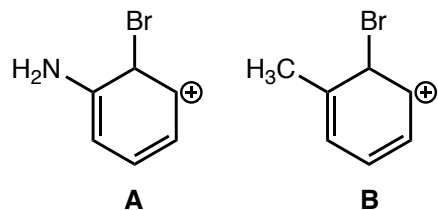


**CHEM 2311 Final Review Worksheet – Spring 2019**

**I. Multiple-choice Questions**

- Which of the following compounds is the weakest base?
  - $\text{CH}_3\text{CO}_2^-$
  - $\text{CH}_3\text{CH}_2\text{OH}$
  - $\text{NH}_3$
  - $\text{CH}_3\text{O}^-$
  - $\text{NH}_2^-$
- Which of the following functional groups is indicated by a strong and broad infrared absorption around  $3300\text{ cm}^{-1}$ ?
  - Carbonyl
  - Alkene
  - Alkane
  - Alcohol
  - Amine
- A particular signal within a  $^1\text{H}$  NMR spectrum has the shape of a quartet. How many equivalent (or nearly equivalent) protons are within coupling distance of the protons corresponding to this signal?
  - 1
  - 2
  - 3
  - 4
  - Additional information is required to answer this question.
- What type of information is provided by a  $^{13}\text{C}$  DEPT experiment?
  - Information about which protons are connected to which carbons
  - The number of hydrogens linked to each carbon
  - The electron density at or near each carbon
  - The connectivity of the carbon skeleton of the molecule
  - The hybridization of each carbon
- Two molecular ion peaks of nearly equal height separated by two  $m/z$  units in a mass spectrum is indicative of which of the following elements?
  - Silicon
  - Nitrogen
  - Bromine
  - Boron
  - Chlorine

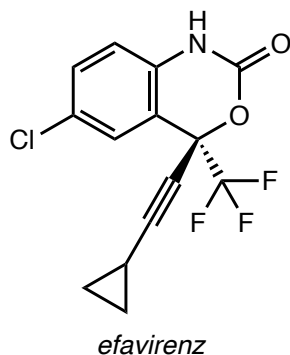
6. Which stability factor best accounts for the greater stability of **A** relative to **B**?



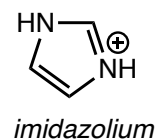
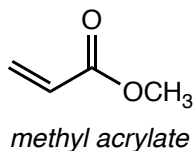
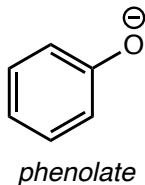
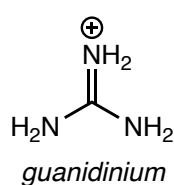
- Electronegativity of the charge-bearing atoms
  - Resonance delocalization
  - Hybridization
  - Inductive effects
  - Steric effects
7. Which of the following electrophiles cannot react (i.e., reacts extremely slowly) with a nucleophile by an  $S_N2$  mechanism?
- $CH_3Br$
  - $CH_3CH_2Br$
  - $Br_2$
  - $(CH_3)_3CBr$
  - $(CH_3)_2CHBr$
8. Which of the following reaction conditions produces a *trans* alkene from an alkyne?
- Li,  $NH_3(l)$
  - $H_2$ , Pt
  - $H_2$ , Lindlar catalyst
  - $H_3O^+$  (cat.),  $H_2O$
  1.  $BH_3$ ; 2. NaOH,  $H_2O_2$

## II. Short-answer Questions

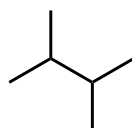
1. Draw a Lewis structure for efavirenz that includes all implied hydrogen atoms and lone pairs. Then, identify the hybridization and geometry of each atom in efavirenz.



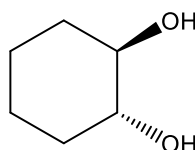
2. Draw all contributing resonance forms of the molecules below.



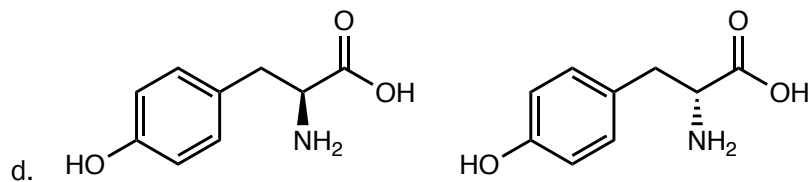
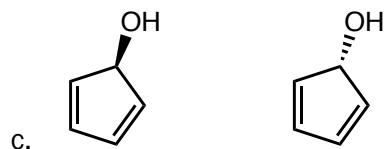
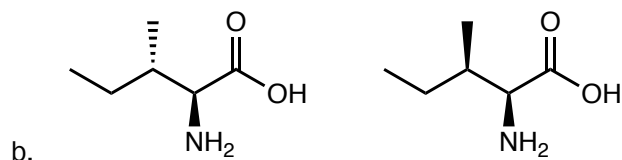
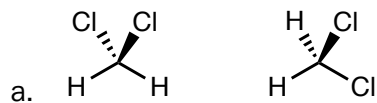
3. Draw a conformation versus potential energy diagram for 2,3-dimethylbutane from the C2-C3 bond. Recall that in these diagrams, energy is plotted on the y-axis and dihedral angle on the x-axis.

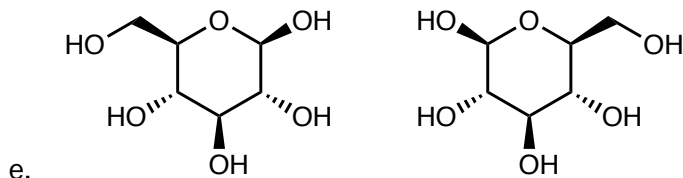


4. Draw the most stable chair conformer of trans-1,2-cyclohexanediol.



5. Identify the stereoisomeric relationship (same, different molecules, enantiomers, diastereoisomers) between each pair of molecules below.



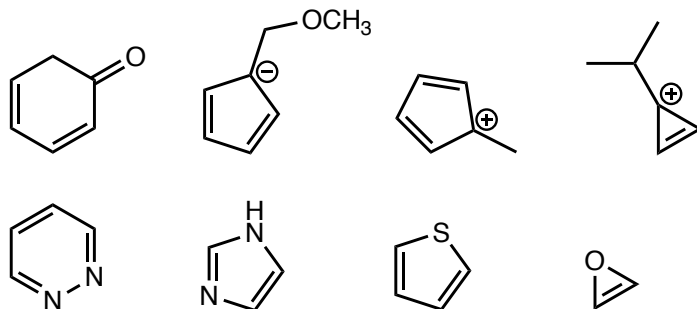


6. Propose structures consistent with the sets of data below. Consult correlation charts for infrared and NMR spectroscopy.

a.  $C_9H_{10}O$        $^1H$  NMR Spectrum      Infrared Spectrum (Key Peaks)  
 singlet  $\delta$  2.0 (3H)      3100, 3000, 1720, 740, 700  $cm^{-1}$   
 singlet  $\delta$  3.75 (2H)  
 singlet  $\delta$  7.2 (5H)

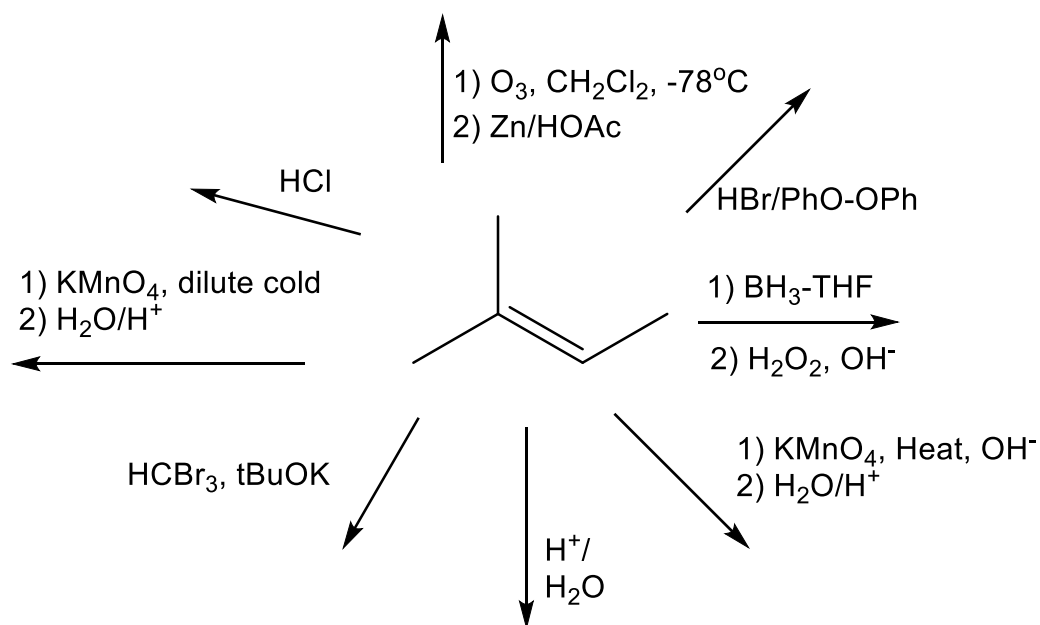
b.  $C_5H_7NO_2$        $^1H$  NMR Spectrum      Infrared Spectrum (Key Peaks)  
 triplet  $\delta$  1.2 (3H)      2980, 2260, 1750  $cm^{-1}$   
 singlet  $\delta$  3.5 (2H)  
 quartet  $\delta$  4.2 (2H)  
 This molecule contains a nitro ( $-NO_2$ ) group.

7. Draw the structure of an alkyl bromide that would be expected to engage in rearrangement when reacted with water in an  $S_N1$  reaction.
8. Draw the structure of an alkene that would be expected to engage in rearrangement when reacted with hydrobromic acid.
9. Determine whether each of the molecules below is aromatic, antiaromatic, or nonaromatic.

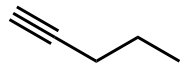


III. Write Reagents and/or Predict the Products

1. Draw the products for each of the following reaction types, starting from 2-methyl-2-pentene. Include stereochemistry where necessary.



2. Write the reagents and draw the products for each of the following reaction types, starting from 1-pentyne. Include stereochemistry where necessary.



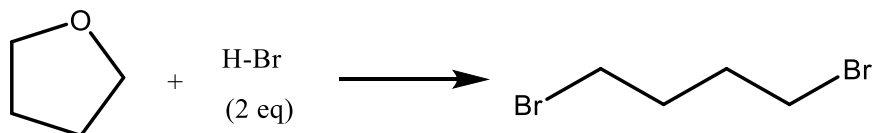
*1-pentyne*

- Deprotonation
- Ionic hydrochlorination
- Ionic hydrochlorination (2 equivalents)
- Hydroboration-oxidation
- Oxidative cleavage
- Acid-catalyzed hydration
- Oxymercuration-demercuration
- Ozonolysis
- Radical hydrobromination
- Radical hydrobromination (2 equivalents)

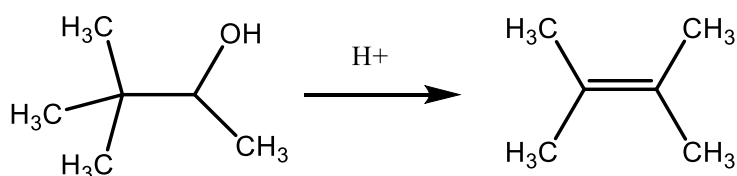
#### IV. Reaction Mechanisms

Propose mechanism for the reactions below

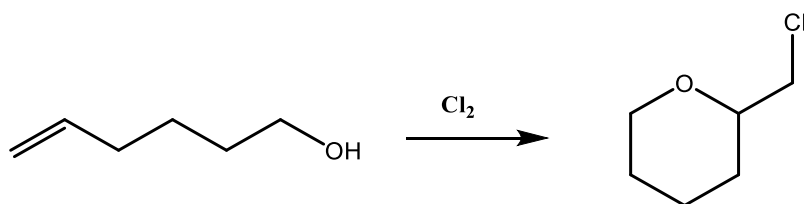
1.



2.

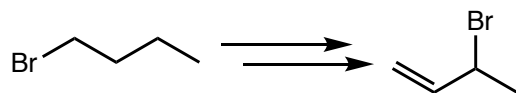


3.

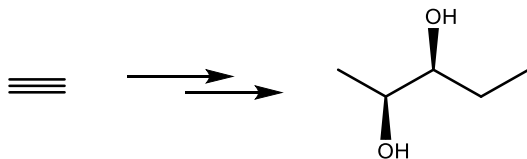


#### V. Multi-step Synthesis

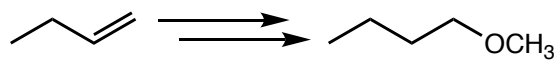
1.



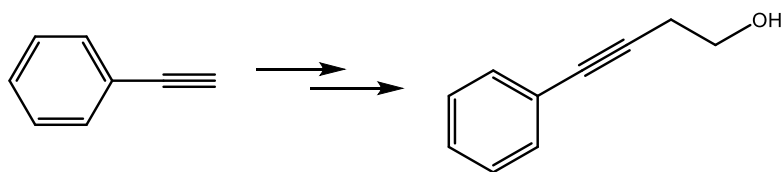
2.



3.

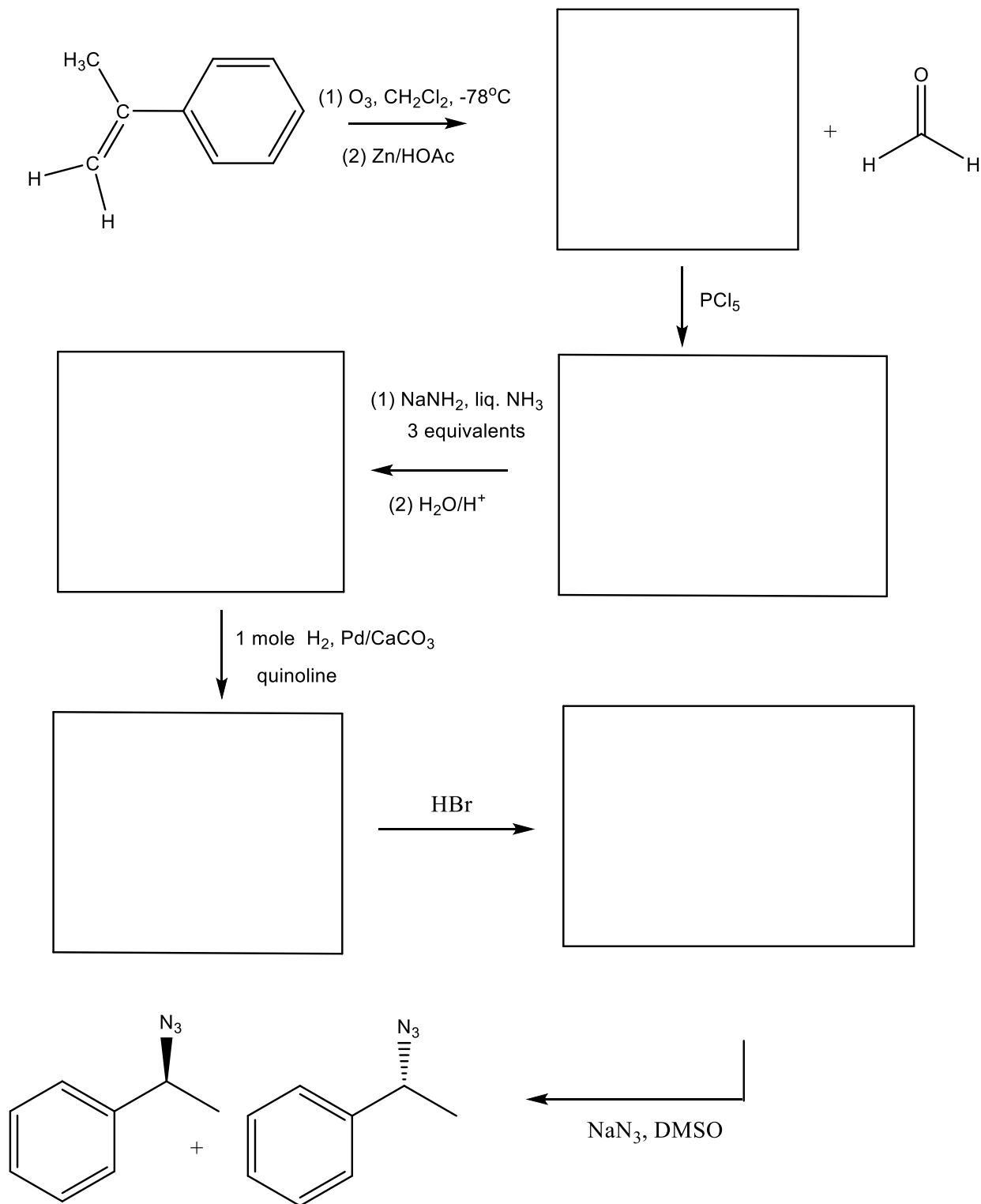


4.





Draw the structures for the products in each of the reactions in the following sequence



### VI. Spectroscopy

Using this IR, NMR and molecular formula, draw the structure of the compound. You must provide: (i) the degree of unsaturation, (ii) analysis the IR spectra, (iii) analysis of NMR and (iv) accurate structure.

