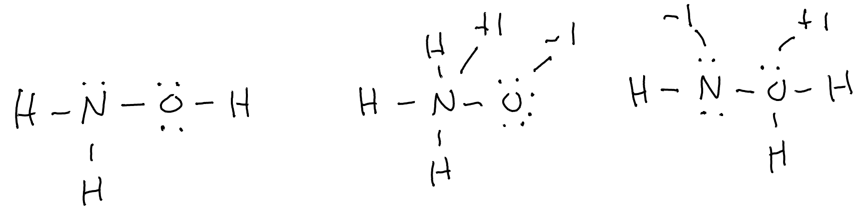
Predicting Structures and Explaining Reactivity
for Inorganic Compounds

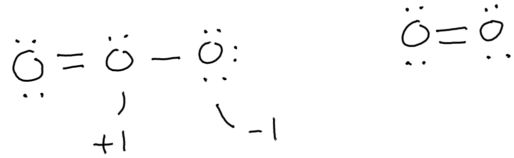
Of the three possible bonding frameworks for hydroxylamine, NH_3O, the one on the left is correct. Using these frameworks, complete the three Lewis structures and use formal charges to justify the claim that the first bonding framework is correct.

There are 14 valence electrons in hydroxylamine, five from 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. A negative formal charge is more likely on an atom with a larger AVEE or electron affinity, which in this case this is oxygen. The middle structure gives more reasonable formal charges, but nitrogen usually has three bonds (and generally is present as a cation when it has four bonds), and oxygen normally has two bonds (and generally is present as an anion when it has just one bond). The structure on the left with no formal charges is the best choice.



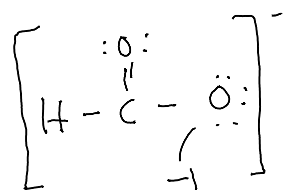
Draw Lewis structures for the allotropes of oxygen (O_2 and O_3) and explain why ozone, O_3, is more reactive than molecular oxygen, O_2.

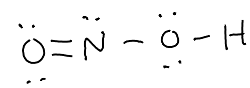
Ozone has 18 valence electrons and molecular oxygen has 12 valence electrons. Unlike molecular oxygen, the Lewis structure for ozone has formal charges on two oxygens. The average O–O bond order in ozone is 1.5, which is smaller than the bond order of 2 for molecular oxygen. A smaller bond order means that the bond energy in ozone is smaller than in molecular oxygen, which means it takes less energy to break the bond. In addition, the presence of a positive formal charge on oxygen further decreases the stability of ozone.

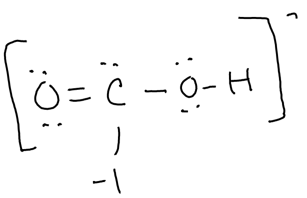


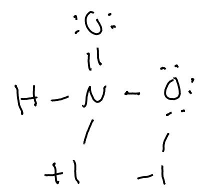
The formate ion, HCO_2^-, and nitrous acid, HNO_2, are isoelectronic because they have the same number of valence electrons. Their bonding frameworks, however, are quite different; for one the hydrogen is bound to an oxygen and for the other the hydrogen is not bound to an oxygen. Find the best Lewis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

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









Draw all possible resonance structures for N_2O using the general framework N–N–O. Which resonance structure is the most important? Is this structure consistent with the observation that reducing N_2O in the presence of acid produces 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 has the most formal charges (including a formal charge of +2) and has two adjacent formal charges of the same sign. The most important resonance structure is the one 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-}, the latter of which picks up two H^+ ions from the acid to form water, H_2O.