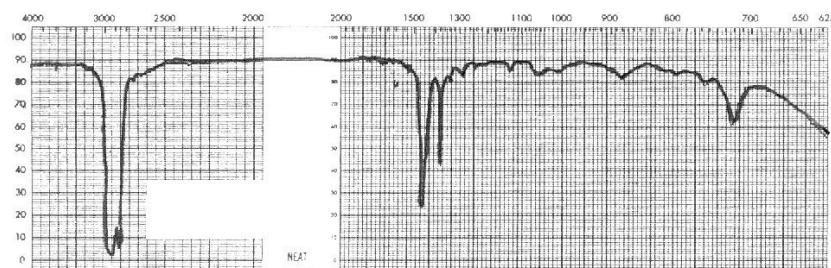
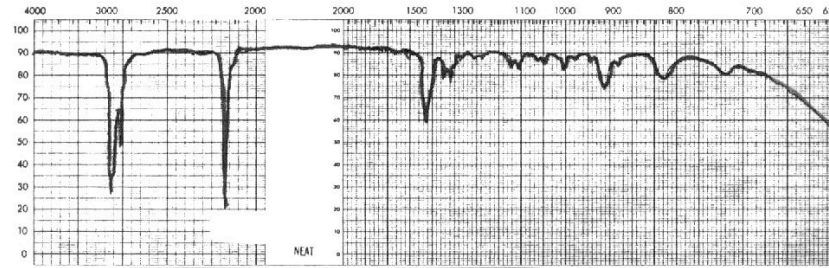
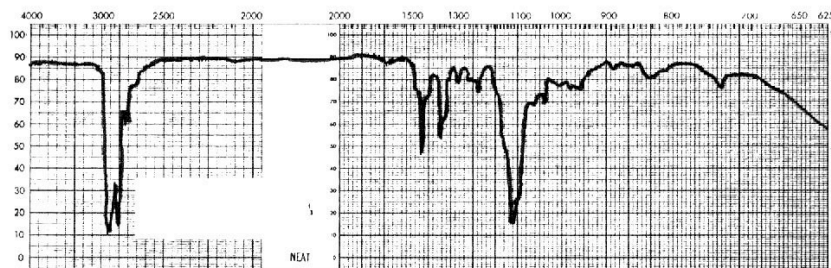
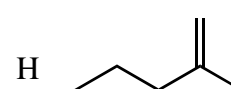
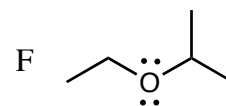
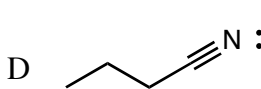
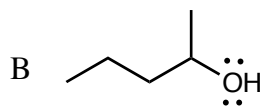
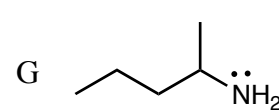
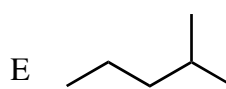
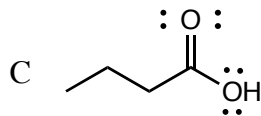
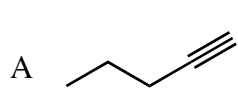
37. In which molecule will the indicated bond absorb more light? Explain your answer.



38. Label the following parts of the frequency axis of an IR spectrum as the "functional group region" or the "fingerprint region."



39. Assign each of the following IR's with one of the compounds shown (not all compounds will be used). Label the important bands

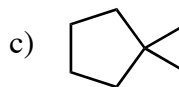
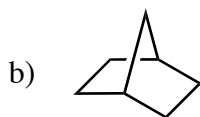
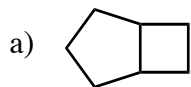


Chapter 4

40. Give the names of the first 10 straight chain alkanes.

41. Give the names of the cyclic alkanes with 3-8 carbons.

42. Label the following as spiro, fused, or bridged bicyclic compounds. Circle the types which are found commonly in nature.



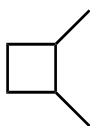
43. Give the molecular formula for a compound which contains:

a) 6 C's and no rings

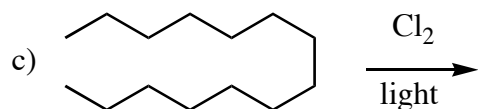
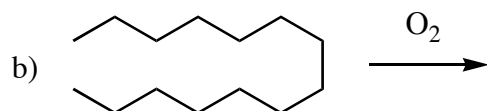
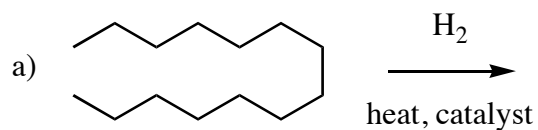
b) 6 C's and one ring

c) 6 C's and two rings

44. Draw all 11 constitutional isomers of the following compound which are cyclic alkanes.



45. Give reasonable products for the following reactions. What is each one called?



46. Draw correct line structures for the following molecules.

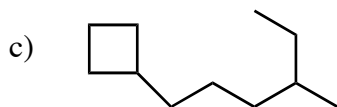
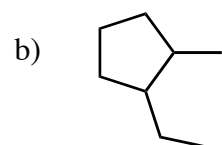
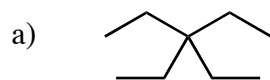
a) 3-ethylhexane

b) 2-cyclopropylbutane

c) 2-methylbutylcyclohexane

d) 3-ethyl-3-methylhexane

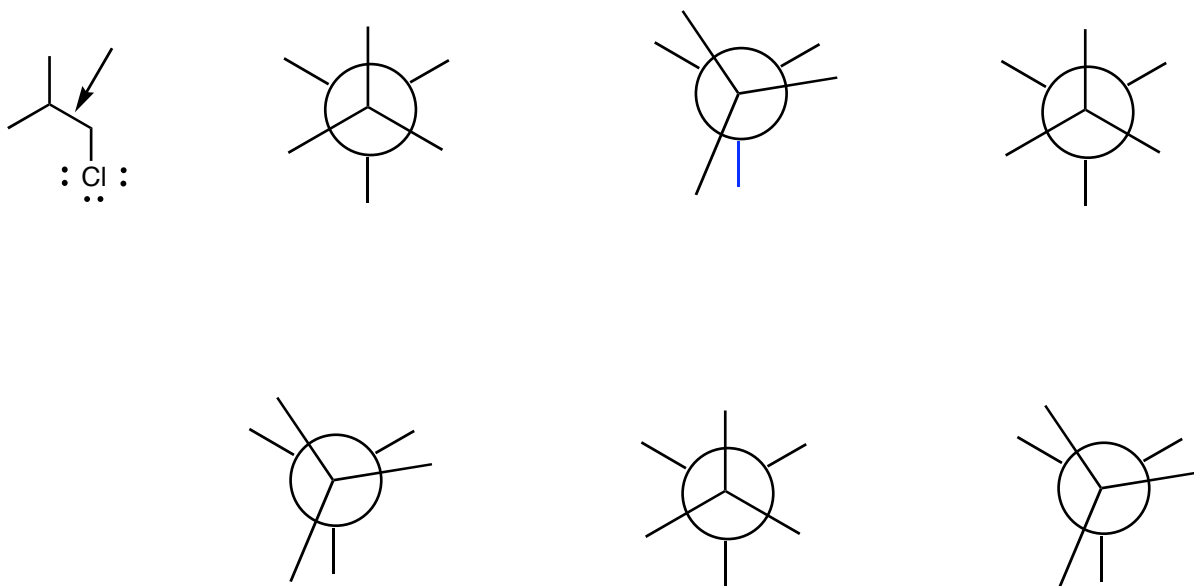
47. Give correct names for the following molecules.



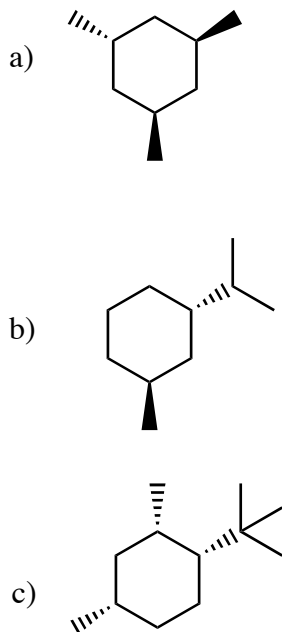
48. a) Draw 6 Newmann projections representing the conformations of the following molecule rotating around the bond indicated.

b) Label the conformations as staggered or eclipsed.

c) Label the conformations with the highest, second highest, lowest, and second lowest energy.

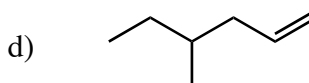
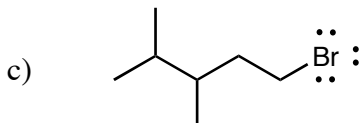
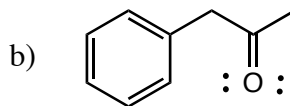
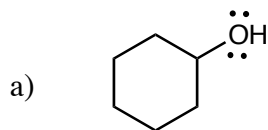


49. Draw both chair conformations of the following molecules. Circle the one which is lower in energy and explain your answer.

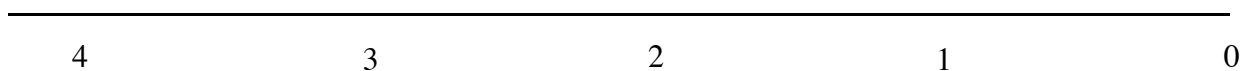
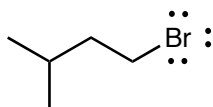


Chapter 5

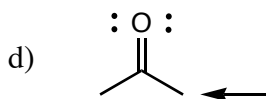
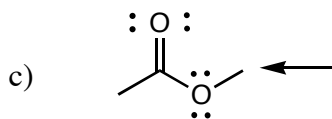
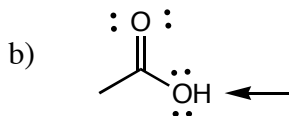
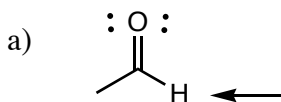
50. How many peaks would you expect to find on a ^1H NMR spectrum and a ^{13}C NMR spectrum for each of the following compounds (assuming none are so close that they overlap)?

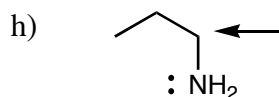
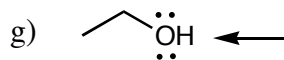
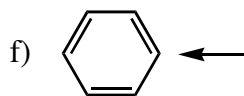
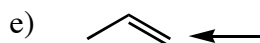


51. Draw in the H's on the following compound. Circle the ones that are equivalent and label them a-d. Draw a chart showing expected chemical shift, integration, and splitting for each peak. Sketch a proton NMR spectrum for the compound, including the peaks and integration line.

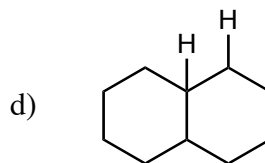
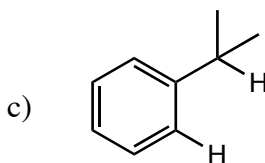
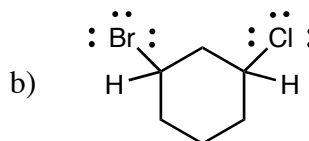
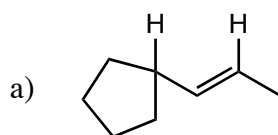


52. In what chemical shift range would you expect to find the following H's?





53. Which of the following labeled H's would you expect to occur further downfield, and why?



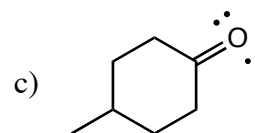
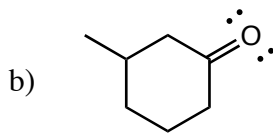
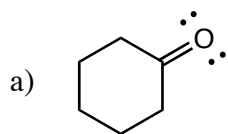
54. a) Why is deuterium useful in NMR?

b) What happens to the spectrum of an alcohol if you add D₂O to the sample?

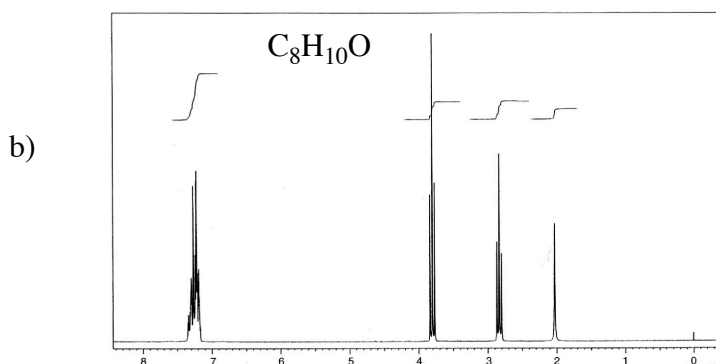
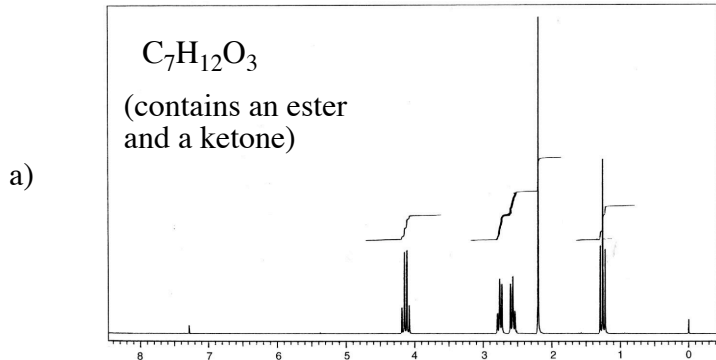
c) What two deuterated solvents are commonly used in NMR?

d) What peaks appear as a result of using these solvents?

55. How many peaks will the ¹³C NMR spectrum of each of the following compounds have?

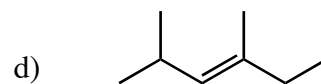
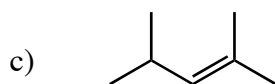
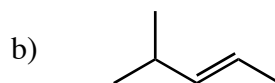
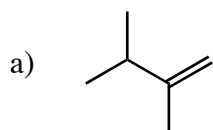


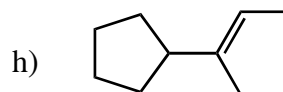
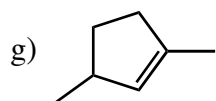
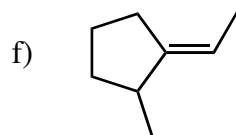
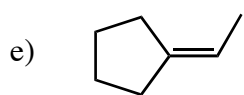
56. Draw a chart showing the chemical shift, integration, and splitting shown in each of the following spectra. Then deduce the structure of the compound, showing how it fits the spectrum.



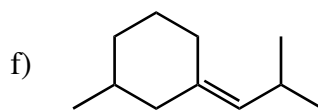
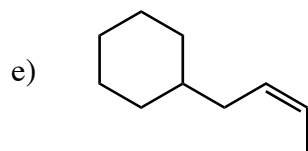
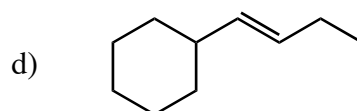
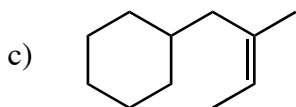
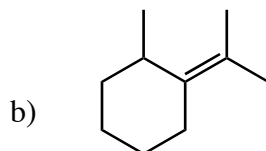
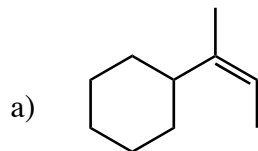
Chapter 6

57. Determine if each of the following compounds will have a stereoisomer. If it will, draw it; if not, write "none".

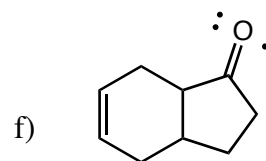
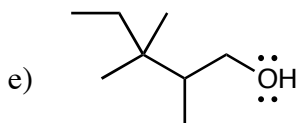
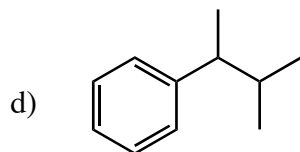
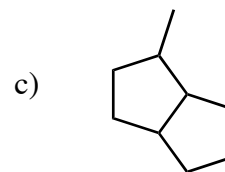
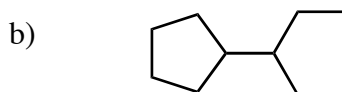
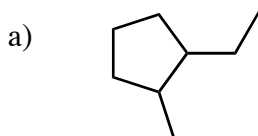




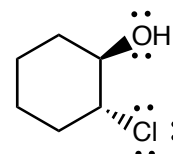
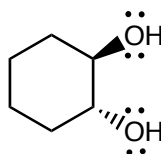
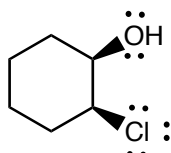
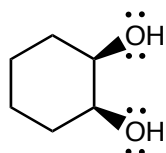
58. Label the following as cis, trans, E, or Z, as appropriate.



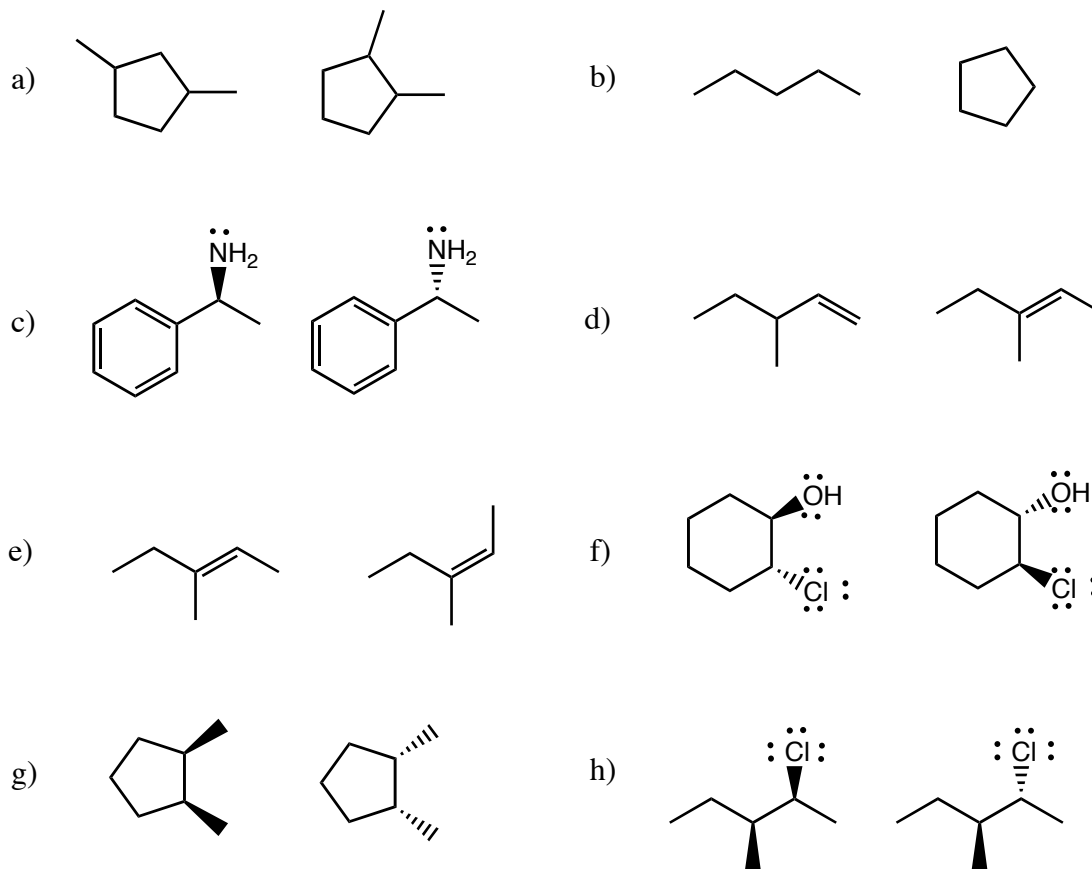
59. Circle all asymmetric carbons in the following molecules.



60. Write "chiral" or "achiral" under each of the following compounds.



61. Give the relationship between each of the following compounds (identical, constitutional isomers, enantiomers, diastereomers, meso, not isomers).

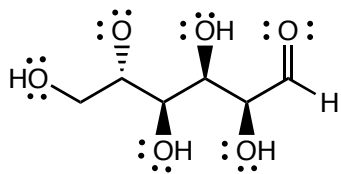


62. Draw a correct line structure for the following compounds.

a) (R)-2,4-dimethylhexane

b) (S)-3-ethyl-1,1-dimethylcyclopentane

63. Draw the Fischer projection for the following compound, and indicate whether it is D or L. Then draw the Fischer projection of its enantiomer, and indicate whether it is D or L.

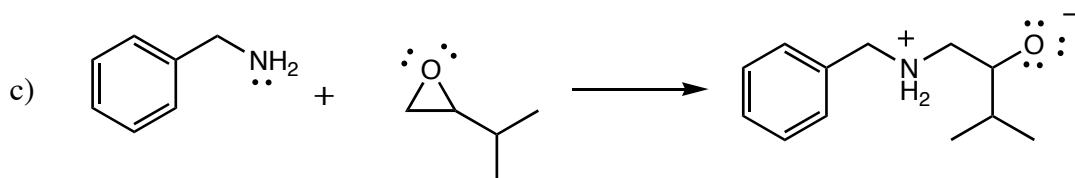
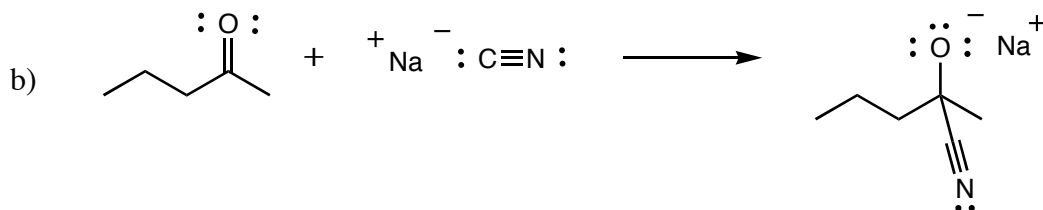
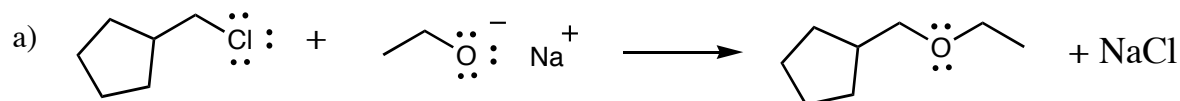


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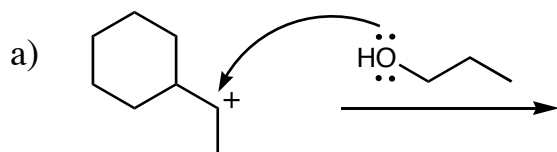
64. Circle the correct answer.

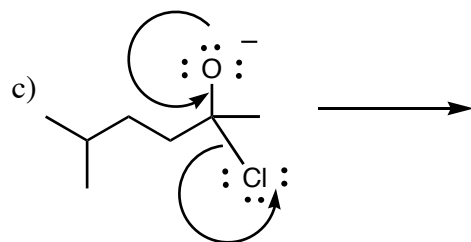
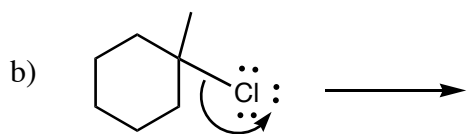
- a) If the K_{eq} is >1 , the reaction is (favorable / unfavorable).
- b) If the ΔG is >0 , the reaction is (favorable / unfavorable).
- c) If you take away a product from a reaction at equilibrium, the (forward / backward) reaction will slow down.
- d) If you take away a product from a reaction at equilibrium, more (reactants / products) will be formed.
- e) If you heat a reaction, the rate will (increase / decrease).

65. Draw in the arrows, and label the nucleophile and electrophile in the following reactions.



66. Using the arrows shown, draw the products of the following reactions - make sure to include any charges.

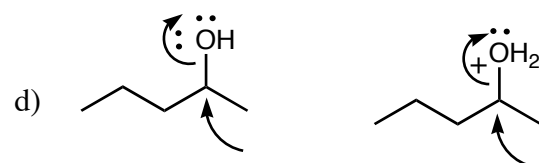
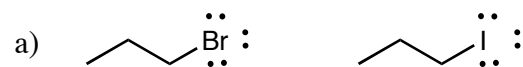




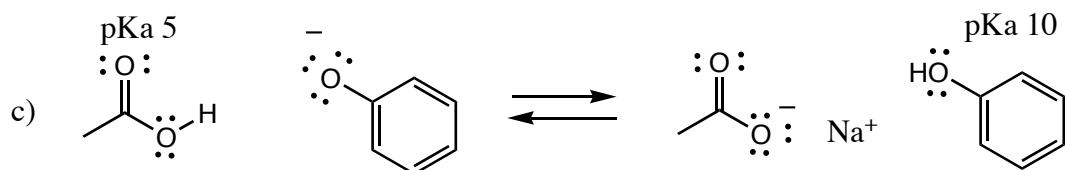
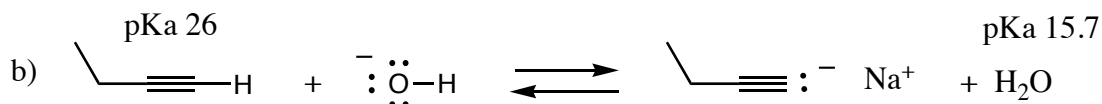
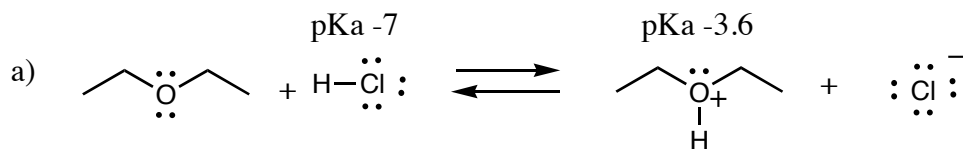
67. Circle the more reactive nucleophile in each pair and briefly explain your choice.



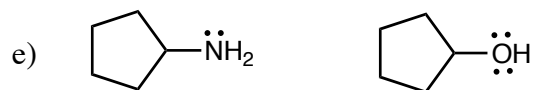
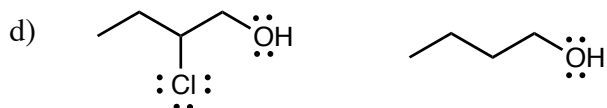
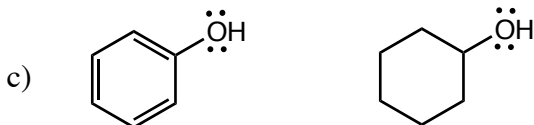
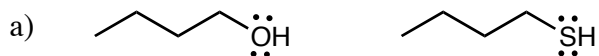
68. Circle the more reactive electrophile in each pair and briefly explain your choice.



69. Identify the acid and base on each side of the following reactions. Then draw arrows showing how the reactions will occur. Next, use the pKa's to calculate the equilibrium constant for the reaction. Finally, answer yes or no - is the first base strong enough to effectively deprotonate the acid?

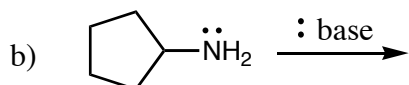
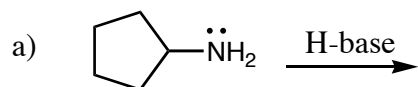


69. Circle the stronger acid, and briefly explain your choice.



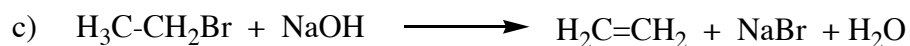
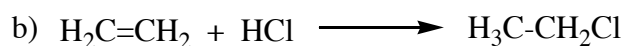
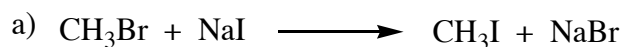
f) acid with a strong conjugate base acid with a weak conjugate base

70. The following compound is amphoteric. Show what would happen to it if it reacted with an acid (shown as H-base) or a base.

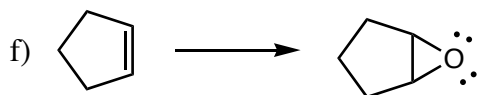
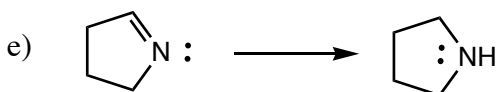
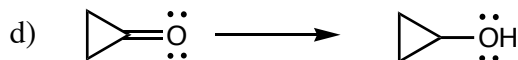
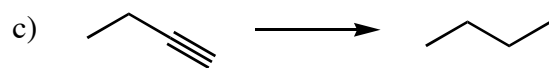
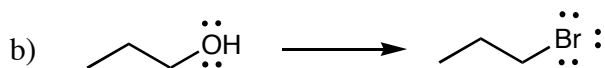
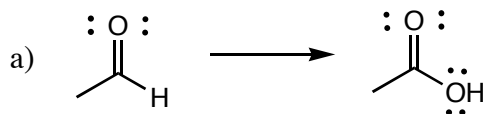


Chapter 8

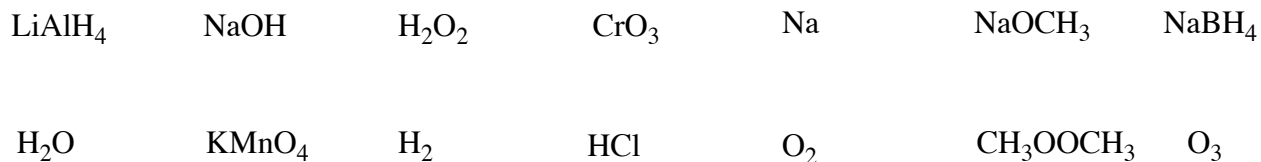
71. Label the following as addition, substitution, or elimination reactions.



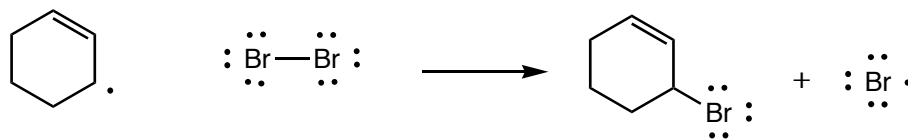
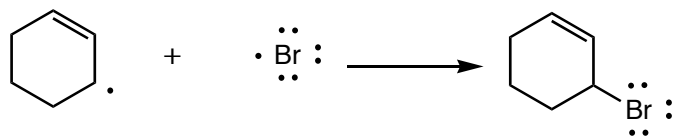
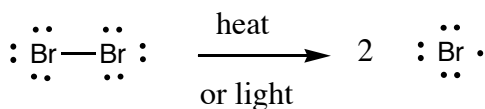
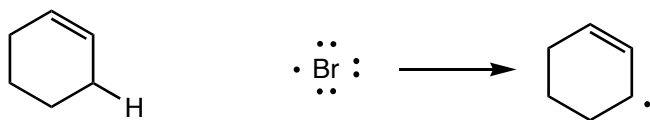
72. Indicate whether oxidation, reduction, or neither are occurring in the following reactions, and explain your answer. Circle the atom(s) being oxidized or reduced.



73. Circle all compounds in the list below that are oxidizing agents; put a box around all compounds that are reducing agents; cross out the compounds that are neither.

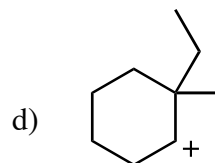
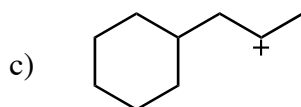
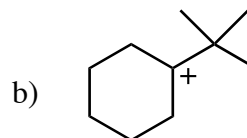
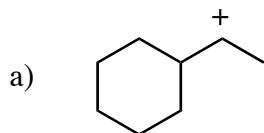


74. Draw in the correct arrows showing how electrons flow in the following reaction. Label the steps as initiation, propagation, or termination. Write the overall reaction which is occurring.

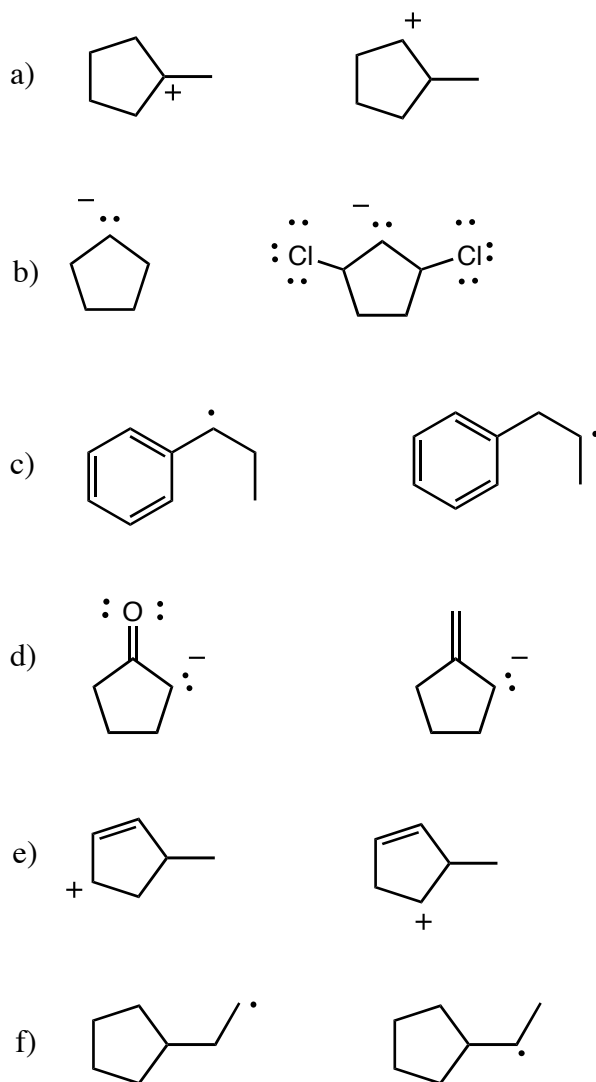


Overall reaction:

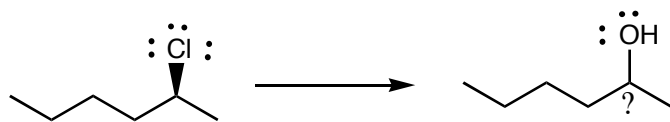
75. For each carbocation below, draw arrows show how a rearrangement could occur, describe the type of rearrangement that will occur, and draw the product would form. If no rearrangements will occur, write "none".



76. Circle the compound in each pair which is the most stable, and briefly explain your answer.



77. Redraw the product of the following substitution reaction according to the stereochemistry given.

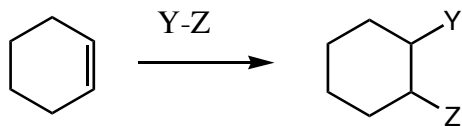


a) stereocenter is conserved

b) stereocenter is inverted

c) stereocenter is racemized

78. Redraw the product of the following addition reaction to show all stereoisomers that would be formed if the reaction had the type of stereochemistry given.



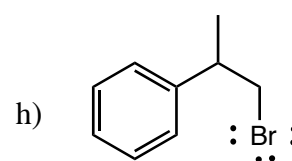
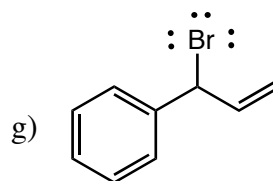
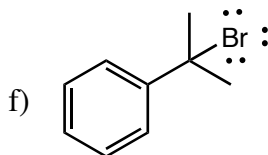
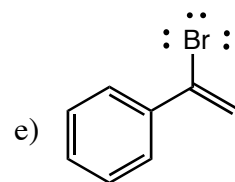
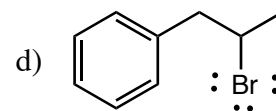
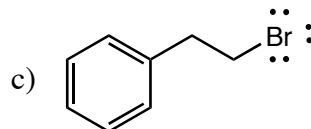
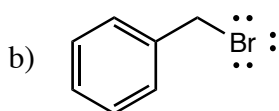
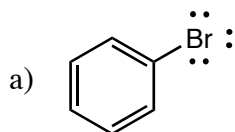
a) syn addition

b) anti addition

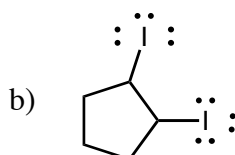
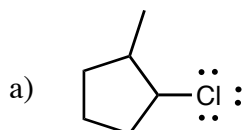
c) nonselective addition

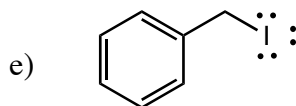
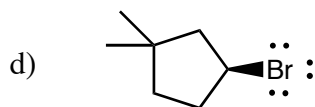
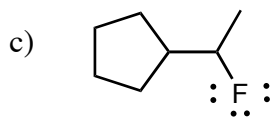
Chapter 9

79. Identify the following halides as alkyl, aryl, or vinyl; then label the alkyl halides which are 1° , 2° , 3° , allyl, or benzyl (more than one may be correct).



80. Give correct names for the following compounds.

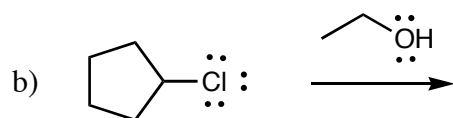
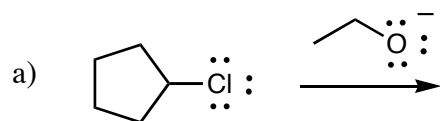




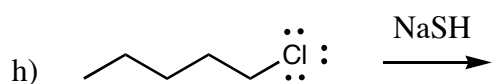
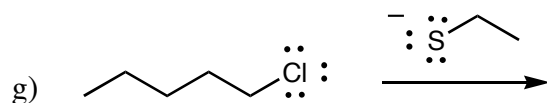
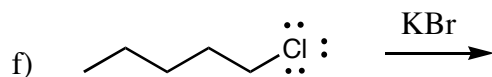
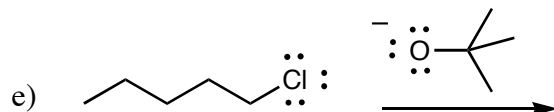
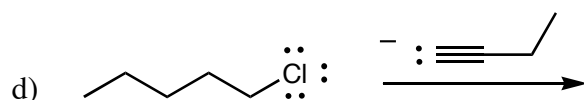
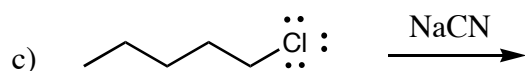
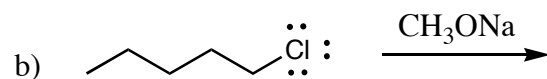
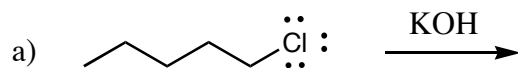
82. Write S_N2 or S_N1 or both after the following descriptions.

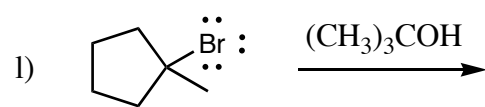
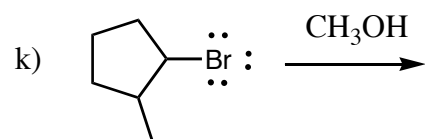
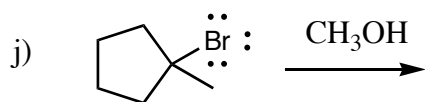
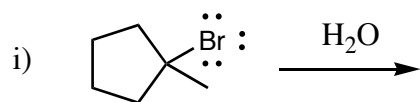
- a) A nucleophile is needed. _____
- b) Occurs in one step. _____
- c) Occurs in three steps. _____
- d) Results in a bond to a halide being replaced by a bond to a new substituent. _____
- e) Will not work with an aryl or vinyl halide. _____
- f) Involves a carbocation intermediate. _____
- g) Is faster in a highly polar but aprotic solvent. _____
- h) Is faster in a high polarity, protic solvent. _____
- i) Is faster with bromine than with chlorine. _____
- j) Rearrangements can occur. _____
- k) Has a second order rate law. _____
- l) Has a first order rate law. _____
- m) Works best with tertiary alkyl halides. _____
- n) Works best with primary alkyl halides. _____
- o) Gives inversion of stereochemistry. _____
- p) Gives racemization of stereochemistry. _____
- q) Happens when a strong nucleophile is present. _____
- r) Happens when a weak nucleophile is present. _____

83. Draw the mechanism for each of the substitution reactions show below. Label then as S_N2 or S_N1 , and explain your reasoning.



84. Give the substitution products of the following reactions. Write the functional group of each product.





85. Write a substitution reaction (starting material and reagent) which could be used to synthesize the following compounds.

