1. Complete the following table. [9 pts]

<table>
<thead>
<tr>
<th></th>
<th>SO₂</th>
<th>ICl₄⁻</th>
<th>ClF₃</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total number of valence electrons in the molecule</strong></td>
<td>18</td>
<td>36</td>
<td>28</td>
</tr>
<tr>
<td><strong>Lewis Structure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>e⁻ pair arrangement</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>trigonal planar</td>
<td>octahedral</td>
<td>trigonal bipyramidal</td>
</tr>
<tr>
<td><strong>molecular geometry</strong></td>
<td>bent</td>
<td>square planar</td>
<td>T-shaped</td>
</tr>
<tr>
<td><strong>bond angle(s)</strong></td>
<td>120°</td>
<td>90° and 180°</td>
<td>90° and 180°</td>
</tr>
</tbody>
</table>

2. True or False? The bonds in the nitrite ion (NO₂⁻) [4 pts]

a) are of different strength  **FALSE**
b) are of equal strength **TRUE**
c) are different in length  **FALSE**
d) are the same length  **TRUE**
3. Write the geometrical shapes (molecular geometry) that VSEPR theory predicts for molecules whose central atoms have the environments indicated. (i.e. Predict the approximate geometrical arrangement of the bonds about the central atom.) [4 pts]

- tetrahedral ▼ 4 single bonds
- angular ◄ 2 single bonds and 2 non-bonding electron pairs
- trigonal planar ◄ two single bonds and one double bond
- trigonal pyramidal ◄ 3 single bonds and 1 non-bonding electron pair

4. The random letter labels in this diagram of crotononitrile are to be associated with the corresponding bond angle (or other property of the nearest atom). [5 pts]

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

Match the following (using the labels a, b, c, d, or e):
- e ▼ bond angle ~180°
- b ▼ atom centering bond angles of ~109.5°
- a ▼ CCH angle ~120°
- d ▼ CCC angle ~120°
- c ▼ atom having one pair of non-bonding valence electrons

5. Use the given average bond energy values to estimate ΔH for the following reaction in the gas phase. [4 pts]

\[2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}\]

<table>
<thead>
<tr>
<th>Bond</th>
<th>Bond Energy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O−H</td>
<td>460</td>
</tr>
<tr>
<td>H−H</td>
<td>436.4</td>
</tr>
<tr>
<td>C−H</td>
<td>414</td>
</tr>
<tr>
<td>O−O</td>
<td>347</td>
</tr>
<tr>
<td>O=O</td>
<td>620</td>
</tr>
</tbody>
</table>

a) +572.8 kJ/mol       b) +620 kJ/mol       c) −620 kJ/mol       d) +347 kJ/mol       e) −347 kJ/mol

Bonds broken: 2 H−H and 1 O=O: \((2)(436.4 \text{kJ/mol}) + (1)(620 \text{kJ/mol}) = 1492.8 \text{kJ/mol}\)
Bonds formed: 4 O−H: \((4)(-460 \text{kJ/mol}) = -1840 \text{kJ/mol}\)
\[\Delta H = 1492.8 \text{kJ/mol} + (-1840 \text{kJ/mol}) = -347.2 \text{kJ/mol}\]

6. Assign all formal charges, including formal charges of zero, to the molecules below. Which is the "best" Lewis structure based on formal charges? [4 pts]

\[
\left[\begin{array}{c}
\vdots & \equiv & \text{N} \\
\text{S} & \equiv & \text{C} \\
\text{C} & \equiv & \text{N} \\
\text{N} & \equiv & \text{S} \\
\end{array}\right] \\
\begin{array}{c}
\vdots \equiv \text{N} \\
\text{S} & \equiv & \text{C}^{-} \\
\text{C} & \equiv & \text{N}^{-} \\
\text{N} & \equiv & \text{S}^{-} \\
\end{array}
\]

\[\text{S}^{-1} \quad \text{S} \quad \text{C} \quad \text{N} \]