1. How many covalent bonds are predicted for an atom of C?

2. Assign a formal charge to the O atom in the given molecule. All lone pairs have been drawn in.

   \[ \text{H}_3C-\text{C}^\cdot-\text{CH}_3 \]

   Tip:
   - Oxygen wants 2 bonds, so
     - 0 wr 2 bonds  \rightarrow neutral
     - 0 wr 1 bond, 3 lone pairs  \rightarrow negative
     - 0 wr 3 bonds, 1 lone pair  \rightarrow positive

3. Calculate the formal charge on each second–row atom:

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

4. Assign formal charges to each N atom in the following molecule. All lone pairs have been drawn in.

   \[ \text{H}_3\text{C}-\text{N=\text{N}}: \]

5. Draw an acceptable Lewis structure (including all lone pair electrons) for the following compound, assuming the atoms are connected as arranged, and there are no formal charges. Glycolic acid is used in dissolving sutures.

   \[ \text{HOCH}_2\text{CO}_2\text{H} \]

6. Draw a valid Lewis structure (including all lone pair electrons and any formal charges) for \( \text{CH}_3\text{NO}_2 \). Assume the atoms are arranged as shown below.

   \[ \text{H} \]
   \[ \text{H}-\text{C}-\text{N}-\text{O}^\cdot-\text{H} \]
7. Draw one valid Lewis structure (including all lone pair electrons and any formal charges) for \(-\text{CH}_2\text{CN}\). Assume the atoms are arranged as shown below.

\[
\text{H} \quad \overset{\text{C}}{\text{\vdots}} \quad \text{C} \equiv \text{N} \quad \overset{\text{H}}{\text{\vdots}} \quad \text{H}
\]

8. Draw the Lewis structure for one isomer of the molecular formula \(\text{C}_3\text{H}_8\text{O}\).

9. Follow the curved arrows to draw a second resonance structure for the following species.

10. Draw one of the resonance structures for the following ion (be sure to include the charge and all lone pairs).

11. Draw a second resonance structure for the following ion. For extra practice, draw all reasonable resonance structures.

**Tip:**
- Only move lone pairs and \(\text{\Sigma} \text{e}^-\)
- Draw H's 2nd row
- Make sure no atom has more than 8 e\(-\)
12. Using the principles of VSEPR theory, you can predict the geometry around any atom in any molecule, no matter how complex. Enanthotoxin is a poisonous compound isolated from a common variety of hemlock grown in England. Predict the geometry around the indicated atoms in enanthotoxin. Be sure to answer all parts.

a. bent (tetrahedral)
b. linear
c. trigonal planar
d. trigonal planar
e. bent (tetrahedral)
f. tetrahedral

13. Convert the following condensed formula to a Lewis structure:
\[ \text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{C}(\text{CH}_3)_3 \]

Tips: \((\text{CH}_2)\) in parentheses will be a chain \(-\text{C}--\text{C}--\text{C}--\text{C}--\) \((\text{CH}_3)\) in parentheses will be attached to the same atom

14. Draw a skeletal structure for the following molecule.
\((\text{CH}_3)_2\text{C}==\text{CH}((\text{CH}_2)_4\text{CH}_3\)

15. With reference to species A drawn below, label compound B as an isomer, a resonance structure, or neither.

Circle One: Isomer  Neither  Resonance structure
16. Citric acid is a naturally occurring compound. What orbitals are used to form each indicated bond? Be sure to answer all parts.

\[
\begin{array}{c}
\text{a} \quad \text{b} \quad \text{c} \\
\text{d} \quad \text{e}
\end{array}
\]

\[
\begin{array}{c}
\sigma \text{ Bond a: C}^{\#} & \text{O}^{\#} \\
\pi \text{ Bond a: C} & \text{O}
\end{array}
\]

\[
\begin{array}{c}
\text{Bond b: O}^{3} & \text{H}^{3} \\
\text{Bond c: C}^{3} & \text{O}^{3} \\
\text{Bond d: C}^{3} & \text{C}^{3} \\
\text{Bond e: } & \\
\end{array}
\]

17. Draw a second resonance structure for the following ion.

\[
\begin{array}{c}
\text{Structures}
\end{array}
\]

18. Rank the following atoms in order of increasing electronegativity: Si, P, F.

least electronegative \( \text{Si} \) < \( \text{P} \) < \( \text{F} \) most electronegative

19. Predict the hybridization and geometry of the indicated atom. Be sure to answer all parts.

\[
\text{CH}_3\text{CH}_2
\]

Hybridization: \( \text{sp}^{3} \) Geometry: tetrahedral

20. Draw one valid Lewis structure (including all lone pair electrons and any formal charges) for \( \text{CH}_2\text{N}_2 \). Assume the atoms are arranged as shown below. For extra practice, draw all resonance structures.

\[
\begin{array}{c}
\text{H} \quad \text{C} \quad \text{N} = \text{N} \\
\text{H}
\end{array}
\]