Chem 220 - Organic Chemistry

Problem Set 1

Chapters 1 and 2, Structure, Bonding, Reactivity

Due: Monday, September 14, 2009

John Dalton

(1766-1844)

John Dalton's formulation of an Atomic Theory in the first decade of the 19th century provided a theoretical basis for understanding chemical behavior. In addition to defining the Law of Multiple Proportions, he also formulated the Rule of Greatest Simplicity, which held that water was a binary compound, OH. (Note: Dalton did not use our modern symbols, which came to us from Berzelius, but rather circles that were distinguishable from one another.) Dalton established the combining masses of H to O in water as ~1:6. This ratio was later refined to 1:8. Dalton postulated that in a molecules comprised of two different atoms, the simplest one in the series would be binary. While this rule applied to CO and CO_2, it did not apply to the pair, water and hydrogen peroxide. Thus, water, according to Dalton, was OH. The Rule of Greatest Simplicity, which was at odds with Gay-Lussac's Law of Combining Volumes of Gases, which demonstrated that the volume of hydrogen produced upon electrolysis of water was twice that of oxygen, was dismissed by Dalton as a faulty result. Moreover, although there was agreement regarding the combining masses of atoms in the first half of the nineteenth century, there was disagreement as to the unit mass of the common atoms encountered in organic chemistry: hydrogen (1), carbon (2x6 or 1x12), oxygen (2x8 or 1x16). Since hydrogen was the lightest of the elements, it was assigned a mass of one (Prout's Hypothesis), a notion that is unrelated to today's mass of hydrogen owing to the presence of a single proton in the hydrogen nucleus. Berzelius's proposal of a mass scale based upon O = 100 would have worked as well.

For a Brief History of Organic Chemistry (PowerPoint), click here.

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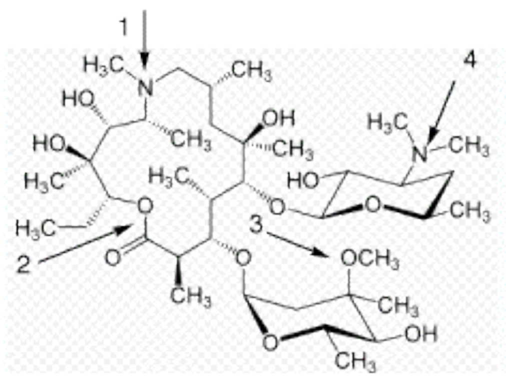
1. a) Identify the four functional groups in azithromycin marked by arrows.

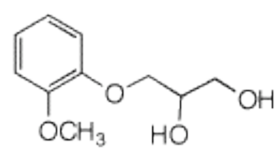
b) How many carboxyl groups are present in the four structures? Circle them.

c) Ethers can be of three types: dialkyl, alkyl-aryl (aromatic) or diaryl. Locate at least one of each type of ether amongst the four structures.

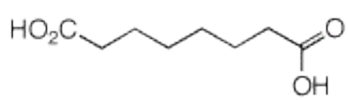
d) What is the structural difference between an alcohol and a phenol? Locate these groups in guaifenesin and thyroxine.



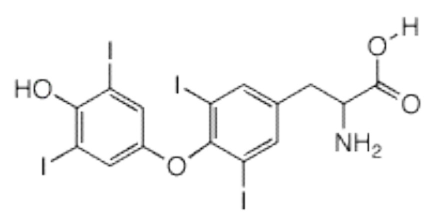
Azithromycin - semi-synthetic antibiotic



Guaifenesin - expectorant (Mucinex)



azelaic acid -topical treatment for rosacea (Finacia)



Thyroxine - thyroid hormone T4

2. Draw resonance structures (if they exist) for the following compounds. Include all formal charges.

a) CH_3N_3 b) $(CH_3)_3AlO(C_2H_5)_2$ c) $CH_2CHCH_2^+$ d) $^-CH_2COCH_3$

3. For each of the following acids or bases, identify the corresponding conjugate base or acid, whichever is appropriate. The pKa table may be of help.

a) $LiNH_2$

b) acetic acid

c) $KOCH_3$

d) CH_3CH_2MgBr

e) C_2H_5OH

4. Arrange the acids and conjugate acids in problem #3 in order of increasing acidity (decreasing pKa).

5. Draw an orbital picture for the monomer, vinylacetylene (CH_2CHCCH). Identify π-bonds and hybridization.

6. A normal alkane, C_nH_{2n+2}, is found to have a vapor density of 1.78 mg/mL at 300^{o}C and 740 mm pressure. Using the ideal gas law, determine the structure of the alkane. (In the early 19th century, the vapor density of an unknown liquid was compared to the vapor density of air to determine the liquids molecular weight.)