How to Determine Resonance Structures for Organic Chemistry

Organic structures follow a similar but different set of steps than inorganic structures as they often have only C, H, N, O and + or – charges associated with the structures.

Rules to Remember – Not to Violate

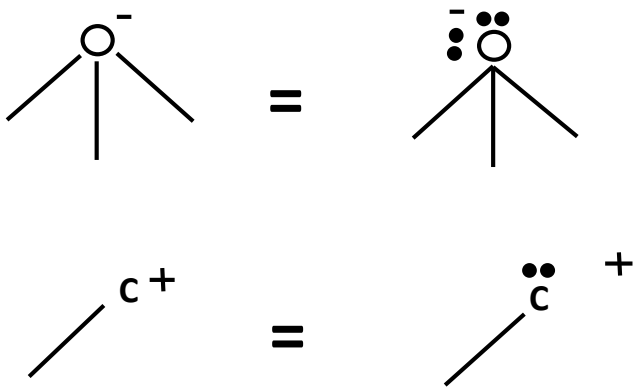
1. Avoid breaking a single bond.
2. Never exceed an octet for C, N, O, F structures.
3. π bonds cannot donate to a structure that has a negative charge as it will violate the octet rule around that atom.
4. Total charges on equivalent resonance structures must equal the charges on the original structure.

Rules for Determining Equivalent Resonance Structures

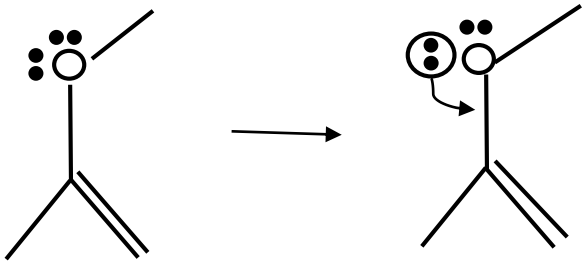
1. Rule of symmetry – If structure can easily be flipped like a windshield wiper blade (either left to right or right to left) And create an equivalent mirror image structure.
2. When there is a π bond between two different (C, O) atoms, the electrons migrate toward the atom with the highest electronegativity.
3. π bonds migrate and donate their extra set of electrons to the nearest atom that contains unpaired electrons or toward positive charges.
4. Atoms with unpaired electrons migrate and form double bonds
5. Lone pairs from negatively charged ions move toward + ions to form a π bond.
6. If the conjugated π bonds are in a ring, all the π bonds move over one position.
7. Once you have determined direction of 1st set of electrons the remainder flow of electrons will be in the same direction.

Steps to Follow to Determine Equivalent Resonance Structures

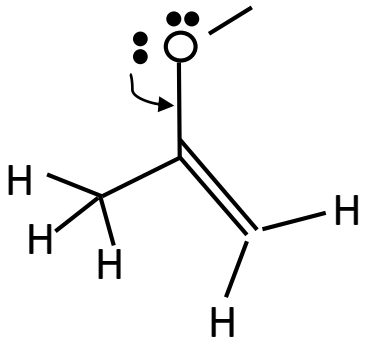
1. Check to see if you can easily create a mirror image of the structure. If you can just flip image (works mainly for linear structures and not ring structures.)
2. Otherwise identify all unpaired electrons. If a structure indicates a + or a – charge around an atom, calculate the formal charge to determine if there is a need to add unpaired electrons.



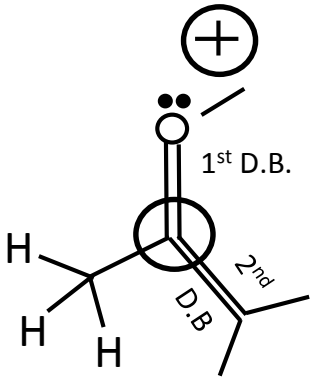
3. Indicate directions that electrons or double bonds will move from unpaired electrons using curved arrow. Tail of arrow means “from”, while tip of arrow means “to”.



4. Identify all implied connected hydrogen bonds to carbon atoms that do not violate the Octet Rule.

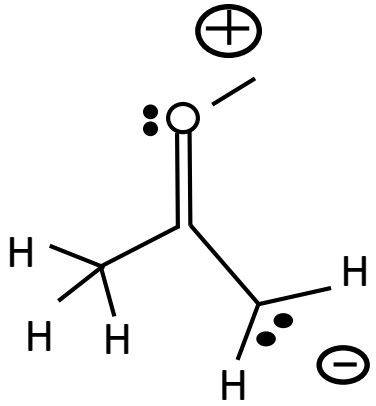


5. Redraw structure and calculate formal charges as well as check on Octet Rule violations



Carbon can only have four total bonds, so this violates the octet rule with five bonds.

6. Problem can be corrected only by transferring electrons from the 2nd D.B. and breaking bond so that the Octet Rule is not violated and total charge on resonance structure is identical to original structure.



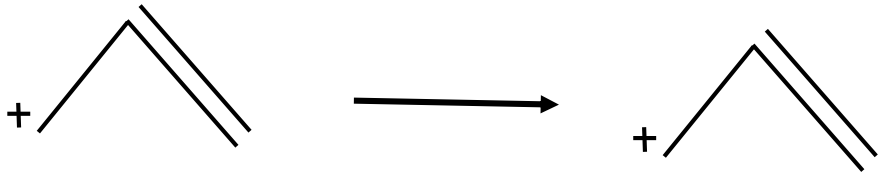
4 – 2 – 3 = - 1 F.C.

Total charge + 1 – 1 = 0

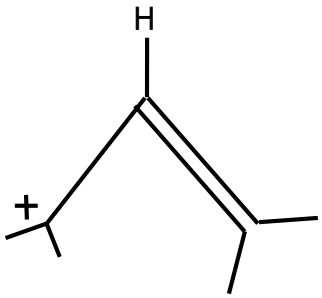
How to Determine Resonance Structures for Organic Chemistry

Problem 1, example with a + charge located on the structure

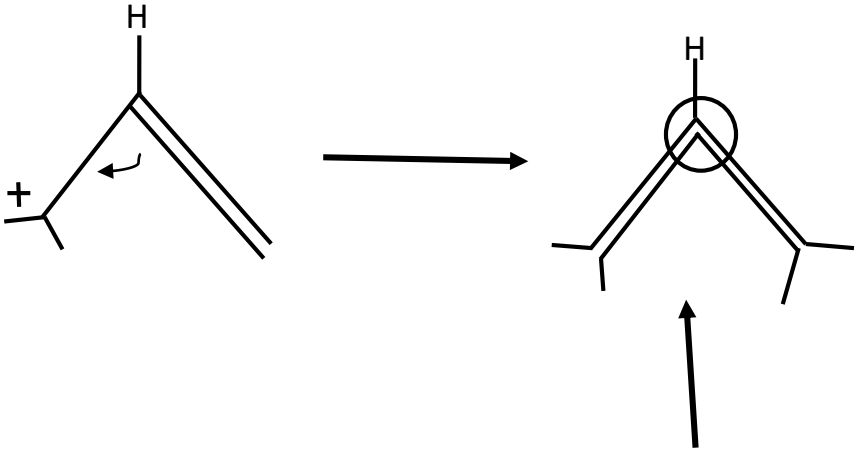
1. No unpaired electrons identified



2. Identify H bonds

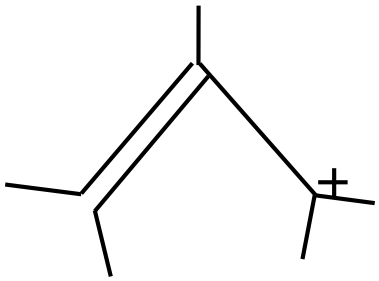


3. Electrons from a double π bond migrate toward positive charge



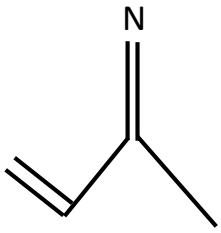
We have now violated the octet rule.

4. Rearranging to support octet rule.

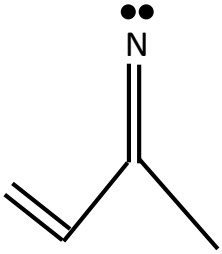


Final structures

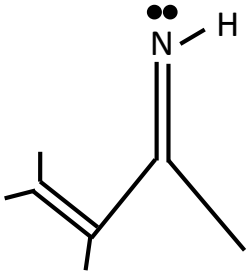
Problem 2



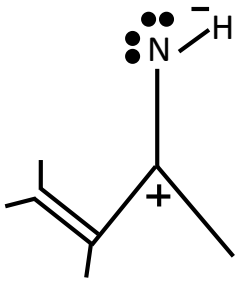
1. Draw lone pairs.



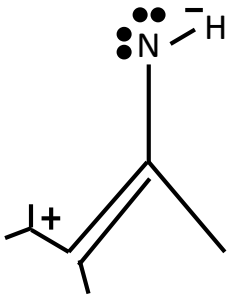
2. Next draw applicable Hydrogen Atoms



3. Note that double bonds head toward unpaired Electrons so that you have the following.



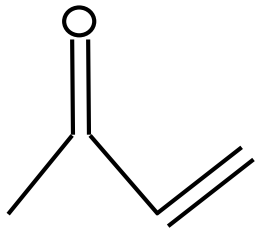
4. Double Bonds move toward +



Quiz Problems:

Find equivalent resonance structures

1.



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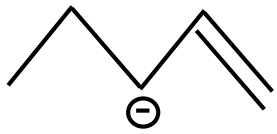

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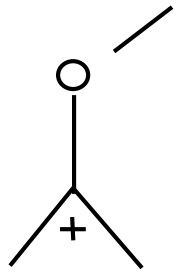

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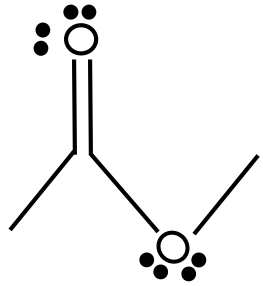

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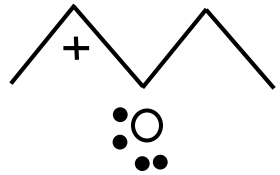
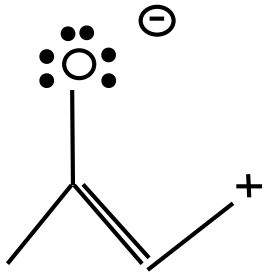


Quiz Solutions:

Find equivalent resonance structures

1. 

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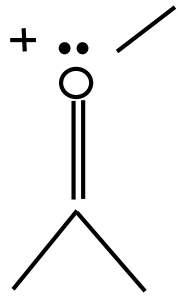
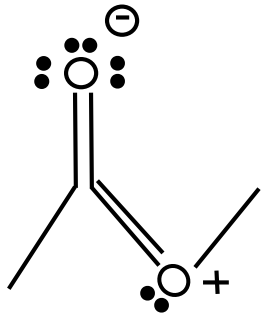
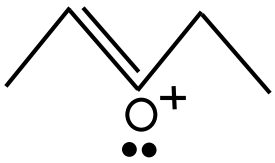
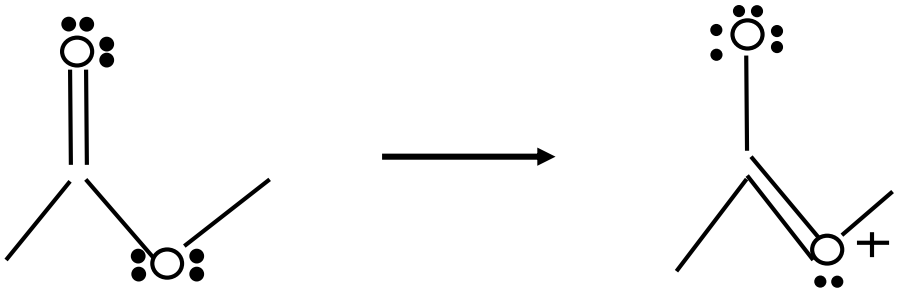
3. 

4. 

5. 

Organic Chemistry
Resonance Problems & Solutions

1.



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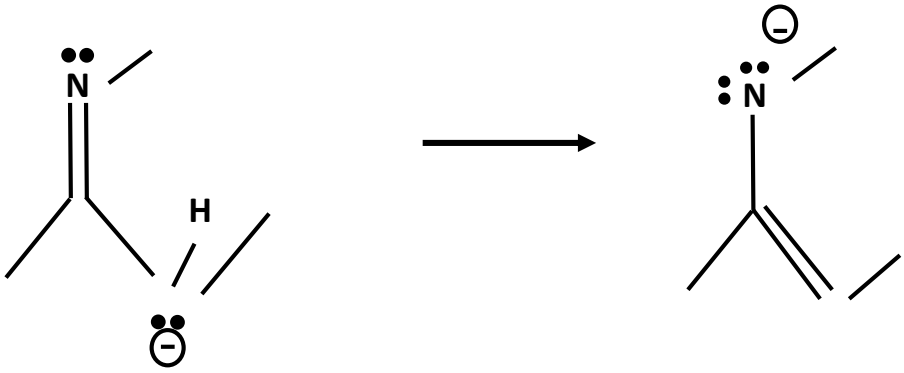

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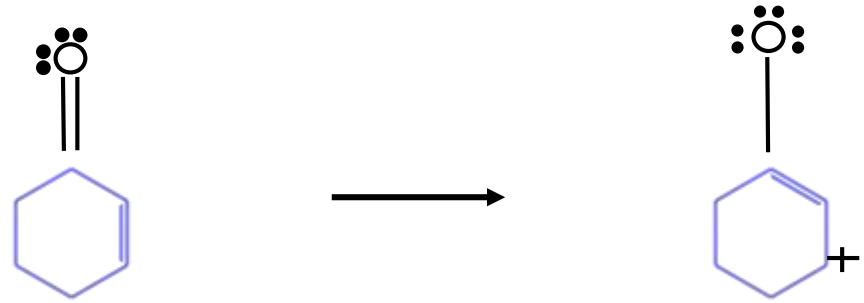
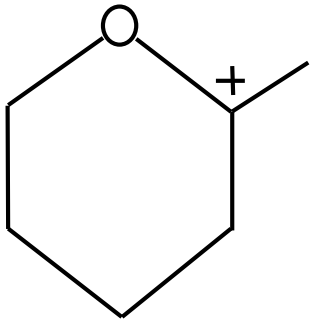
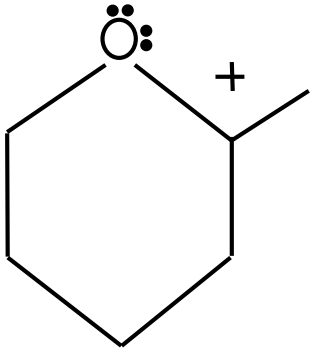


4.

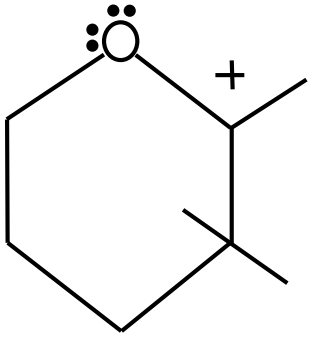
Apply these steps to the following problems



1. Draw a lone pairs



2. Next draw hydrogen atoms around carbons that could be affected.



3. Electrons unpaired will move toward charge + so that we have structure.