Chemistry Department

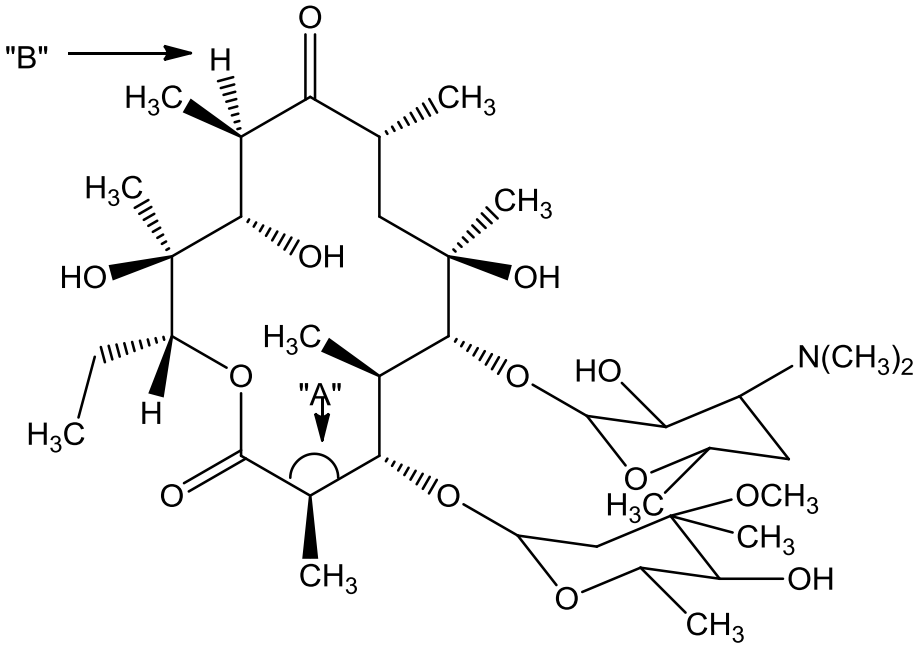
University of Alberta

CHEM 261

Exam I

May 11, 2012

1. Erythromycin is a macrolide antibiotic that has an antimicrobial spectrum similar to or slightly wider than that of penicillin, and is often used for people who have an allergy to penicillins. For respiratory tract infections, it has better coverage of atypical organisms, including *Mycoplasma* and legionellosis. (http://en.wikipedia.org/wiki/Erythromycin).



Erythromycin A

a. Name the nitrogen containing functional group in this compound. (2 points)

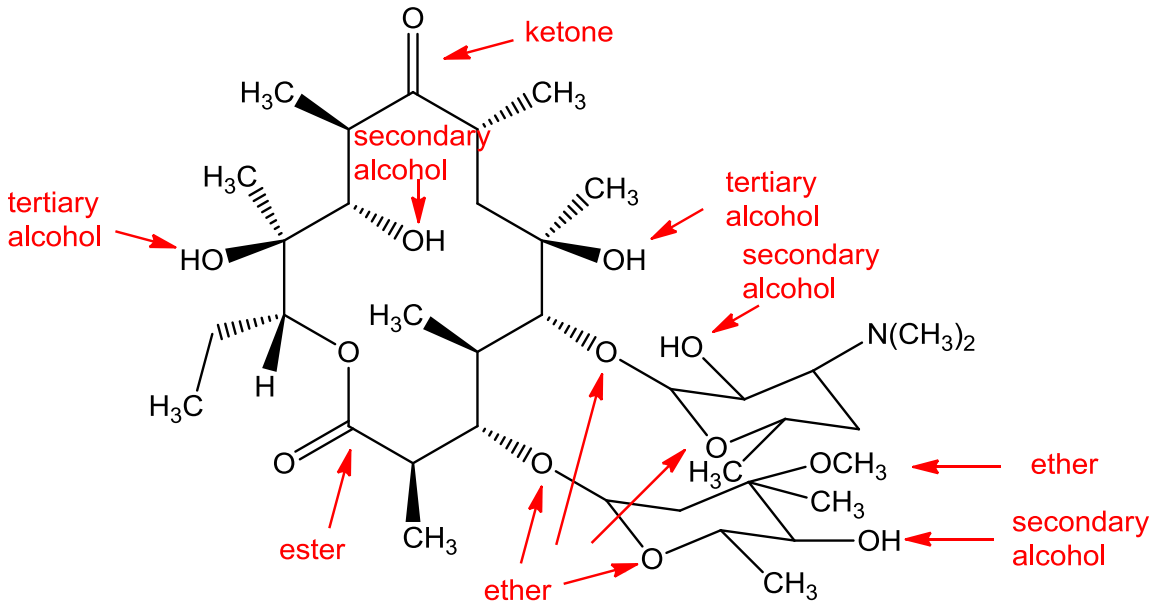
   Tertiary amine

b. What is the magnitude of the angle labeled “A”? (1 point)

   109.5°

c. Name the oxygen containing functional groups in Erythromycin A. (10 points)

Secondary alcohol
Tertiary alcohol
Ether
Ester
Ketone



d. What is the classification of the hydrogen labeled “B”? (Primary, etc.) (1 point)

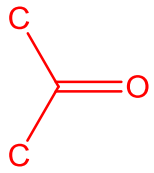
tertiary

e. What is the hybridization of the nitrogen? (1 point)

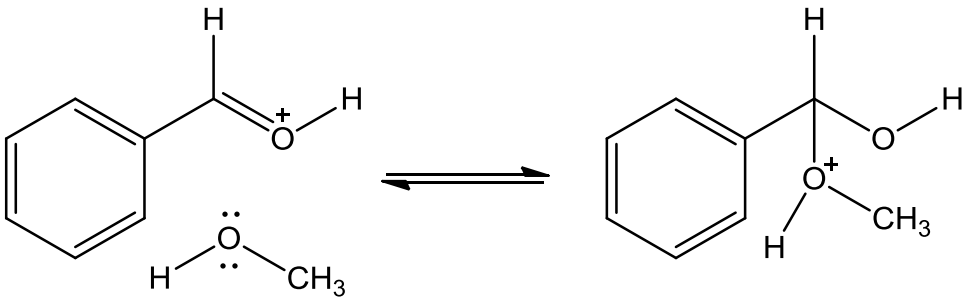
sp^3

2. We will study aldehydes and ketones in CHEM 263.

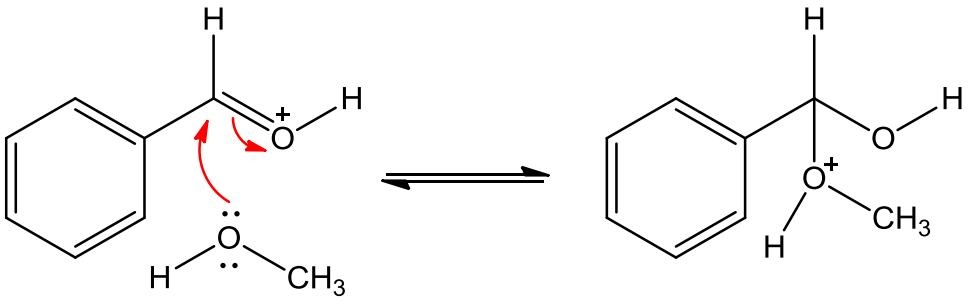
   a. Draw the structure of a ketone. (2 point)



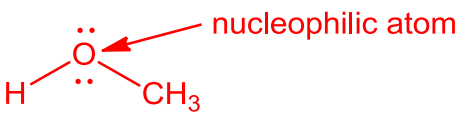
   b. Alcohols react with aldehydes to give hemiacetals and acetals. Here is the second step in a specific example:



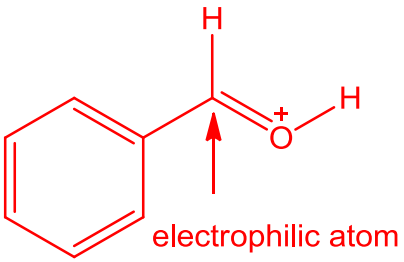
      i. Use curved arrows to depict the electron flow in this ring-opening process. (2 points)



      ii. Circle AND label the nucleophilic atom. (1 point)



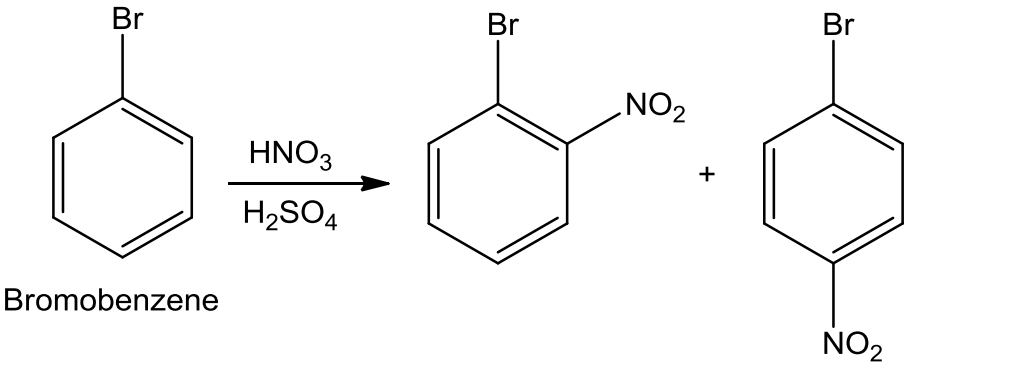
iii. Circle AND label the electrophilic atom. (1 point)



c. A compound C_2H_6O shows a broad peak in the 3300 – 3500 cm^{-1} region of its IR spectrum. Draw its structure. (2 point)

CH_3CH_2OH

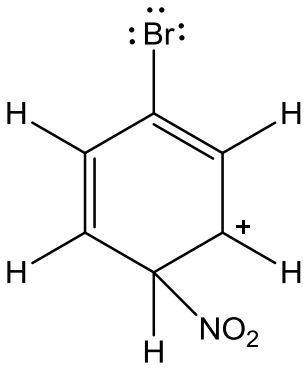
3. In CHEM 263 we will also study electrophilic aromatic substitution an example of which is the nitration of bromobenzene which gives two products:



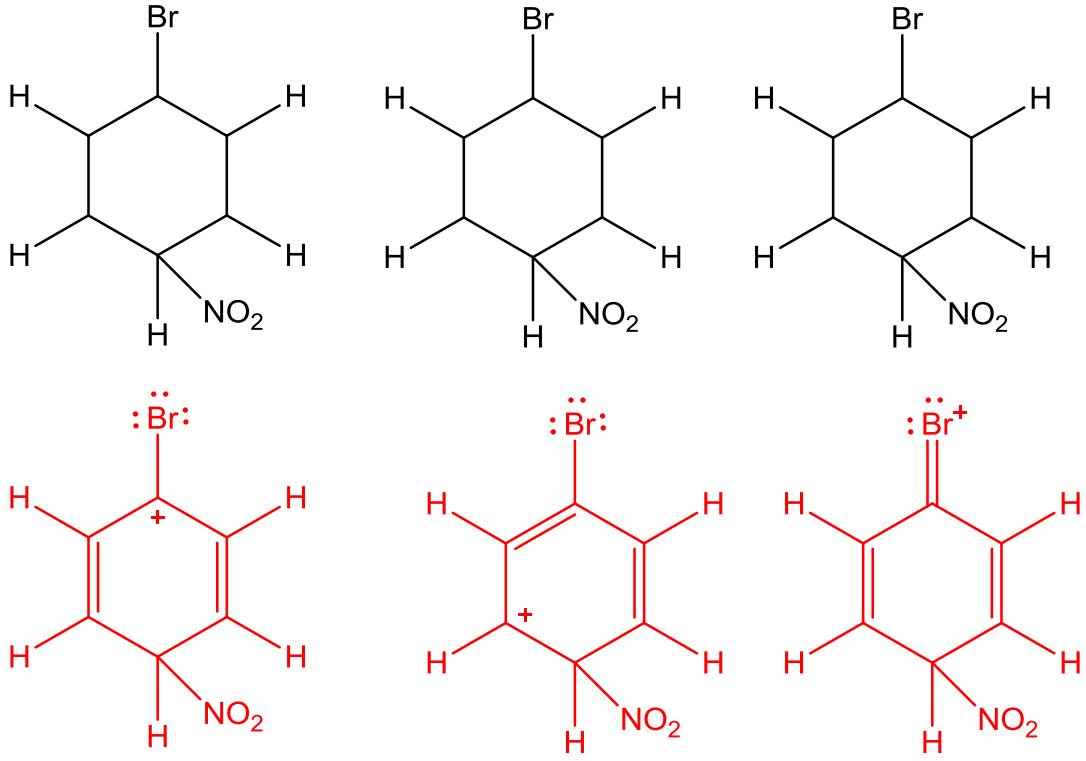
Bromobenzene

1-bromo-4-nitrobenzene

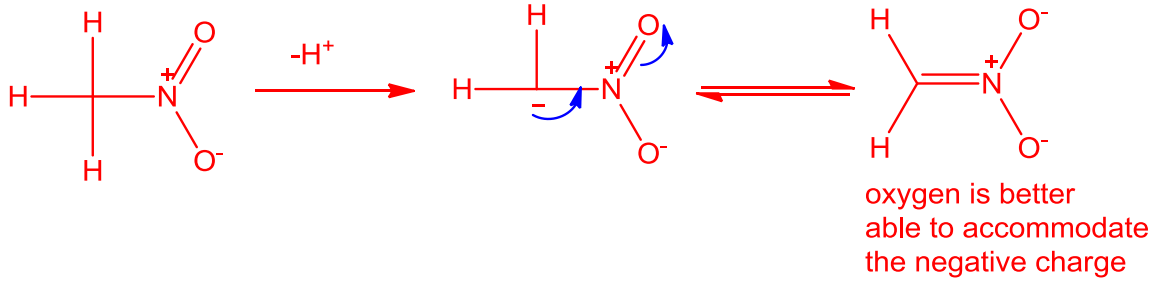
The reaction leading to the formation of 1-bromo-4-nitrobenzene involves a resonance stabilized cation. Here is one of the contributing structures:



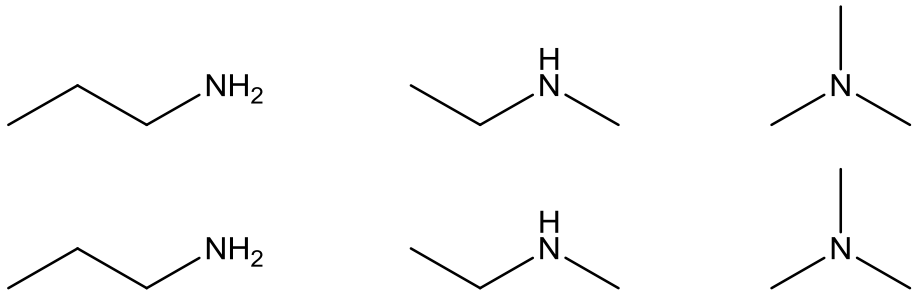
Draw the remaining 3 structures that contribute to the hybrid using the following partial structures: (6 points)



4. The pK_a of CH_3NO_2 is 10, making its C-H bond more acidic than most C-H bonds. Explain using Lewis structures. (3 points)



5. The three amines shown below have boiling points of 4°, 35°, or 48° in random order. Assign the correct boiling point to each of the compounds. (3 points)

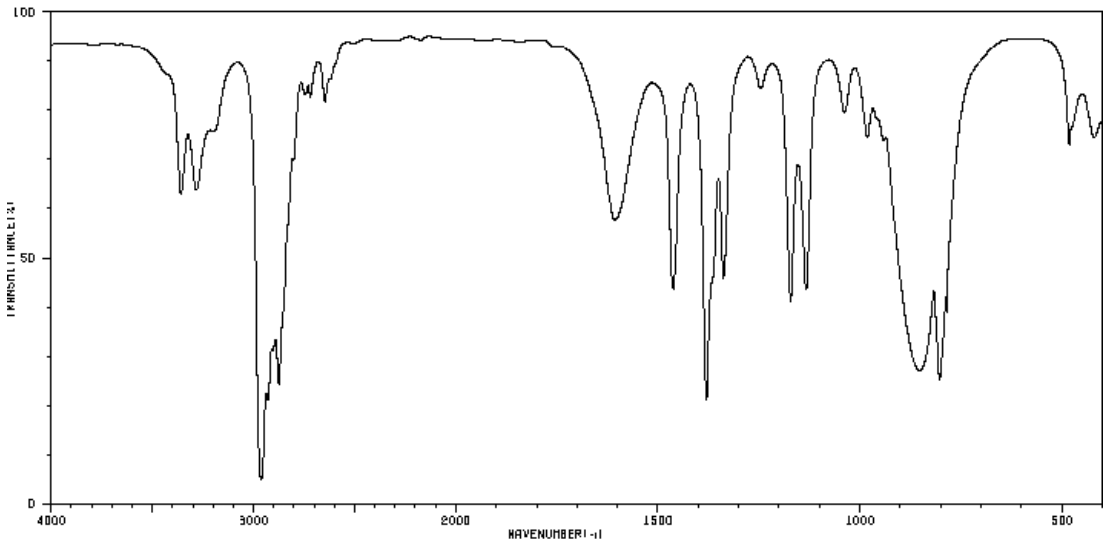


48°

35°

4°

6. The IR spectrum of a compound of molecular formula C_3H_9N is given below:



SDBSWeb : http://riodb01.ibase.aist.go.jp/sdbs/ (National Institute of Advanced Industrial Science and Technology, 9 May 2012)

a. Calculate the degree of unsaturation indicated by the molecular formula. (1 point)

(2 x 3 + 1 – 9 + 2)/2 = 0

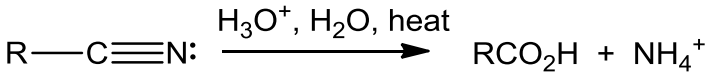
b. List the possible nitrogen-containing functional groups gleaned from the molecular formula. (2 points)

Primary amine
Secondary amine
Tertiary amine
Nitrile

c. What is the nitrogen-containing functional group that the IR spectrum shows to be present in the unknown? (2 point)

Primary amine

7. Acidic hydrolysis of nitriles produces carboxylic acids:



Draw the first step in the mechanism using curved arrows to show electron movement. (3 points)

8. The approximate pKa of acetic acid, CH_3CO_2H is 4.75 and that of the protonated acetone, $(CH_3)_2C{=}OH^+$, is -2.9.

   a. Will acetic acid protonate acetone? (1 point)

      No

   b. Explain your answer. (2 points)

      The K_a of acetic acid is $10^{-4.75}$ whereas that of the protonated acetone is $10^{2.9}$. The protonated acetone is a stronger acid and the equilibrium will favor the weaker species.

9. Which is the stronger acid HI or HBr? (1 point)

   HI

10. Which is the stronger base $CH_3CH_2^-$ or CH_3NH^-? (1 point)

    $CH_3CH_2^-$

11. Which is weaker base? (1 point)

12. Which is weaker base HO^- or HS^-? (1 point)

    HS^-