RESONANCE STRUCTURES MADE EASY

1) Identify the pi-system in the molecule (adjacent sp and sp2 hybrid atoms).

2) Determine if the pi-system is a cation, anion, radical, or neutral.

3) Count the total number of atoms (p-orbitals) in the pi-system and number them.

4) Count the total number electrons in the pi-system (do not forget to include lone pairs and radicals).

5) Draw a series of p-orbitals in a line (if linear) or circle (if a ring) which have the same number atoms as the pi-system (step 3). Draw the series once for every atom in the pi-system. In other words, if there are four p-orbitals, draw four series or four p-orbitals. The first atom in the molecules pi-system will be represented by the first p-orbital in each series. Each atom will correlate with one p-orbital.

6) Place all of the pi-electrons (counted in step 4) into the orbitals in all possible combinations using the following rules :
a. Place one electron in each orbital first. When all electrons have been placed, if each orbital has only one electron (neutral or a radical), make each pi-system identical.
b. If there is an extra electron (anion), draw individual systems where the extra electron is in a different orbital in each system.
c. If there are not enough electrons and one orbital is empty (cation) draw systems where the empty orbital is on a different atom in each system.

7) Draw bonds to connect ***unpaired*** electrons in each pi system. These bonds represent the pi-bonds in the resonance contributor. Remember: stable structures form the maximum number of pi- bonds. Any pi system which has more than one unpaired electron after the bonds are drawn is unstable and can be removed. All remaining structures are valid.

8) Place the charges on the appropriate atoms (no bonds to other p-orbitals).
2 e- on one atom => negative
1 e- on one atom => neutral
0 e- on one atom => positive

9) Superimpose the valid pi-systems back on the original molecule.

10) Draw the arrows to show the implied electron motion. Place the resonance arrows between structures

CHECKLIST FOR FINAL STRUCTURES

Yes

- ☐ Are the positions of ***all atoms*** identical in each resonance hybrid?
- ☐ Is the total number of electrons identical in each resonance hybrid?
- ☐ Is the total charge identical in each resonance hybrid?
- ☐ Do your arrows ***correctly*** show the implied movement of electrons?
- ☐ Are the correct resonance arrows (⟷) used between structures?
- ☐ Does the most stable structure have the maximum number of double bonds (filled octets)?