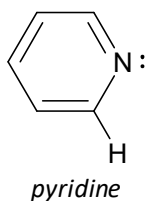
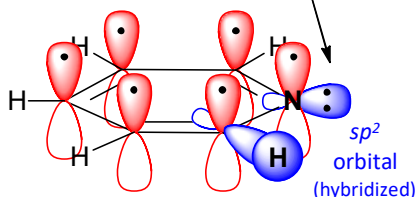


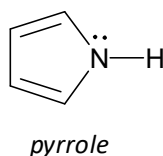
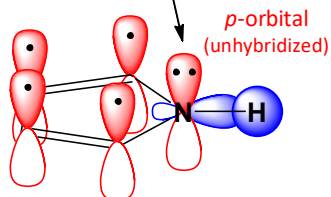
## Resonance Essentials

To master resonance, you must understand the difference between hybridized atomic orbitals and unhybridized atomic orbitals. This includes being able to determine what type of orbital a non-bonding lone pair resides in. **It is soooooo helpful to understand that lone pairs in hybridized orbitals cannot participate in resonance.**

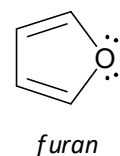
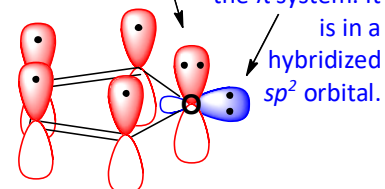
This lone pair is orthogonal (perpendicular) to the  $p$ -atomic orbitals. It is **not** part of the  $\pi$  system.



This lone pair resides in a  $p$ -atomic orbital and is therefore part of the  $\pi$  system.



This lone pair is part of the  $\pi$  system. It is in an unhybridized  $p$ -orbital.



One Atom,  
One Pi



One Atom,  
One Pi

### Four amazingly helpful rules regarding resonance structures:

- $sp^3$  carbons stop resonance. A pi bond cannot form on an  $sp^3$  carbon because  $sp^3$  lacks the necessary unhybridized  $p$ -orbital.
- All resonance structures must have the same net molecular charge. This is very easy to cross-check quickly.
- All resonance structures must have identical connectivity of atoms (you can't change positions of atoms). This includes hydrogens. Resonance never breaks or forms a  $\sigma$  bond (the  $\sigma$  skeleton must be identical for all resonance structures).
- Structures that start with a single formal charge should probably NOT be turned into structures with three formal charges.



### Criteria for determining the major resonance contributor (in order of importance):



1. **Fewest atoms with formal charges** (and it is best to minimize charge separation of opposite charges).
2. **Filled octets** – you want the greatest number possible of atoms having filled octets. This is a concern when dealing with cations, but not anions.
3. **When there are formal charges, they should be on the most appropriate atoms *but do not forget about the second rule regarding filled octets.*** Filled octets (rule 2) is more important than charges on appropriate atoms (rule 3).

For example, carbocations (you should know that ALL carbocations possess an unfilled octet) lose to full octet nitrogens and oxygens when it comes to identifying the major resonance contributor.