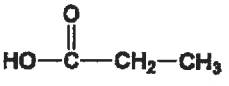
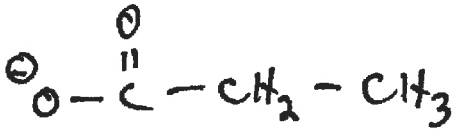
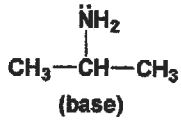
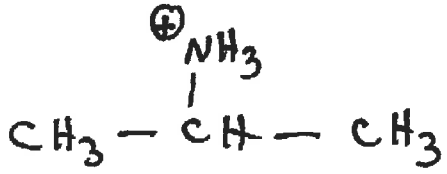
Names of all students (please print) Answer Key

CHEM 243 Organic Chemistry I **Points**_____ **(10 max)**

Worksheet #4: September 13, 2021. Complete the following worksheet by collaborating with a group of 3-4 students. You can use a text book or your lecture video notes. You must work together, with the names of all students included on **ONE** sheet and turned in for a group grade.

(1) Acids and Bases. For each acid draw the conjugate base, and for each base draw the conjugate acid. **Be sure to label atoms with their appropriate formal charge!**

(a)  (acid) **conjugate base:** 

(b)  (base) **conjugate acid:** 

(c) HSO_4^- (base) **conjugate acid:** H_2SO_4

(d) $CH_3-CH_2-CH_2-C\equiv C-H$ (acid) **conjugate base:** 

(2) Acids, Bases, Conjugate Acids, Conjugate Bases, and pKa's. What follows is a series of acid-base reactions. Although I expect that you should be able to identify the more common acids and bases, in some cases I have placed lone pairs on the base. For each acid/base reaction shown below (a-d), do the following:

(i) Label the acid (A) and base (B) <u>reactants</u>, and label the conjugate acid (CA) and conjugate base (CB) <u>products</u>;

(ii) Using the pKa table, label each acid (A) and conjugate acid (CA) with their <u>approximate</u> pKa's.

Example: 

(a) $H_2SO_4(aq) + 2\,Na^+(aq) + 2\,OH^-(aq) \rightleftharpoons SO_4^{-2}(aq) + 2\,H_2O(l) + 2\,Na^+(aq)$

A B CB CA

pKa < 0 pKa ~ 16

(b) 

B A CA CB

pKa ~ 16 pKa ~ 9

(Connected 9-14-21)

(c) 

A B CA CB

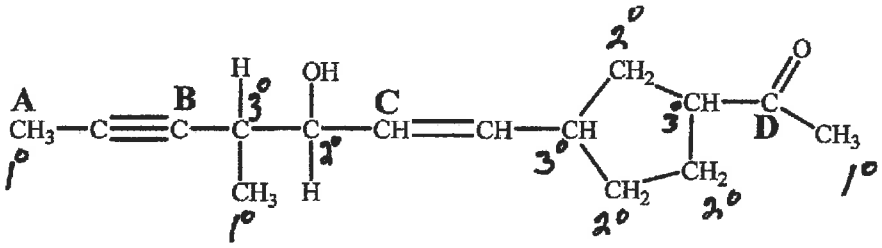
pKa ~ 25 pKa ~ 38

(d) 

B A CA CB

pKa ~ 5 pKa ~ 9

(3) REVIEW. For the compound drawn at the right, indicate the number of:



(a) 1° carbons 3 2° carbons 4 3° carbons 3

(b) For the structure drawn above: (i) How many pi bonds are there? 4 x 2 = 8

(ii) How many rings are there? 1 x 2 = 2

8 + 2 = 10 = HD

(iii) Based on your answers to (i) & (ii), what is the Hydrogen Deficiency? 10

(c) Indicate the **Hybridization and Molecular Geometry** for the atoms labeled A-D:

A Sp3, tetrahedral

B Sp, linear

C Sp2, trigonal planar

D Sp2, trigonal planar

(c) Based on the functional groups in this compound, which of the following IR bands might be present (circle):

1700 **2100** **3300** **3200-3600**

(4) REVIEW. Two un-labeled vials were found in the organic chemistry stockroom. The crystalline solids in each vial were analyzed, and found to have the same molecular formula: $C_9H_{18}O$. Are the following statements about these compounds **TRUE or FALSE:**

HD = (2n+2) − 18
= 20 − 18
= 2

True They may be constitutional isomers or identical

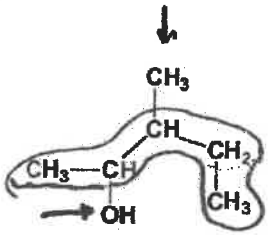
False The Hydrogen Deficiency is 4 (if false, then what is the HD?) 2

True The unknowns may be an alcohol or an ether or contain a carbonyl

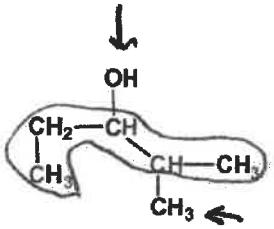
True Each unknown contains a double bond or a ring

True If a ring is present, then **all** carbon atoms must be sp3 hybridized

(5) REVIEW. Comparing Organic Structures. Are the following pairs of compounds: Identical, Different, or Constitutional Isomers?

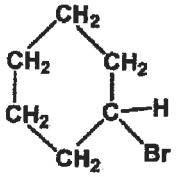


$C_6H_{14}O$

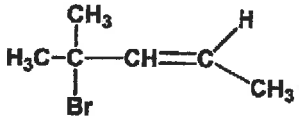


$C_6H_{14}O$

Constitutional

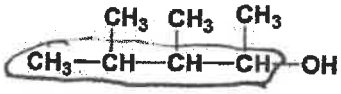


$C_6H_{11}Br$

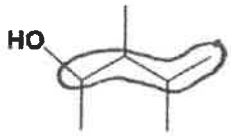


$C_6H_{11}Br$

Constitutional



$C_7H_{16}O$



$C_7H_{16}O$

Identical