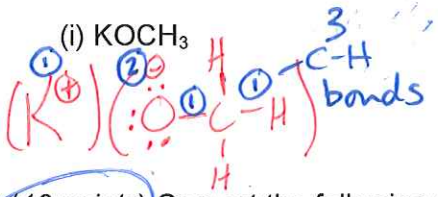
CHEM 108A, SS16 Last Name, First Initial _____

1. Fundamentals

5 pts each

(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)

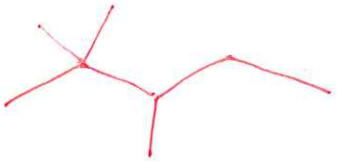
(b) (*10 points*) Convert the following condensed structures into **skeletal (zig-zag)** format.

$CH_3CH_2CH(CH_3)_2$

2pts → 4C parent
2pts → Me on 2

$(CH_3)_3CCH(CH_3)CH_2CH_3$

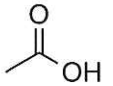
1 2 3 4 5



2pts → 5C parent
2pts → 2× Me on 2
1 pt → Me on 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.

2pts each



H_3O^+		NH_4^+	H_2O	NH_3
0	5	10	16	35

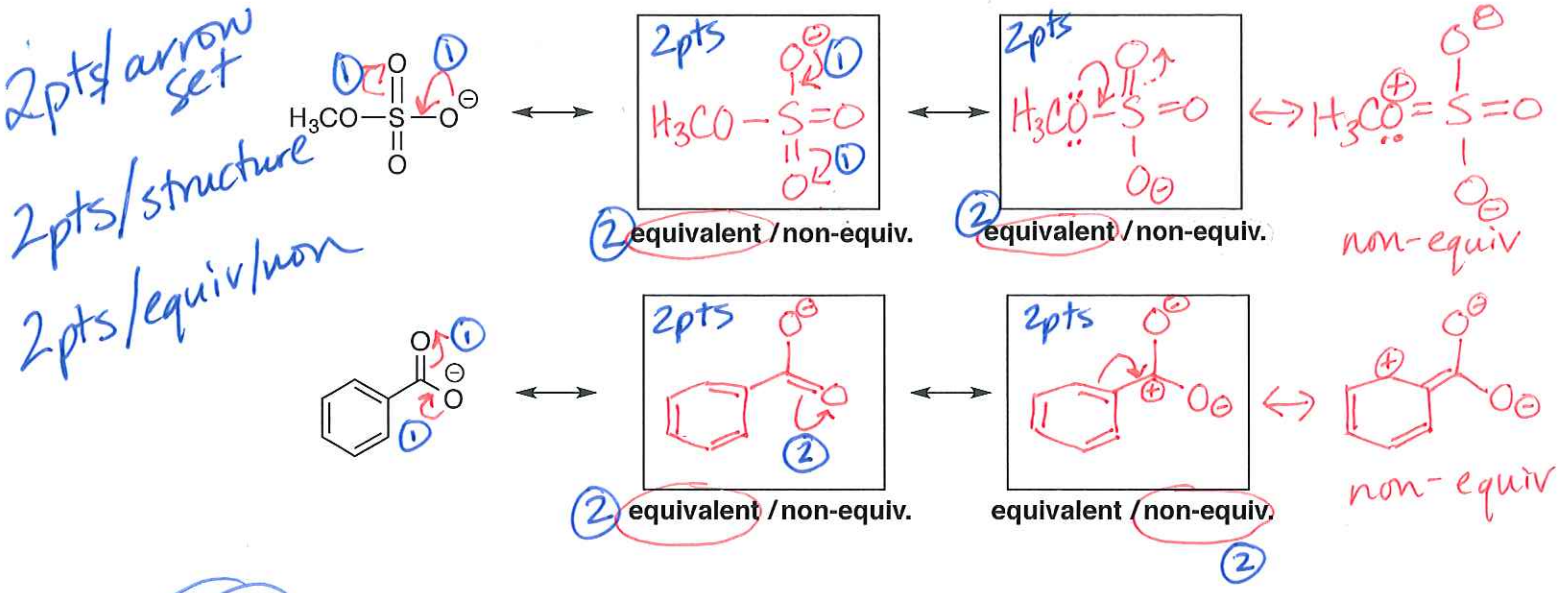
±2 ok

(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!).

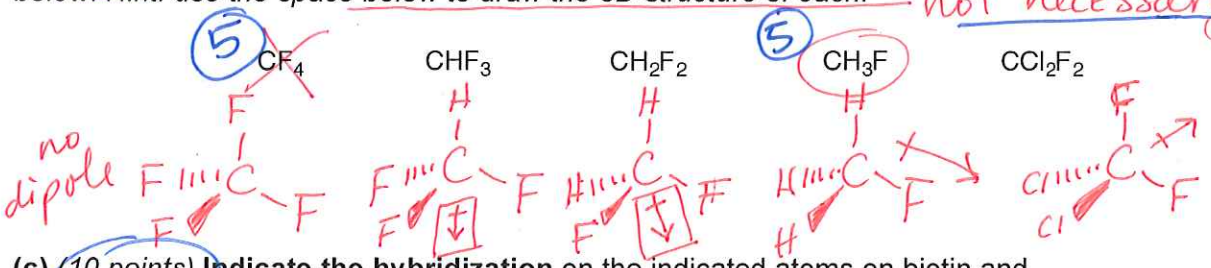
Affinity of an acid for its proton/H^+ must be very similar to this

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).

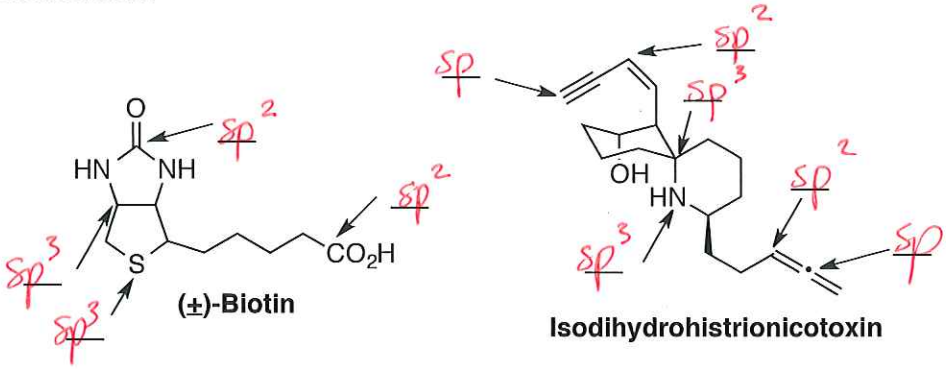


(b) (*10 points*) **Circle the most polar molecule** and draw a **large X over the least polar molecule** below. *Hint: use the space below to draw the 3D structure of each.* not necessary for credit



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

1pt each



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

sp^3	**sp^2**	**sp**
109.5°	120°	180°
tetrahedral	trigonal planar (flat/planar OK)	linear

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 > $CH_3OH_2^+$ > $CH_3NH_3^+$

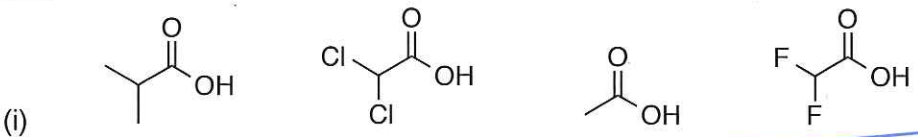
(iii) $CH_3OH_2^+$ > CH_3OH > $CH_3NH_3^+$ > CH_3NH_2 > CH_3CH_3

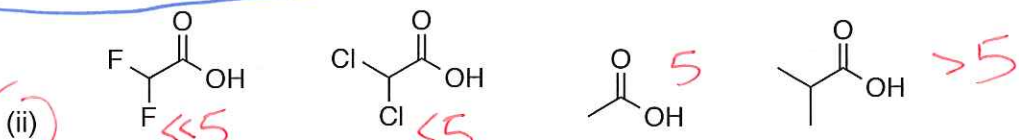
(iv) $CH_3OH_2^+$ > $CH_3NH_3^+$ > CH_3OH > CH_3NH_2 > CH_3CH_3

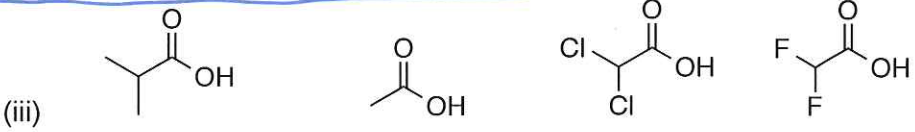
Ø 10 16 35 50

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

Most acidic Least acidic

(i) 

(ii) 

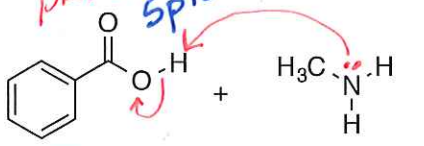
(iii) 

***(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.

25 pts

(i) pKa 5 both arrows 5pts

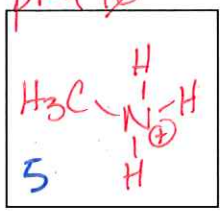


acid / base acid / base

5

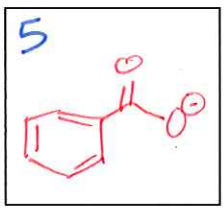
direction of equilibrium

pKa 10



conjugate acid

5

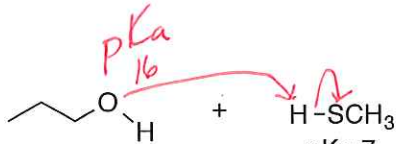


conjugate base

(ii)

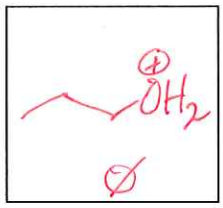
25 pts

pKa 16

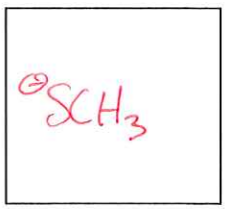


acid / base acid / base

direction of equilibrium



conjugate acid

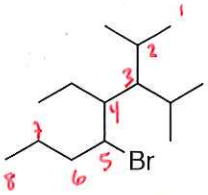


conjugate base

4. Nomenclature and Functional Groups

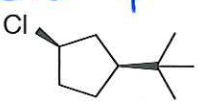
(a) *(15 points)* Provide the **IUPAC names** for the three following compounds.

lpt #'s



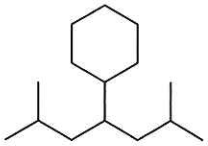
5-bromo-4-ethyl-3-isopropyl-2-methyloctane = 6

cis → lpt



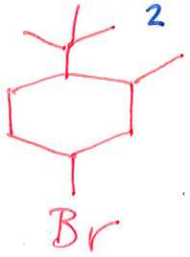
(1S,3R)-1-tert-butyl-3-chlorocyclopentane

lpt #'s = 6



4-cyclohexyl-2,6-dimethylheptane = 3

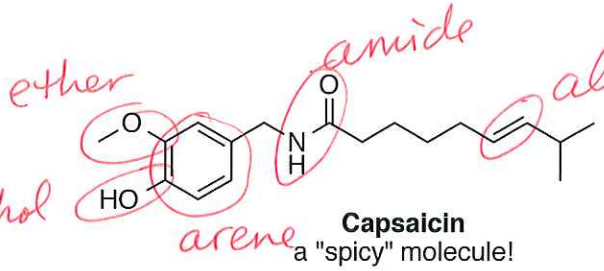
(b) *(10 points)* **Draw** the structure of **4-bromo-1-*tert*-butyl-2-methylcyclohexane**.



(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!*

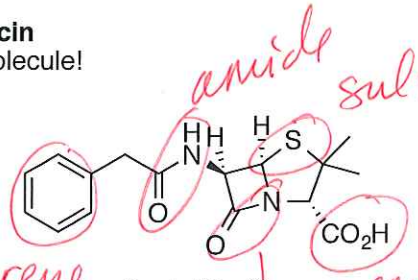
11 total groups can miss 1 & still get full credit

2pts/group



Capsaicin
a "spicy" molecule!

Camphor
(active ingredient in VapoRub)



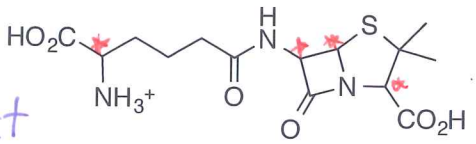
Penicillin G
(antibiotic)

-1 per extra group identified

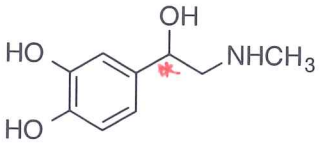
5. Stereochemistry

(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 (*)**.

3pts/*
-1 per incorrect Star

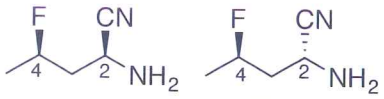


Isopenicillin N



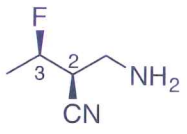
Epinephrine
(adrenaline)

(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.

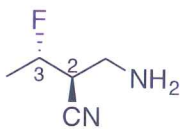


A 4 R ,2 S

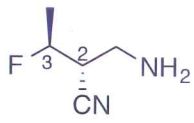
B 4 R ,2 R



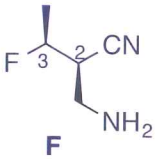
C 3 R ,2 S



D 3 S ,2 S



E 3 S ,2 R



F 3 S ,2 R

1pt each

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

1pt each

A & B diastereomers

B & C const. isomers ~~diastereomers~~

A & C constitutional isomers

C & D diastereomers

C & E enantiomers

D & E diastereomers

C & F enantiomers

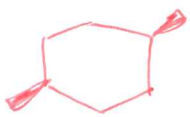
E & F same

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

(must have chiral centers & plane of symmetry)

ex.

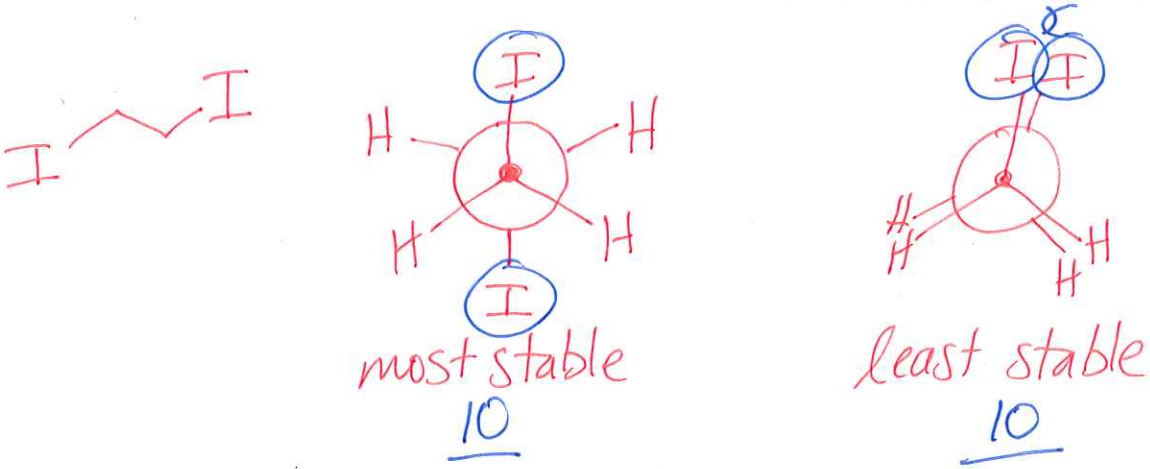
(NOT



no chiral centers)

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**.

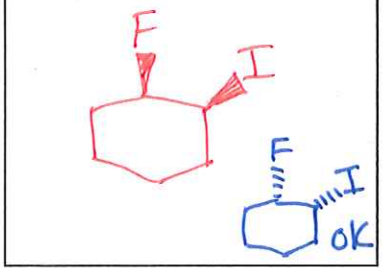


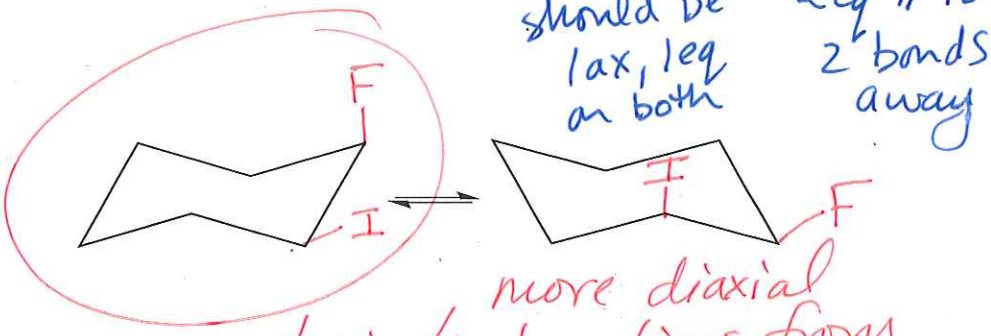
(b) (*30 points*) Consider the following compounds:

***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**