1. For each of the following molecules, draw a Lewis structure that also indicates reasonable 3-dimensional positioning for all atoms and electron pairs.

(a) $\text{H}_3\text{COH}$

(b) $\text{H}_3\text{C}^+$

(c) $\text{H}_3\text{CCN}$
2. Consider the hydrogen peroxide molecule, H–O–O–H.
   (a) Draw a Newman projection, looking down the O–O bond, in which the dihedral angle between the two hydrogens is 180°. Be sure to indicate the positions of the oxygen lone pairs.

   (b) Translate your Newman projection from part (a) into a wedge-and-dash depiction.

   (c) Draw a wedge-and-dash picture of the conformation of hydrogen peroxide in which the H’s eclipse each other.

   (d) What hybridization did you pick for the oxygens in the above drawings?

   (e) Adjacent to your drawings in parts (b) and (c) above, clearly indicate the overall dipole moment for the H₂O₂ molecule in that particular conformation.
3. By drawing appropriate resonance structures, rationalize the observation that the nitrate anion ([NO$_3^-$]) contains three identical nitrogen–oxygen bonds. Use the arrow formalism to interconvert the resonance structures.
4. Imagine two $2p_z$ orbitals, each containing a single electron, interacting as they approach each other along the $y$-axis. Take the coordinate axes to be as defined below.

(a) Construct a diagram that shows the following:

1. The starting $2p_z$ orbitals
2. The molecular orbitals formed by the side-to-side interaction of the two $2p_z$ orbitals
3. The relative energies of the starting $2p_z$ orbitals and the resulting molecular orbitals. (Do this by including an energy axis on your diagram.)
4. Whether the resulting molecular orbitals are bonding or anti-bonding
5. Any new nodes formed when the two $2p_z$ orbitals combine in side-to-side fashion to form molecular orbitals.

(b) Fill in the electrons in your molecular orbital scheme.

(c) Is this two-electron system stabilized or destabilized by the side-to-side interaction of the two $2p_z$ orbitals?

(d) Are the molecular orbitals that you’ve created $\sigma$-type orbitals? Very briefly explain why or why not.
5. Look down the C₁–C₂ bond of 1-chloropropane (also known as n-propylchloride).
   (a) Draw a Newman projection in which the dihedral angle between the –Cl and –CH₃ groups is 180°.
   \[
   \begin{array}{c}
   \text{(a) Newman projection (180°)}
   \end{array}
   \]
   (b) Change the dihedral angle in 60° increments, drawing each Newman projection, until you have completed
   a full rotation about C₁–C₂.
   \[
   \begin{array}{c}
   \text{(b) Newman projections (60° increments)}
   \end{array}
   \]
   (c) Label each of your Newman projections in (a) and (b) with the corresponding Cl→CH₃ dihedral angle.
   (e) Construct an energy versus dihedral angle diagram for a full rotation about the C₁–C₂ bond of 1-
   chloropropane. You need show only relative energies.