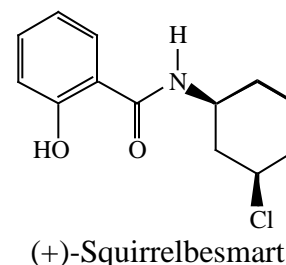
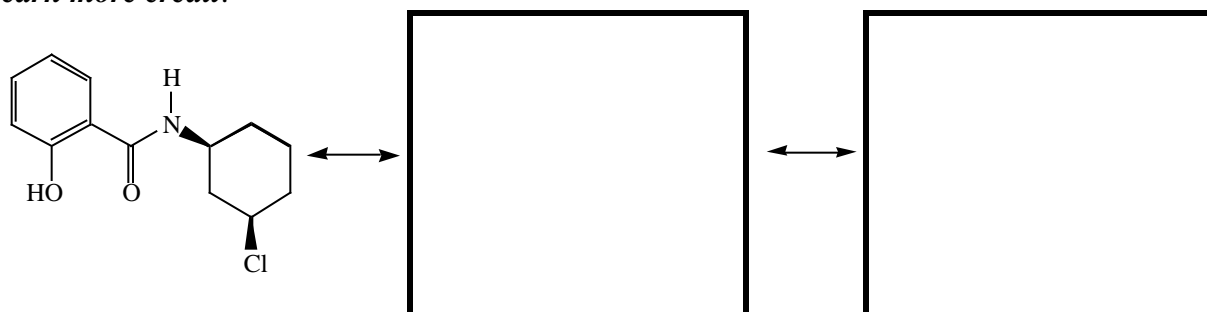


Behold (+)-Squirrelbesmart, a fictitious drug that renders squirrels smart enough to master organic chemistry.



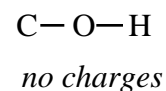
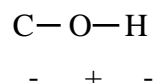
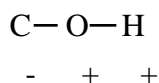
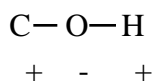
- (4 points) On the structure above, circle and label all the functional groups.
- (2 points) By adding, subtracting or otherwise changing *at most three atoms* rewrite the structure of (+)-Squirrelbesmart so that it includes an ester.
- (2 points) By adding, subtracting or otherwise changing *at most one atom* rewrite the structure of (+)-Squirrelbesmart so that it has a formal negative charge.
- (2 points) The Cl-C-C bond angle of (+)-Squirrelbesmart is (fill in a number) _____.
- (3 points) Fill in the blanks with appropriate numbers: (+)-Squirrelbesmart has _____ lone pairs, _____ sp^2 atoms and _____ hydrogen atoms.
- (6 points) Draw two additional resonance contributors for (+)-Squirrelbesmart in the boxes. Include all lone pairs and formal charges. *More significant resonance contributors will earn more credit.*



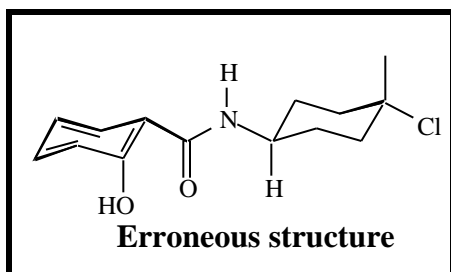
7. (5 points) Very briefly explain what is meant when a carbon atom is said to be sp^2 .
8. (6 points) Consider the structure of ethylene, $H_2C=CH_2$. Make a drawing that shows how the orbitals on each atom overlap to form the bonds of this molecule. Label each atom as C or H. Label each orbital as nonhybridized, sp^3 , sp^2 or sp . Label each bond as σ or π .

9. (2 points) Fill in the blanks with electronegativity numbers. Cl _____ C _____.

10. (1 point) Circle the correct charge distribution:



11. (3 points) List three things that are wrong with representation of (+)-Squirrelbesmart shown. *Single sentence answers are sufficient.*

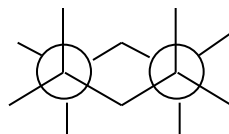
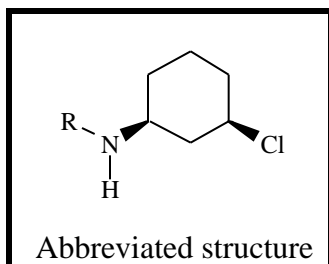


Error #1:

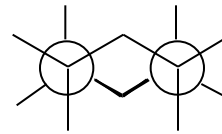
Error #2:

Error #3:

12. (a) (4 points) Complete the partial Newman projections to show the most and least stable chair conformations of Squirrelbesmart. You may abbreviate the molecule as shown.



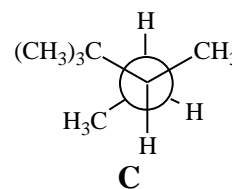
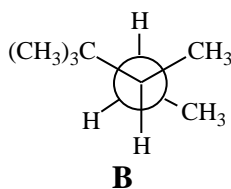
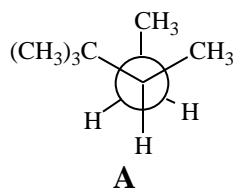
Most stable chair



Least stable chair

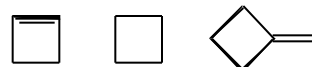
- (b) (1 point) Circle and label two atoms or groups that are gauche to each other in the least stable chair structure.
- (c) (6 points) Based on the completed Newman projections, very briefly explain why the least stable chair is less stable than the most stable chair conformation.

13. (3 points) Consider these conformations, then circle the appropriate answers.

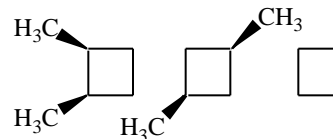


- (a) The conformation with the least torsional strain is: **A** **B** **C**
- (b) The conformation with the most torsional strain is: **A** **B** **C**
- (c) When the *tert*-butyl group of conformation **A** is replaced with a chlorine atom, the torsional strain: increases decreases remains unchanged.
14. (2 points) By doing nothing more than rotating around a bond, redraw conformation **A** from the question 13 so that it has even more torsional strain.

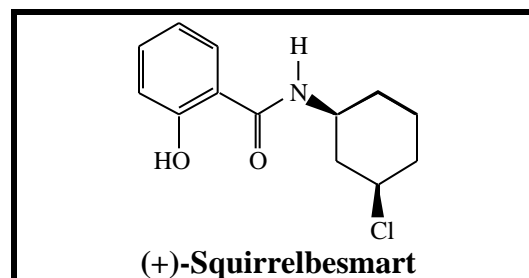
15. (1 point) Circle the molecule with the most angle strain:



16. (1 point) Circle the molecule with the most torsional strain:



17. (2 points) Label each stereocenter of as R or S:



18. (a) (3 points) By adding subtracting or otherwise changing *just one atom* redraw the structure of (+)-Squirrelbesmart so it is a meso compound.

(b) (3 points) Complete this sentence: This new structure is meso because....

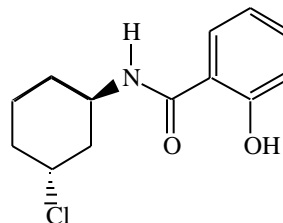
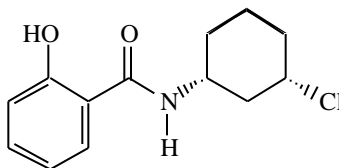
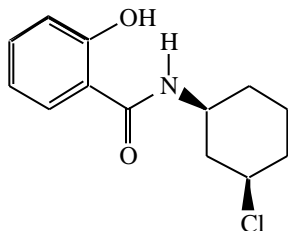
19. (2 points) The N and Cl atoms of (+)-Squirrelbesmart are (circle one answer in each case):

(a) Cis Trans Neither

(b) Always equatorial Always axial Switch between axial and equatorial

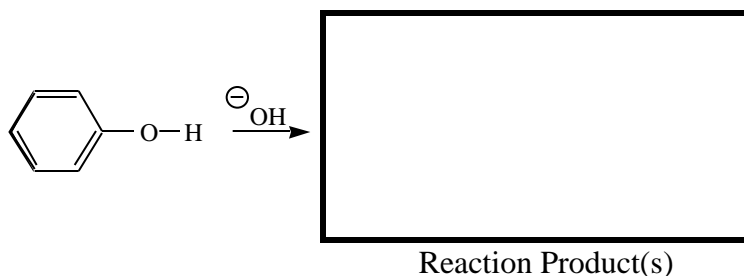
20. (2 points) Draw the structure of any enantiomer of (+)-Squirrelbesmart.

21. (4 points) In the boxes below each structure write the term(s) that describe its relationship to (+)-Squirrelbesmart. Some terms may be used more than once, while others might not be used at all. Each structure will have either exactly one or two answers (not zero, not three). **Term choices: enantiomer, diastereomer, meso, stereoisomer, conformational isomer, same, none of these.**



22. (3 points) If (+)-Squirrelbesmart makes squirrels smart, what can be concluded about its enantiomer? Circle the best answer in each case.
- (a) The optical rotation of the (-) enantiomer is: Dextrorotatory Levorotatory Rotary Club
- (b) The (-)-enantiomer is: Optically active Optically inactive Racemic
- (c) The (-)-enantiomer makes squirrels: Smart Stupid Has no effect Cannot be guessed
23. (3 points) Clearly but concisely define: Resolution

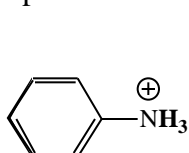
24. (6 points) Write the all the reaction products arising from the deprotonation of the H-O group in the molecule shown below with hydroxide ion as the base. Include all curved arrows and formal charges. Label the nucleophile and electrophile in this reaction.



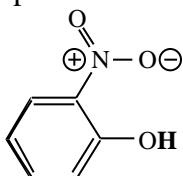
25. (18 points) In lecture we discussed several structural features that influence a molecule's acidity, as measured by its pK_a value. Some of these features are listed below as well as a few molecules and their pK_a values. For each structural feature:

- Circle the letters of a pair of molecules whose pK_a *difference* arises from the feature. Pick the pair of molecules that **best** illustrates the structural feature.
- Briefly explain how the feature operates in each case. Two or three sentences should suffice in each case.

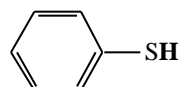
Compound choices (acidic proton is **bold**):



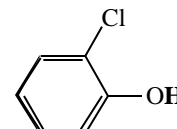
A: $pK_a = 4.6$



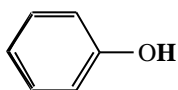
B: $pK_a = 7.2$



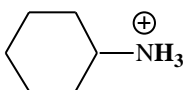
C: $pK_a = 7.8$



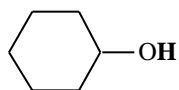
D: $pK_a = 8.1$



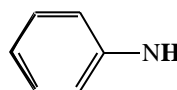
E: $pK_a = 10$



F: $pK_a = 10.67$



G: $pK_a = 18$



H: $pK_a = 30$

Structural feature: Resonance. Molecules: **A B C D E F G H**

Brief explanation:

Structural feature: Atomic radius. Molecules: **A B C D E F G H**

Brief explanation:

Structural feature: Inductive effect. Molecules: **A B C D E F G H**

Brief explanation: