1. (a) Draw a resonance structure for the sulfate ion, $\text{SO}_4^{2-}$, in which all atoms obey the octet rule. Assign a formal charge to each atom.

\[
\begin{align*}
\text{FC}_S &= 6 - 0 - \frac{1}{2}(8) = 2^+ \\
\text{FC}_O &= 6 - 6 - \frac{1}{2}(2) = -1
\end{align*}
\]

(b) Draw a 6 resonance structure for the sulfate ion that are valid Lewis structures that violate the octet rule. Assign the formal charges to each atom.

\[
\begin{align*}
\text{FC}_S &= 6 - 0 - \frac{1}{2}(12) = 0 \\
\text{O single bond} &= 6 - 6 - \frac{1}{2}(2) = -1 \\
\text{O double bond} &= 6 - 4 - \frac{1}{2}(4) = 0
\end{align*}
\]

(c) Why are your structures in (b) more acceptable than the one in (a).

(a) has formal charges on every atom and one is $+2$. This is too many. Because they may violate the octet rule, we can form the structures in (b) which have fewer formal charges and the charges are only ($-1$)

(d) Comment on the relative stability of the structures in (b).

They are all equal.
2. Draw three resonance structures of N₂O, including formal charges. (One of the N atoms is the central atom.) Label your structures A, B, and C and rank them in order of decreasing stability. The electronegativities for N = 3.0, O = 3.5.

Formal charges:
- N=^N=O: N=^N=O: ^N=^N=O:
- N=^N=O: N=^N=O: ^N=^N=O:
- N=^N=O: N=^N=O: ^N=^N=O:

3. Give a brief answer or explanation for the following.

(a) Supercritical CO₂ (CO₂ that is a at temperature above the critical point so that it can not be condensed into the liquid phase.) is a good solvent for removing fats from foods. What property of CO₂ make it a good solvent for this purpose? (Hint what do fats and CO₂ have in common?)

Both are nonpolar

(b) Name a biomolecule or class of biomolecules in which hydrogen bonding is important.

Carbohydrates, proteins, or nucleic acids

(c) Draw the Lewis structure of Formaldehyde H₂C=O and describe approximately what the you would expect for the H-C-O and H-C-H angles.

(d) The structure of BrF₅ (42 e⁻) is a square pyramid. The Br atom is below the base formed by four of the F atoms. Why?

(e) Glycerin (shown below) is a viscous syrupy liquid that is used as a food additive. Explain why this relatively low molecular weight substance is so highly viscous.

OH groups form many hydrogen bonds
4. Draw a valid Lewis structure for the following molecules or ions. Include formal charges to each atom in (b), (c), (d), and (e).

(a) PCl₂ 

(b) NO⁻ 

(c) O₃ 

(d) NSBr₃ 
(S central) 

(e) PO₄⁻³ 

(f) F₂SO 
(S atom central) 

5. Draw a valid Lewis structure and determine whether the following molecules are polar. The number in parenthesis is the number of electrons in the molecule.

(a) SF₄ (34) 

(b) H₂O₂ (14) 
(eclipsed) 

(c) H₂O₂ (14) 
(staggered) 

(d) Cl₃Br 
(consider Size of Br when you determine the shape) 

(e) PF₃ (40) 

(f) BF₂Cl (24) 
(B atom central)
6. Draw a valid Lewis structure for the following molecules or ions. Include formal charges in (b) and (f). Describe the shape of these molecules or ions that is predicted by the VSEPR theory.

(a) \( \text{NH}_3 \)

(b) \( \text{ClO}_3^- \)

(c) \( \text{SO}_2 \)

(d) \( \text{OCl}_2 \)

(e) \( \text{XeBr}_4 \)

(f) \( \text{ICl}_2^- \)

(g) \( \text{PF}_6^- \)

(h) \( \text{HCN (C is central)} \)

- \( \text{NH}_3 \) is trigonal planar.
- \( \text{ClO}_3^- \) is trigonal pyramidal.
- \( \text{SO}_2 \) is bent.
- \( \text{OCl}_2 \) is bent.
- \( \text{XeBr}_4 \) is square planar.
- \( \text{ICl}_2^- \) is linear.
- \( \text{PF}_6^- \) is octahedral.
- \( \text{HCN} \) is linear.