Hi everyone! My name is Sowmya Duddu and I am the Master Tutor for O-chem 1 this semester! This class is known to be very difficult, but it is also very doable if you put in the effort. I am super excited to be helping y'all out this semester! I will be providing a resource like this one once a week that will help clarify major topics and give some good examples for the more tricky concepts. Please feel free to reach out if you have any questions or concerns about the resource!

Additionally, I will be offering weekly Group Tutoring sessions for biology 1306/1406. These sessions will happen every Monday from 6:30 – 7:30 PM in Sid Rich Room 74. Please visit baylor.edu/tutoring for more information about group tutoring. Feel free to reach out to me at Sowmya_duddu1@baylor.edu for any questions you have!

Keywords: Bond Line Structures, Formal Charge, Resonance

Chapter 1: Gen Chem review
- Chapter 1 is all general chemistry review, so this resource will not cover any of these topics. If you need a refresher on some of these topics there are general chemistry resources available on our website, and there are some helpful videos linked below
  - http://leah4sci.com/intro
  - https://www.khanacademy.org/science/a-to-orgo-video-series/p-chemistry

TOPIC OF THE WEEK: RESONANCE
Resonance is one of the most important concepts that you will learn in organic chemistry, and it is related to every topic you will learn from here on out, so if you remember anything from this chapter make sure it’s resonance!

What is resonance? MOVEMENT OF ELECTRONS IN A MOLECULE
Resonance helps explain the inadequacy of bond line drawings (they are not perfect for every occasion). With bond line drawings, it is assumed that a line represents 2 bonding electrons between a certain pair of atoms and that the electrons are localized, meaning that they are stuck where they are. In some cases, this assumption is not correct, and the electron density can be spread throughout the entire molecule or delocalized. Resonance is several drawings that represent one reality. There is ALWAYS one way that the molecule is situated, but in drawing, we cannot draw electrons in more than one place at a time, so we draw several structures and mentally meld them together.
**Resonance analogy:** A Mule is a cross between a donkey and a horse. A mule will never be more like a donkey or more like a horse because it is an equal combination of the two. Just drawing a donkey or just drawing a horse will never be a good representation of a mule. But if we draw both and put the two images together in our minds, we can come up with a mule would look like.

![Mule analogy](image)

**How do I know if a molecule has resonance structures?** THERE ARE 5 PATTERNS THAT YOU NEED TO BE ABLE TO RECOGNIZE.

If a molecule exhibits one or more of these patterns, it will have a resonance structure.

1. **Allylic lone pair**

![Allylic lone pair](image)

2. **Allylic positive charge**

![Allylic positive charge](image)

3. **Lone pair adjacent to a positive charge**

![Lone pair adjacent to a positive charge](image)
In order to understand resonance, it is important that you are first able to read and **draw bond line structures.** **What is a bond line structure?** This is a way to draw out molecules that is more efficient than writing out every single atom. So here’s what you need to know:

- Each carbon in a bond line structure is represented by an endpoint or corner of the lines (draw in zig zag form)
- Single bonds are denoted by one line, double bonds with two lines, and triple bonds by three lines.

- You might be wondering where all of the hydrogens are. **IT IS ASSUMED THAT THERE ARE ENOUGH HYDROGENS TO SATURATE THE CARBON** (each carbon needs 4 total bonds.) You do not draw the hydrogens in the bond line structures. They are assumed to be present.
Practice #1 Draw the bond line structure of the following molecules:

a. 

b. 

HIGHLIGHT 2: One last thing to know before jumping into resonance! **Lone pairs and formal charge**

*What is formal charge?* The charge assigned to an atom in a molecule assuming that all of the electrons are being shared equally

**FORMAL CHARGE EQUATION:**

Formal charge = (how many electrons does the atom want?) - (How many electrons does the atom have?)

---

Example:

Find the formal charge of oxygen

Step 1: look at periodic table to see how many valence electrons the oxygen wants to be happy. It wants six because it is in group 6A

Step 2: how many electrons does it have right now? It has 7. 6 from the lone pairs and 1 from the covalent bond it shares with carbon

Step 3: $6-7 = -1$

This oxygen has a formal charge of $-1$. 

---
Practice #2 determine the formal charge of the following nitrogen and oxygen atoms

a. 

b. 

Practice #3 Draw resonance structures for the following molecules and identify what patterns are exhibited

a. 

b. 

THINGS YOU MAY STRUGGLE WITH

1. The hardest part of resonance is being able to recognize the patterns. This simply takes practice and repetition, so do every problem you can get your hands on. Having a good foundation with resonance will benefit you in the future!
2. Another thing that some struggle with is not drawing ALL of the resonance structures. Sometimes when you draw a resonance structure, a new pattern will emerge meaning that there is ANOTHER resonance structure of the molecule.
Answers to practice:

1.
   a. 

   b. 

2.
   a. 

   b. 

   $5 - 5 = 0$

   $6 - 5 = +1$
I hope this first resource was helpful for you. Don’t forget that these weekly resources are available for you in the tutoring center website, at:
https://www.baylor.edu/support_programs/index.php?id=967950