PLEASE DO NOT WRITE ON THE EXAM (EVEN YOUR NAME) UNTIL TOLD TO START!

UCSC, Binder Name_____

Student ID # _____

CHEM 8A, 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	

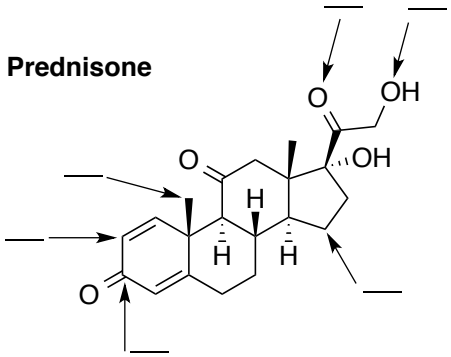
1. Fundamentals

(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. No geometry is necessary.

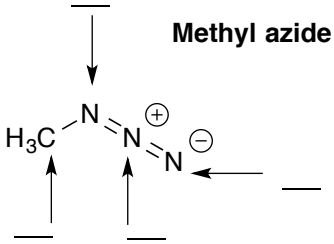
	Carbonate (CO_3^{2-})	**Chloroform ($CHCl_3$)**
Lewis Structure (line-bond)		
Hybridization of Central Atom		
Name of Geometry		

(b) *(20 points)* **Indicate the hybridization** on the indicated atoms on **prednisone and methyl azide.**

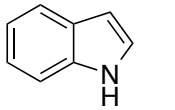
Prednisone

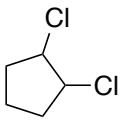


Methyl azide



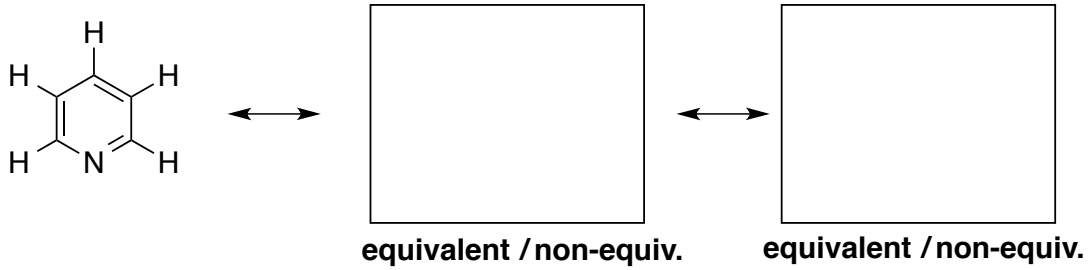
(c) (*10 points*) **Fill in any hydrogens** not shown and indicate the **molecular formula** of the compound in the box provided.



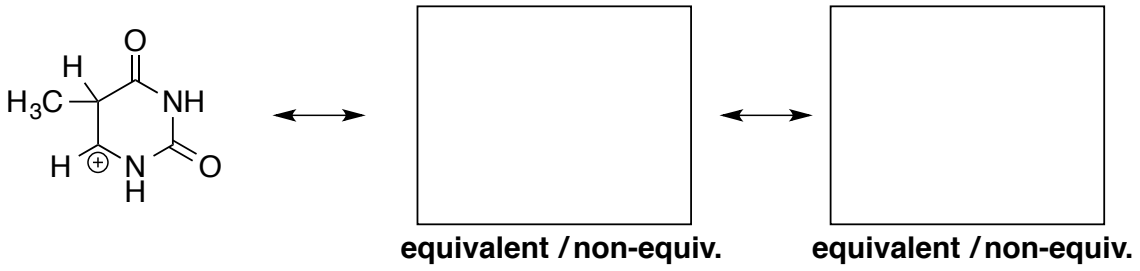


2. Resonance and Formal Charge

(a) (*20 points*) **Draw two additional resonance structures** for each compound below and use **curved arrow notation** to show electron movement. Indicate (circle) whether each new structure is **equivalent to the original provided structure or non-equivalent**. All hydrogen atoms are drawn on the provided structure, but it is not necessary to draw all H's in your answers. Lone pairs are not shown on heteroatoms (O and N).

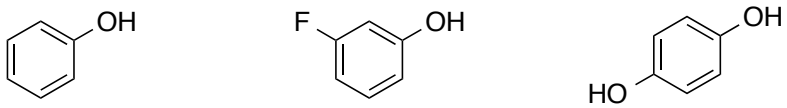


equivalent / non-equiv. **equivalent / non-equiv.**

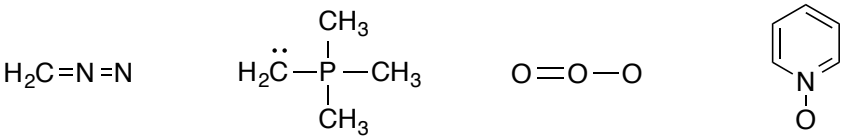


equivalent / non-equiv. **equivalent / non-equiv.**

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

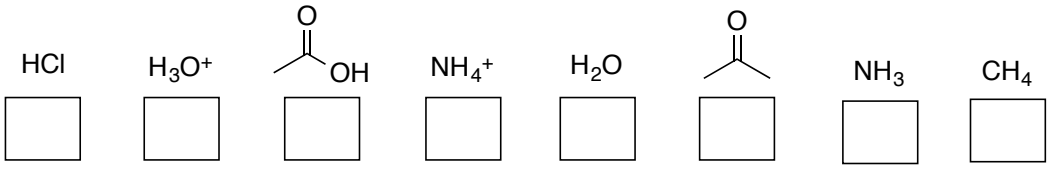


(c) (*10 points*) **Add formal charges to all charged atoms below**. Lone pairs are provided on carbon where applicable, but lone pairs on heteroatoms are implied (add them yourself). **Circle the charge** and make sure it's clear to which atom the charge belongs!



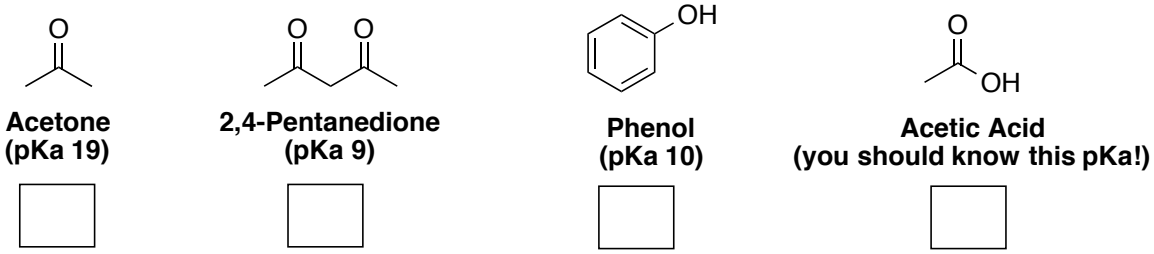
3. Acidity

(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.

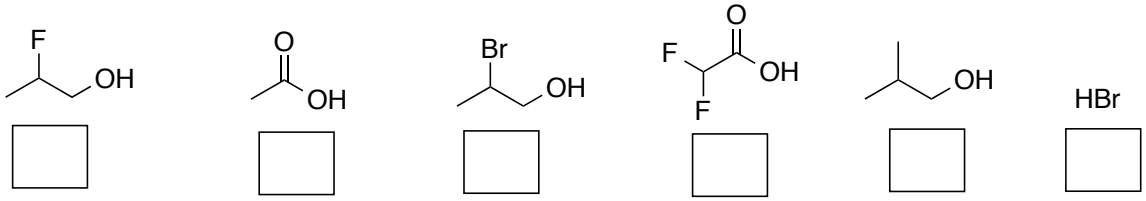


(b) (*20 points*) **Rank** the following sets of molecules in terms of acidity where **"1" is the most acidic**. Give your numerical answer in the box provided under each. There are no ties!

Set 1



Set 2



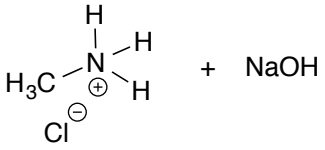
(c) (*10 points*) **Explain the meaning of a compound's pKa in <u>10 words or less</u>** without equations or references to equations ("used to rank acidity" is not an acceptable answer!).

4. Acid-Base Chemistry

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

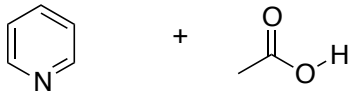
- Label the **acid** and the **base,**
- Draw the **products**,
- Label the **conjugate acid** and the **conjugate base,**
- Use **curved arrows** to indicate electron movement between reactants, and
- Predict the **direction of the equilibrium** with a larger arrow pointing towards either reactants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

(a)



+ NaOH

(b)



(c)

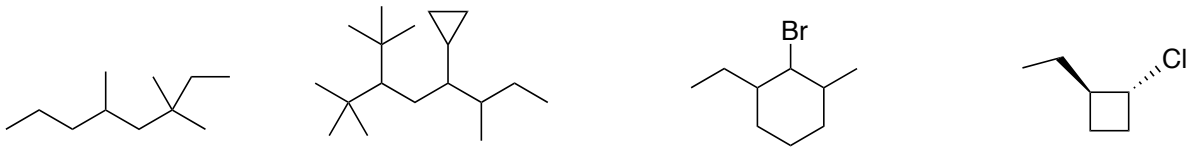
CH_3O-H + NaOH

(d)

CH_3O-H + H–Cl

5. Nomenclature and Functional Groups

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



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

( ) _____

( ) _____

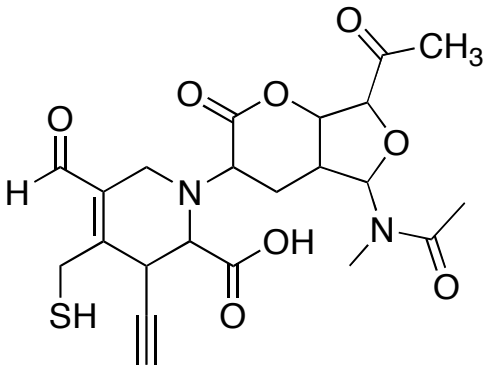
( ) _____

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

(i) 4-Isopropyl-3-methylheptane

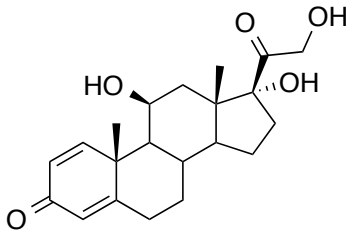
(ii) 4-Ethyl-2,2-dimethylhexane

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

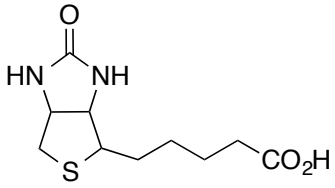


6. Stereochemistry

(a) (*16 points*) Chiral centers are important for metabolic function by providing the specific 3D shape needed to fit into a receptor or enzyme active site. **Indicate the chiral centers** (AKA stereogenic centers) **with a star (*)** on the two naturally occurring molecules below.

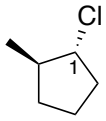


Prednisolone



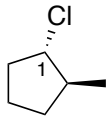
Biotin

(b) (*22 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. Note the label "1" given to help you keep track.



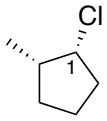
A

1___,2 ___



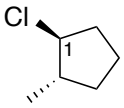
B

1 ___,2____



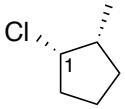
C

1___,2___



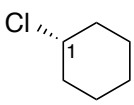
D

1___,2___



E

1___,2___



F

1____

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

A & B _____ A & C _____

C & D _____ C & E _____

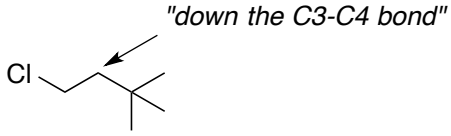
C & F _____ D & E _____

D & F _____ E & F _____

(d) (*4 points*) **Circle the pair(s)** in part **(c)** above that would be called a **"racemic mixture"** if they were mixed 50/50 in solution.

7. Conformational Analysis

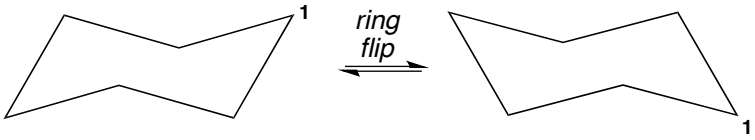
(a) (*20 points*) Consider the rotation around the *C3-C4* bond of **2,2-dimethyl-4-chlorobutane.** Site *down the C3-C4 bond* and draw **the least stable and most stable conformations** of this compound in **Newman projections**. You may draw other Newman projections as well, as long as the least and most stable are clearly circled and labeled.



2,2-dimethyl-4-chlorobutane

(b) (*30 points*) Consider the following compounds:
***cis*-1-Methyl-3-*tert*-butylcyclohexane** and ***trans*-1-Methyl-3-*tert*-butylcyclohexane**.
Draw the **skeletal structures** and **two chair conformations** of each. Indicate the more stable conformation of each compound and briefly explain your answer.

cis-1-Methyl-3-tert-butyl-cyclohexane



trans-1-Methyl-3-tert-butyl-cyclohexane