

NAME (PRINT CLEARLY) _____

Answer Key v1

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 1 (version-1), 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 =

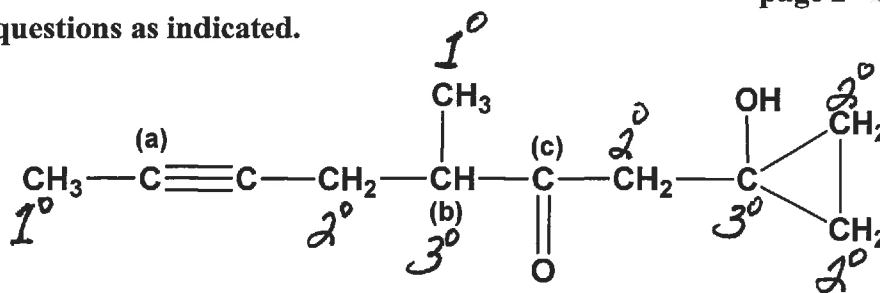
Total Points _____ (150) = _____ %

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 and linear
 (b) sp³ and tetrahedral
 (c) sp² and trigonal planar

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

(iii) For the structure drawn above:

How many pi bonds are there? 3 x H₂ = 6 HD

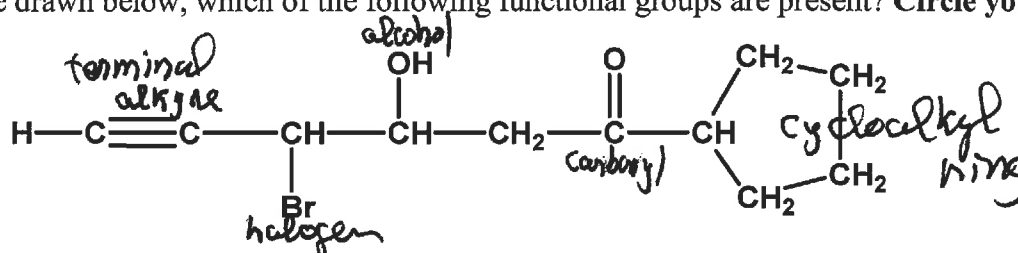
How many rings are there? 1 x H₂ = 2 HD

Based only on pi bonds and rings, what is the Hydrogen Deficiency? 8

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

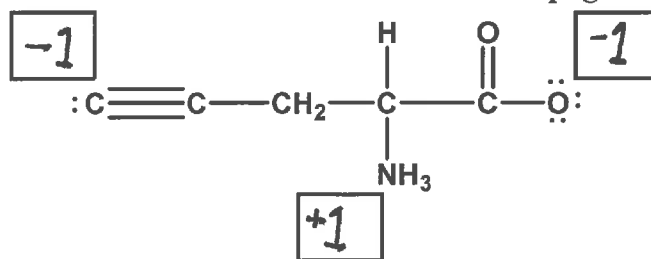
1700 carbonyl 2100 internal alkyne 3300 3200-3600 alcohol

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



~~alkene~~ ~~internal alkyne~~ terminal alkyne cycloalkyl (ring) alcohol
halogen (alkyl halide) ~~ether~~ carbonyl ~~amine~~

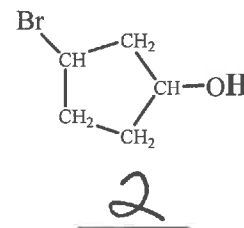
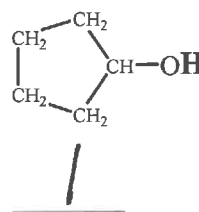
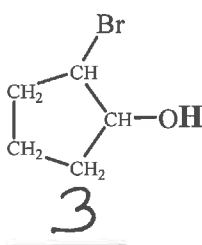
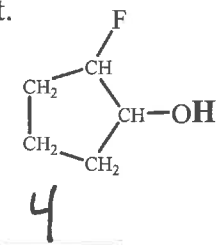
(c) For the compound drawn at the right, write the **Formal Charge** in the boxes for the indicated atoms (0 or -1 or +1). All necessary electron lone pairs are drawn.



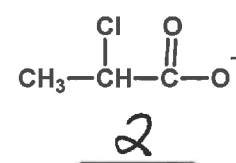
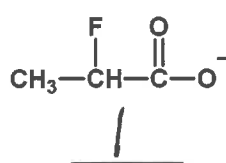
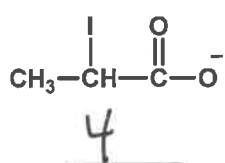
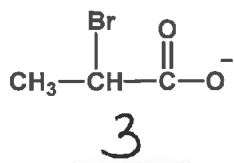
(d) Rank the following molecules in order of increasing acidity (1 = weakest.....4 = strongest).



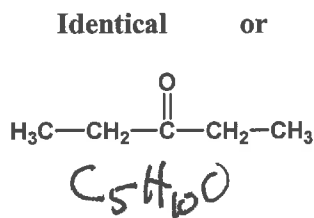
(e) Rank the following molecules in order of increasing acidity (1 = weakest.....4 = strongest). The acid proton is in **bold print**.



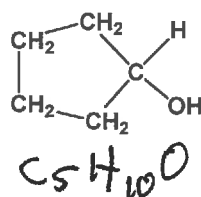
(f) Rank the following molecules in order of **base strength** (1 = weakest.....4 = strongest).



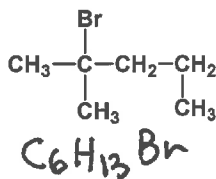
2. (9 Points) Comparing Organic Structures. Are the following pairs of compounds:



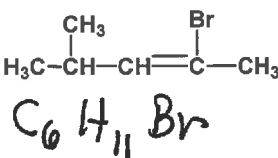
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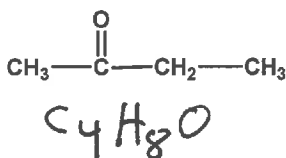
Constitutional



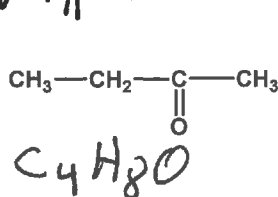
and



Different

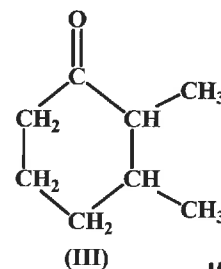
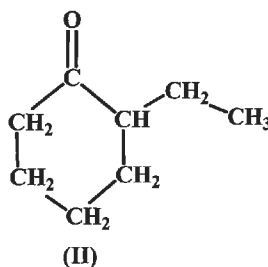
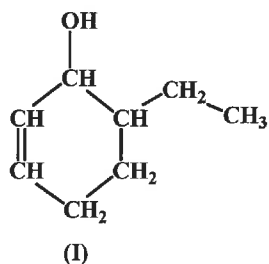


and



Identical

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 ($C_8H_{14}O$):

4

$$\begin{aligned} HD &= 2n + 2 - 14 \\ &= 18 - 14 \\ &= 4 \end{aligned}$$

(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)

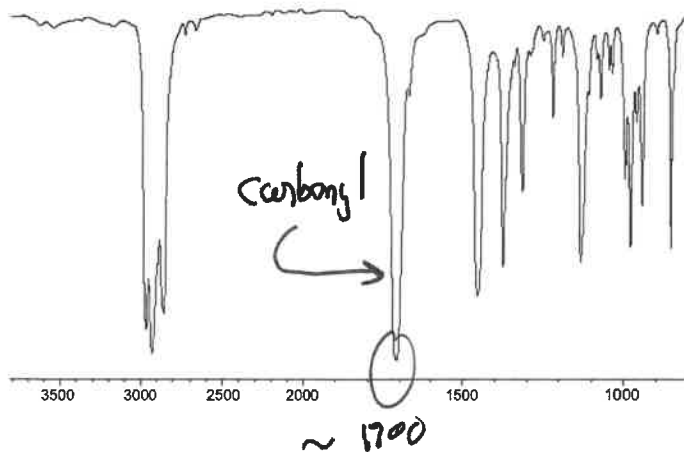
alcohol
(R-OH)

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

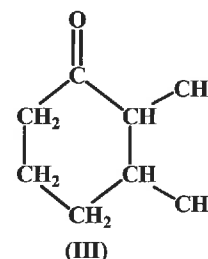
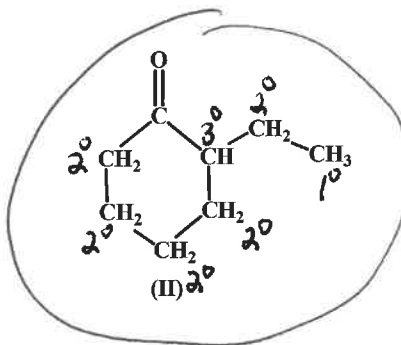
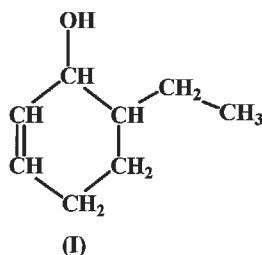
carbonyl

_____ 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 **one 1° carbon, five 2° carbons, and one 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 0.2215 grams of this compound, how many moles would you have? 0.001755 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 0.1981 g.

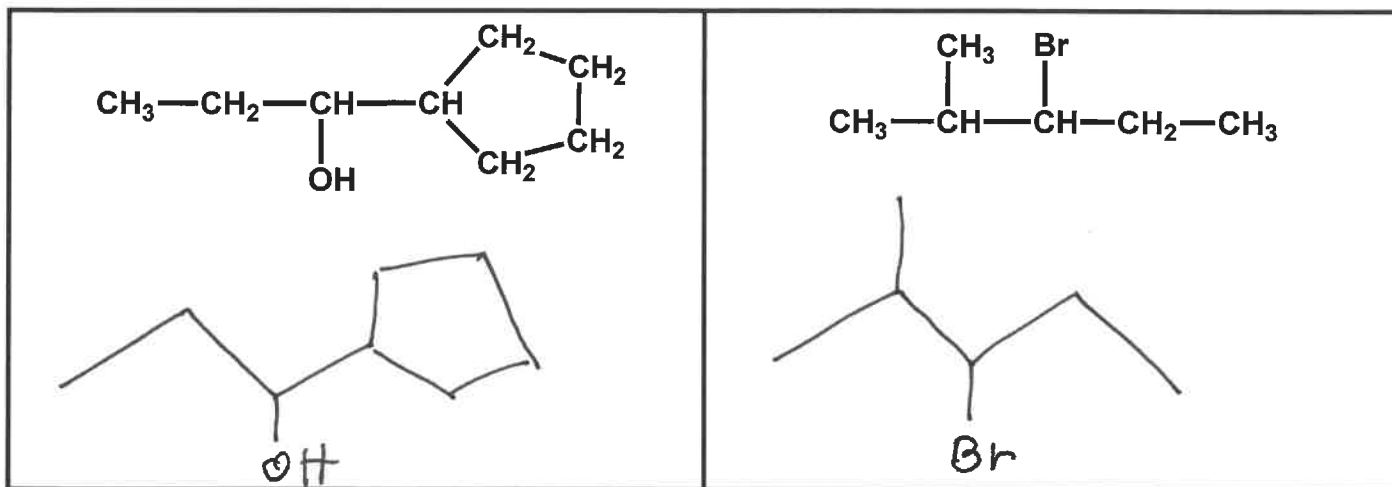
Calculate your % Recovery 89.44 %

You MUST show your work in the space below:

$$(a) \frac{0.2215 \text{ g}}{1} \times \frac{1 \text{ mole}}{126.2 \text{ g}} = 0.001755 \text{ mole} \\ \text{or } 1.755 \times 10^{-3} \text{ mole}$$

$$(b) \%R = \frac{\text{recovered}}{\text{original}} \times 100 = \frac{0.1981 \text{ g}}{0.2215 \text{ g}} \times 100 = 89.44 \%$$

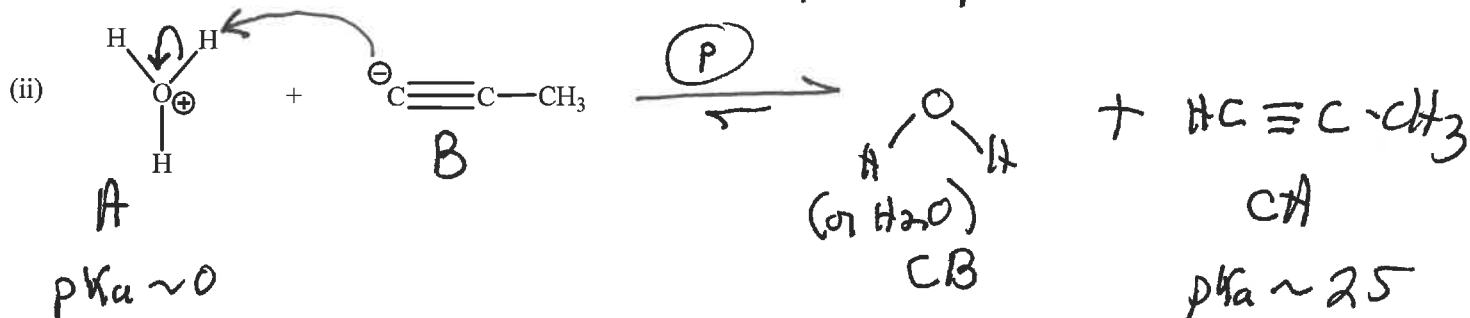
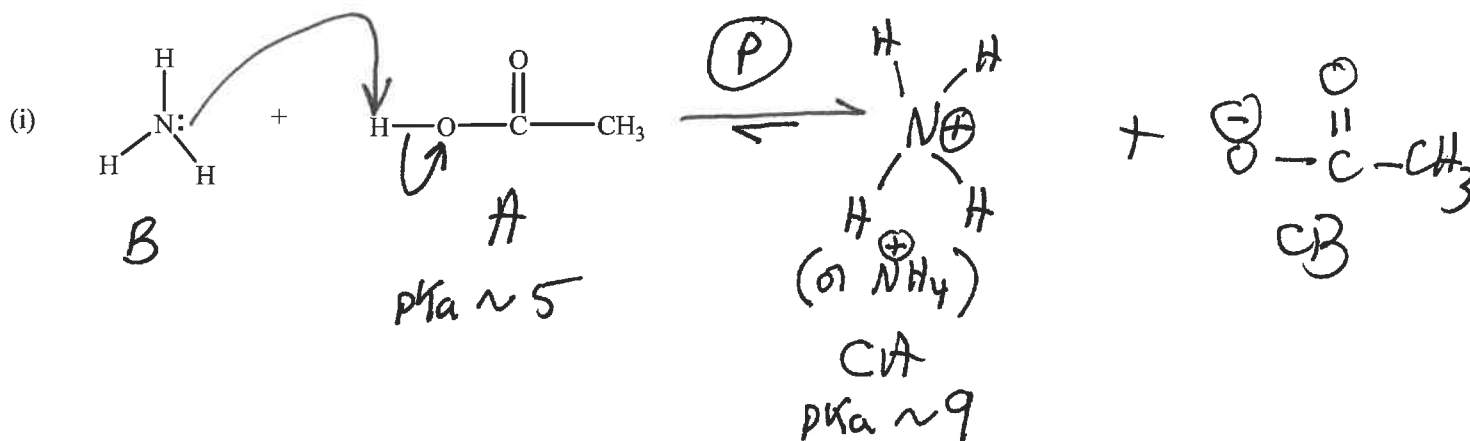
5. (10 Points) "Zig-Zag" structures. Re-draw each of the following compounds as "zig-zag" structures.



6. (47 Points) Acid/Base Questions.

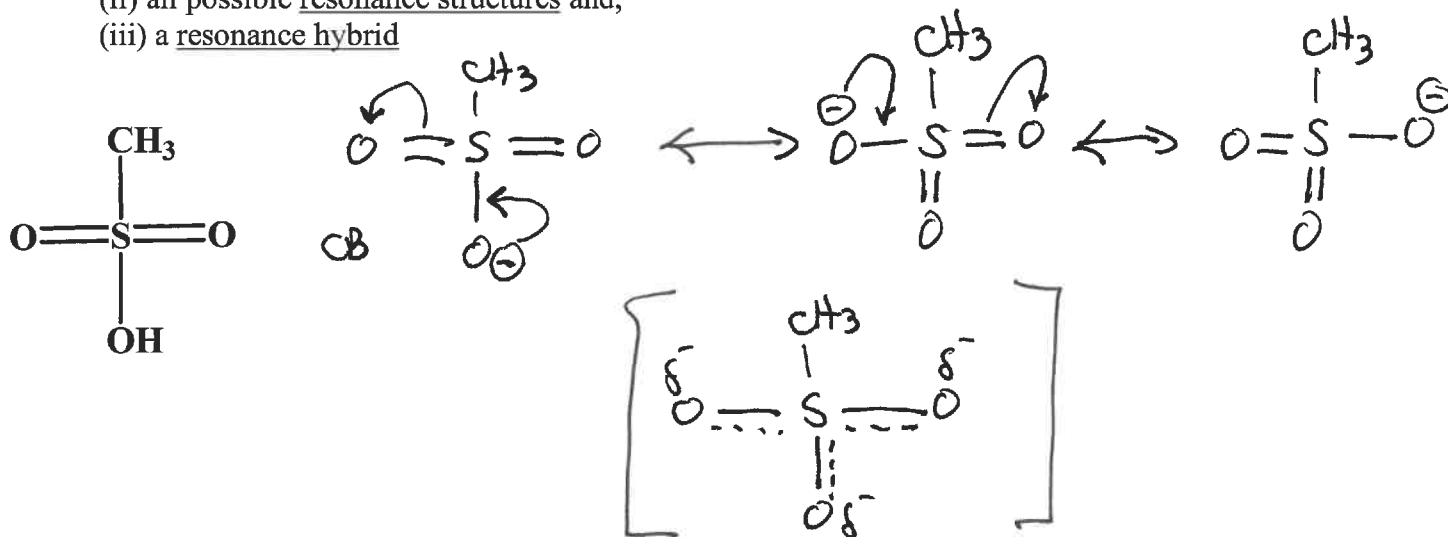
(a) **Acid/Base Reactions and Mechanisms.** Illustrate the complete mechanism for each of the acid-base reactions shown below. You must complete each of the following exercises:

- 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.

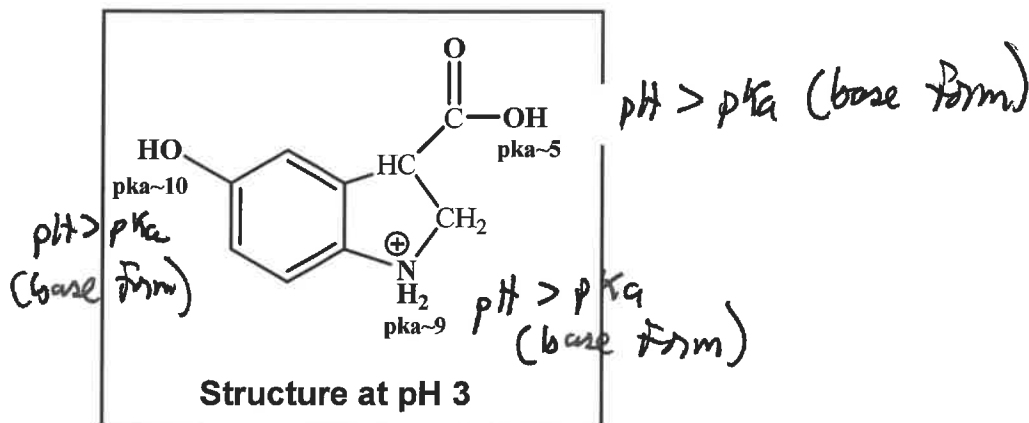


(b) **Resonance.** For the acid shown below, draw:

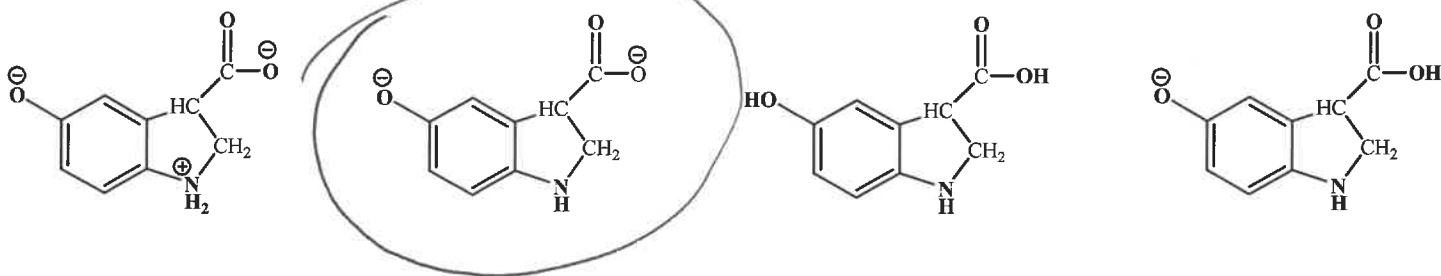
- the conjugate base
- all possible resonance structures and,
- a resonance hybrid



(c) **Effect of pH and 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 12? Circle your answer:



(ii) Based on the structure in the box at pH 3, and the structure you circled at pH 12, would this compound be more water soluble at (CIRCLE):

pH 3

or

pH 12

or

equally soluble at either pH

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

The compound has two charges at pH 12 versus one charge at pH 3, so more soluble at pH 12.

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