

Chapter 1-2:

1. Which of the following species has a negative charge but NO lone pair of valance shell nonbonding electrons? [all atoms have complete valance shell of electrons, but lone pairs are not shown]

A. NH_4 B. CH_3 C. HO D. BH_4

2. Which functional groups and structural features are present in the following molecule (strychnine)?

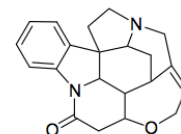
i. 2° amine ii. ester iii. ether iv. ketone
v. amide vi. *sp* carbon vii. carbonyl viii. methyl group

E. i, ii and vi only

G. ii, iii, iv, and vii only

F. iii, v and vii only

H. i, ii, vii and viii only



2. Which of the following molecules has an *sp* hybridized carbon atom?

Q. CH_3I R. CO_2 S. CH_3CHO T. $\text{CH}_3\text{CH}_2\text{OH}$

3. Which of the following have approximately tetrahedral geometries? [nonbonded electrons not shown]

i. methyl anion, CH_3^- ii. boron trichloride, BCl_3
iii. tetrachloroaluminate, AlCl_4^- iv. amide anion, NH_2^-

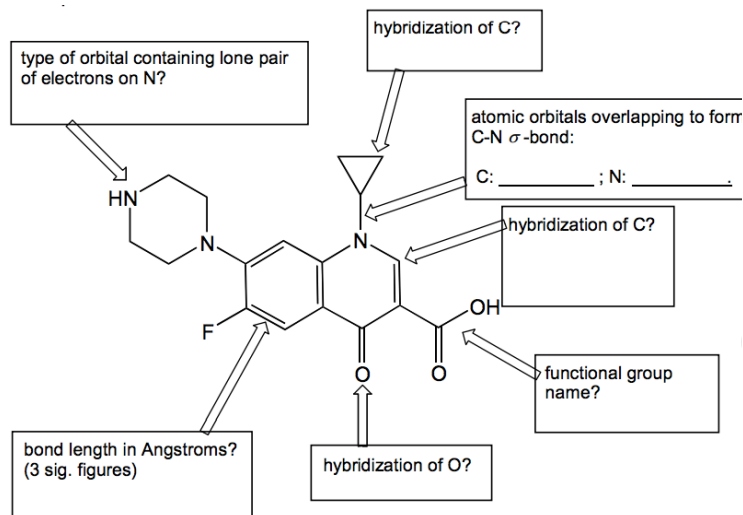
U. only i and iv V. only i and iii W. only i, iii and iv X. i, ii, iii and iv

4. In which of the following compounds is hydrogen bonding absent?

Y. 2° amine Z alcohol. AA. aldehyde BB. carboxylic acid

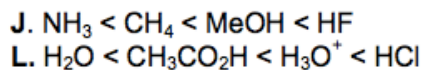
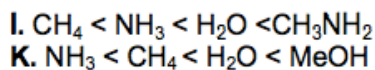
5. The structure of ciprofloxacin (Cipro®) is shown below.

- a. Provide appropriate descriptions of the molecular features in the boxes.
- b. How many lone pairs of non-bonding valance shell electrons does Cipro possess?

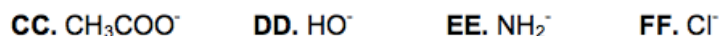


Chapter 3:

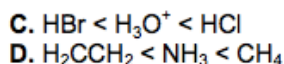
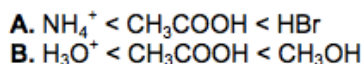
1. Which of the following is the correct order of increasing acidity (less acidic < more acidic)?



2. Which of the following anions is the strongest base?



3. Which of the following is the correct order of increasing acidity (less acidic < more acidic)?

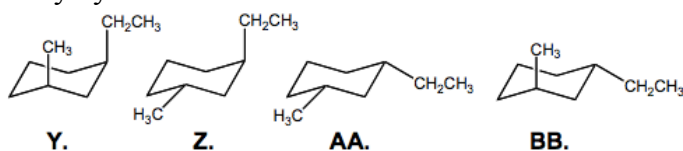


4. Which of the following is the weakest base?



Chapter 4:

1. Which of the following is the most stable conformation of trans-1-ethyl-3-methylcyclohexane?





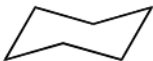
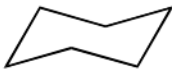
2. What is the approximate dihedral angle between the two chlorine atoms in a chair conformation of cis-1,2-dichlorocyclohexane?



3. Provide line bond structures for each of the following, clearly indicating stereochemistry wherever appropriate.

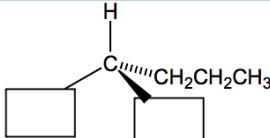
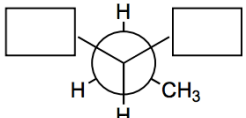
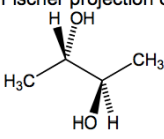
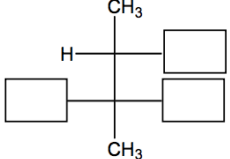
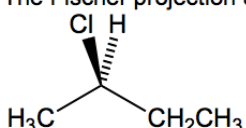
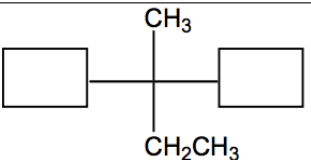
4. Provide systematic IUPAC names for each of the following compounds.

5. Provide the structure of each of the following.

<p>(a) The Newman projection along the C2-C3 bond of the lowest energy conformation of 2,3-dimethylbutane</p> 	<p>(b) The Newman projection along the C2-C3 bond of the highest energy conformation of 2,3-dimethylbutane</p> 
<p>(c) The lowest energy chair conformation of <i>trans</i>-1-<i>tert</i>-butyl-3-methylcyclohexane.</p> 	<p>(d) The lowest energy chair conformation of <i>trans</i>-1-<i>tert</i>-butyl-4-methylcyclohexane.</p> 

Chapter 5:

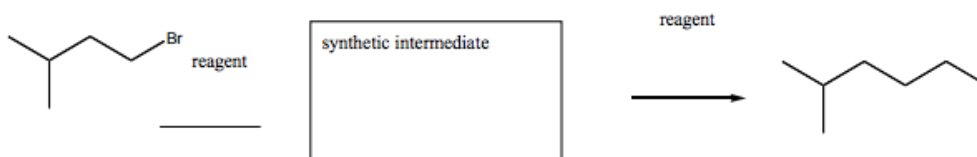
1. Complete the structures on the right by placing the correct substituents in each box.

<p>S-3-bromohexane</p>	
<p>Newman projection of <i>R</i>-2-butanol</p>	
<p>Fischer projection of:</p> 	
<p>The Fischer projection of the <i>enantiomer</i> of</p> 	

2. Which of the following statements is true?
- M.** All mirror images are enantiomers
 - N.** All molecules that have stereocenter centers are chiral
 - O.** Isomers that are not superimposable on their mirror images are enantiomers
 - P.** Superimposable structural isomers are enantiomers

Chapter 6:

1. During which of the following reactions did a rearrangement occur?
- M.** *t*-butanol → 2-methylpropene
 - N.** 3,3-dimethyl-2-butanol → 2,3-dimethyl-2-butene
 - O.** cyclohexene → 1,2-dichlorocyclohexane
 - P.** *t*-butanol → *t*-butyl chloride
2. Which of the following is would react most quickly in an SN1 reaction with acetic acid?
- Q.** methyl fluoride
 - R.** ethyl chloride
 - S.** isopropyl chloride
 - T.** *tert*-butyl bromide
3. Which of the following statements is not true regarding the reaction of 1° alkyl halides with good nucleophiles?
- U.** the rate depends on concentration of nucleophile
 - V.** alkyl fluorides are unreactive
 - W.** large groups near the halide will not effect the rate
 - X.** the rate will be faster at higher temperatures
4. Conversion of 1-bromo-3-methylbutane to 2-methylhexane requires two synthetic steps. Provide reagents and the structure of the synthetic intermediate in the following scheme.



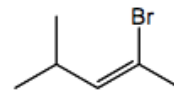
5. Suggest syntheses of the following molecules from the indicated molecules and any other starting materials. [Both of these can be completed in a single synthetic step. Show starting materials and reagents, NOT the mechanism]



Chapter 7:

1. What is the IUPAC name of the following compound?

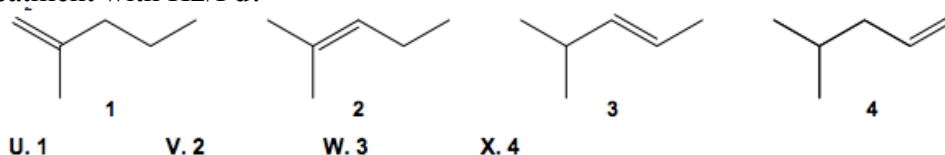
- E. (*E*)-4-bromo-2-methyl-4-pentene F. (*Z*)-4-bromo-2-methyl-4-pentene
G. (*E*)-2-bromo-4-methyl-2-pentene H. (*Z*)-2-bromo-4-methyl-2-pentene



2. Which of the following alcohols is most likely to undergo rearrangement during acid-promoted dehydration?

- M. 2,3-dimethyl-2-butanol N. 3,3-dimethyl-2-butanol
O. 3,3-dimethyl-1-butanol P. 4-methyl-2-pentanol

3. Which of the following alkenes undergoes the least exothermic hydrogenation upon treatment with H₂/Pd?



Chapter 8:

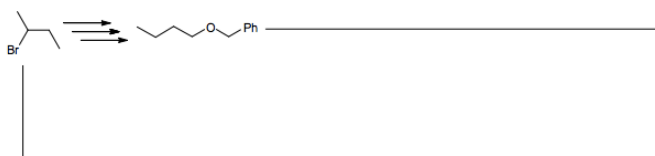
1. Which of the following reactions of alkenes is stereospecific?

- A. Markovnikov addition of HBr
B. acid-catalyzed hydration (treatment with aqueous H₂SO₄)
C. hydrogenation (treatment with H₂/Pt)
D. anti-Markovnikov addition of HBr to alkenes (treatment with HBr, peroxides)

2. What type of reactive intermediate is formed in the reaction of an alkene with HBr and peroxides to give a bromoalkane?

- Q. Carbocation R. Cyclic bromonium ion S. Carbanion T. Radical

3. The following transformations cannot be performed in a single step. Provide sequences of reactions, showing reagents and isolated synthetic intermediates, to achieve each transformation.



4. Reaction of *cis*-2-butene with Br₂ provides racemic 2,3-dibromobutane. However, reaction with OsO₄ followed by NaHSO₃ gives *meso*-2,3-butanediol. Briefly explain the origin of the different stereochemical outcomes of these reactions.

5. Which of the following reactions of alkenes is not stereospecific?

- A. epoxidation (treatment with *m*-chloroperbenzoic acid)
B. acid-catalyzed hydration (treatment with aqueous H₂SO₄)
C. cyclopropanation (treatment with CH₂I₂ and Zn(Cu))
D. bromination (treatment with Br₂)

Chapter 9,11:

1. Predict the splitting pattern you would observe for the proton on C3 of 2-bromo-3-methylbutane in an ^1H NMR spectrum?

M. 4

N. 5

O. 6

P. 8

2. Which of the following is the thermodynamic product obtained upon treatment of 1,3-butadiene with one mole of HCl at elevated temperature?

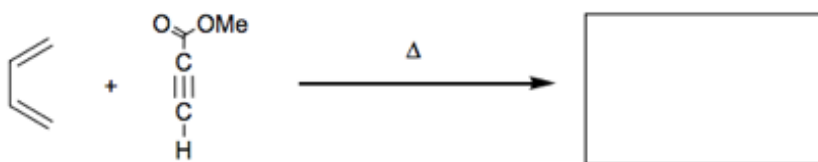
CC 1,4-dichloro-2-butene

EE 3-chloro-1-butene

DD 4-chloro-1-butene

FF 1-chloro-2-butene

3. Provide the structure of the major organic product of each of the following reactions, indicating appropriate stereochemistry wherever appropriate.



4. Propose a structure that is consistent with each set of the following data.

(d) $\text{C}_9\text{H}_{10}\text{O}$

^1H NMR spectrum

Singlet δ 2.0 (3H)

Singlet δ 3.75 (2H)

Singlet δ 7.2 (5H)

IR spectrum

3100, 3000, 1720,

740, 700 cm^{-1}

and other peaks.

(e) $\text{C}_5\text{H}_7\text{NO}_2$

^1H NMR spectrum

Triplet δ 1.2 (3H)

Singlet δ 3.5 (2H)

Quartet δ 4.2 (2H)

IR spectrum

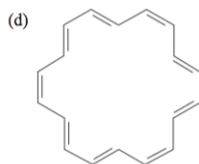
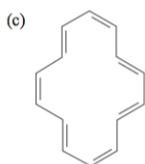
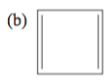
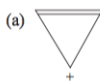
2980, 2260, 1750 cm^{-1}

and other peaks.

This compound has a nitro group.

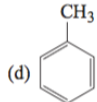
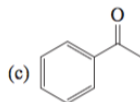
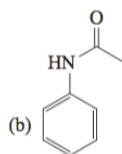
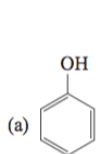
Chapter 14,15:

1. Which of the following molecules or ions is not aromatic according to Huckel's rule?



(e) All are aromatic.

2. Which of the following compounds would be most reactive toward ring bromination?

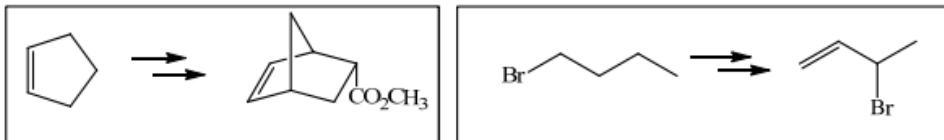


3. Which of the following is *not* a meta-directing substituent when present on a benzene ring?

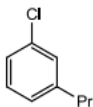
- (a) $-\text{C}_6\text{H}_5$ (b) $-\text{NO}_2$ (c) $-\text{N}^+(\text{CH}_3)_3$ (d) $-\text{C}\equiv\text{N}$ (e) $-\text{CO}_2\text{H}$

4. What carbon is protonated in the first step of the reaction of 3-methyl-2,4-heptadiene with one equiv of HBr?

5. Provide a synthetic route:

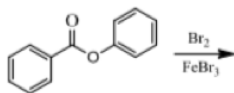


6. Synthesize this compound from benzene.



7. Complete the reactions.

a.)



b.)



d.)

