Resonance Structures

The Lewis structure of ozone (O_3)

1. Sum of valence electrons = (6*3) = **18**

2. Drawing the bond connectivities:

3. Complete the octets of the atoms bonded to the central atom:

4. Place any leftover electrons (18-16 = **2**) on the central atom:

5. Does the central atom have an octet?

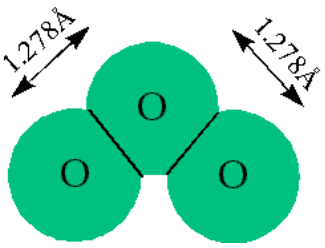
- **NO**, it has 6 electrons
- Add a multiple bond (first try a double bond) to see if the central atom can achieve an octet:

6. Does the central atom have an octet?

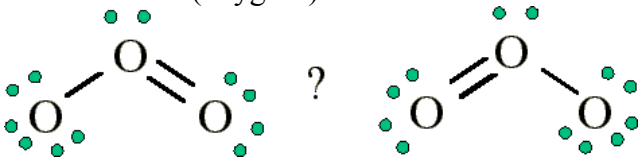
- **YES**, we are done
- Ozone would appear to have one single bond, and one double bond

However... known facts about the structure of ozone

- The bond lengths between the central oxygen and the other two oxygens are ***identical***:



- We would expect that if one bond was a double bond that it should be ***shorter*** than the other (single) bond
- Since all the atoms are identical (oxygens) which atom is chosen for the double bond?



These Lewis structures are equivalent except for the placement of the electrons (i.e. the location of the double bond)

Equivalent Lewis structures are called <u>resonance structures</u>, <u>or resonance forms</u>

The correct way to describe ozone as a Lewis structure would be:

This indicates that the ozone molecule is described by ***an average*** of the two Lewis structures (i.e. the resonance forms)

The important points to remember about resonance forms are:

- The molecule is ***not*** rapidly oscillating between different discrete forms
- There is ***only one form*** of the ozone molecule, and the bond lengths between the oxygens are ***intermediate*** between characteristic single and double bond lengths between a pair of oxygens
- We draw two Lewis structures (in this case) because a single structure is insufficient to describe the real structure

The Nitrate (NO_3^-) ion:

1. Count up the valence electrons: (1*5) + (3*6) + 1(ion) = **24** electrons

2. Draw the bond connectivities:

3. Add octet electrons to the atoms bonded to the center atom:

4. Place any leftover electrons (24-24 = **0**) on the center atom:

5. Does the central atom have an octet?

- **NO**, it has 6 electrons
- Add a multiple bond (first try a double bond) to see if the central atom can achieve an octet:

6. Does the central atom have an octet?

- YES
- Are there possible resonance structures? YES

Note: We would expect that the bond lengths in the NO_3^- ion to be somewhat shorter than a single bond