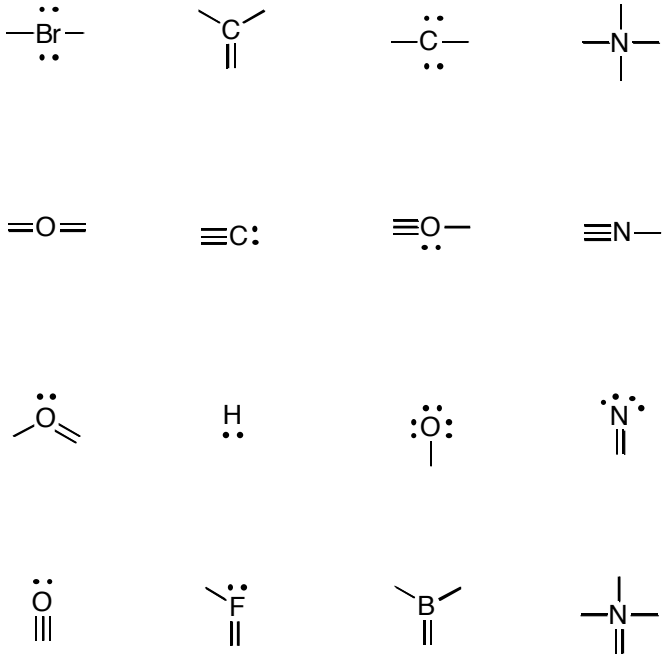
Problem Set #1

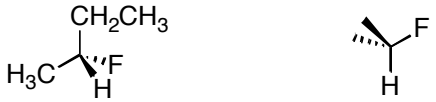
Due: February 10, 4:00 pm

1. Assign formal charges to each atom below (a formal charge of zero is assumed if no charge is indicated). Cross out the configurations that are not reasonable, and provide an explanation (large charge - greater than +/- 1, incomplete octet, octet exceeded).

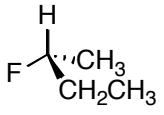


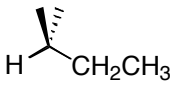
2. Reorient the molecule at the left to match the partially drawn perspective at the right. Complete the drawing at the right by adding the two missing substituents at their correct positions. Build a model if necessary.

a)



b)





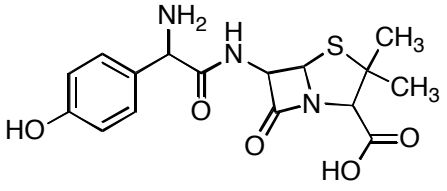
3. Provide Kekulé structures for the following molecules, including all major resonance contributors (no more than 2 formal charges, no formal charge greater than +/- 1).

a) N_2

b) CH_3CO_2Na

c) O_3

4. Label all of the functional groups in amoxicillin, an antibiotic from the penicillin family.



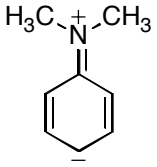
5. Provide orbital drawings of the following molecules. (Don't forget to shade the p orbitals appropriately!) Indicate the hybridization and bond angle at each non-hydrogen atom. Indicate the sigma and pi bonds and all lone pairs of electrons.

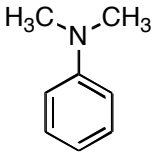
a) $BeCl_2$

b) $H_2C=C=O$

6. Circle the following pairs of structures that do not constitute resonance structures. For the proper resonance pairs, draw curved arrows to convert the first structure to the second. Draw in all lone pairs of electrons.

a)





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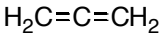

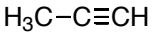

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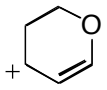
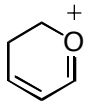
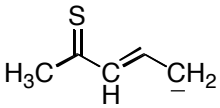
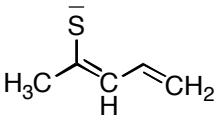




d)





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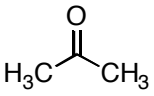
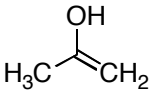
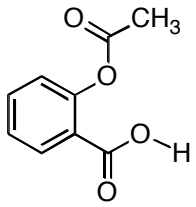




7.

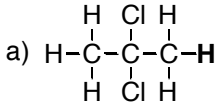
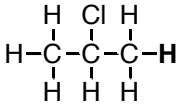
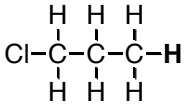
Smith, Janice G. *Organic Chemistry*. 1st ed. New York, NY: McGraw-Hill, 2006, p. 77. ISBN: 0072397462.

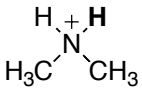
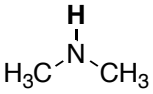
8. When you ingest aspirin, it passes through your stomach, which has an acidic pH, before traveling through the basic environment of your intestine. Provide the correct structure of aspirin **a)** as it exists in the stomach and **b)** as it exists in the intestine.



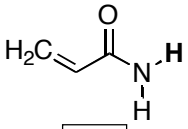
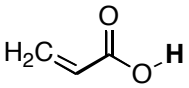
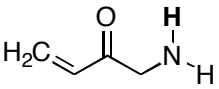
aspirin

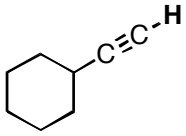
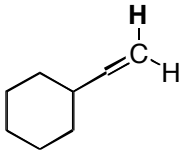
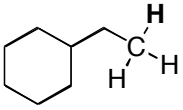
9. Rank the following sets of molecules according to acidity (1= most acidic). Explain your choices.

a)   

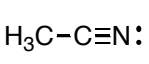
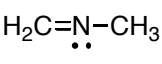
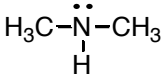
b)  

c) HCl H_2O H_2S

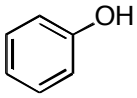
d)   

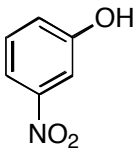
e)   

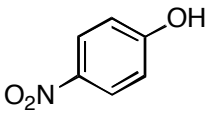
10. Rank the following molecules according to basicity (1 = most basic). Explain.

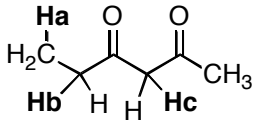
11. Rank the molecules in order of acidity (1 = most acidic). Explain your answer by drawing all resonance contributors of each conjugate base. Use the back of this page, if necessary.

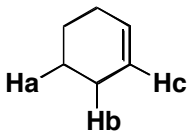






12. Rank the hydrogen atoms ($\mathbf{H_a}$, $\mathbf{H_b}$, $\mathbf{H_c}$) in the following molecules according to acidity.





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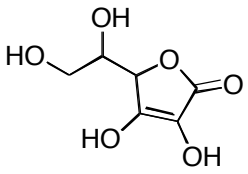
13. Circle the most acidic H atom in ascorbic acid (vitamin C).



14.

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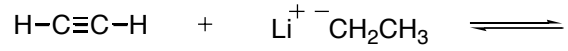
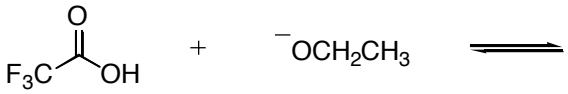
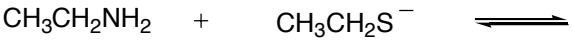
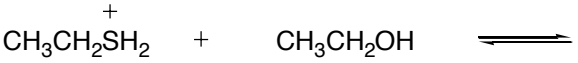
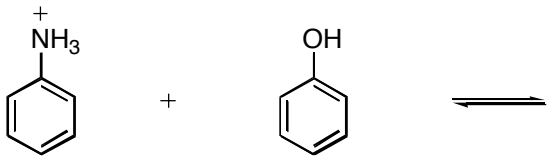
15. Draw the products of each reaction. Show all lone pairs in reactants and products. Circle the side of the reaction that is favored at equilibrium.

a) 

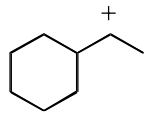
b) 

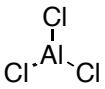
c) 

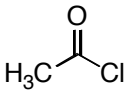
d) 

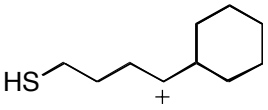
e) 

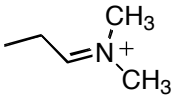
16. Draw in all lone pairs and provide the product of each reaction. Use curved arrow notation to show the mechanism. Show all resonance contributors of reactants and products, if applicable.

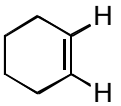
a)  + H_2O ⟶

b)  + $Cl-CH_3$ ⟶

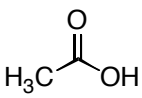
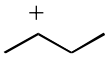
c)  + ^{-}OH ⟶

d)  ⟶

e) $H-C\equiv C^{-}$ +  ⟶

f)  + $H-Cl$ ⟶

Hint: find nucleophile (electron rich) and electrophile (electron poor).

g)  +  ⟶