Hi everyone! My name is Emily, and I am the Master Tutor for O-chem 1 this semester! I am a biology major, and my goal is to become a nurse practitioner, so I am attending Baylor Nursing School after graduation! This is my fourth semester as the O-chem 1 master tutor, and I am so excited to meet everyone! This class is known to be very difficult, but it is also very doable if you put in the effort, and I am here to help you along the way by giving study tips, answering questions, and providing resources for your success! It isn’t as scary as the rumors make it seem, but it will take studying and time on your part. 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 always feel free to reach out if you have any questions or concerns about the resource. This week most classes are covering Chapters 1 and 2.

Don’t forget that group tutoring begins this week! It is every Thursday from 6:30-7:30, and we hope to see everyone there. Here is the link to sign up. https://www.baylor.edu/support_programs/index.php?id=40917

Keywords: Gen chem, 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
- https://www.khanacademy.org/science/ap-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.
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

2. Allylic positive charge

3. Lone pair adjacent to a positive charge

4. Pi bond between two atoms of differing electronegativity

5. Conjugated pi bonds in a ring

Note: don’t forget about brackets and arrows! Also, red arrows denote movement of electron pairs.
Example of drawing resonance structures

HIGHLIGHT 1: Let’s back track a little bit and see what we need to know to fully understand resonance

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 (drawn in zig zag form)

This molecule has 5 carbons

- Single bonds are denoted by one line, double bonds with two lines, and triple bonds by 3 lines.

**REMEMBER:** triple bonds have sp hybridized orbitals which are linear

- 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). Aka you do not draw hydrogens in bond line structures. They are assumed to be present.
Practice #1 Draw the bond line structure of the following molecules:

a. 
```
H H H H
\/ \/ \/
H - C - C - C - C - C - H
H H H H C
```

b. 
```
O
\=
C - C = C
H H H H
```

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. 
```
H - O - H
```

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 #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 repletion, 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.  
   ![Chemical structure image]
   
   b.  
   ![Chemical structure image]

2.  
   a.  
   ![Chemical structure image]  
   \[5 - 5 = 0\]
   
   b.  
   ![Chemical structure image]  
   \[6 - 5 = 1\]

3.  
   a.  
   \[\text{Allylic lone pair}\]
   ![Chemical structure image]
   
   Pi bond between 2 atoms of differing electronegativity and allylic positive charge
   
   ![Chemical structure image]