UCSC, Binder Name_____

Student ID # _____

Organic Chemistry
EXAM 1 (300 *points*)

In each of the following problems, use your knowledge of organic chemistry conventions to answer the questions in the proper manner. **Be sure to read each question carefully.** You will have the entire class period to complete this exam (approximately 2 hours), but hopefully you won't need it! You are welcome to use pre-built models.

Keep your eyes on your own paper. Electronic devices of any kind are not allowed, including cell phones and calculators. Any student found using any of said devices, or found examining another student's exam, will be promptly removed from the exam room and at minimum will receive a zero on this exam. Such an incident may also be considered a form of academic dishonesty and reported to the UCSC Judiciary Affairs Committee.

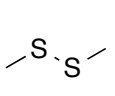
1 (50)	
2 (40)	
3 (45)	
4 (30)	
5 (45)	
6 (40)	
7 (50)	
Total	

1. Fundamentals

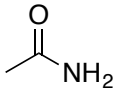
(a) (*20 points*) Draw a **Lewis structure** for each of the following molecules. Be sure to include all lone pair electrons and circle all formal charges, where appropriate.

	Carbonate (CO_3^{2-})	**Chloroform ($CHCl_3$)**
Lewis Structure		
Hybridization of Central Atom		
Geometry		
3D Structure		

(b) (*10 points*) **Fill in any nonbonding valence electrons** that are missing from the following structures.



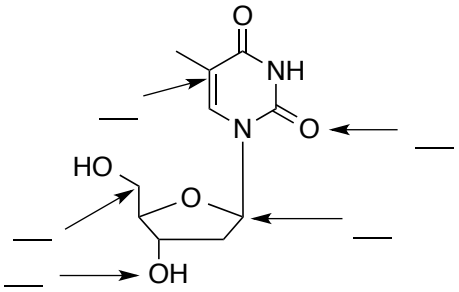
Dimethyl disulfide



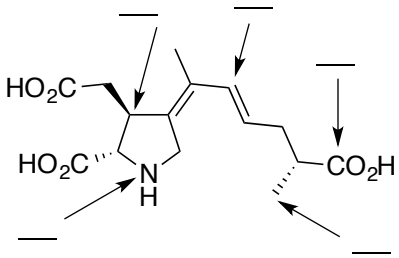
Acetamide

Acetate Ion

(c) *(10 points)* **Indicate the hybridization** on the indicated atoms on **Deoxythymidine** and **Isodomoic acid H**.

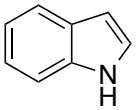


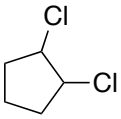
Deoxythymidine



Isodomoic acid H

(d) (*10 points*) **Fill in any hydrogens** not shown and **indicate the *total* number of hydrogens** in each molecule below.

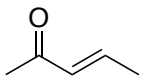


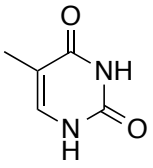


Number of H's

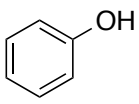
2. Resonance and Formal Charge

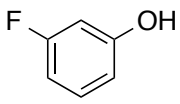
(a) (*20 points*) **Draw two additional *non-equivalent* resonance structures** for each compound below, using **curved arrow notation** to indicate electron movement. Lone pairs are not shown on heteroatoms (O and N).

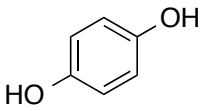




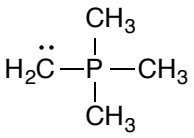
(e) (*10 points*) **Circle the molecule(s)** that have a dipole moment and **indicated the expected direction** of the molecule's net dipole using a dipole arrow.

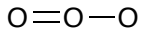


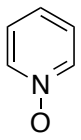




(f) (*10 points*) **Add formal charges to any charged atoms below**. Lone pairs are provided on carbon where applicable, but lone pairs on heteroatoms are implied (add them yourself). **Circle the charge** and make sure it's clear to which atom the charge belongs!

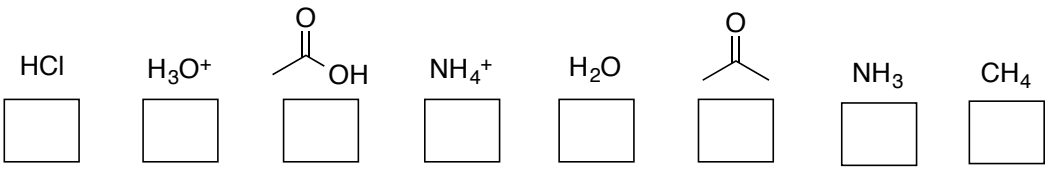






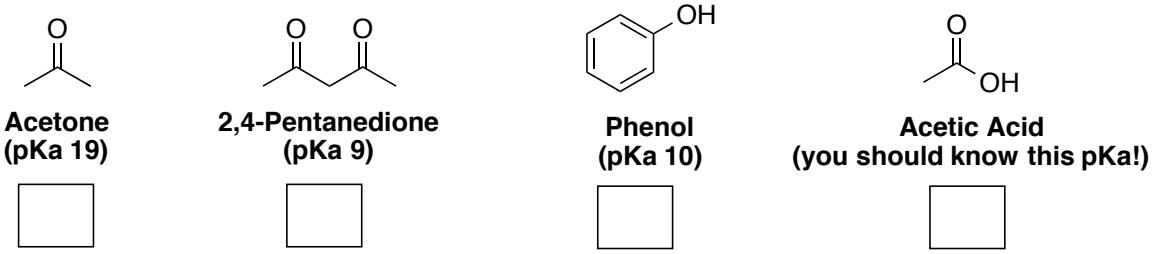
4. Acidity

(a) (*15 points*) The following compounds are listed in order of acidity (most acidic on the left). Indicate the approximate **pKa value** that belongs to each compound in the boxes provided.



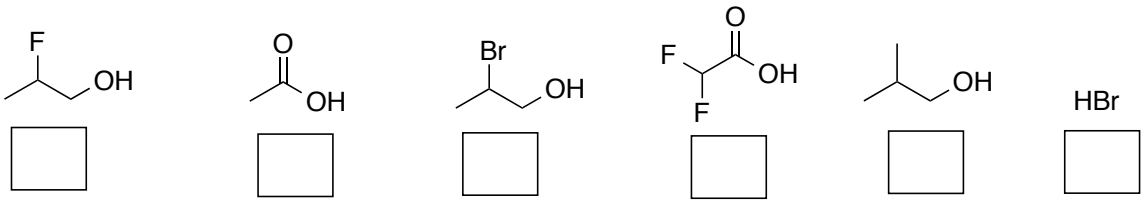
(b) (*20 points*) **Rank** the following sets of molecules in terms of acidity where **"1" is the most acidic**.

Set 1



Acetone (pKa 19) | **2,4-Pentanedione (pKa 9)** | **Phenol (pKa 10)** | **Acetic Acid (you should know this pKa!)**

Set 2



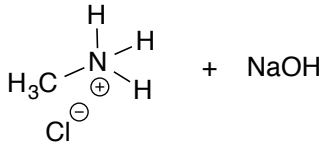
(d) (*10 points*) **Explain the meaning of a compound's pKa in <u>10 words or less</u>** without equations or references to equations ("used to rank acidity" is not an acceptable answer!).

5. Acid-Base Chemistry

(*30 points*) For each set of reactants…

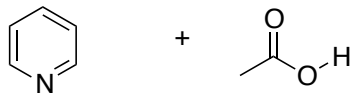
- **Label the acid and the base,**
- **Draw the products**,
- **Label the conjugate acid and the conjugate base,**
- **Use curved arrows** to indicate electron movement,
- **Predict the direction of the equilibrium** with an arrow pointing towards either reactants or products.

(a)



+ NaOH

(b)



(c)

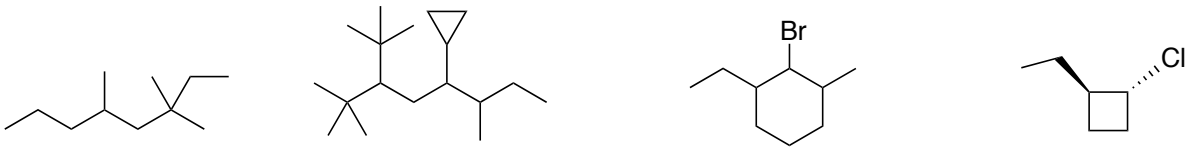
+ NaOH

(d)

+ H−Cl

3. Nomenclature and Functional Groups

(a) (15 points) Provide **names for any three** following compounds. Write the letter (**i**-**iv**) of the molecule you are choosing in the parentheses next to the blank line for full credit.



(i) **(ii)** **(iii)** **(iv)**

( ) _____

( ) _____

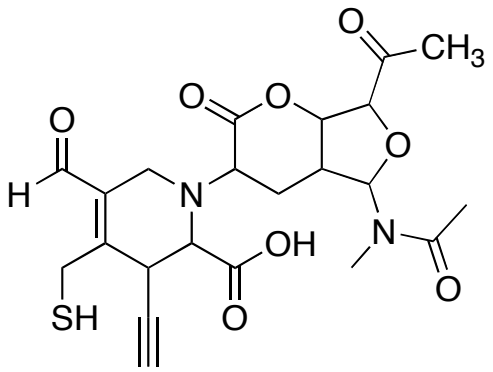
( ) _____

(b) *(10 points)* **Draw** the structures of…

(i) 4-Isopropyl-3-methylheptane

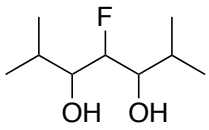
(ii) 4-Ethyl-2,2-dimethylhexane

(d) (*20 points*) **Circle and identify all the functional groups** in the fictitious molecule below.

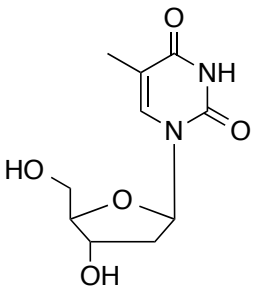


6. Stereochemistry

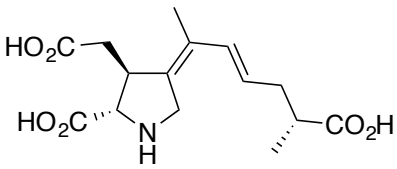
(a) (*18 points*) Chiral centers are of great importance in recognition by cell receptors and enzyme active sites. **Indicate the chiral centers** (AKA stereocenters) in each compound **with a star (*)** then indicate the **maximum number of stereoisomers** for each compound on the lines below.



1,6-Dimethyl-4-fluoro-3,5-heptanediol



Deoxythymidine

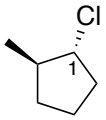


Isodomoic acid H

Max # stereoisomers:

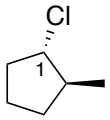
_____ _____ _____

(b) (*11 points*) **Designate each chiral center as *R* or *S*** on the lines below each structure. If the indicated atoms are not chiral, leave the line blank.



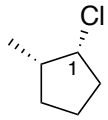
A

1___,2 ___



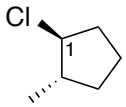
B

1 ___,2____



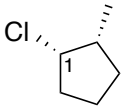
C

1___,2___



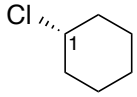
D

1___,2___



E

1___,2___



F

1____

(b) *(8 points)* **Indicate** whether the following pairs of compounds are **enantiomers, diastereomers, constitutional isomers, the same compound, or not related**.

A & B _____ A & C _____

C & D _____ C & E _____

C & F _____ D & E _____

D & F _____ E & F _____

(c) (*3 points*) **Briefly define the term 'racemic mixture.**' **Give an example** of a racemic mixture using the compounds above.

7. Conformational Analysis

(a) (*20 points*) Consider the rotation around the *C1-C2* bond of **2,3-dimethylbutane.**
Draw the <u>least stable and most stable</u> conformations of this compound as **Newman projections**.

(b) (*30 points*) Consider the following compounds:
***cis*-1-Methyl-4-*tert*-butylcyclohexane** and ***trans*-1-Methyl-4-*tert*-butylcyclohexane**.
Draw the **skeletal structures** and **two chair conformations** of each. Indicate the more stable conformation of each compound and <u>briefly explain your answer.</u>

***cis*-1-Methyl-4-*tert*-butyl-cyclohexane**

***trans*-1-Methyl-4-*tert*-butyl-cyclohexane**