1. Briefly describe ionic versus covalent bonding pointing out the most important differences between the two types of bonding. (3 points)

 Ionic bonds occur between positively charged ions (cations, formed by loss of one or more electrons) and negatively charged ions (anions, formed by gain of one or more electrons). Ionic bonds are non-directional, strength depending only on the charge and distance between the ions, not the bond angle or direction.

 Covalent bonds are formed by sharing of a pair of electrons between atoms. They are highly directional with strength depending on overlap or mixing of atomic orbitals.

2. Complete the following Lewis structures by adding nonbonding electron pairs, multiple bonds, and formal charges as appropriate. (3 points ea = 12 points)

 \[ \text{H-O-N=O} \]

 \[ \begin{align*}
    1 \times H &= 1e^- \\
    2 \times O &= 12e^- \\
    1 \times N &= 5e^- \\
    \text{total} &= 18e^- \\
\end{align*} \]

 \[ \begin{align*}
    3 \times O &= 18e^- \\
\end{align*} \]

 \[ \text{O=O-O} \]

 \[ \begin{align*}
    1 \times H &= 1e^- \\
    2 \times C &= 8e^- \\
    1 \times N &= 5e^- \\
    1 \times O &= 6e^- \\
    \text{total} &= 24e^- \\
\end{align*} \]

 \[ \text{C-C-N} \]

 \[ \text{C-H} \]

 \[ \begin{align*}
    5 \times H &= 5e^- \\
\end{align*} \]

 \[ \text{Give full credit for} \]

 \[ \text{O-H} \]
3. Draw another valid resonance structure for each of the following Lewis structures. Include formal charges in the resonance structure. (2 points ea = 4 points)

\[ \text{H} \quad \text{C} \equiv \text{N} \equiv \text{N} \quad \leftrightarrow \quad \text{C} \quad \text{N} \equiv \text{N}^1 \]

\[ \text{H} \quad \text{C} \equiv \text{C} \quad \text{C} \equiv \text{C} \quad \text{H} \quad \leftrightarrow \quad \text{C} \quad \text{C} \equiv \text{C} \quad \text{C} \equiv \text{H} \]

4. Specify the hybridization and geometry (or bond angles) of each indicated atom in the following molecule. (Note: nonbonding electron pairs are not shown) (6 points)

\[ \text{H} \quad \text{C} \equiv \text{C} \quad \text{C} \equiv \text{C} \quad \text{O} \quad \text{H} \]

- $\text{SP}$, linear, 180°
- $\text{SP}^3$, tetrahedral, 109°
- $\text{SP}^2$, trigonal planar, 120°