

CHEM HELP *ASAP*

Organic Chemistry Problem Set with Solutions

Picking the Most Acidic Hydrogen

Instructions: Some of the questions below show just one molecule. For these questions, identify the most acidic hydrogen in the structure. Other questions show two molecules. For these questions, compare the molecules and determine which is more acidic. Finding the most acidic hydrogen often requires consideration of the different possible conjugate bases of the structure. Note that the structures are drawn in the line-angle style, and potential acidic hydrogens may not be explicitly shown.

Suggested playlist:

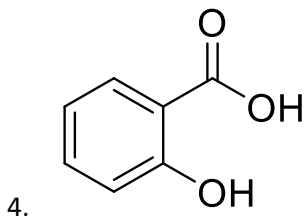
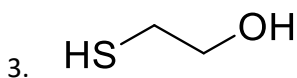
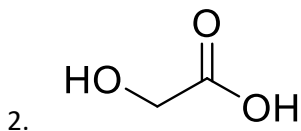
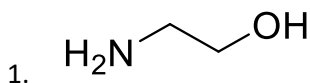
<https://www.youtube.com/watch?v=pOV233xEoS4&list=PLIzSRqjN72jfpR4AbALbsRCCUzPzrBkeu>
(acidity)

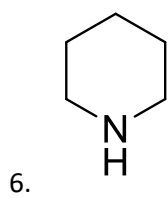
<https://www.youtube.com/watch?v=vaWYMfto4dM&list=PLIzSRqjN72jd9-qRqhJeuGgJia2eEouzR>
(charge stabilization)

YouTube video of answered questions:

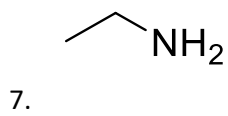
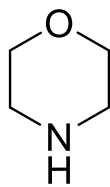
<https://youtu.be/cS-71si0Pzs>

Questions:

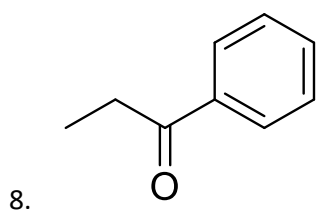
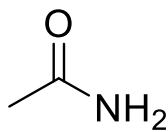




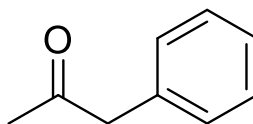
vs.



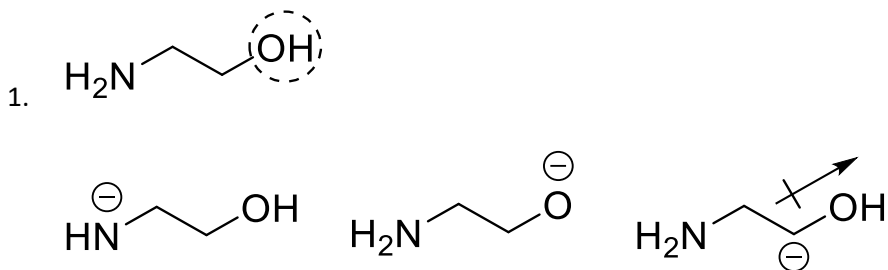
vs.



vs.

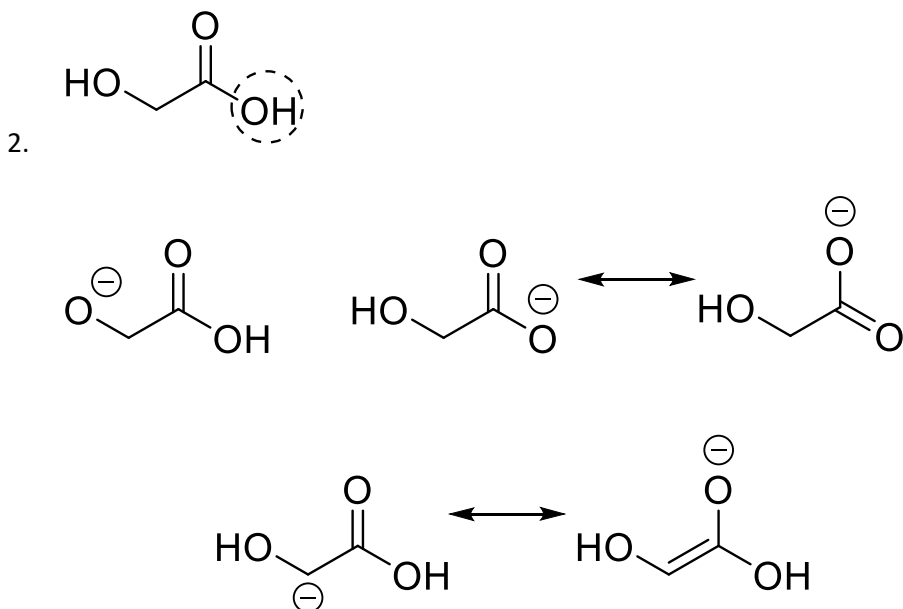


Solutions: *most acidic hydrogens circled*



The O^- (middle) is more stable than N^- (left) because oxygen is more eN than nitrogen.

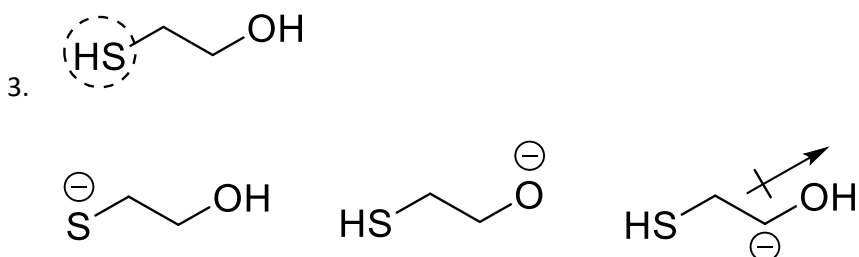
Deprotonating either carbon (for example, the right structure) is even worse because carbon has an even lower eN. The carbon deprotonations are stabilized by inductive effects from the attached oxygen or nitrogen, but this inductive effect is not as stabilizing as the eN effect.



Of the two oxygens, the alcohol on the oxygen on the left gives a localized O^- (top left) while the acid OH gives a resonance-stabilized, delocalized O^- (top middle, top right).

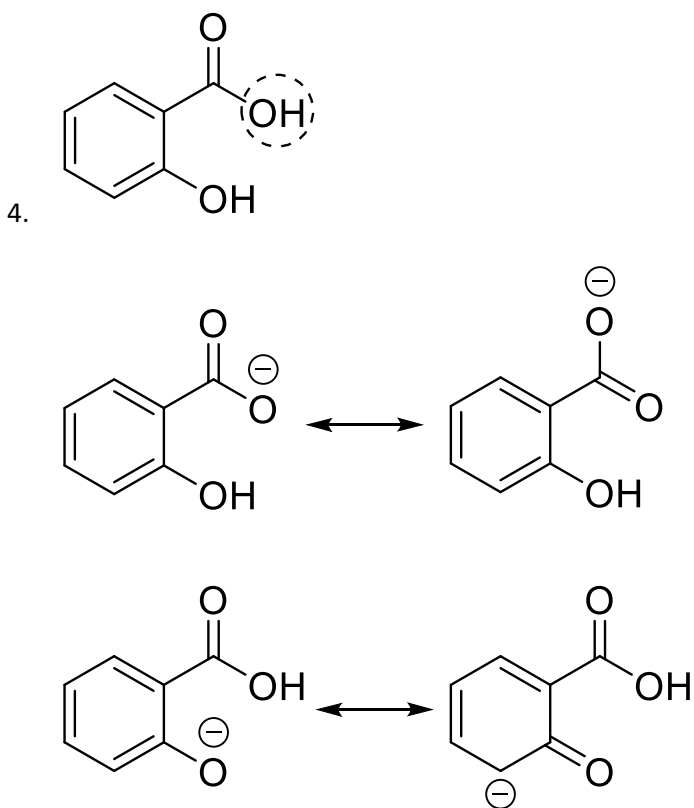
The carbon can be deprotonated to give a C^- (bottom) with resonance delocalization

onto the carbonyl oxygen. The acid would be most acidic. The alcohol and carbon may be similar, but both would be much less acidic than the acid.



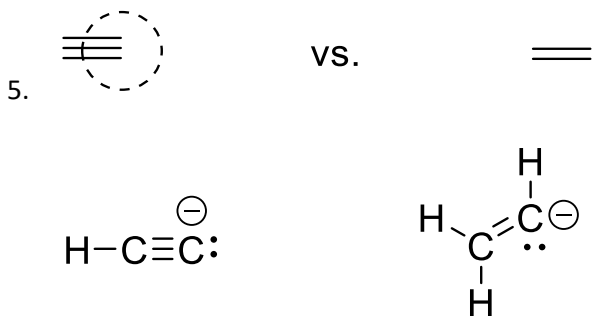
The S^- (left) is more stable than O^- (middle) because sulfur is larger than oxygen.

Deprotonating either carbon (for example, the right structure) is even worse because carbon is both smaller than sulfur and less eN than oxygen. The carbon deprotonations are stabilized by inductive effects from the attached oxygen or sulfur, but this inductive effect is not very strong.

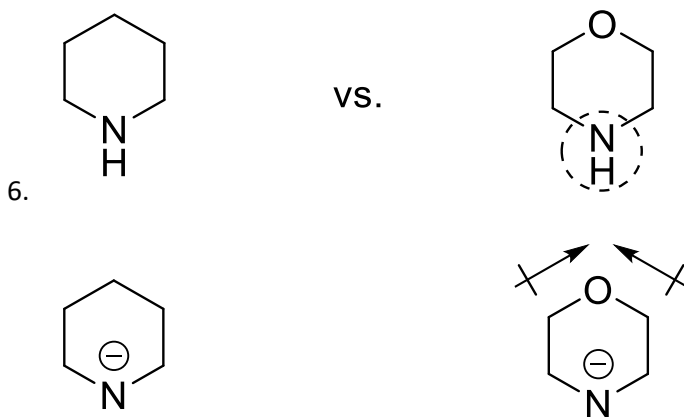


Deprotonation of the acid oxygen gives a carboxylate in which the O^- (top left) has resonance and can be delocalized to the other oxygen of the acid (top right).

Deprotonation of the phenolic oxygen gives an O^- (bottom left). This anion also has resonance, but the charge is delocalized to carbon, which, because of its lower eN , is not as favorable as oxygen.

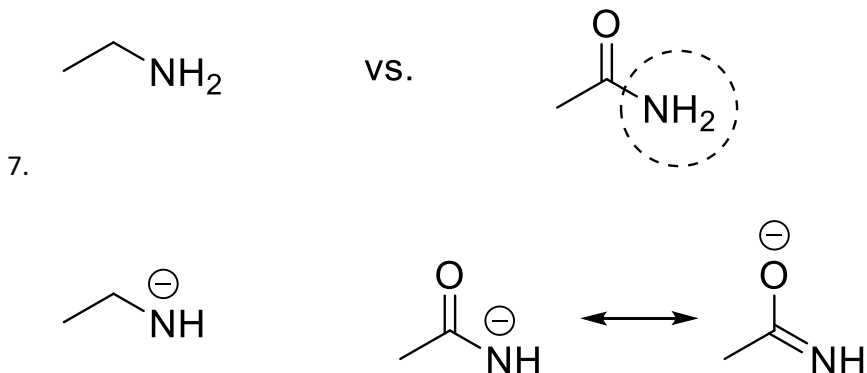


The left structure has sp -hybridized carbons, while the right structure is sp^2 -hybridized. sp -hybridized carbons are more acidic because the sp -hybridized orbital holds the electron-density closer to the carbon nucleus than the more elongated sp^2 -hybridized orbital.

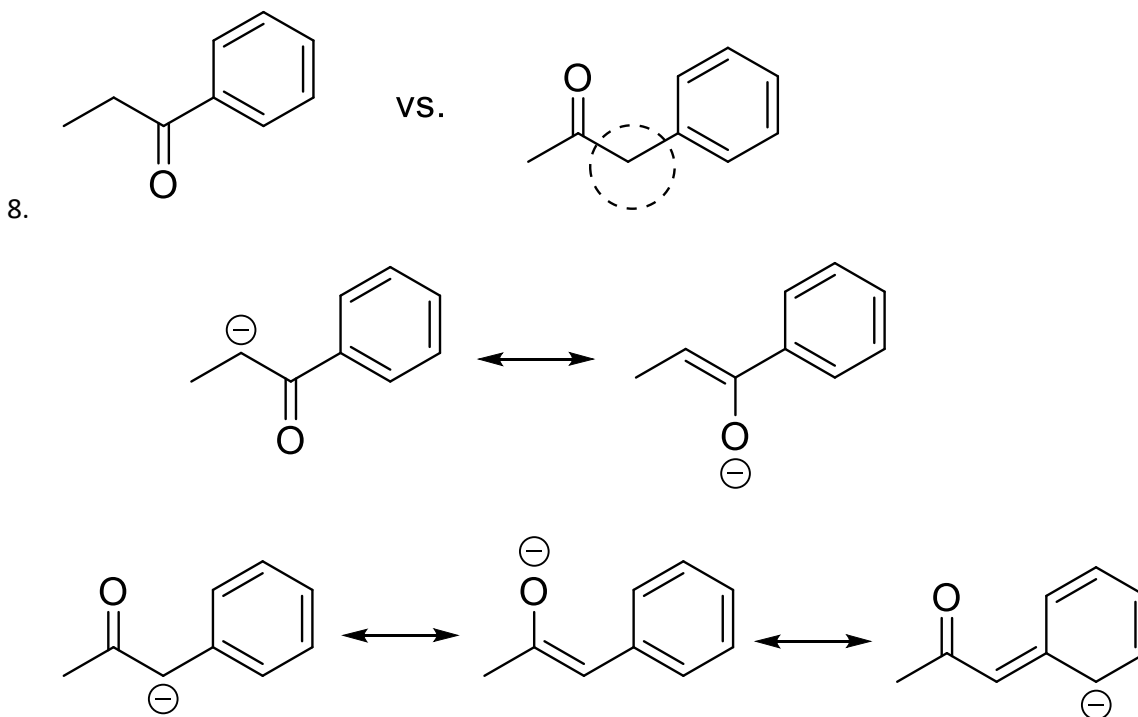


The two conjugate bases are shown. The left structure is a localized N^- . The right structure is also a localized N^- . Neither structure has resonance, but the right structure is somewhat stabilized by an inductive effect through the eN oxygen in the ring. This

inductive effect makes the N-H of the right compound more acidic than the left compound.



The left molecule would be deprotonated to give a localized N⁻. The right structure also gives an N⁻ upon deprotonation, but the anion can be delocalized through resonance onto a neighboring oxygen. The additional resonance form is more stable than the original because the negative charge is placed on the more eN oxygen rather than the less eN nitrogen. Therefore, the right structure is more acidic.



The left structure gives a conjugate base (top left) that is stabilized through resonance into the carbonyl. This kind of anion is called an enolate. The right structure forms a conjugate base (bottom left) that also has resonance stabilization into the carbonyl. It is also an enolate. Additionally, the right structure conjugate base can be further delocalized into the benzene ring. The best resonance form for both structures places the negative charge on the oxygen. The additional resonance structures for the conjugate base of the right structure, however, makes that conjugate base more stable and the right molecule is therefore more acidic.