

Chemistry Department

University of Alberta

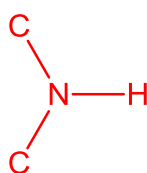
CHEM 261

Exam I

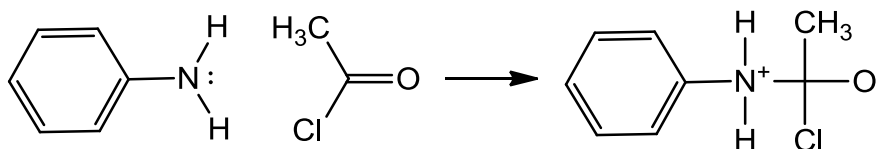
February 9, 2012

1. We will study amines in CHEM 263.

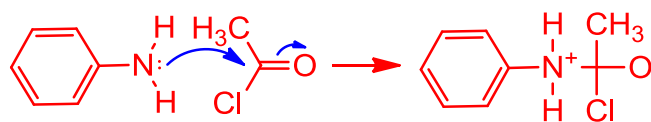
a. Draw the structure of a secondary amine. (2 point)



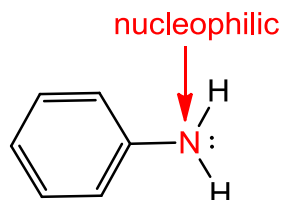
b. Amines react with acyl chlorides to give amides. Here is the first step in a specific example:



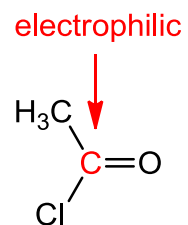
i. Use curved arrows to depict the electron flow in this ring-opening process. (2 points)



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



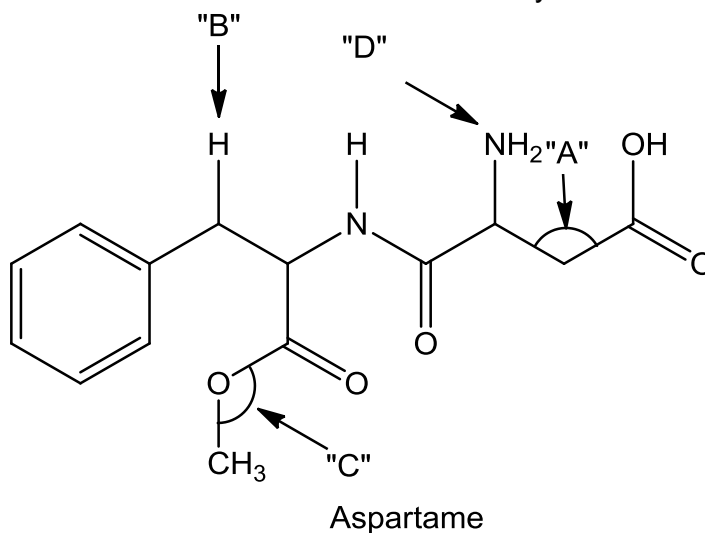
iii. Circle AND label the electrophilic atom. (1 point)



c. A compound $\text{C}_2\text{H}_7\text{N}$ shows two peaks in the $3300 - 3500 \text{ cm}^{-1}$ region of its IR spectrum. Draw its structure. (2 point)



2. Aspartame is the artificial sweetener used in many diet beverages:



a. Name the nitrogen containing functional groups. (6 points)

Amide, primary amine

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

109.5°

c. Name the oxygen containing functional groups. (6 points)

Amide, carboxylic acid, ester

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

Secondary

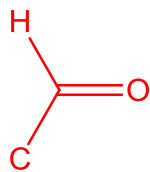
e. What is the magnitude of the angle labeled "C"? (1 point)

104.5°

f. What is the hybridization of the nitrogen labeled "D"? (1 point)

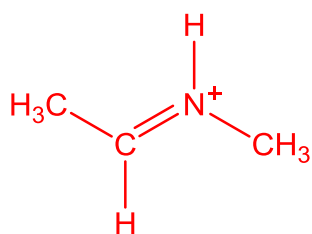
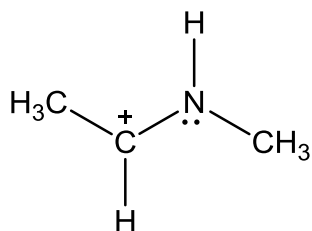
Sp³

3. Draw the functional group of an aldehyde. (2 points)

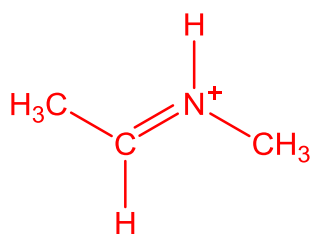


4.

- a. Draw a second resonance structure for the following species: (2 points)



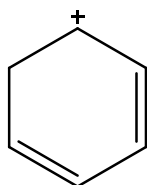
- b. Which is the more stable? (1 point)

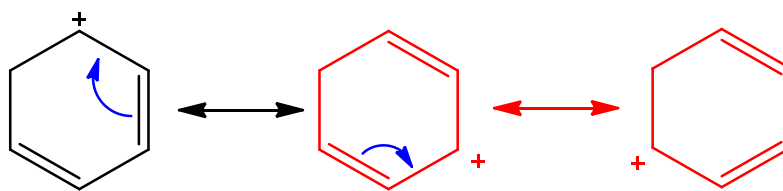


- c. Explain your answer to part "b". (2 points)

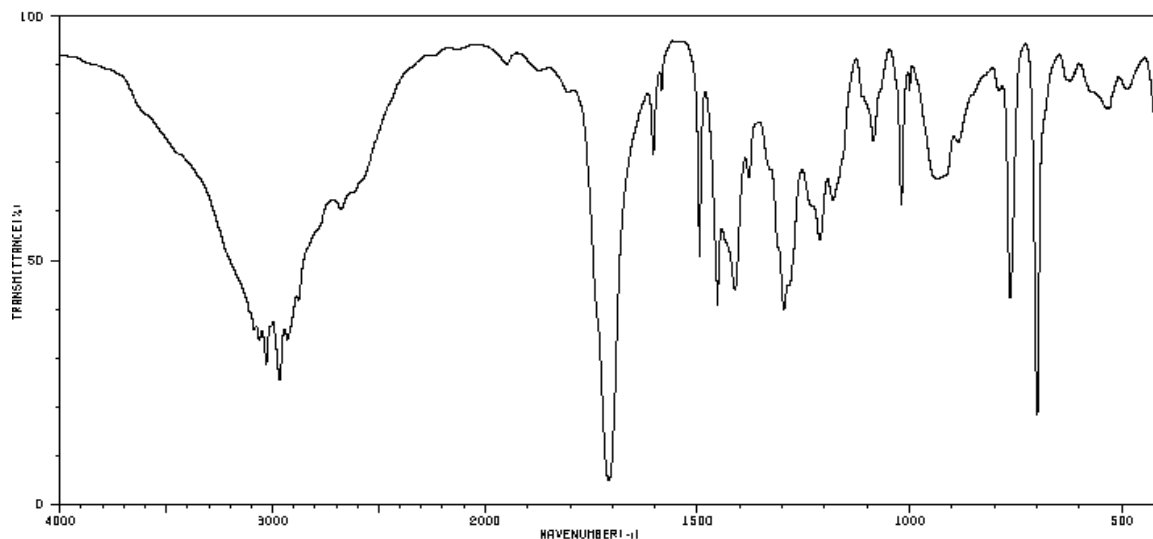
This structure is more stable because all second row elements have an octet whereas the positive carbon in the other structure only has six outer electrons

- d. Draw all reasonable resonance structures for the following cation: (4 points)





5. The IR spectrum of a compound of molecular formula $C_{10}H_{12}O_2$ is given below:



SDBSWeb : <http://riodb01.ibase.aist.go.jp/sdbs/> (National Institute of Advanced Industrial Science and Technology, 6 January 2012)

- a. Calculate the degree of unsaturation indicated by the molecular formula. (1 point)
- b. List the possible oxygen-containing functional groups gleaned from the molecular formula. (2 points)

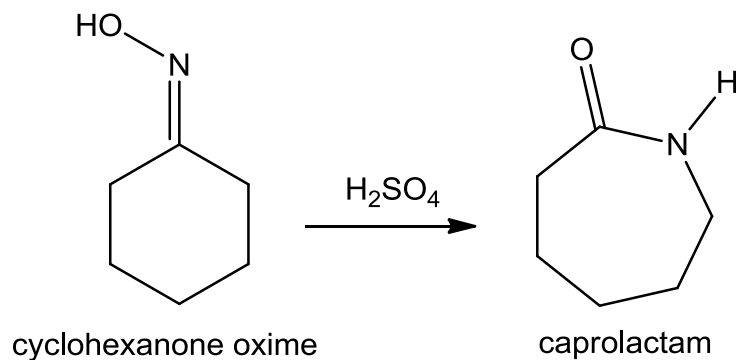
$$(2 \times 10 - 12 + 2) / 2 = 5$$

Alcohol
Aldehyde
Carboxylic acid
Ester
Ether
Ketone
Phenol

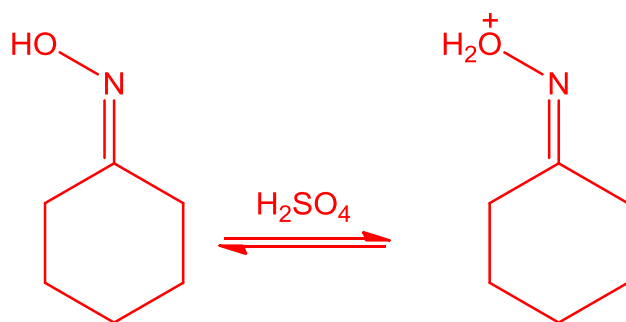
- c. What is the oxygen-containing functional group that the IR spectrum shows to be present in the unknown? (2 point)

Carboxylic acid

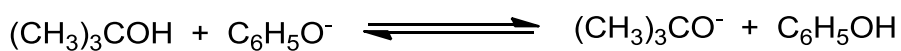
6. Cyclic oximes undergo the Beckmann rearrangement to form lactams. The following is an industrial preparation of caprolactam from cyclohexanone oxime by a Beckmann rearrangement :



Caprolactam is the monomer of nylon-6 (see http://en.wikipedia.org/wiki/Nylon_6). Draw the first step in the synthesis of this monomer from cyclohexanone oxime. (2 points)



7. Consider the following reaction:



The pK_a of $\text{C}_6\text{H}_5\text{OH}$ is 9.9 and the pK_a of $(\text{CH}_3)_3\text{COH}$ is 18.0. Does the equilibrium favour the starting materials or the products? Explain your answer. (3 points)

The reactants are favoured as the equilibrium lies towards the side having the weaker acid, i.e. the acid having the higher pK_a .

8. Which is the weaker acid HI or HBr? (1 point)

HBr

9. Which is the stronger acid CH₄ or NH₃? (1 point)

NH₃

10. Which is weaker base HO⁻ or HS⁻? (1 point)

HS⁻

11. Draw the most stable conformation of 1,2-dichloro-1-fluoroethane using the following partial Newman projection (2 point):

