

NAME (PRINT CLEARLY) \_\_\_\_\_

Answer Key V2

page 1

*I am on my honor that I will not discuss the contents of this exam with anyone until after 6:00 pm on Monday, September 30, and will notify Dr. Brush if I am made aware of any cases of academic dishonesty.*

I understand and agree to these conditions (signature) \_\_\_\_\_

~~CHEM 243~~ ORGANIC CHEMISTRY I  
Exam I (version-2), Friday, September 27, 2024

Answer all questions in the space provided, continuing on the back if necessary. **Read each question carefully and be sure to answer all parts to each question!** This exam is worth a total of 150 points.

Exams will be returned within one week. An answer key to this exam will be linked to the course web page.

(37) 1. \_\_\_\_\_

(9) 2. \_\_\_\_\_

(20) 3. \_\_\_\_\_

(10) 4. \_\_\_\_\_

(10) 5. \_\_\_\_\_

(47) 6. \_\_\_\_\_

Sub-total = \_\_\_\_\_ (133) x 1.128 =

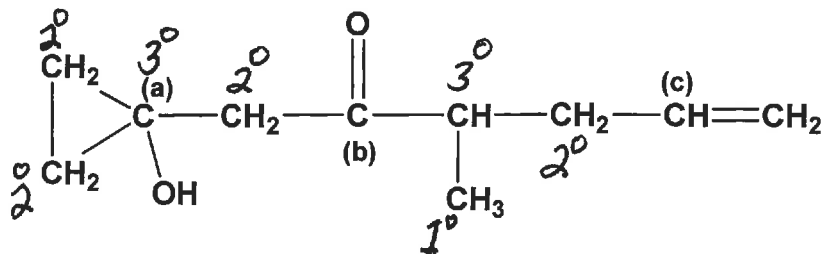
Total Points \_\_\_\_\_ (150) = \_\_\_\_\_ %

Total Worksheet Points to date \_\_\_\_\_ = \_\_\_\_\_ %

**IF YOU DO NOT UNDERSTAND A QUESTION, PLEASE ASK FOR AN EXPLANATION!**

1. (37 Points) Answer the following questions as indicated.

(a) Answer the following questions for the compound drawn at the right:



(i) What is the Hybridization and Geometry for atoms labeled (a) – (c):

(a) sp<sup>3</sup> and tetrahedral  
 (b) sp<sup>2</sup> and trigonal planar  
 (c) sp<sup>2</sup> and trigonal planar

(ii) Indicate the number of: 1° carbons 1 2° carbons 4 3° carbons 2

(iii) For the structure drawn above:

How many pi bonds are there? 2 x HD<sub>2</sub> = 4 HD

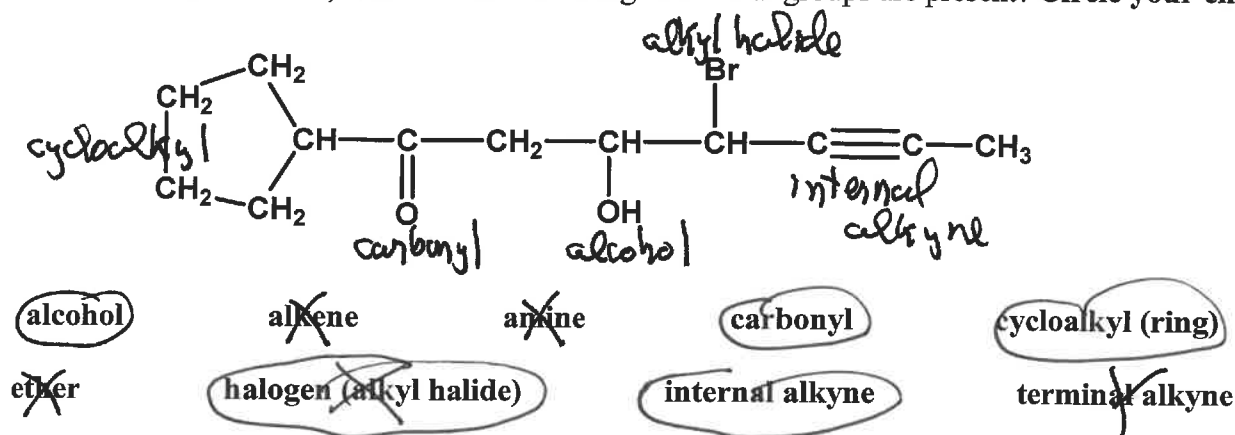
How many rings are there? 1 x HD<sub>2</sub> = 2 HD

Based only on pi bonds and rings, what is the Hydrogen Deficiency? 6

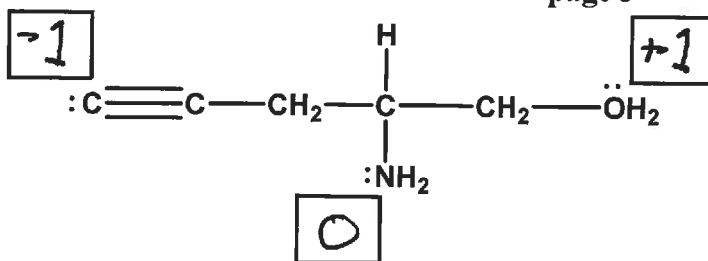
(iv) Based on the functional groups in the compound above, which of the following IR bands might be present (circle):

1700      2100      3300      3200-3600  
 carbonyl      alcohol

(b) In the molecule drawn below, which of the following functional groups are present? Circle your choice(s).



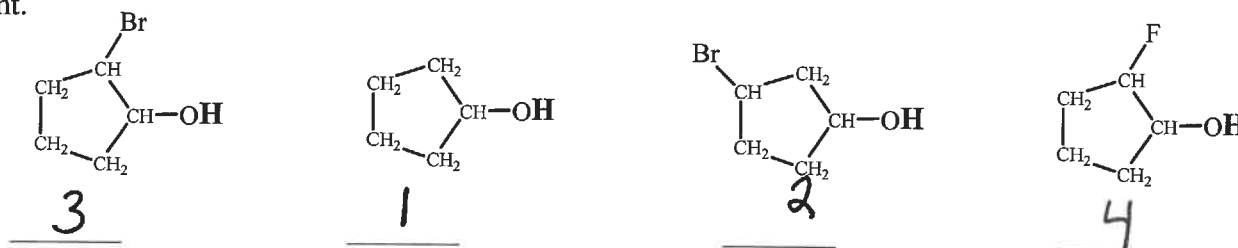
(c) For the compound drawn at the right, write the **Formal Charge** in the boxes for the indicated atoms (0 or -1 or +1). All necessary lone electron pairs are drawn.



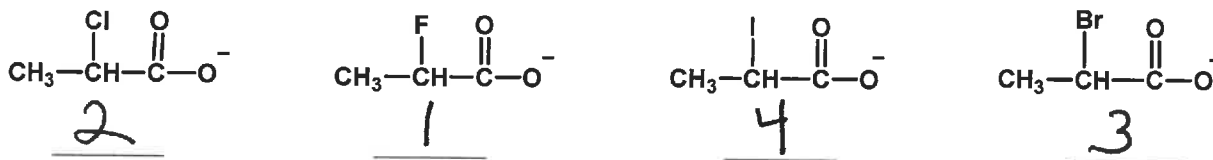
(d) Rank the following molecules in order of increasing acidity (1 = weakest.....4 = strongest).



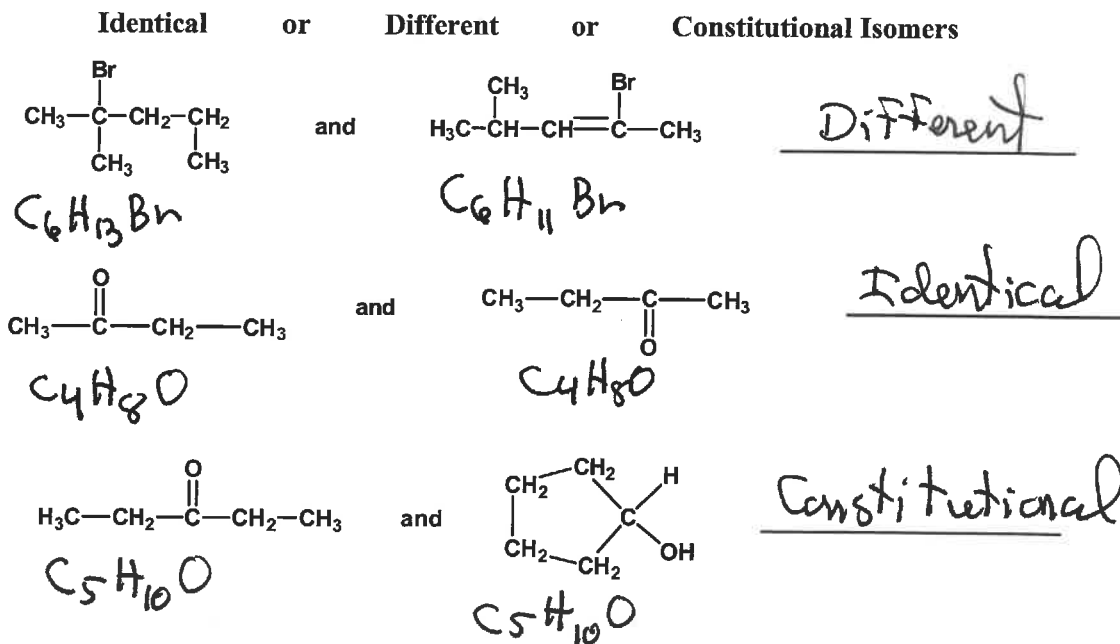
(e) Rank the following molecules in order of increasing acidity (1 = weakest.....4 = strongest). The acid proton is in **bold print**.



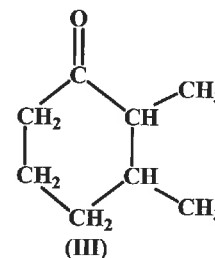
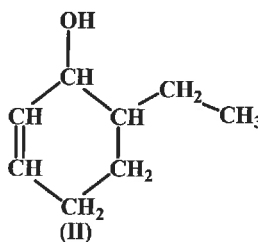
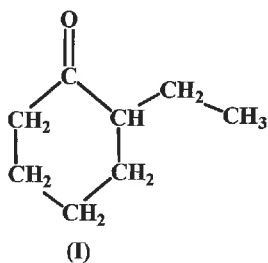
(f) Rank the following molecules in order of **base strength** (1 = weakest.....4 = strongest).



2. (9 Points) Comparing Organic Structures. Are the following pairs of compounds:



3. (20 Points) Organic Structure Identification. An unknown organic compound with a formula of  $C_8H_{14}O$  is thought to be one of the three molecules drawn below (I, II, or III):



(a) Calculate the Hydrogen Deficiency (HD) for this unknown ( $C_8H_{14}O$ ):

$$HD = 2n + 2 - 14 = 18 - 14 = 4$$

(b) Based on the **HD and Formula**, what type(s) of functional groups might be present? **CIRCLE all possibilities from the list below:**

**alkene**  
(C=C double bond)

**carbonyl**  
(C=O double bond)

**alkyne**  
(C≡C triple bond)

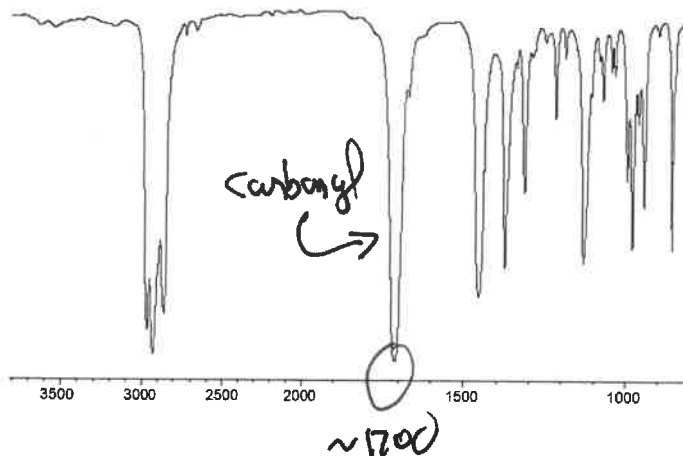
**alcohol**  
(R-OH)

**ether**  
(R-O-R)

**cycloalkyl**  
(C atoms form a ring)

(c) Based on the information in (a) and (b), the unknown could be: **(I) (II) (III)** (circle all that apply)

(d) The IR spectrum for this unknown is given below. Place an "X" for each functional group consistent with the IR data:

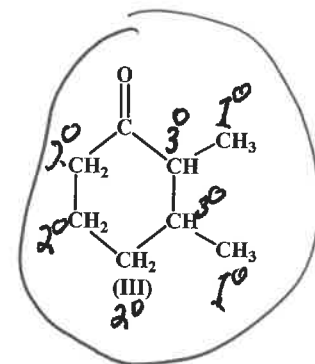
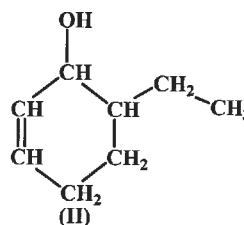
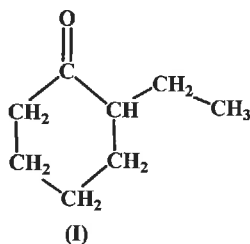


alcohol                       terminal alkyne  
 internal alkyne               carbonyl  
 none of these

If "none of these", is there a hidden functional group? HINT: Look at your answer to (b).

(e) Based on all the information above, the unknown could be: **(I) (II) (III)** (circle all that apply)

(f) The unknown has **two 1° carbons, three 2° carbons, and two 3° carbon**. Based on all the information above, identify the unknown by circling **ONE** structure at the right:



4. (10 Points) Basic Calculations (use correct significant figures and units).

The compound in problem #4 ( $C_8H_{14}O$ ) has a molecular mass of: 126.2 g/mole

(a) If you had 0.3112 grams of this compound, how many moles would you have? 0.002466 mole

(b) You accidentally spilled this compound on the lab bench. You used a spatula to recover as much as possible. After re-weighing, you now have 0.2275 g.

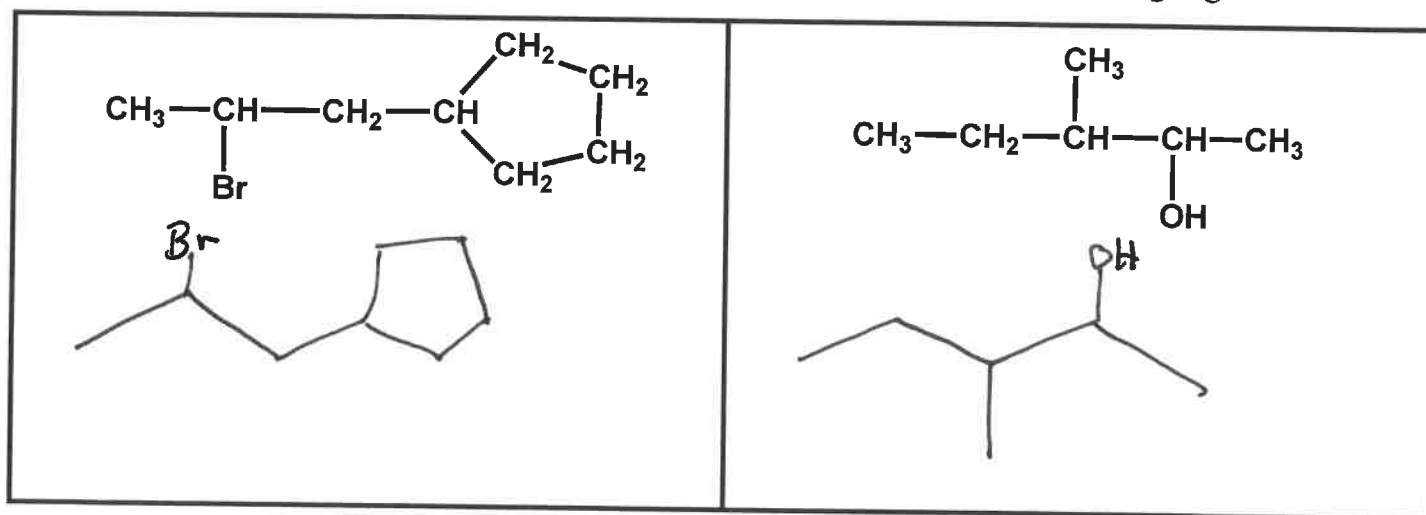
Calculate your % Recovery 73.10%

You MUST show your work in the space below:

$$(a) \quad \frac{0.3112 \text{ g}}{1} \times \frac{1 \text{ mole}}{126.2 \text{ g}} = 0.002466 \text{ mole} \\ \text{or } 2.466 \times 10^{-3} \text{ mole}$$

$$(b) \quad \% R = \frac{\text{recovered}}{\text{original}} \times 100 = \frac{0.2275 \text{ g}}{0.3112 \text{ g}} \times 100 = 73.10\%$$

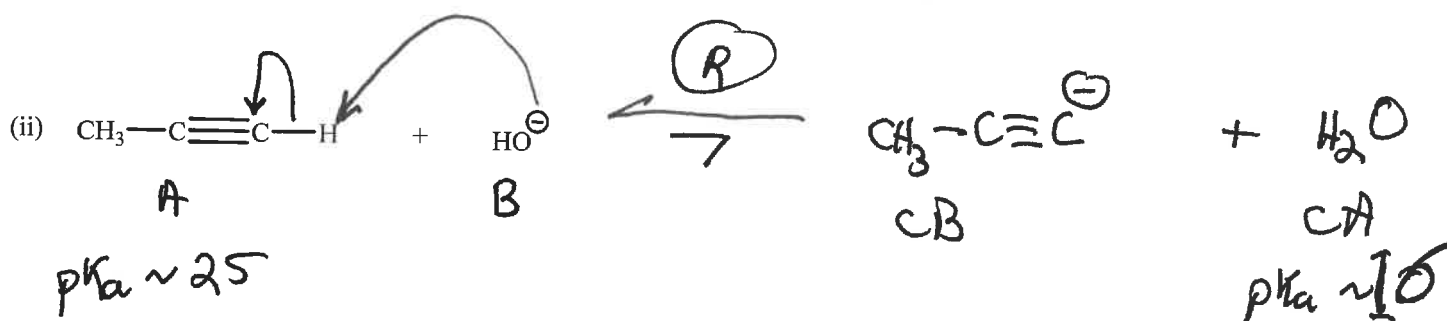
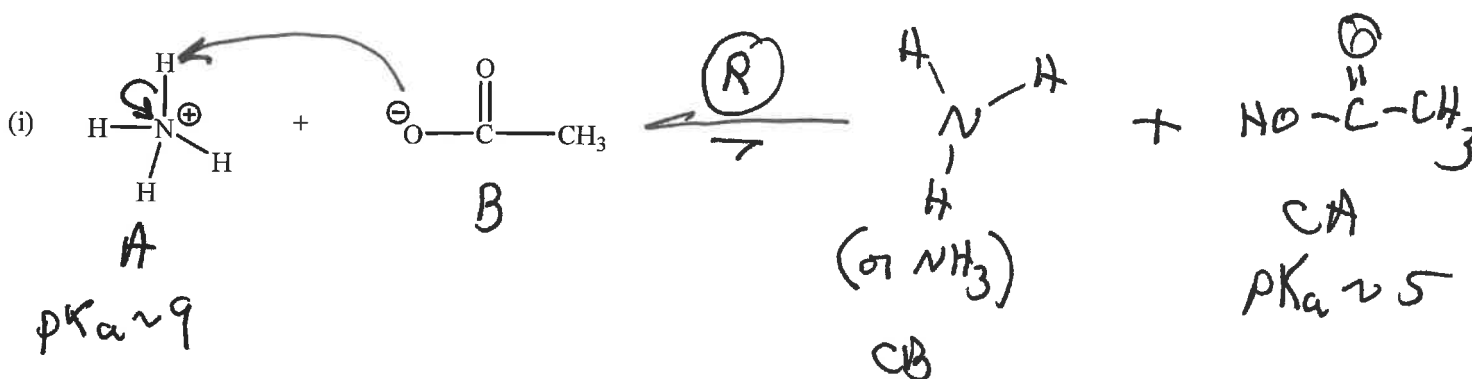
## 5. (10 Points) "Zig-Zag" structures. Re-draw each of the following compounds as "zig-zag" structures.



## 6. (47 Points) Acid/Base Questions.

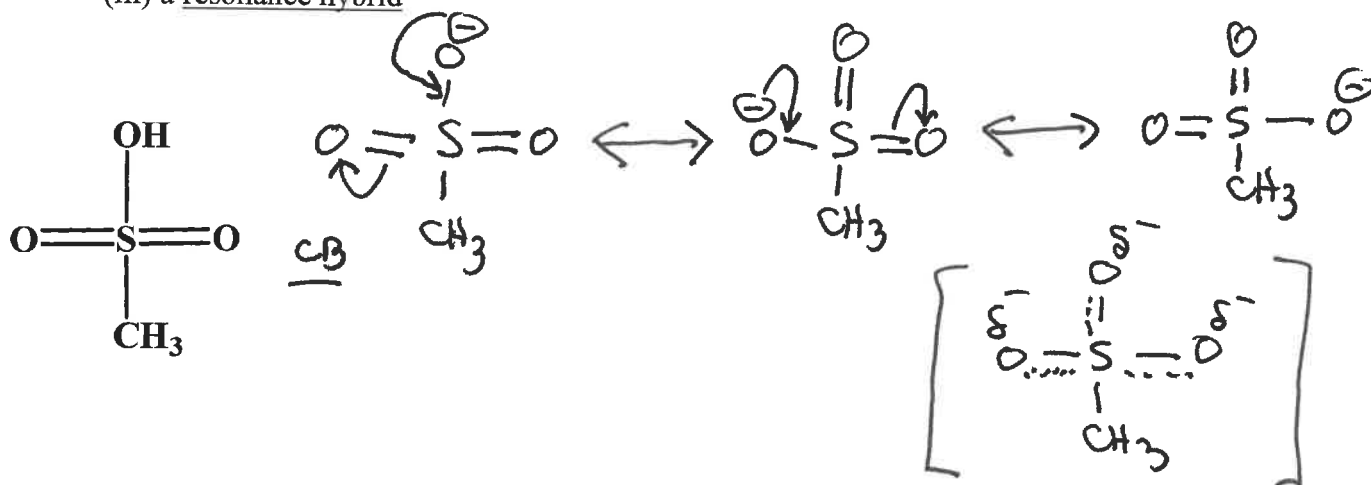
(a) **Acid/Base Reactions and Mechanisms.** Illustrate the complete mechanism for each of the acid-base reactions shown below. You must complete each of the following exercises:

- Label the Acid (A) and Base (B) on the reactant side of the equation;
- Use curved arrows to indicate the flow of electrons;
- Draw the products of the reaction, and make sure that the equation is balanced;
- Label the Conjugate Acid (CA) and Conjugate Base (CB);
- Assigning approximate pKa values to the reactant acid and product conjugate acid;
- Drawing equilibrium arrows that **clearly show** in which direction the reaction is favored.

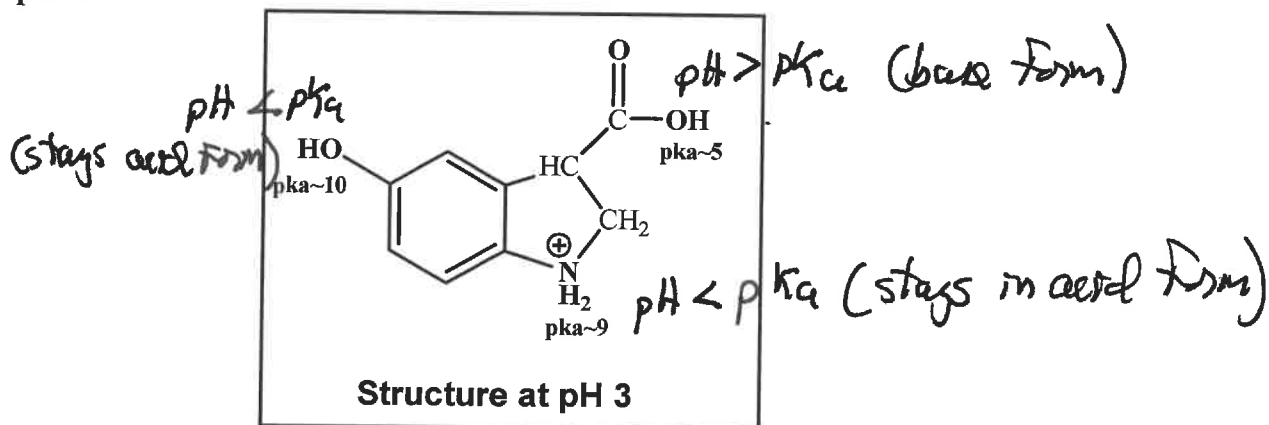


(b) **Resonance.** For the acid shown below, draw:

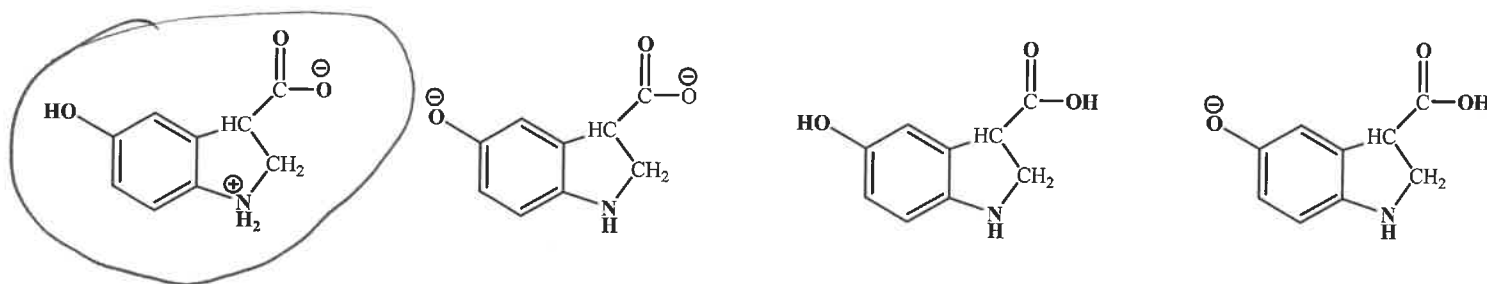
- the conjugate base
- all possible resonance structures and,
- a resonance hybrid



(c) **Effect of pH & pKa on Acid/Base Structure.** The compound drawn below is shown as it would exist at pH 3.



(i) Which is the correct chemical form of this compound at pH 7? Circle your answer:



(ii) Based on the structure in the box at pH 3, and the structure you circled at pH 7, would this compound be **more water soluble** at (CIRCLE):

pH 3

or

pH 7

or

equally soluble at either pH

(iii) **Briefly** explain your reasoning for your answer to (ii) above.

The compound has 2 charges at pH 7 and only one charge at pH 3. More charges = more polar = more soluble in H<sub>2</sub>O.

**The End! Please hand your exam and scrap paper to Dr. Brush**