

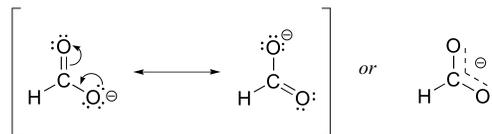
14.3: Common Examples of Resonance

1) Three atoms in a A=B-C where C is an atom with a p orbital.

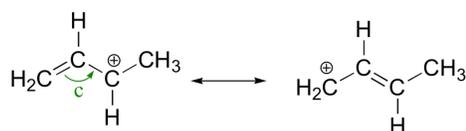
There are two major resonance possible. The two structures differ in the location of the double bond. The anion, cation, or radical is stabilized by delocalization.

Examples

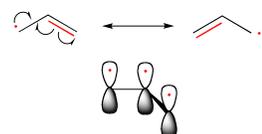
Carboxylate Anion



Allylic carbocation

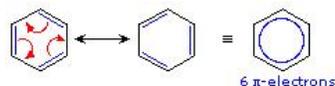


Allylic radical

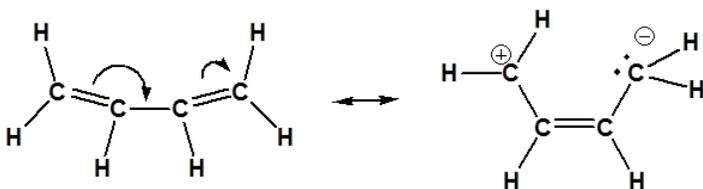


2) Conjugated double bonds

The benzene ring has two resonance structures which can be drawn by moving electrons in a cyclic manner.

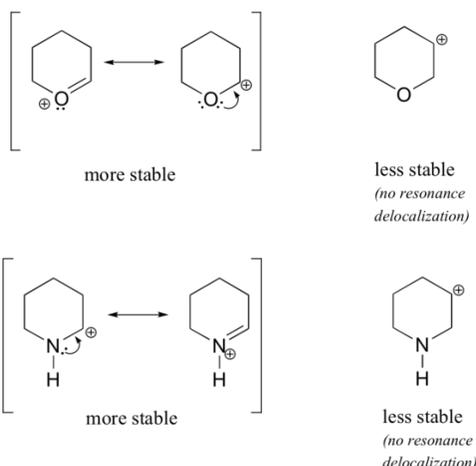


Conjugated double bonds contain multiple resonance structures.



3) Cations adjacent of an atom with lone pair electrons.

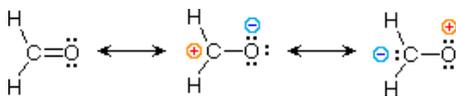
Because heteroatoms such as oxygen and nitrogen are more electronegative than carbon, you might expect that they would by definition be electron withdrawing groups that destabilize carbocations. In fact, the opposite is often true: if the oxygen or nitrogen atom is in the correct position, the overall effect is carbocation stabilization. This is due to the fact that although these heteroatoms are electron *withdrawing* groups by induction, they are electron *donating* groups by resonance, and it is this resonance effect which is more powerful. (We previously encountered this same idea when considering the relative acidity and basicity of phenols and aromatic amines in [section 7.4](#)). Consider the two pairs of carbocation species below:



In the more stable carbocations, the heteroatom acts as an electron donating group by resonance: in effect, the lone pair on the heteroatom is available to delocalize the positive charge. In the less stable carbocations the positively-charged carbon is more than one bond away from the heteroatom, and thus no resonance effects are possible. In fact, in these carbocation species the heteroatoms actually *destabilize* the positive charge, because they are electron withdrawing by induction

4) Double bonds with one atom more electronegative than the other

Multiple resonance structures are possible which causes a charge separation in the molecule.



Organic Chemistry With a Biological Emphasis by Tim Soderberg (University of Minnesota, Morris)

- William Reusch, Professor Emeritus ([Michigan State U.](#)), [Virtual Textbook of Organic Chemistry](#)
- Prof. Steven Farmer ([Sonoma State University](#))
- Jim Clark ([Chemguide.co.uk](#))

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