Chemistry Department

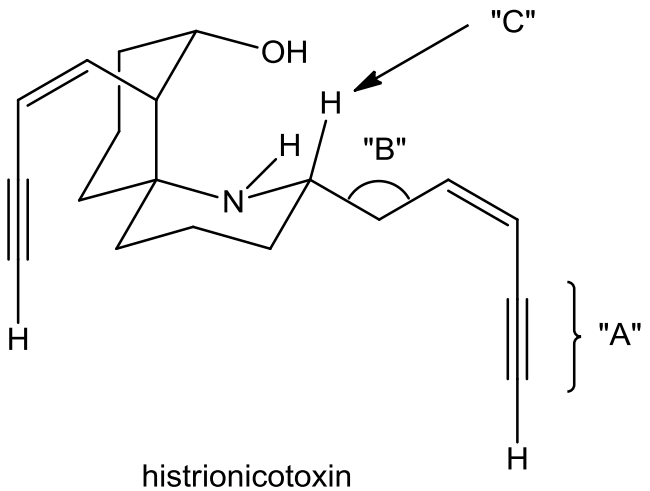
University of Alberta

CHEM 261

Exam I

May 13, 2011

1. Histrionicotoxin is a defensive toxin produced by the poison dart frog. It blocks the action of acetylcholine and paralyses the respiratory muscles:



histrionicotoxin

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

   Secondary amine

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

   sp^3

c. Name the oxygen containing functional group. (2 points)

   Secondary alcohol

d. Name the functional group labeled “A”. (1 point)

   Alkyne

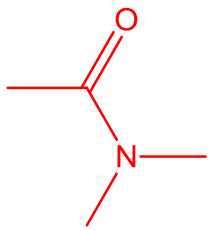
e. What is the magnitude of the angle labeled “B”? (1 point)

   109.5^o

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

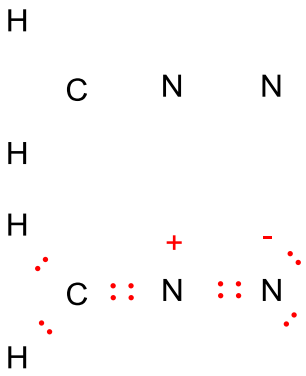
Secondary

2. Draw the functional group of an amide. (2 points)

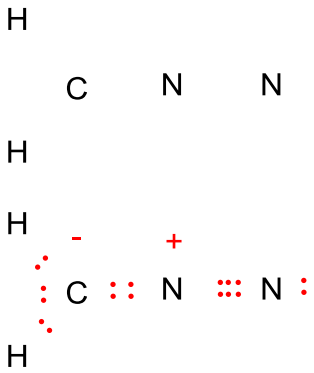


3. Diazomethane, CH_2N_2, forms the highly reactive species methylene, H_2C:, on irradiation or exposure to heat. It has two resonance contributors.

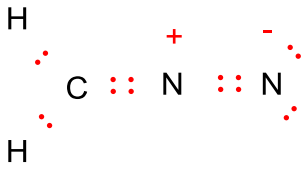
a. Draw one of these resonance forms using the following partial structure. Include all formal charges. (3 points)



b. Draw the other resonance form using the following partial structure. Include all formal charges. (3 points)



c. Which is the major contributor? (1 point)

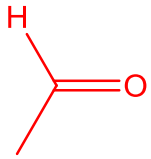


d. Explain your answer to part “c”. (1 point)

Nitrogen is more electronegative than carbon and is therefore better able to accommodate the negative charge.

4. In November (two weeks hence) we will study the Wittig reaction which is an excellent method for preparing alkenes from aldehydes and ketones.

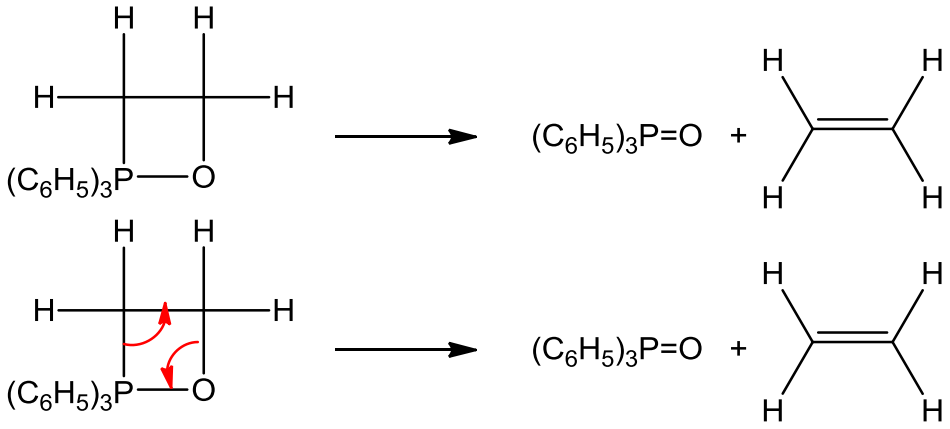
a. Draw the functional group of an aldehyde. (1 point)



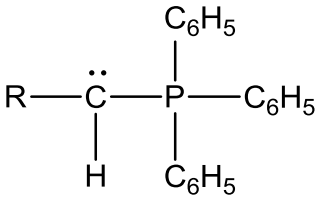
b. How would you use infrared spectroscopy to distinguish between an aldehyde and a ketone? (1 point)

The spectrum of the aldehyde would show a peak between 2720 and 2850 cm^{-1} due to the C – H stretching.

c. The mechanism of the reaction involves the intermediate formation of an oxaphosphacyclobutane which ring opens as depicted below. Use curved arrows to depict the electron flow in this ring-opening process. (2 points)



d. One of the first steps in the Wittig reaction involves the formation of an ylid. A typical ylid is shown below. What is the formal charge on the phosphorus? Phosphorus belongs to the same group as nitrogen. (1 point)



+1

e. What is the formal charge on the carbon bonded to the R group? (1 point)?

-1

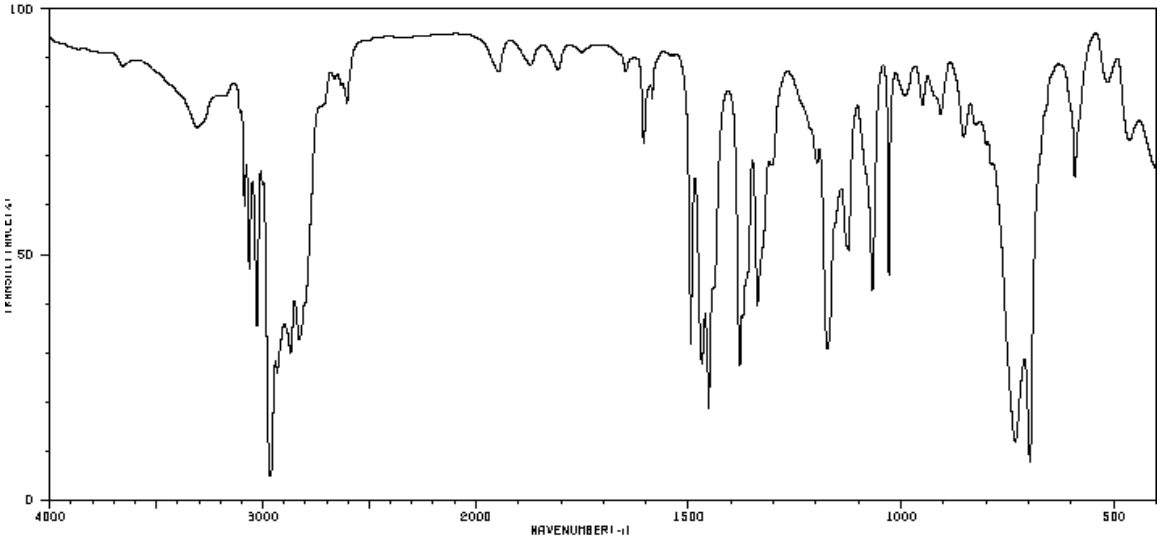
f. Is this a nucleophilic carbon, electrophilic, or neither? (1 point)

nucleophilic

g. The infrared spectrum of a compound of molecular formula C_3H_8O shows no broad absorption at 3400 cm^{-1}. Draw the structure of this compound. (2 points)

$CH_3CH_2OCH_3$

5. The IR spectrum of a compound of molecular formula $C_{10}H_{15}N$ is given below:



SDBSWeb : http://riodb01.ibase.aist.go.jp/sdbs/ (National Institute of Advanced Industrial Science and Technology, 30 March 2011)

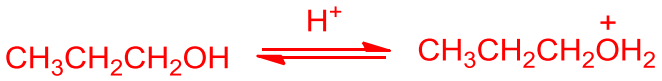
a. Calculate the degree of unsaturation indicated by the molecular formula. (1 point)

(2 x 10 + 1 – 15 + 2)/2 =4

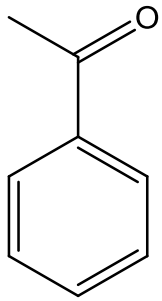
b. Identify the nitrogen containing functional group. (2 points)

Secondary amine

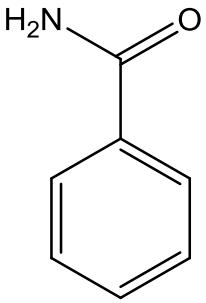
6. Propanol, $CH_3CH_2CH_2OH$, when treated with concentrated sulfuric acid (95%) at 170^{o}C, undergoes dehydration (loss of a molecule of water) to form propene ($CH_3CH=CH_2$). This is a multi-step process. Write an equation for the first step. (3 points)



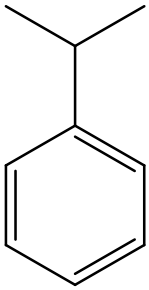
7. The melting points of the four compounds shown below in random order have melting points of -96°, 3°, 20°, or 130°. Assign the correct melting point to each of the compounds. (2 points)



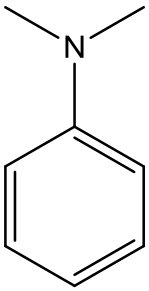
20°



130°

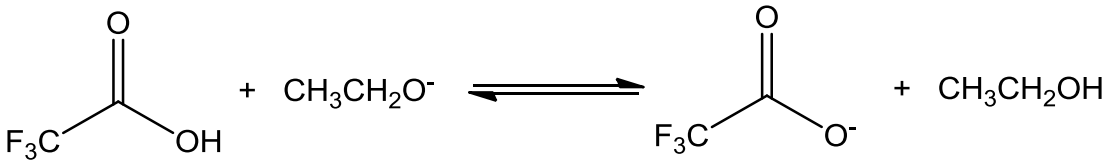


-96°



3°

8. Consider the following reaction:



The pK_a of F_3CCO_2H is 0.2 and the pK_a of CH_3CH_2OH is 16.0. Does the equilibrium favour the starting materials or the products? Explain your answer. (3 points)

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

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

HBr

10. Which is the weaker acid CH_4 or NH_3? (1 point)

CH_4

11. Identify the strongest base in the following group (1 point):

HSe^-, HS^-, HTe^-

HS^-

12. Identify the strongest acid in the following group (1 point):