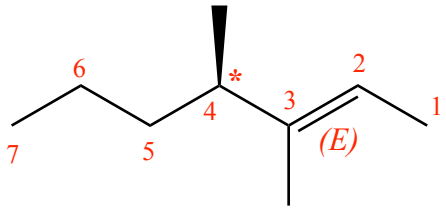
NAME (Print): _____

SIGNATURE: _____

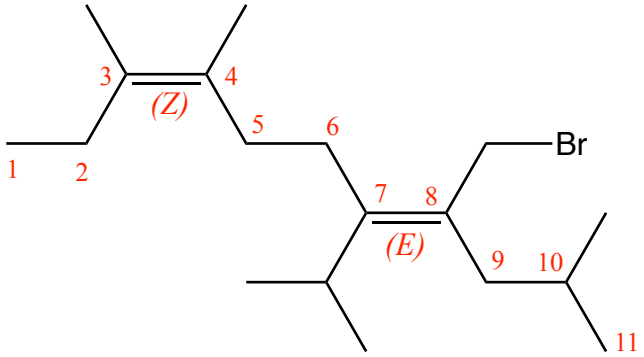
Chemistry 320M/328M
Dr. Brent Iverson
4th Homework
September 27, 2022

Please print the first three letters of your last name in the three boxes

1. Name the following alkenes according to IUPAC and the E,Z nomenclature rules.



(4R,2*E*)-3,4-Dimethyl-2-heptene



(3*Z*,7*E*)-8-bromomethyl-7-isopropyl-3,4,10-trimethyl-3,7-undecadiene
(3*Z*,7*E*)-8-bromomethyl-3,4,10 trimethyl-(1-methylethyl)-3,7-undecadiene

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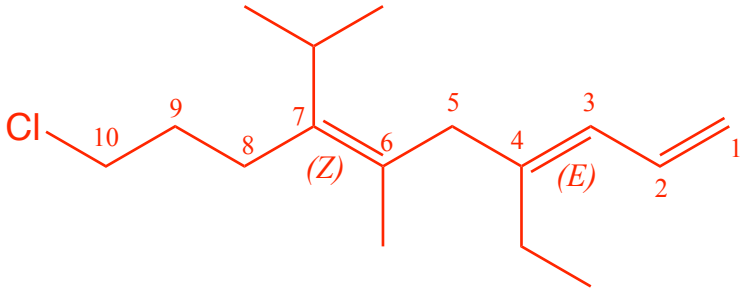
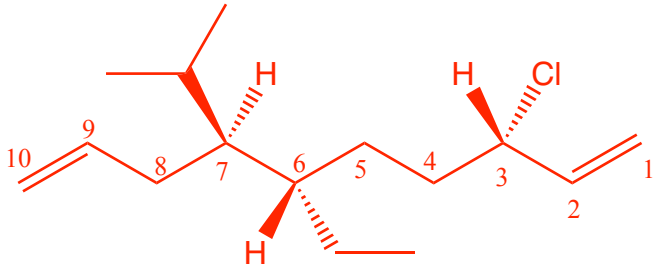
2. Draw the alkene with the following name:

(*3E,6Z*)-10-chloro-4-ethyl-7-isopropyl-6-methyl-1,3,6-decatriene



3. (6 pts) Draw the following molecule:

(*3S,6S,7S*)-3-Chloro-6-ethyl-7-isopropyl-1,9-decadiene



4. The two important consequences of the pi bond in alkenes is that:

A) The double bond cannot rotate.

and

B) Electron density is above and below the bond axis, so it is available to react with electron deficient species (called electrophiles)

5. (1 pt each) Circle all of the TRUE statements.

A. For a reaction to occur, it must have both "motive" (thermodynamic driving force) and "opportunity" (a relatively low overall energy barrier to reaction).

B. Reactions always go faster if the products are lower in energy than the starting materials.

C. Reactions have a "motive" (thermodynamic driving force) if the products are lower in energy than the starting materials.

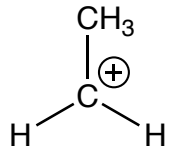
D. Reactions will go faster if they have a lower energy barrier.

E. Reactions will always have a "motive" (thermodynamic driving force) if they have a lower energy barrier.

F. Hyperconjugation is due to the overlap of electronegative elements with empty 2p orbitals in pi bonds.

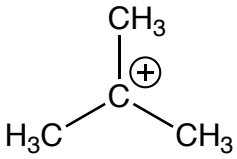
G. Hyperconjugation is due to the overlap of an empty 2p orbital of a carbocation with adjacent sigma bonding electron density.

6. (1 pt each) Rank the following carbocations in terms of overall stability, with a 1 under the most stable carbocation, and a 5 under the least stable carbocation.



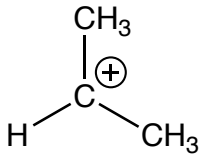
4

(1°)



2

(3°)



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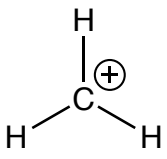
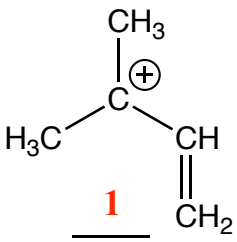
(2°)



5

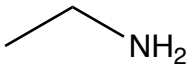
(methyl)



1

(resonance stabilized and 3°)

7. (1 pt each) Rank the following molecules with respect to acid strength, with a 1 under the strongest acid and a 4 under the weakest acid.



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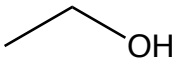

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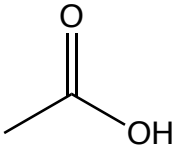

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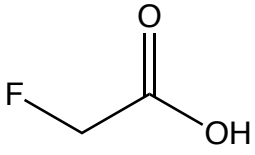
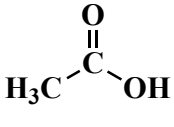


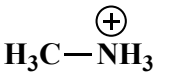
1

Signature_____

8. (18 pts) **Complete the following three structures by adding appropriate numbers of lone pair electrons, H atoms, and formal charges to the atoms in the boxes.** You must adjust your answers to indicate the predominant species at each indicated pH value. (You do not have to add anything such as H atoms to atoms not drawn in the boxes.) This problem is testing your understanding of the relationship of protonation state to pH to pKa values for certain functional groups we have discussed. **Next, in the space provided, write the overall charge on each structure at the indicated pH. For your reference, here are the relavant pKa values:**



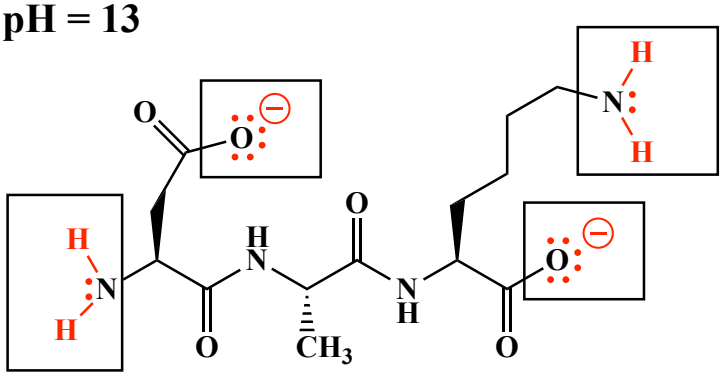
$pK_a = 4.76$



$pK_a = 10.64$

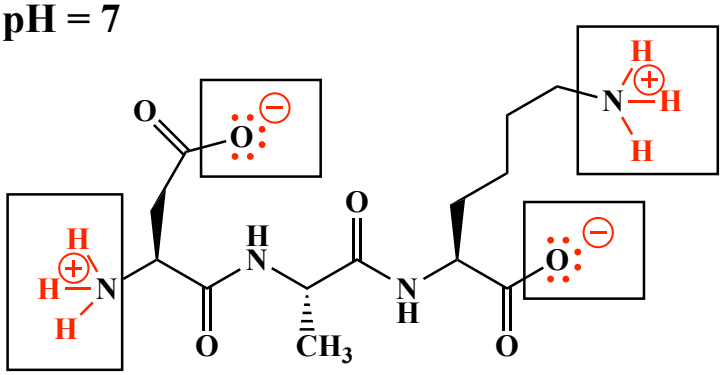
$pK_a = 38$

pH = 13



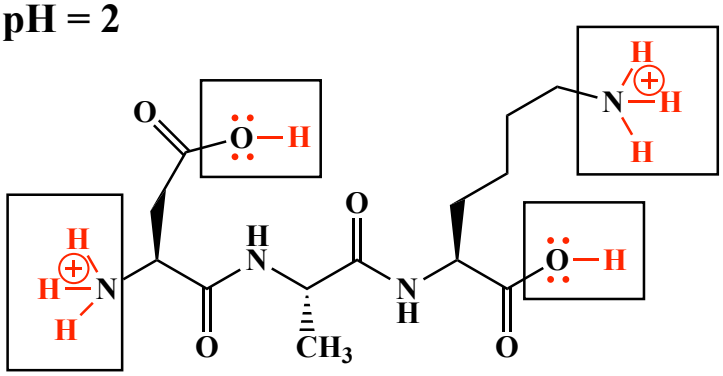
Total charge on molecule: -2

pH = 7



Total charge on molecule: 0

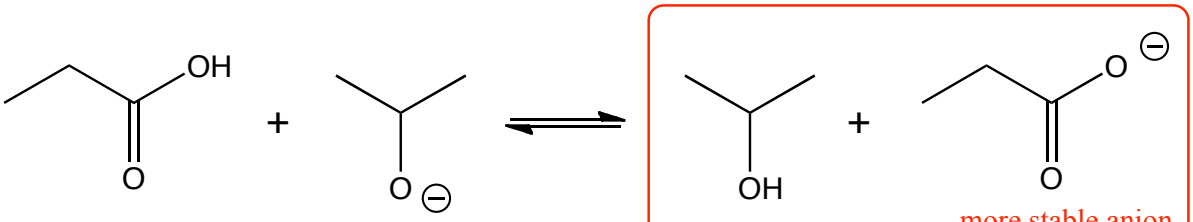
pH = 2

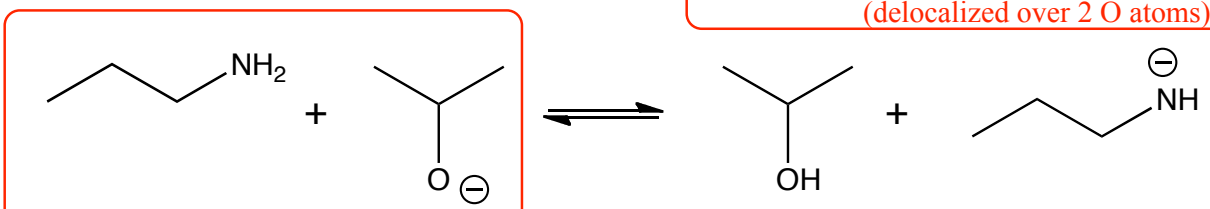


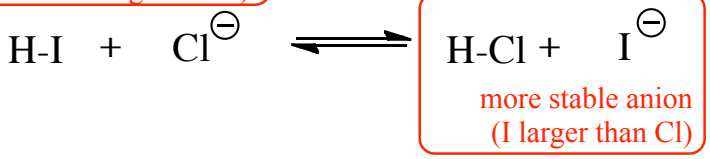
Total charge on molecule: +2

9. For the following acid base reactions, circle the side of the equation that predominates at equilibrium.

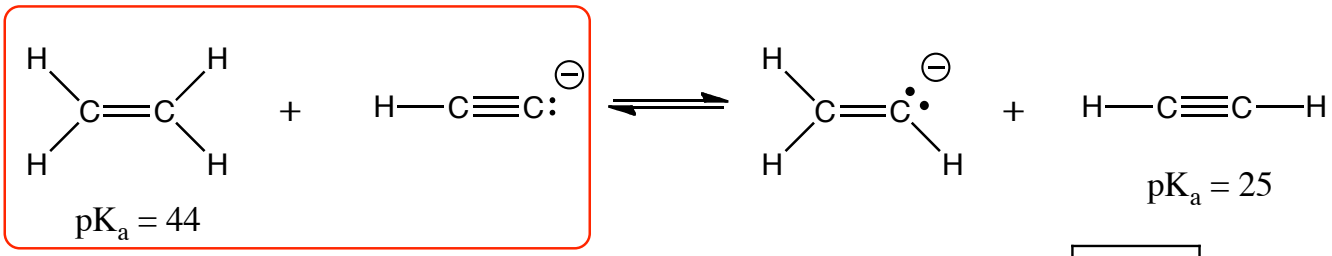
Look for the side with the more stable anion



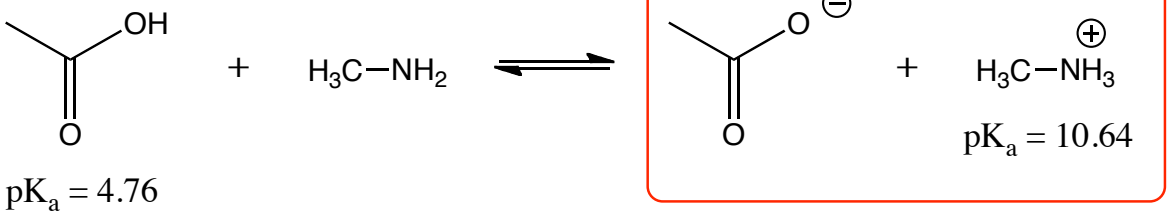




10. For the following two equations, the pKa values are listed underneath each acid. Circle the side of the equation that predominates at equilibrium, and in the space provided estimate the equilibrium constant for the reaction in the direction written.



The equilibrium constant for this process is $K_{eq} =$ 10^{-19}

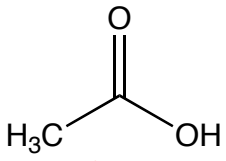


The equilibrium constant for this process is $K_{eq} =$ $10^{5.88}$

11. Rank the following from 1 to 4 with respect to relative acidity, with a 1 under the most acidic and a 4 under the least acidic molecule.

H_2O	CH_4	NH_3	H_2S
2	4	3	1

HF	HBr	HCl	HI
4	2	3	1



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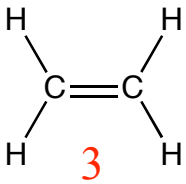
2



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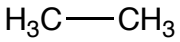

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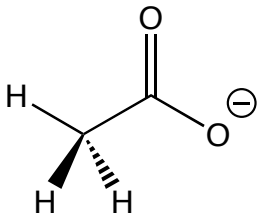
12. Rank the following from 1 to 4 with respect to relative anion stability, with a 1 under the most stable anion and a 4 under the least stable anion.



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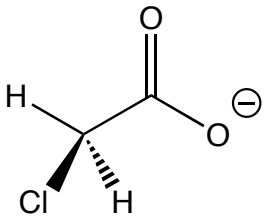

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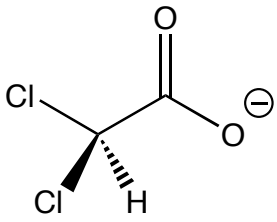

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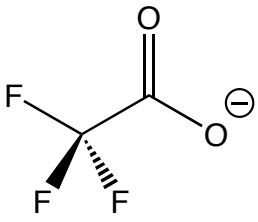

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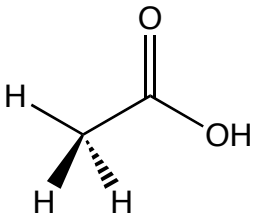
13. Rank the following from 1 to 4 with respect to relative acidity, with a 1 under the most acidic and a 4 under the least acidic molecule.



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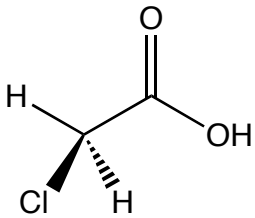

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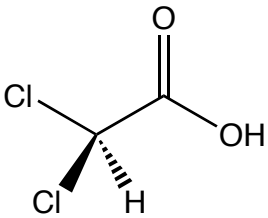

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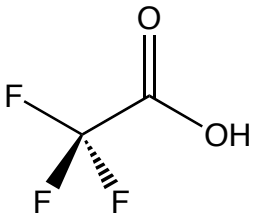

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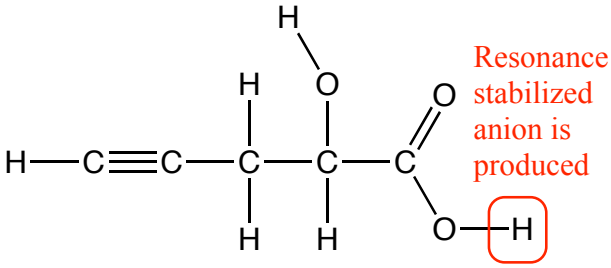
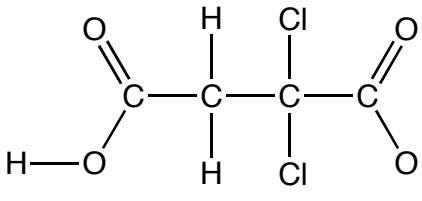
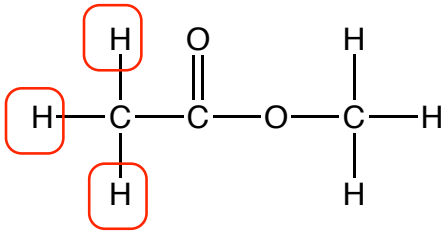
14. For each molecule, draw a circle around the most acidic H atom. Note there might be more than one on the same molecule, and you will get it correct if you circle any of the most acidic H atoms.



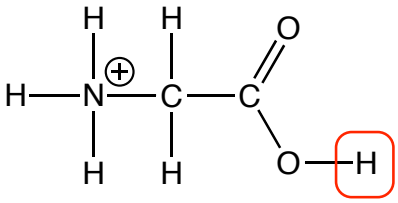
Resonance stabilized anion is produced



Greater inductive effect, closer to the Cl atoms



I circled all three, you only needed to circle one of them. These are more acidic because when they are removed they form a resonance-stabilized anion with a pi-way!! Think about the anion and the contributing structures that are generated following the loss of any of these hydrogen atoms. The resulting anion is called an enolate ion and will be important to you later.



The carboxylic acid is much more acidic than the amonium functional group. We talked about this directly in lecture.

15. (8 pts). List the four mechanism elements most commonly found in organic reaction mechanisms. For this you need to list them in the same order presented in class.

1. Make a new bond between nucleophile (electron rich species with an electron source) and electrophile (electron deficient species that has an electron sink atom).

2. Break a bond to create stable molecules or ions

3. Add a proton

4. Take a proton away