NAME (PRINT CLEARLY)_____

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 =

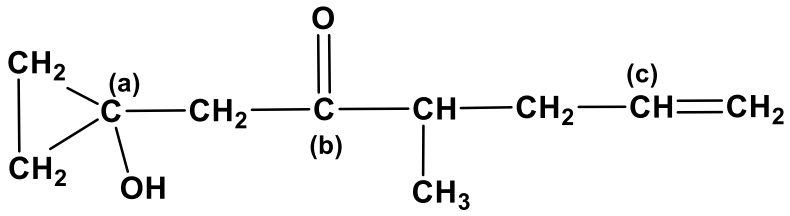
Total Points _____(150) = _____%

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) _____ and _____

(b) _____ and _____

(c) _____ and _____

(ii) Indicate the number of: 1^o carbons _____ 2^o carbons _____ 3^o carbons _____

(iii) For the structure drawn above:

How many pi bonds are there? _____

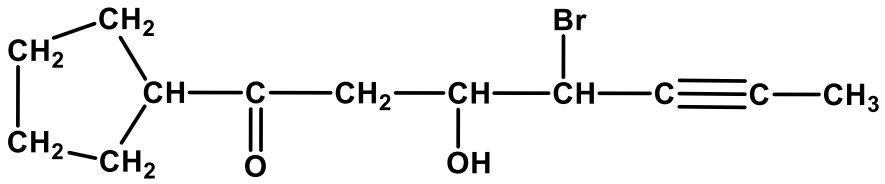
How many rings are there? _____

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

(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**

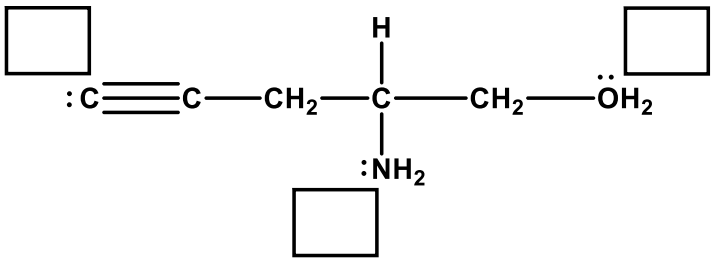
(b) In the molecule drawn below, which of the following functional groups are present? **Circle your choice(s).**



alcohol **alkene** **amine** **carbonyl** **cycloalkyl (ring)**

ether **halogen (alkyl halide)** **internal alkyne** **terminal alkyne**

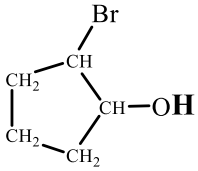
(c) For the compound drawn at the right, write the **Formal Charge** in the boxes for the indicated atoms (0 or -1 or +1). All necessary lone electron pairs are drawn.



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

H_4Si _____ **H_2S_____** **HCl_____** **H_3P_____**

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



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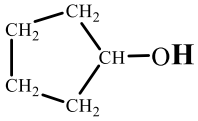

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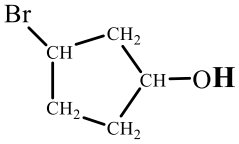

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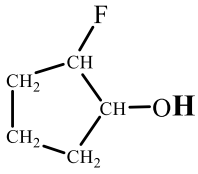

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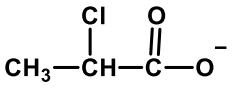
(f) Rank the following molecules in order of **base strength** (1 = weakest.....4 = strongest).



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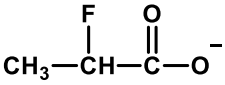

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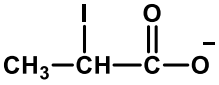

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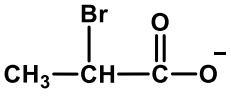

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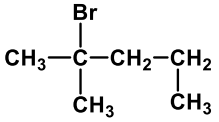
2. (9 Points) Comparing Organic Structures. Are the following pairs of compounds:

Identical or Different or Constitutional Isomers



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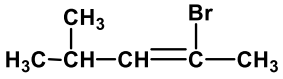

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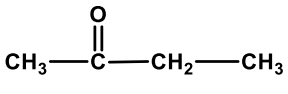

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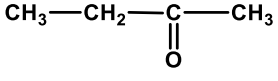

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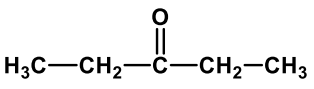

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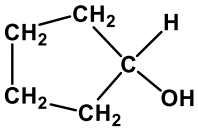

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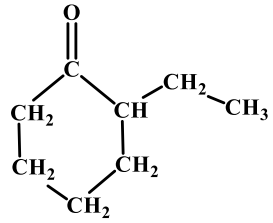
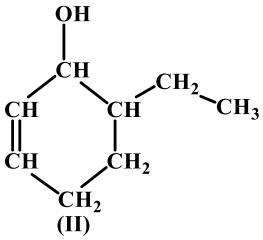
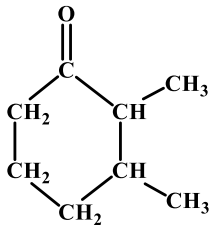
3. (20 Points) Organic Structure Identification. An unknown organic compound with a **formula of $C_8H_{14}O$** is thought to be one of the three molecules drawn below (I, II, or III):



(I)



(II)



(III)

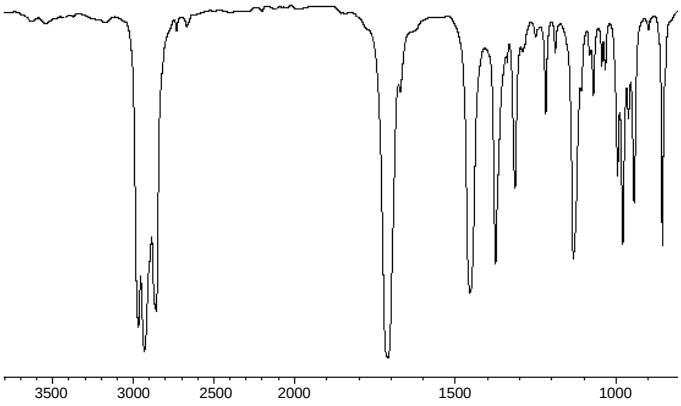
(a) Calculate the Hydrogen Deficiency (HD) for this unknown **($C_8H_{14}O$)**: _____

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

alkene	**carbonyl**	**alkyne**	**alcohol**	**ether**	**cycloalkyl**
(C=C double bond)	(C=O double bond)	(C≡C triple bond)	(R-OH)	(R-O-R)	(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

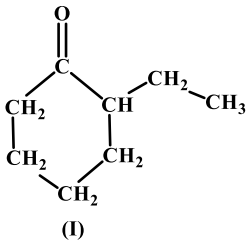
_____ internal alkyne _____ carbonyl

_____ none of these

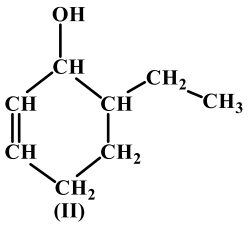
If "none of these", is there a hidden functional group? HINT: Look at your answer to (b).

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

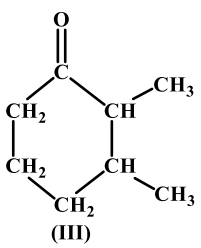
(f) The unknown has **two 1º carbons, three 2º carbons, and two 3º carbon**. Based on all the information above, identify the unknown by circling **<u>ONE</u>** structure at the right:



(I)



(II)



(III)

4. (10 Points) Basic Calculations (use correct <u>significant figures and units</u>).

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

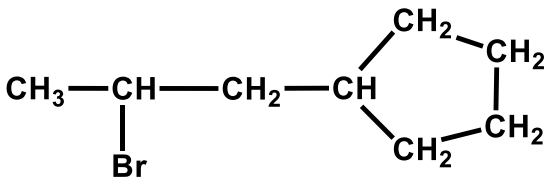
(a) If you had 0.3112 grams of this compound, how many moles would you have? _____

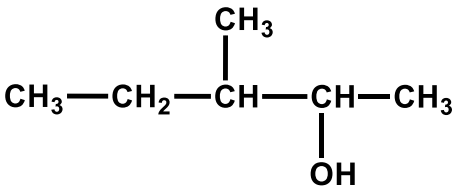
(b) You accidently spilled this compound on the lab bench. You used a spatula to recover as much as possible. After re-weighing, you now have 0.2275 g.

Calculate your % Recovery _____

You MUST show your work in the space below:

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

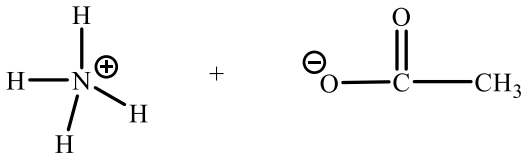


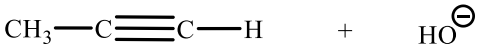


6. (47 Points) Acid/Base Questions.

(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:

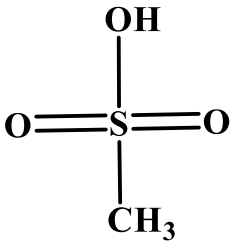
- Label the Acid (A) and Base (B) on the reactant side of the equation;
- Use curved arrows to indicate the flow of electrons;
- Draw the products of the reaction, and make sure that the equation is balanced;
- Label the Conjugate Acid (CA) and Conjugate Base (CB);
- Assigning approximate pKa values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

(i) 

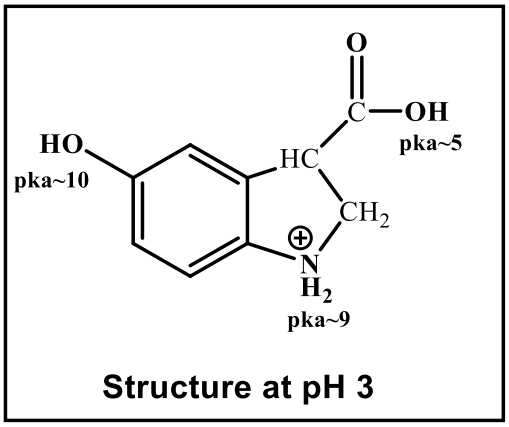
(ii) 

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

(i) the conjugate base
(ii) all possible resonance structures and,
(iii) a resonance hybrid

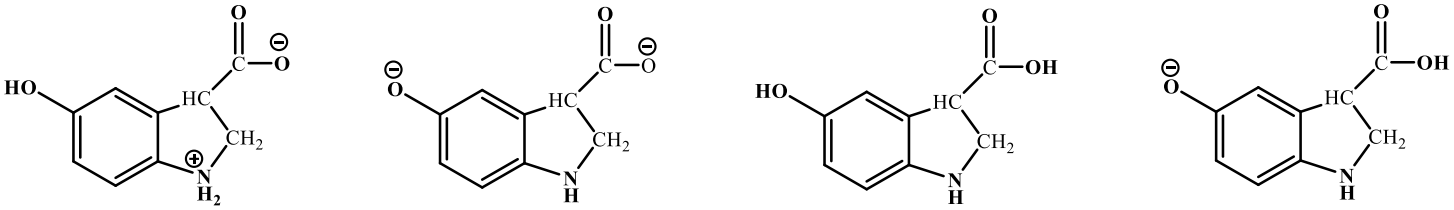


(c) Effect of pH & pKa on Acid/Base Structure. The compound drawn below is shown as it would exist at **pH 3.**



Structure 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 **<u>more</u> water soluble at** (CIRCLE):

pH 3 or **pH 7** or **equally soluble at either pH**

(iii) **<u>Briefly</u>** explain your reasoning for your answer to (ii) above.

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