KEY

Organic Chemistry 17-18
Semester 1 Final Exam Study Guide

- ✓ The final exam will be all multiple-choice and true false.
- ✓ Do not bring electronic devices to the exam. This includes cell phones, tablets, game systems. If I see them I will take them.
- ✓ There will be no rest room passes until you are done with the test.
- ✓ This study guide will be worth daily points for completing the assigned portions.
- ✓ BRING A PENCIL!!! Don't come to your final without one.

"Success is a state of mind. If you want success, start thinking of yourself as a success."

- ✓ Keys to success:
  - Review old labs and homework.
  - Complete this study guide using notes, labs, diagrams, the book, and old assignments.
  - Don't wait until Wednesday or Thursday before finals to get help.
  - Start studying early. Remember, you have all winter break to relax.
  - Use old study guides in addition to this study guide for help and extra practice. Be sure to focus on what this study guide covers, but those old study guides help a lot.
  - Be prepared.

Final exam will cover chapters 1, 2, 3, 4, and 7.

1st Semester Finals Schedule					
Wednesday, January 10th		Thursday, January 11th		Friday, January 12th	
Resource	8:10-9:40	Resource	8:10-9:40	Resource	8:10-8:45
5th period	9:50-11:20	1st period	9:50-11:20	3rd period	8:50-10:20
6th period	12:20-1:50	2nd period	12:20-1:50	4th Period	10:30- 12:00
7th period	2:00-3:30	Resource	2:00-3:30	Busses Leave	12:30
				8th period make-up	12:30-3:30

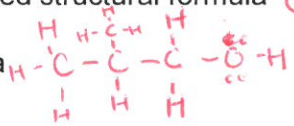
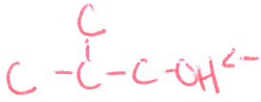
Chapter 1 Bonding & Isomerism (18 Questions):

1. What charge the ion will carry when each of the following elements reacts to form an ionic compound: Al, Li, S, H.

   Al^{+3} Li^{+1} S^{-2} H^{+1}

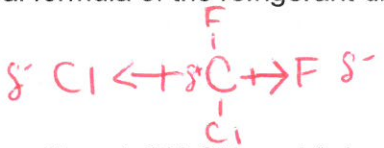
2. Which is the more electropositive element: (Na) or Al, (B) or C, B or (Al). (Circle correct choice.)

3. Which is the more electronegative element: O or (F), (O) or N, (F) or C. (Circle correct choice.)

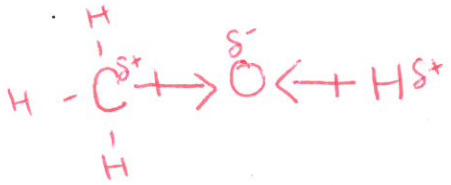
4. For $(CH_3)_2CHCH_2OH$, list the following::
   a. Molecular formula C_4H_9OH or $C_4H_{10}O$
   b. Abbreviated/condensed structural formula GIVEN IN #4
   c. Full structural formula 
   d. Skeletal formula 
   e. Line segment

5. Diagram the polarity of the N-Cl bond and of the S-O bond with δ+ and δ-.

6. Draw the full structural formula of the refrigerant dichlorodifluoromethane and indicate the polarity of the bonds.

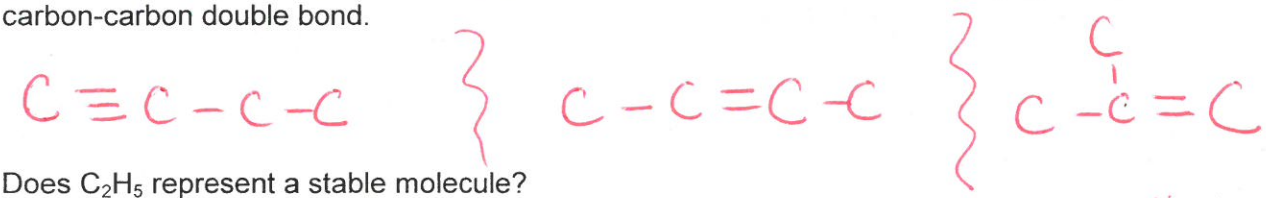
   

7. Draw the formula for methanol, CH_3OH, and (where appropriate) indicate bond polarity with an arrow, .

8. Draw the Lewis Electron Dot diagram for H_2CO

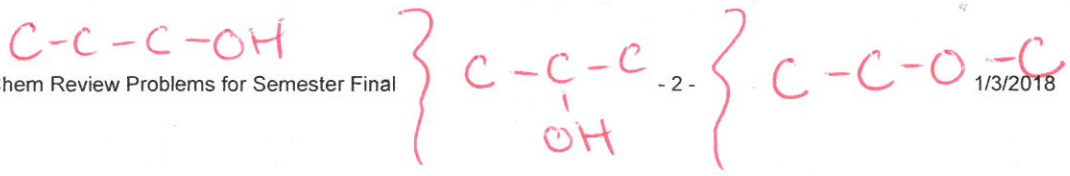
9. Draw skeletal formulas for three different molecules that have the formula, C_4H_8, and have one carbon-carbon double bond.

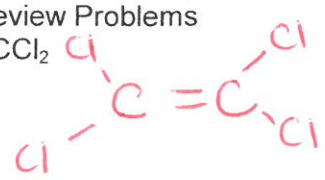
10. Does C_2H_5 represent a stable molecule?

    No, you can't draw a structure to fill all valences so that Carbon has 4 bonds & Hydrogen has 1

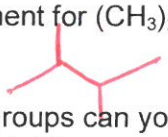
11. Draw structural formulas for all isomers of C_3H_8O (there are 3).

12. Write a structural formula that shows all bonds for $CCl_2=CCl_2$



13. Write a line-segment for $(CH_3)_2CHCH(CH_3)_2$.



14. What functional groups can you find in the following natural products? (Their formulas are given in Figures 1.11 and 1.12, pages 33-34)

a. geraniol
- alkene
- alcohol

b. muscone
- ketone
- (alkane too)

c. limonene
- alkene

d. testosterone
- ketone
- alcohol
- alkene

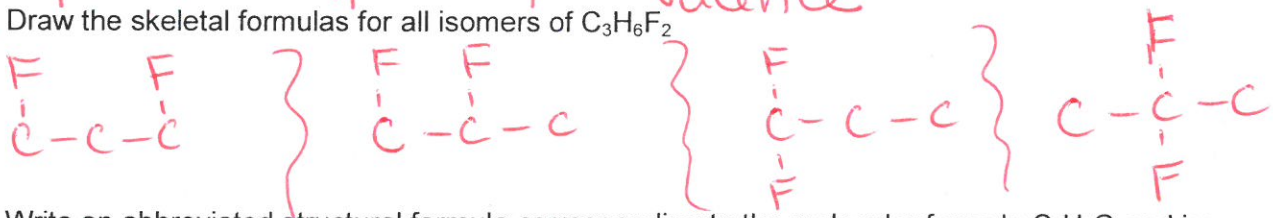
15. Are the following ionic or covalent? If covalent, is it polar or non-polar?

a. Br_2 - covalent/nonpolar
b. LiBr - ionic
c. $SiCl_4$ - covalent/polar
d. KCl - ionic
e. PCl_3 - covalent/polar
f. P_2O_5 - covalent/polar

16. How many valence electrons does each of the following have, and what is its valence? Oxygen Fluorine Carbon Hydrogen

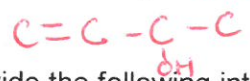
	Fluorine	Carbon	Hydrogen
# ve⁻	7	4	1
valence	1	4	1

17. Draw the skeletal formulas for all isomers of $C_3H_6F_2$



18. Write an abbreviated structural formula corresponding to the molecular formula C_4H_8O and is:

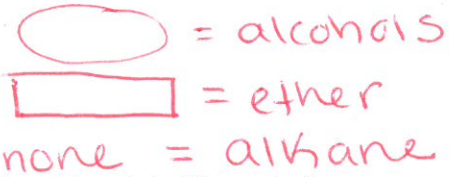
a. Acyclic many possible



b. carbocyclic

c. heterocyclic

19. Divide the following into groups that might be expected to exhibit similar chemical properties. List the characteristic that defines each group: C_5H_{12} CH_3OCH_3 C_3H_7OH C_4H_9OH C_8H_{18} $CH_3OCH_2CH_3$ $HOCH_2CH_2OH$ CH_3OH C_6H_{14}



20. Write abbreviated formula for:

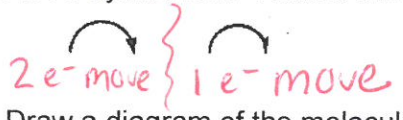
a). $CH_3CH_2C(CH_3)=CH_2$
b). $CH_3C(CH_3)_2CH(CH_3)_2$
c). $CH_3CH_2OCH_2CH_3$

a.

b.

c.

21. Arrow symbolism: What is the difference in meaning between the following 2 arrows?



22. Draw a diagram of the molecule that would be formed based on the arrows:

23. Thinking Critically: As you flip through your notes and past lab activities from chapter one, are there any topics left out? If so list them below and provide an example for each.

Formal Charge

S/P orbitals (see pg 11)

Chapter 2 Alkanes & cycloalkanes; Conformational & Geometric Isomerism (23 Questions)

24. What is the molecular formula of an alkane with 20 carbon atoms? An alkene? An alkyne?

alkane $C_{20}H_{42}$ / alkene $C_{20}H_{40}$ / alkyne $C_{20}H_{38}$

25. Which of the following are alkanes?

a. C_8H_{16} NO b. C_7H_{16} yes c. C_7H_{18} NO d. $C_{27}H_{56}$ yes

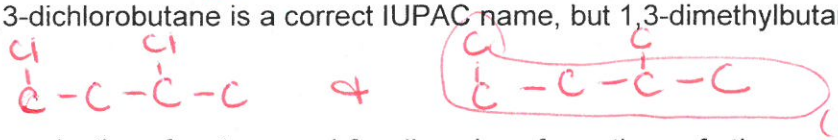
26. Give the correct IUPAC name for CH_2BrCl.

bromochloromethane or 1 bromo-1 chloro methane

27. Write the formula for each of the following compounds:

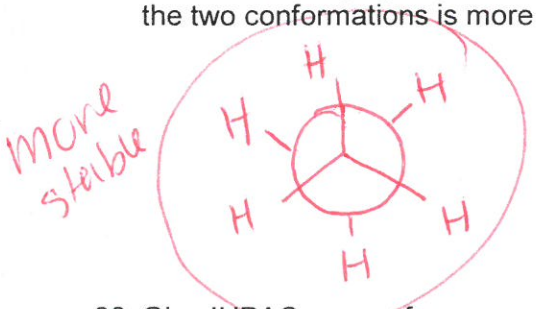
a. 2-chloropropane $CH_3CH(Cl)CH_3$ or C-C(Cl)-C b. all alkyl fluorides R-F or $C_nH_{(2n+1)}F$

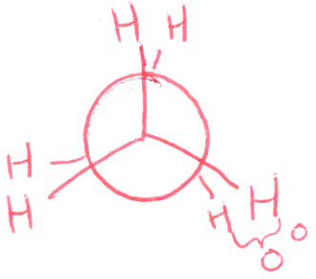
28. Explain why 1,3-dichlorobutane is a correct IUPAC name, but 1,3-dimethylbutane is not a correct IUPAC name.



should be 2-methyl pentane (longest chain is 5 C)

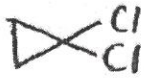
29. Draw Newman projections for staggered & eclipsed conformations of ethane, and predict which of the two conformations is more stable.

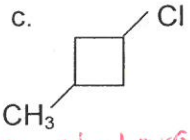




30. Give IUPAC names for:

a. ethyl cyclobutane

b.  1,1-dichloro cyclopropane

c.  1-chloro-3methyl cyclobutane.

31. Draw the structure for the cis and trans isomers using solid and dashed wedges:
    a. 1,2-dichlorocyclopropane

    b. 1-bromo-3-chlorocyclobutane

32. Classify each of the following isomer pairs according to the scheme in Figure 2.5 (structural, conformational, or configurational isomers):
    a. 1-bromopropane and 2-bromopropane structural
    b. cis- and trans-1,2-dimethylcyclohexane configurational

33. Which represents the more oxidized form of carbon, (a) methanol (CH_3OH) or formaldehyde ($CH_2=O$)? (b) methanol or dimethyl ether (CH_3OCH_3)?

more bonds with oxygen

neither - both equally oxidized.

$\frac{1C-O}{1C} = 1$ $\frac{2C-O}{2C} = 1$

34. Write an equation for the monobromination of methane.

$$CH_4 + Br_2 \xrightarrow[\text{light}]{\text{heat}} CH_3Br + HBr$$

35. Write abbreviated structures of all possible products of monobromination of pentane.

$CH_2BrCH_2CH_2CH_2CH_3$ $\}$ $CH_3CHBrCH_2CH_2CH_3$ $\}$ $CH_3CH_2CHBrCH_2CH_3$

36. How many organic products can be obtained from the monobromination of cyclopentane?

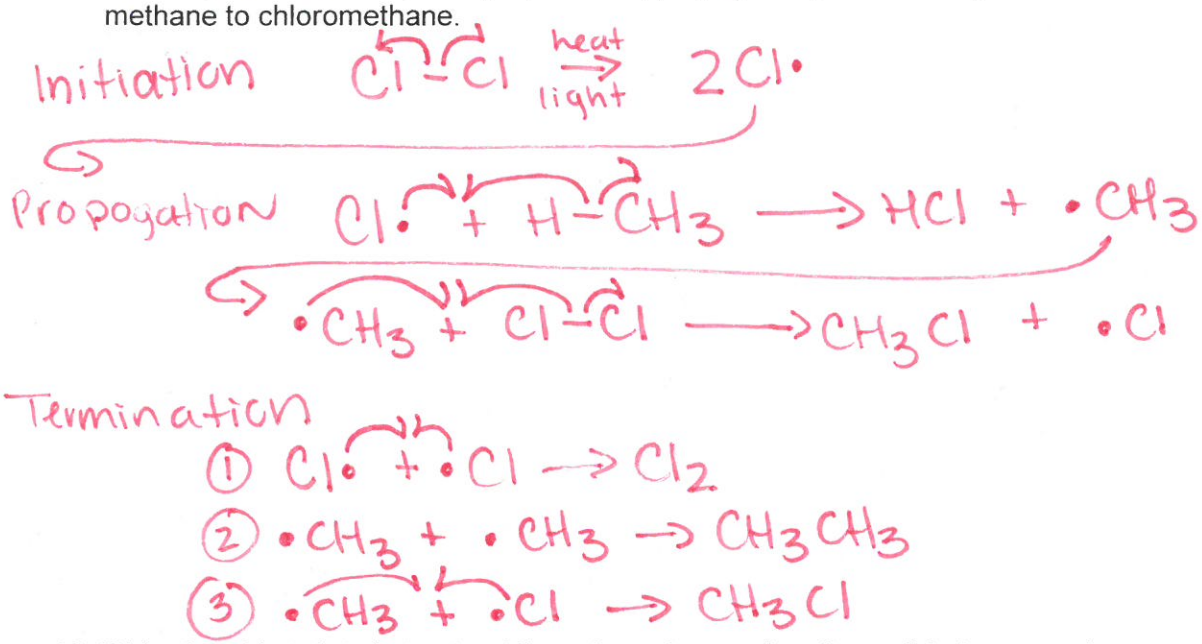
Only 1

no matter what corner the Br is on, it's 1-bromocyclopentane.

37. List the following in order of increasing boiling point (list lowest boiling point first)
    A. 2-methylhexane B. Heptane C. 3,3-dimethylpentane D. Hexane E. 2-methyl-pentane

E < D < C < A < B

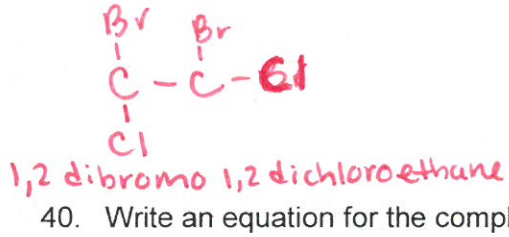
38. Write equations for all the steps (initiation, propagation, termination) in the free radical chlorination of methane to chloromethane.



39. Write the abbreviated structural formula and name for all possible isomers of:

A. C_4H_{10} (2) $CH_3CH_2CH_2CH_3$ butane | CH_3CHCH_3 CH_3 2-methyl propane

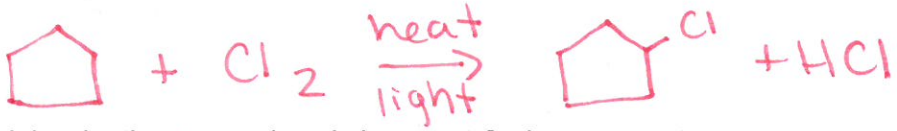
B. $C_2H_2Cl_2Br_2$ (3)



1,2 dibromo 1,2 dichloroethane | 1,1 dibromo 2 dichloroethane | 2,2 dibromo 1,1 dichloro ethane

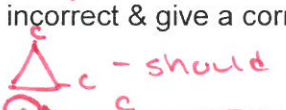
40. Write an equation for the complete combustion of hexane

41. Write an equation for the monochlorination of cyclopentane



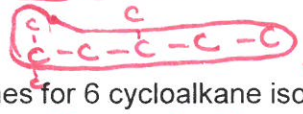
42. Explain why the name given is incorrect & give a correct name:

a. 1,3-dimethylcyclopropane



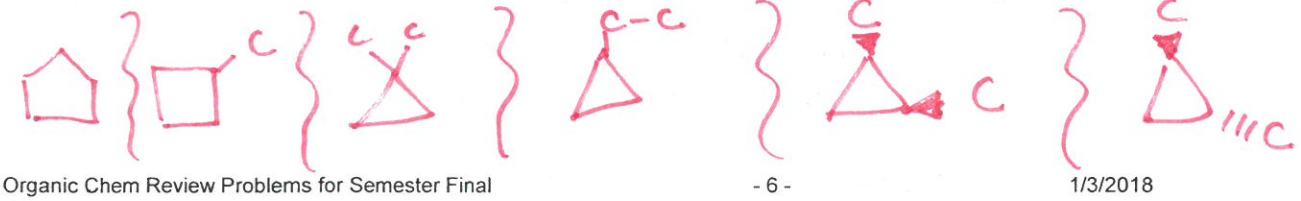
should be 1,2 dimethylcyclopropane

b. 1,1,3-trimethylpentane

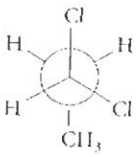


Didn't count the longest chain. Shd be 2,4 dimethyl hexane

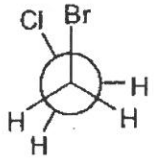
43. Write skeletal formulas & names for 6 cycloalkane isomers w/the following molecular formula: C_5H_{10}



44. Name the molecules below.

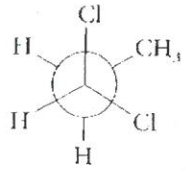
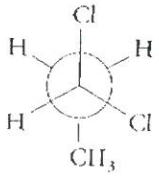


1,1 dichloropropane

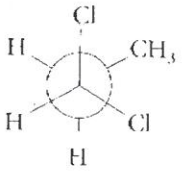
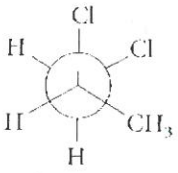


1 bromo 2 chloro pentane

45. Are the following structural isomers, conformational, configurational, or identical?

c.  and 

• conformational (rotamers)

d.  and 

• structural (-Cl on different carbons)

e. $CH_3CHCH_2CH_2CH_3$ (with CH_3 branch) and $CH_3CH_2CH_2CHCH_3$ (with CH_3 branch)

• identical (same name)

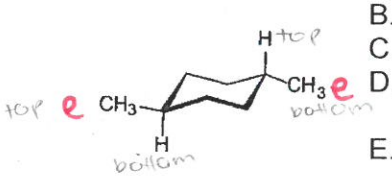
46. Boat & chair isomers:

A. What type of isomers are they; conformational, rotamers or structural?

B. Is the diagram at the left a boat or chair?

C. Label each CH3 group as axial or equatorial.

D. Name the molecule, including a cis or trans prefix.

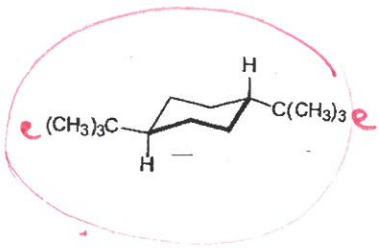


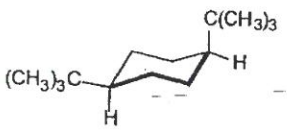
trans 1,4 dimethylcyclohexane

E. How would a ring flip affect axial/equatorial positions and cis/trans orientation?

change

stays the same





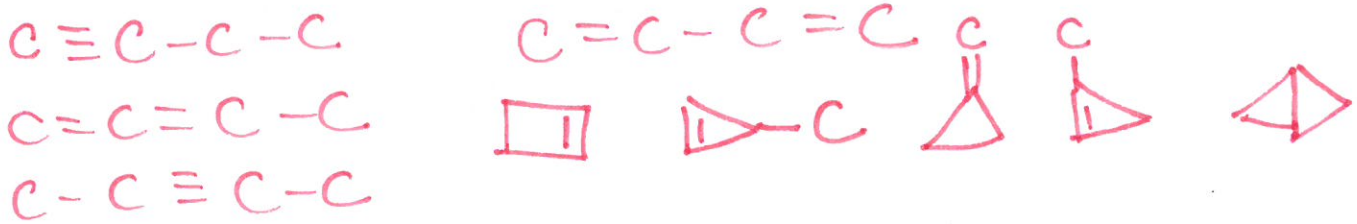
F. Which molecule is more stable? Circle it and explain why.

Both groups (substituents) are equatorial

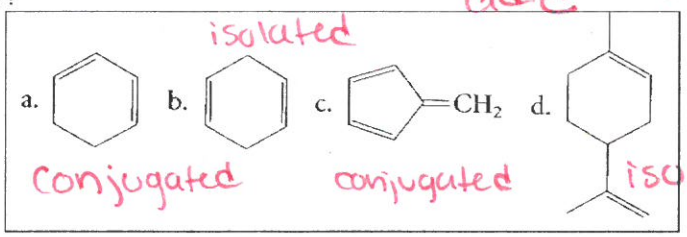
47. Thinking Critically: As you flip through your notes and past lab activities from chapter two, are there any topics left out? If so list them below and provide an example for each.

Chapter 3 Alkenes & Alkynes (23 Questions)

48. What are all the structural possibilities for C_4H_6? (4-acyclic & 5 cyclic. List 5 of them.)

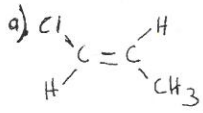


49. Which of the following compounds have conjugated multiple bonds? If not conjugated, what kind of bonds are they?



50. Name each of the following structures by the IUPAC system. Include cis/trans or E/Z if appropriate.

trans 1-chloro-1-propene

a) 

b. $(CH_3)_2C=C(CH_3)_2$

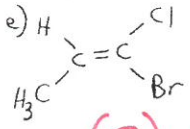
2,3, dimethyl 2butene

3-methyl-1-pentene

c. $CH{\equiv}CCH(CH_3)CH{=}CH_2$ -4yn

d)

1 methylcyclohexene

e) 

(Z)-1 bromo-1 chloro-1 propene

f. $HC{\equiv}C(CH_2)_3CH_3$

1-hexyne

51. Write the abbreviated structural formula for:

a. 2,4-dimethyl-2-pentane

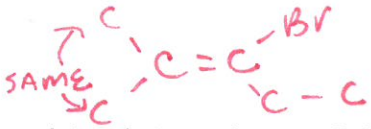
b. 2-hexyne

c. 1,2-dibromocyclobutene

d. 2-chloro-1,3-butadiene

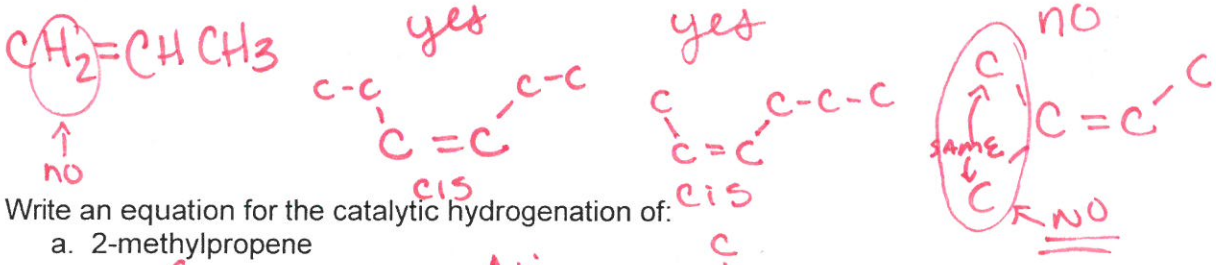
e. ~~(E)~~-3-bromo-2-methyl-2-pentene

not possible



52. Which of the following compounds can exist a cis-trans isomers? Draw their structures.

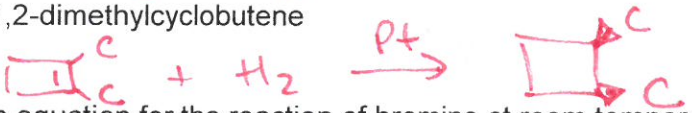
a. propene b. 3-hexene c. 2-hexene d. 2-methyl-2-butene



53. Write an equation for the catalytic hydrogenation of:

a. 2-methylpropene

b. 1,2-dimethylcyclobutene



cis results from hydrogenation

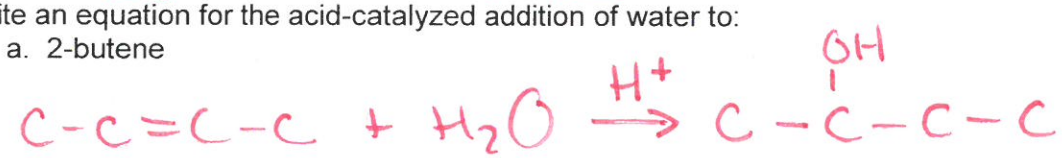
54. Write an equation for the reaction of bromine at room temperature with:

a. 1-butene

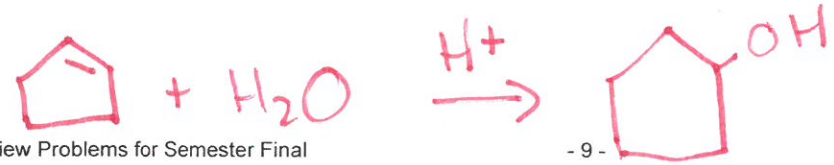
b. cyclohexene

55. Write an equation for the acid-catalyzed addition of water to:

a. 2-butene

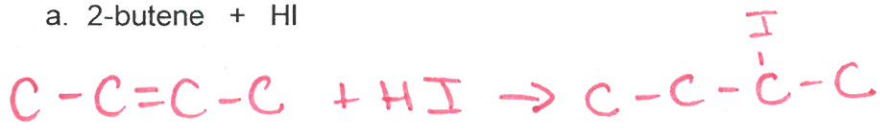


b. cyclopentene

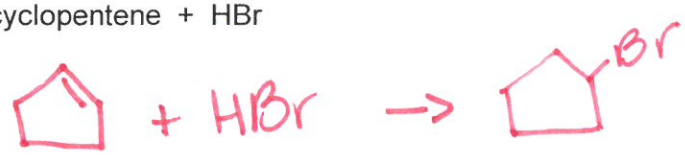


56. Write an equation for each of the following reactions:

a. 2-butene + HI

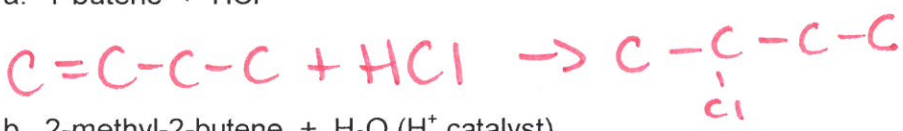


b. cyclopentene + HBr



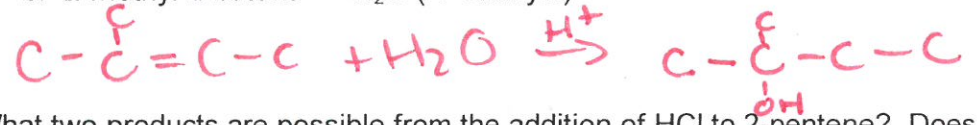
57. Use Markovnikov's rule to predict which regioisomer predominates in each of the following reactions:

a. 1-butene + HCl

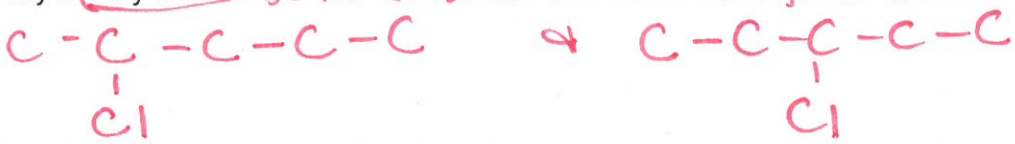


NOT

b. 2-methyl-2-butene + H_2O (H^+ catalyst)



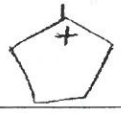
58. What two products are possible from the addition of HCl to 2-pentene? Does one predominant? Why or why not? BOTH carbons of the original bond have the same #H



59. Classify each of the following carbocations as primary, secondary, or tertiary:

a. 2°

b. 1°

c. 3° 

60. Which carbocation in Question #57 above is most stable? Least stable?

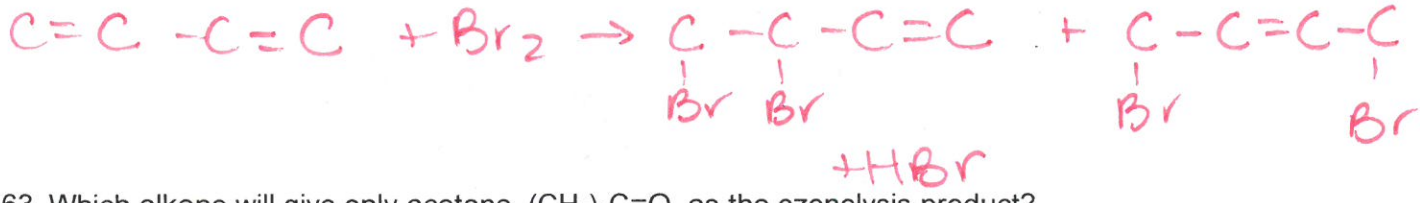
3° 1°

61. Explain why in the first step in the addition of HBr to 1,3-butadiene, the proton adds to C-1 and not C-2.

$CH_2=CHCH=CH_2$

Has more H than C-2

62. Write an equation for the expected products of 1,2-addition and 1,4-addition of Br to 1,3-butadiene.



+HBr

63. Which alkene will give only acetone, $(CH_3)_2C=O$, as the ozonolysis product?

$(CH_3)_2C=C(CH_3)_2$

64. Write equations for the following reactions:

a. $CH_3C{\equiv}CH + Cl_2$ (1 mol) $\longrightarrow$ $CH_3C(Cl)=CHCl$

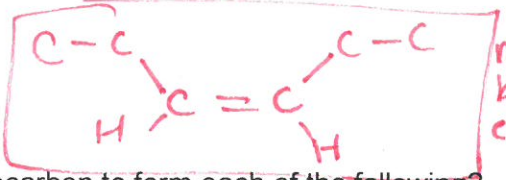
b. $CH_3C{\equiv}CH + Cl_2$ (2 mol) $\rightarrow$ $CH_3C(Cl)_2-CHCl_2$

c. 1-butyne + HBr (1 and 2 mol)

1 mol $C{\equiv}C-C-C + HBr \rightarrow C=C(Br)-C-C$

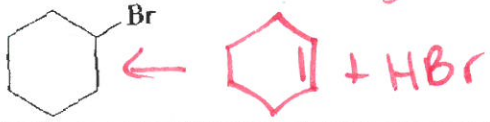
2 mol $C{\equiv}C-C-C + 2HBr \rightarrow C-C(Br)_2-C-C$

65. Write an equation for the hydrogenation of 3-hexyne using Lindlar's catalyst.

$C-C-C{\equiv}C-C-C + H_2 \xrightarrow{\text{Lindlars}}$  must be cis

66. What reactant will react by addition with what unsaturated hydrocarbon to form each of the following?

a. $CH_3CHClCHClCH_3 \leftarrow CH_3CH=CHCH_3 + Cl_2$

d. 

c. $(CH_3)_3COH \xleftarrow{H^+} C-C=C + H_2O$

f. $CH_3CCl_2CCl_2CH_3 \leftarrow C-C{\equiv}C-C + 2Cl_2$

67. Does a carbon with four single bonds have....

A. sp^3, sp^2 or sp orbitals around it?

B. Any p orbitals around it? NO

68. What is an sp^3 orbital? hybrid orbital formed by a combination of 1s + 3p orbitals (angle is 109.5°).

69. Describe the structure of a pi bond. horizontal sharing of e⁻

a. What type of orbitals combine to make a pi bond? two p orbitals

b. Where do you find pi bonds in a molecule? found in double and triple bonds between adjacent carbons (lateral overlap)

70. What type of bond is formed between the carbon and each hydrogen in methane?

sigma.

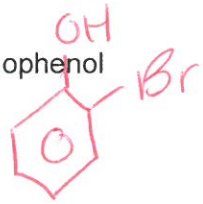
71. Thinking Critically: As you flip through your notes and past lab activities from chapter three, are there any topics left out? If so list them below and provide an example for each.

Chapter 4 Aromatic Compounds (24 Questions)

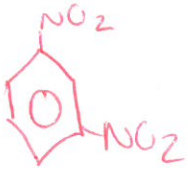
72. Draw the structure of:

a. *p*-nitrotoluene

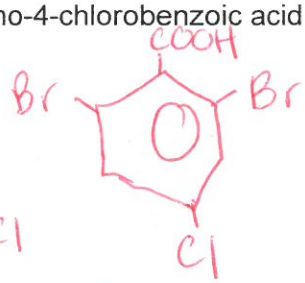
b. *o*-bromophenol



c. *m*-dinitrobenzene

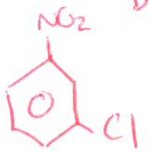


d. 2,6-dibromo-4-chlorobenzoic acid

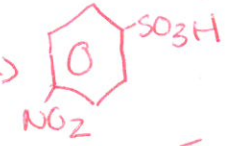


73. Indicate the main monosubstitution products:

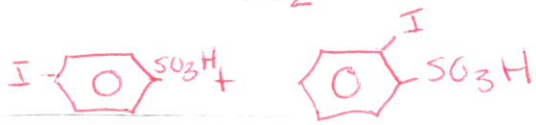
a. Nitrobenzene + chlorine (Fe catalyst) →



b. Benzenesulfonic acid + HNO3 (H2SO4 catalyst) →

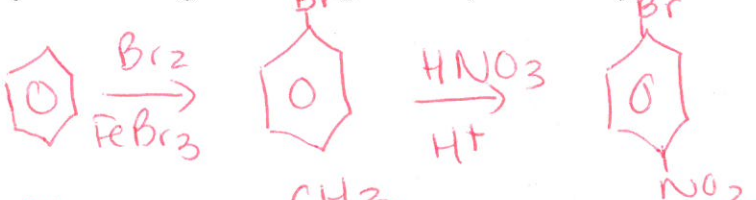


c. Iodobenzene + H2SO4 + SO3 →

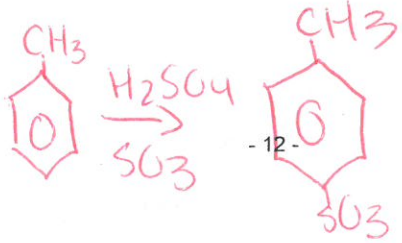


74. Using benzene or toluene as the only aromatic organic starting material, devise a synthesis for the following:

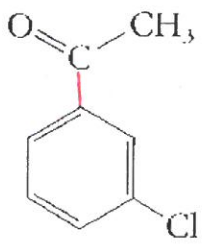
d. P-bromonitrobenzene

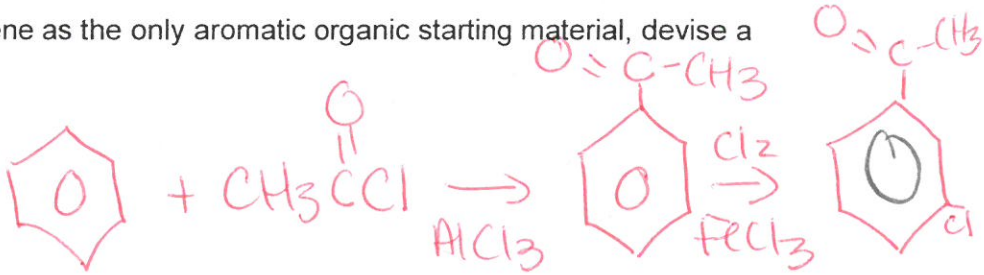


e. P-methylsulfonicacid

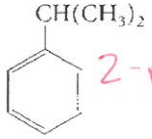


74 Continued: Using benzene or toluene as the only aromatic organic starting material, devise a synthesis for the following:

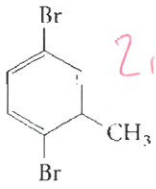


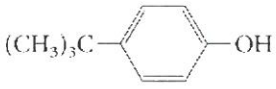


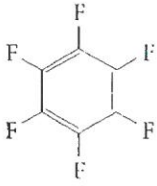
75. Name:

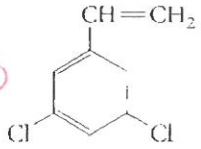
a. 
2-phenyl propane

b.
m-bromo benzaldehyde

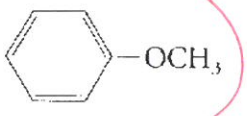
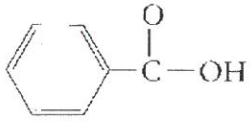
d. 
2,5-dibromo toluene

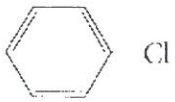
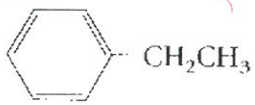
e. 
p (1,1-dimethylethyl) phenol

g. 
hexafluoro benzene

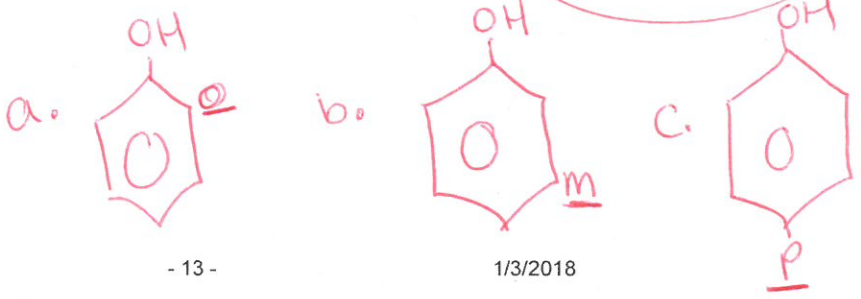
h. 
3,5-dichlorostyrene

76. Which compound is more reactive toward electrophilic substitution (for example nitration)?

a.  or 

b.  or 

77. Draw an example of each for phenol
   a. O placement
   b. M placement
   c. P placement



78. What is an activator? it speeds up a reaction

a. How do you recognize them?
All o/p directers

b. What molecules are the exception to this rule?
Halogens

c. What happens to reaction rate if you have 2 activators on a benzene ring?
It is 2x as fast

d. What happens to reaction rate if you have an activator with a deactivator on a benzene ring? it cancels and runs as normal

79. What is a deactivator? slows a reaction

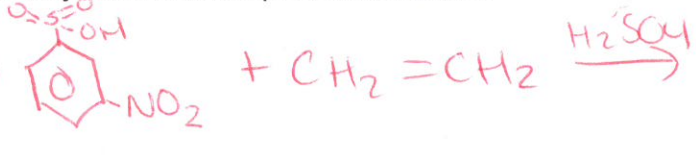
a. How do you recognize them?
m directors + Halogens

b. What happens to reaction rate if you have 2 deactivators on a benzene ring?
It is 2x as slow

80. What is a polycyclic molecule?
multiple rings

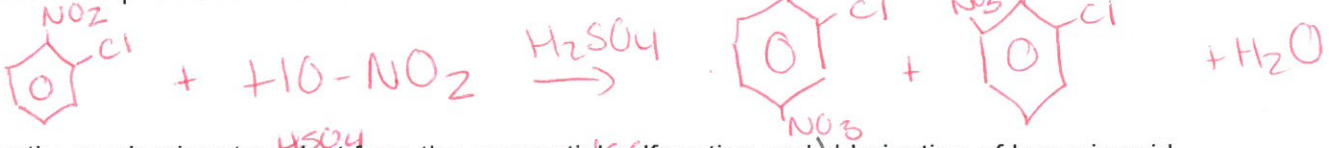
a. Draw an example below:

81. If m-nitrobenzenesulfonic acid is treated with $CH_2 = CH_2$ in the presence of H2SO4, draw and name the only trisubstituted product observed.

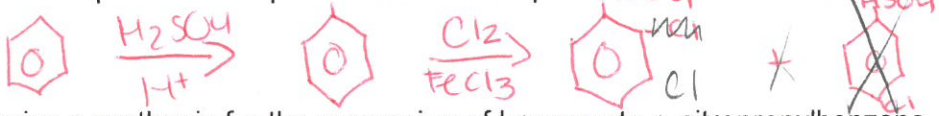


4 ethyl 3 nitro benzenesulfenic acid

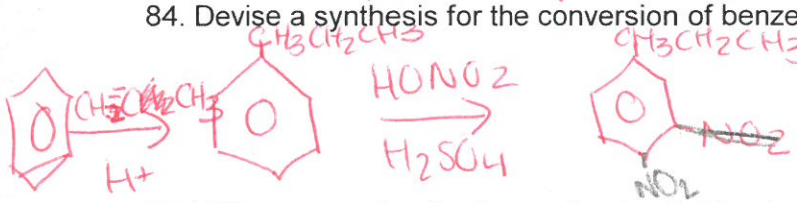
82. If o-chloronitrobenzene is treated with HNO3 in the presence of H2SO4, how many trisubstituted products are possible? Draw & name them. 2



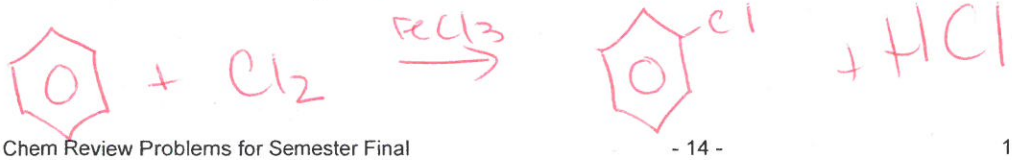
83. Draw the predominant product from the sequential sulfonation and chlorination of benzoic acid.



84. Devise a synthesis for the conversion of benzene to p-nitropropylbenzene.



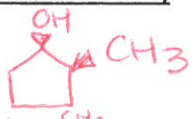
85. Write an equation for the synthesis of chlorobenzene from benzene



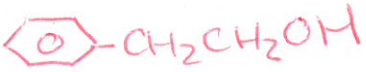
86. Thinking Critically: As you flip through your notes and past lab activities from chapter four, are there any topics left out? If so list them below and provide an example for each.

Chapter 7:Alcohols, Phenols & Thiols (29 Questions)

87. Write an abbreviated formula for:

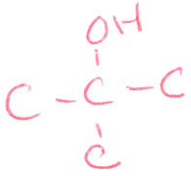
a. Cis-2-methylcyclopentanol 

b. 2-methyl-2-propen-1-ol $CH_2C(OH)(CH_3)=CH_2$

c. 2-phenylethanol 

88. Name the alcohols and their derivatives by the IUPAC system:

a. $BrCH_2CH_2CH_2OH$ b. $CH_2=CHCH_2CH_2OH$ c. $(CH_3)_3COH$



3 bromo propanol 3 butene-1-ol 2 methyl propanol

d. $CH_3CH_2CH_2CH_2-SH$ e. $HS-CH_2CH_2-OH$

1 butanethiol 2 mercaptoethanol or 2 hydroxyethanethiol

89. Define an acid according to:

a. Arrhenius/Standard - contains H^+

b. Bronsted-Lowry donates H^+

c. Lewis accepts e⁻ pair

90. Is water an acid or a base in the following reactions? Label the conjugate acid/base pairs.

$H_3PO_4 + H_2O \rightarrow H_2PO_4^- + H3O^+$

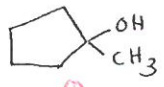
acid base conj base conjugate acid

91. Which of the following are Lewis acids, and which are Lewis bases?

a. $H:^-$ Base b. $(CH_3)_3B$ ACID c. Mg^{2+} ACID

d. CH_3OCH_3 BASE e. $(CH_3)_3C^+$ ACID d. $(CH_3)_2C{=}O$ BASE

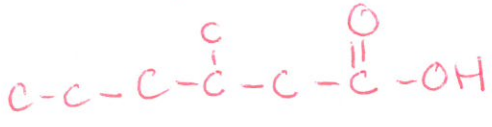
92. Classify the following alcohols

a)  3°

b) $CH_3CH_2C(CH_3)_2CH_2OH$ 1°

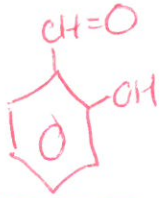
c) $CH_3CH_2\overset{CH_3}{\underset{|}{C}}HOH$ 2°

93. Draw the structure for:

d. 3-methyl hexanoic acid 

e. ethylpropanoate

c. *p*-ethylphenol

d. *o*-hydroxyacetophenone 

94. The p*Ka* for ethanol is 15.9 and for 2,2,2-trifluoroethanol is 12.4.

e. Which is the stronger acid? →

f. Based on its name, explain why it is a stronger acid.

Has 3F which stabilize the negative charge after H^+ is given off

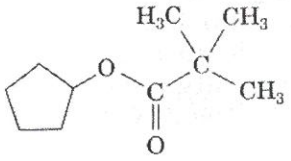
95. Rank the following five compounds in order of increasing acid strength:

highest lowest

2-chloroethanol, *p*-chlorophenol, *p*-methylphenol, ethanol, phenol

2 5 3 1 4

96. Name the following molecule. Then write an equation showing its formation.



$\xleftarrow{H^+}$ + $HO-\overset{O}{\overset{\|}{C}}C(CH_3)_3$

97. Write an equation showing how you would prepare the following from 1-propanol:

A. $CH_3CH_2\overset{O}{\overset{\|}{C}}H$ $\xleftarrow{PCC}$ C-C-C-OH

B. $CH_3CH_2\overset{O}{\overset{\|}{C}}OH$ $\xleftarrow[(CrO_3)]{Jones}$ C-C-C-OH

H_3PO_3 + C. $CH_3CH_2CH_2Cl$ $\longleftarrow$ C-C-C-OH + PCl_3

H_2O + D. $CH_3CH=CH_2$ $\xleftarrow{H^+}$ C-C-C-OH

98. Alcohols & their derivatives have many uses biologically and industrially. Draw a specific example or general formula for each of the following AND give a specific example in nature or a use industrially/commercially:

g. alcohol

h. glycol

i. glycerol

j. quinine

k. aldehyde

l. ketone

m. carboxylic acid

n. thiol

99. Use your recent review material for a guide to reactions and problems not listed on this sheet. Use the space below to create a review template for yourself of topics not included on this study guide that were included in chapter 7 notes and review documents.