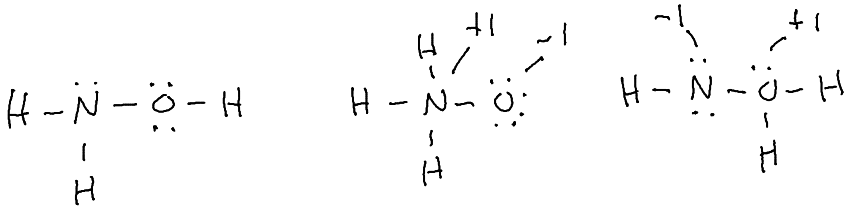
# Predicting Structures and Explaining Reactivity for Inorganic Compounds

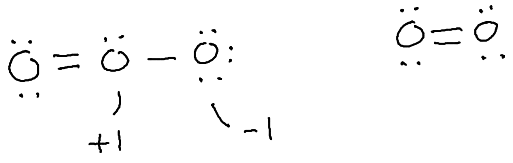
Of the three possible bonding frameworks for hydroxylamine, $NH_3O$, the one on the left is correct. Complete the three Lewis structures and use formal charges to justify the claim that the first bonding framework is correct.

*There are a total of 14 valence electrons in hydroxylamine, five from the nitrogen, three from the hydrogens, and six from the oxygen. The structure on the right is unfavorable because it places a positive formal charge on the oxygen and a negative formal charge on the nitrogen. Negative formal charges are more likely on atoms with larger AVEEs and in this case that is oxygen. The middle structure gives more reasonable formal charges, but nitrogen usually has three bonds (and generally is in a cation when it has four bonds) an oxygen normally has two bonds (and is more likely to be in an anion when it has but one). The structure on the left with no formal charges is the best choice.*



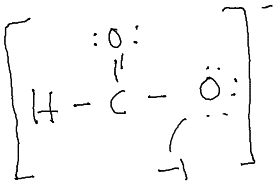
Draw Lewis structures for the allotropes of oxygen ($O_2$ and $O_3$) and explain why ozone, $O_3$, is more reactive than molecular oxygen, $O_2$.

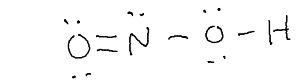
*There are 18 valence electrons for ozone and 12 valence electrons for molecular oxygen. Unlike molecular oxygen, the Lewis structure for ozone shows formal charges on two of the oxygens. The presence of a positive formal charge on oxygen further decreases the molecule's stability. In addition, the average O-O bond order in ozone is 1.5, which is smaller than the bond order of 2 for molecular oxygen.*

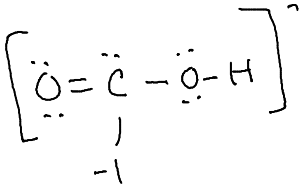


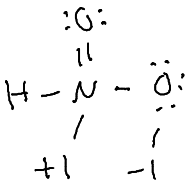
The formate ion, $HCO_2^-$, and nitrous acid, $HNO_2$, are isoelectronic because they have the same number of valence electrons in their Lewis structures. Their bonding frameworks, however, are quite different; for one ion the hydrogen is bound to an oxygen and for the other ion the hydrogen is not bound to an oxygen. Find the best Lewis structure for each ion and show that the bonding frameworks are indeed different.

*The structures shown on the right make the most sense. As drawn, the formate anion has a negative formal charge on oxygen, which is more favorable than on carbon, as required by the alterative*









*structure shown on the left. The correct Lewis structure for nitrous acid, as shown above, has no formal charges, unlike its alternative structure, shown to the left has formal charges on two atoms.*

Draw the resonance structures for $N_2O$ (all possibilities must contain a N-N single, double, or triple bond). Which resonance structure is the most important? Is this consistent with the observation that when $N_2O$ is chemically reduced in the presence of acid the products are $N_2$ and $H_2O$? Explain.

*Three resonance structures are shown below. Of these, the least important is the one on the right because it uses the most formal charges (including a formal charge of +2) and has two adjacent formal charges with the same sign. The most important resonance structure is on the left, which places the formal charges on the best combination of atoms. Breaking the N-O bond and moving the pair of bonding electrons to the nitrogen gives $N_2$ and an oxide ion, $O^{2-}$, that picks up two $H^+$ from the acid to form water, $H_2O$.*