

# Chem 30A Fall 2002 Final Exam Solutions Page 1

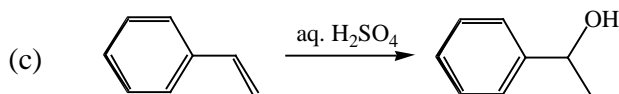
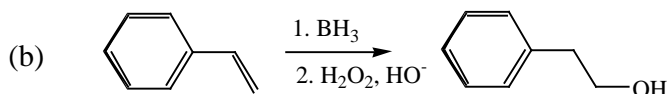
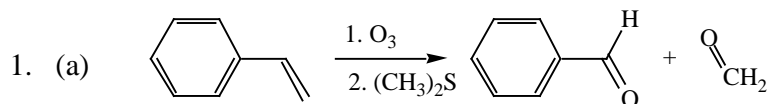
Statistics: High score = 92 Average = 61.9 Low score = 11

Standard Deviation = irrelevant as it does not control grade distribution in this class.

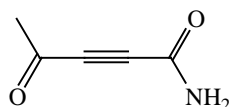
**A note about exam keys: The answers presented here are usually significantly longer than expected from a student taking the exam. An exam key serves not only to reveal what was expected, but to instruct you as well.**

**To see the final course grade cutoffs, consult "If Grades Were Assigned Today" at the Chem 30A Home Page.**

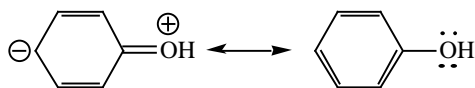
---



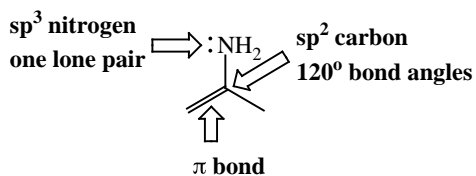
2. There are many possible answers. The structure shown here is among the simplest possible answers.



3. The most significant resonance contributor has the greatest number of atoms with full octets and the least number of atoms with formal charges.

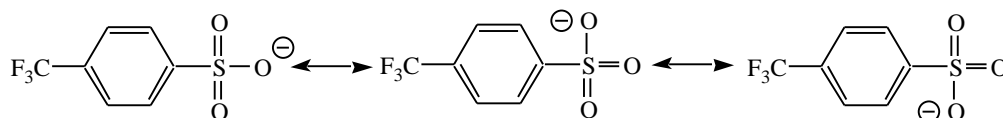


4. The structure shown here is among the simplest of many possible answers.



5. LeBel and van't Hoff suggested that a carbon atom bearing four attachments adopts tetrahedral geometry, and if the four attachments are different, these molecules exist as a pair of isomers.

6. Angle strain and torsional strain. (In an epoxide ring strain is caused by a combination of these two effects.)
7. Many students assumed incorrectly that the question refers only to molecules **A – D**, when in fact the question was not limited in this way.
- (a)  $\text{H}_2\text{SO}_4$  or  $\text{H}_2\text{O}$ .  $\text{NaOH}$  was also accepted, even though ionic compounds are not true molecules.
- (b) None.
- (c) **B and C** or **C and D**.
- (d) **B and D**.
- (e)  $\text{H}_2\text{SO}_4$  or  $\text{H}_2\text{O}$ .  $\text{NaOH}$  was also accepted, even though ionic compounds are not true molecules.
- (f) **B or D**.
8. The negative charge of the conjugate base is stabilized by resonance delocalization. This distribution of negative charge reduces the conjugate base's driving force to share electron density, and increases the acid's driving force to lose a proton. The structure of this molecule prevents the benzene ring from participating in resonance stabilization of the negative charge. The trifluoromethyl group also contributes to the molecule's acidity through an inductive effect, but this factor is not as significant as resonance.

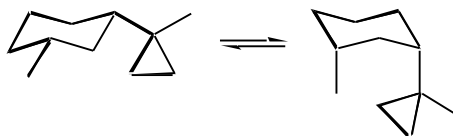


9. (a) The least favored side of this equilibrium is the **right**.
- (b) The least favored side of any equilibrium is the least stable (highest energy) side. In this case, the difference between the two sides of the equilibrium is the relative position of the cyclopropyl group: Axial or equatorial. In the Newman projections below we can see that the cyclohexyl ring substituent suffers a significant gauche interaction with the ring when it is axial, but this interaction is absent when the group is equatorial. Thus the axial conformation is less stable, and the equilibrium favors the equatorial conformation.

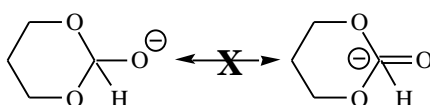


Axial: Significant gauche interaction    Equatorial: Significant gauche interaction absent

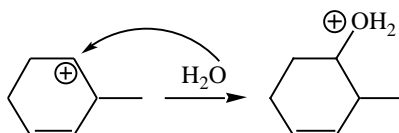
- (c) The axial conformation can be disfavored to an even greater extent by increasing the magnitude of the gauche interaction. Replacing a hydrogen atom with a larger group such as a methyl achieves this end.



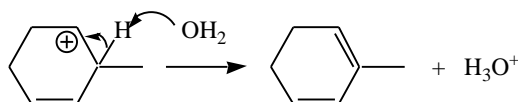
10. The statement is **false**. Alcohol **F** and its conjugate base do not have any resonance, so resonance cannot be said to influence its acidity. (Many students forgot about the hydrogen on the carbon bearing the OH group, and thus assumed resonance was possible.)



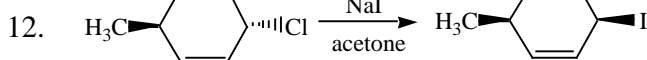
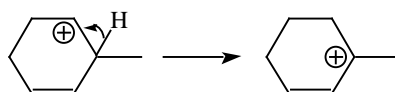
11. Capture nucleophile:



- Lose proton; form bond:



- Rearrangement:

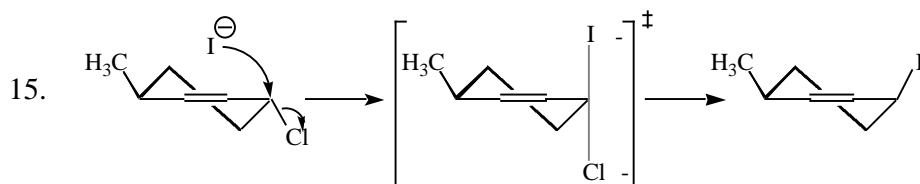


13. The most likely mechanism for this reaction is  $S_N2$ .

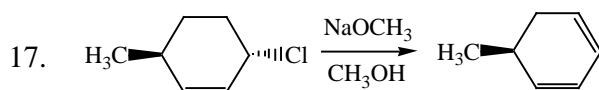
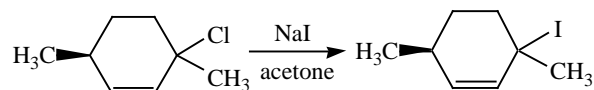
14. When deciding between  $S_N2$  and  $S_N1$  (the only choices the question allows), we consider  $S_N2$  first because it generally has the lowest activation energy for its rate-determining step. For an  $S_N2$  reaction to proceed, the following factors are important.

- Nucleophile: Iodide is a good nucleophile.
- Leaving group: Chloride is a modest leaving group.
- Steric hindrance: The carbon undergoing substitution is secondary.

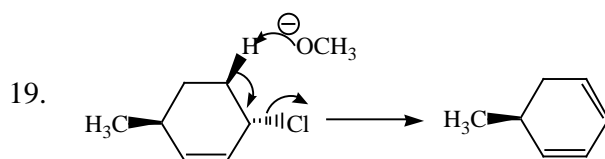
These factors suggest the  $S_N2$  transition state can be readily achieved so the  $S_N2$  mechanism is a reasonable choice.



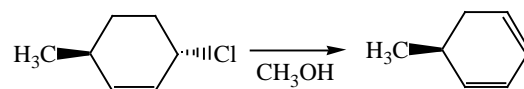
16. The mechanism can be changed in several ways. Perhaps the most obvious is to add another alkyl group to the carbon undergoing substitution. This makes it too crowded for the  $S_N2$  transition state to occur.



18. The most likely mechanism for this reaction is **E2**.



20. Removing the strong base disfavors the E2 mechanism.



21.  $\text{CF}_3\text{SO}_3^-$

22.  $\text{Br}^-$

