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. Make sure there are 6 pages (6 problems). Please write your last name and first initial on the top of each page once instructed to start the exam.

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 (40)	
2 (50)	
3 (65)	
4 (45)	
5 (45)	
6 (50)	
Total (300)	
	%

1. Fundamentals

(a) (*10 points*) Draw a **Lewis structure (lines for covalent bonds)** for each of the following molecules. Be sure to include all lone pair electrons and circled formal charges, where appropriate.

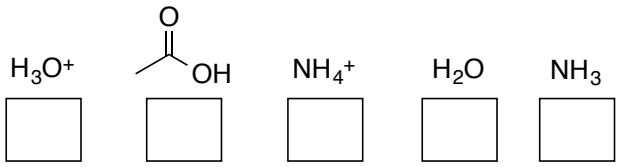
(i) $KOCH_3$ (ii) Hydrogen Sulfide (H_2S)

(b) (*10 points*) Convert the following condensed structures into **skeletal (zig-zag)** format.

$CH_3CH_2CH(CH_3)_2$

$(CH_3)_3CCH(CH_3)CH_2CH_3$

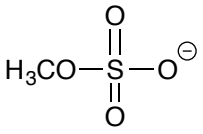
(c) (*10 points*) The following compounds are listed in order of acidity (most acidic on the left). Indicate the approximate **pKa value** that belongs to each compound in the boxes provided.



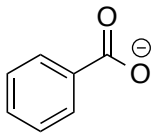
(d) (*10 points*) **Explain the meaning of a compound's pKa in 10 words or less** without equations or references to equations ("used to rank acidity" is not an acceptable answer!).

2. Molecular Structure

(a) (*24 points*) **Draw two additional resonance structures** for each compound below, using **curved arrow notation** to indicate electron movement. Indicate whether each new structure is **equivalent** to the given structure or **non-equivalent**. Lone pairs are not shown on heteroatoms (O and S).



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

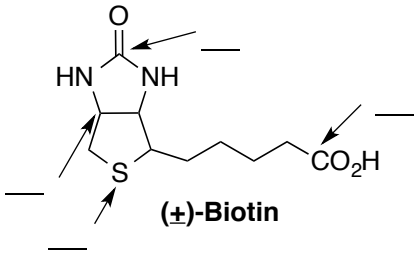


equivalent / non-equiv. **equivalent / non-equiv.**

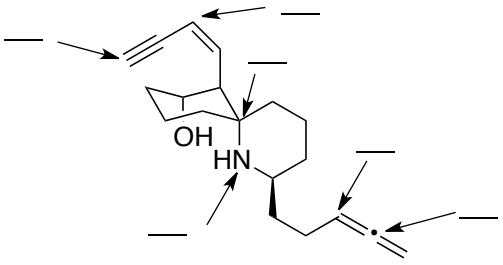
(b) (*10 points*) **Circle the most polar molecule** and draw a **large X over the least polar molecule** below. *Hint: use the space below to draw the 3D structure of each.*

CF_4 CHF_3 CH_2F_2 CH_3F CCl_2F_2

(c) *(10 points)* **Indicate the hybridization** on the indicated atoms on biotin and isodihydrohistrionicotoxin.



(±)-Biotin



Isodihydrohistrionicotoxin

(d) (*6 points*) What is the **bond angle** and **shape** for each type of hybridization?

sp^3 **sp^2** **sp**

3. Acid-Base Chemistry

(a) (*5 points*) **Circle the correct order of relative acidity for the molecules below from** most (left) to least (right) acidic.

Most acidic Least acidic

(i) $CH_3NH_3^+$ > $CH_3OH_2^+$ > CH_3NH_2 > CH_3OH > CH_3CH_3

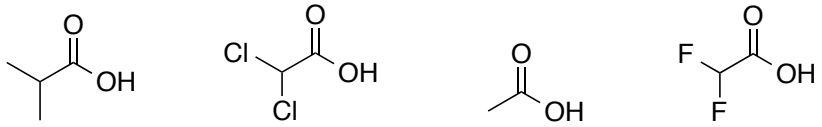
(ii) CH_3CH_3 > CH_3OH > CH_3NH_2 > $CH_3OH_2^+$ > $CH_3NH_3^+$

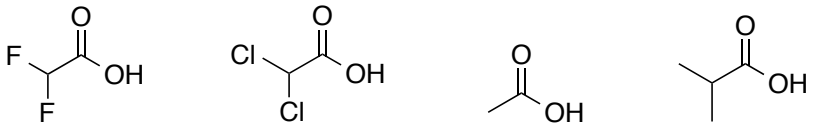
(iii) $CH_3OH_2^+$ > CH_3OH > $CH_3NH_3^+$ > CH_3NH_2 > CH_3CH_3

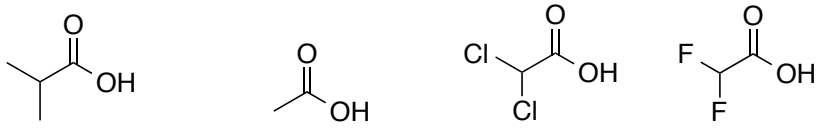
(iv) $CH_3OH_2^+$ > $CH_3NH_3^+$ > CH_3OH > CH_3NH_2 > CH_3CH_3

(b) (*10 points*) **Circle the correct acidity ranking.**

Most acidic Least acidic

(i) 

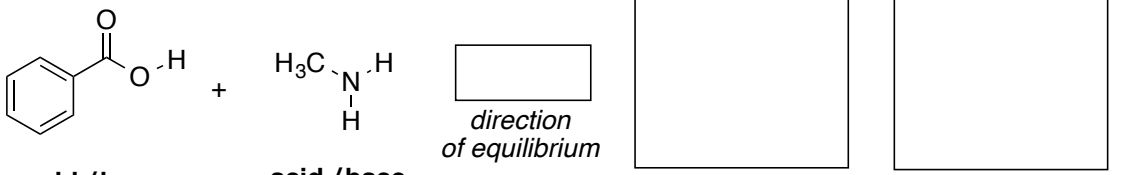
(ii) 

(iii) 

***(c)** (*50 points*) For each set of reactants…

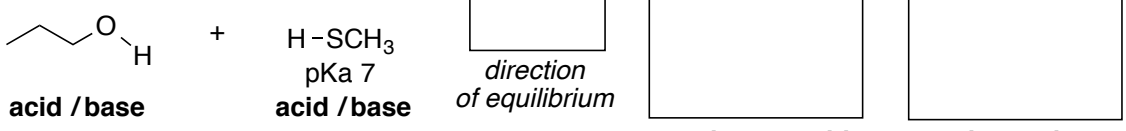
- **Indicate (circle) which is the acid and the base**
- **Draw the products** in the appropriate place to indicate the **conjugate acid and base**
- **Use curved arrows** to indicate electron movement in starting materials (reactants)
- **Predict the direction of the equilibrium** with an arrow pointing to reactants or products.

(i)



acid / base **acid / base** **conjugate acid** **conjugate base**

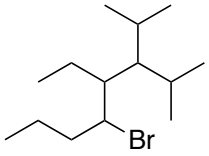
(ii)



acid / base **acid / base** **conjugate acid** **conjugate base**

4. Nomenclature and Functional Groups

(a) *(15 points)* Provide the **IUPAC names** for the three following compounds.



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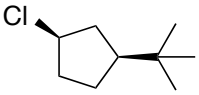

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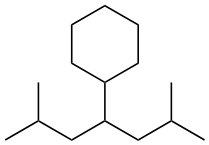

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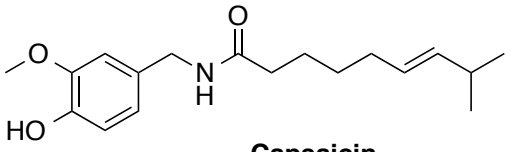
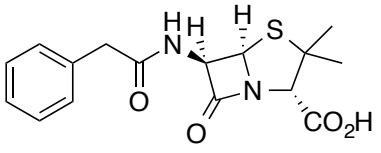
(b) *(10 points)* **Draw** the structure of **4-bromo-1-*tert*-butyl-2-methylcyclohexane**.

(c) (*20 points*) **Circle and identify all the functional groups** in the molecules below. Alkanes don't count as functional groups in this context. *Hint: there may be more than one of the same functional group and you should circle and identify each of them!*



Capsaicin
a "spicy" molecule!

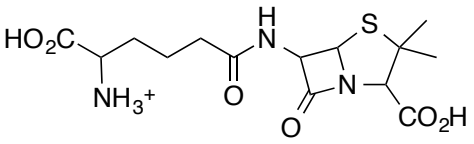
Camphor
(active ingredient in VapoRub)



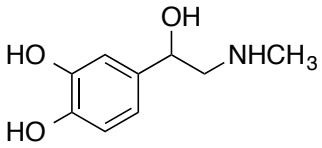
Penicillin G
(antibiotic)

5. Stereochemistry

(a) (*15 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 (*)**.

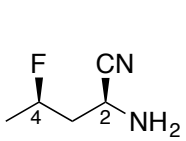


Isopenicillin N

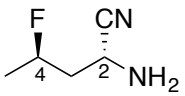


Epinephrine
(adrenaline)

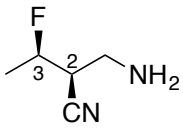
(b) (*12 points*) **Designate each chiral center as *R* or *S*** on the lines below each structure. If the indicated atoms are not chiral, leave the line blank.



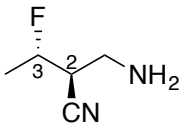
A



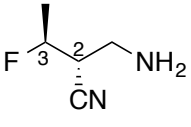
B



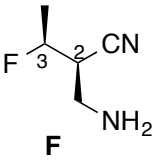
C



D



E



F

4___,2___ 4___,2____ 3___,2___ 3___,2___ 3___,2___ 3____,2____

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

A & B _____ B & C _____

A & C _____ C & D _____

C & E _____ D & E _____

C & F _____ E & F _____

(d) (*10 points*) Draw any two examples of **meso compounds**.

6. Conformational Analysis

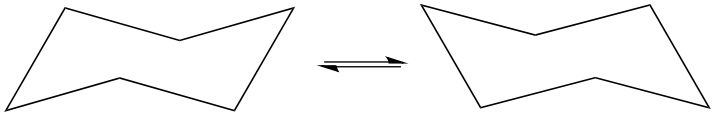
(a) (*20 points*) Consider the rotation around the *C1-C2* bond of **1,2-diiodoethane.**
Draw the <u>least stable and most stable</u> conformations of this compound as **Newman projections**.

(b) (*30 points*) Consider the following compounds:

***cis*-1-Fluoro-2-iodocyclohexane** and ***trans*-1-Fluoro-2-iodocyclohexane**

Draw the **skeletal structures** and **two chair conformations** of each. Circle the more stable conformation of each compound and <u>briefly explain your selections below each pair.</u> Your explanation should include the relative strain of each compound.

cis-1-Fluoro-2-iodocyclohexane



trans-1-Fluoro-2-iodocyclohexane