

# WS 4: Drawing Lewis Structures Answer Key

## Part 1: Lewis structures for molecules that obey the octet rule.

Lewis Structure	
<p>CH<sub>4</sub></p> <p>4 4 8</p> <div style="text-align: center;"> </div>	<p>N<sub>2</sub></p> <p>5 5 <hr style="width: 10px; margin: 0 auto;"/>10</p> <div style="text-align: center;"> </div>
<p>CO<sub>2</sub></p> <div style="text-align: center;"> </div>	<p>CO</p> <div style="text-align: center;"> </div>
<p>HCN</p> <div style="text-align: center;"> </div> <p>If you draw <math>\text{:}\overset{\ominus}{\text{C}}\equiv\overset{\oplus}{\text{N}}-\text{H}</math>, why is better!</p>	<p>NH<sub>3</sub></p> <div style="text-align: center;"> </div>
<p>HOBr</p> <div style="text-align: center;"> </div> <p><math>\text{H}-\overset{\oplus}{\text{Br}}-\overset{\ominus}{\text{O}}</math> not as good!</p>	<p>NO<sub>2</sub>Cl (N is the central atom)</p> <div style="text-align: center;"> </div> <p style="text-align: right;">5 12 <hr style="width: 10px; margin: 0 auto;"/>7 24</p>
<p>GeCl<sub>4</sub></p> <div style="text-align: center;"> </div>	<p>NF<sub>3</sub></p> <div style="text-align: center;"> </div>

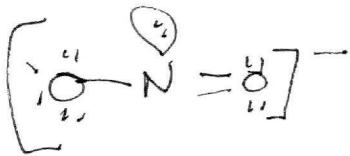
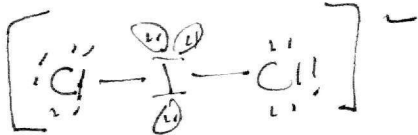
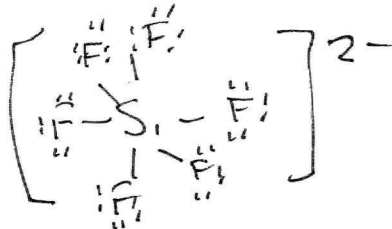
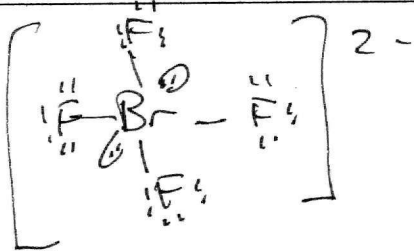
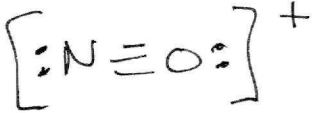
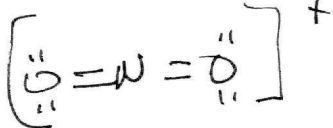
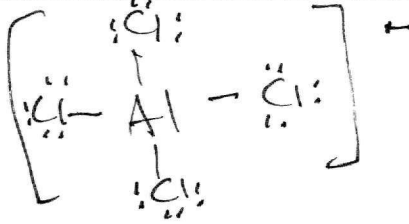
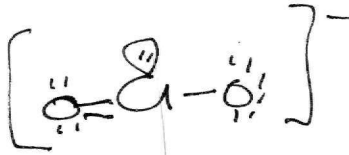
## PART 2: MOLECULES THAT VIOLATE THE OCTET RULE

Lewis Structure	
<p>BF<sub>3</sub></p>	<p>SF<sub>4</sub></p> <p style="text-align: center;"> <math display="block">\begin{array}{r} 28 \\ - 6 \\ \hline 34 \end{array}</math> </p>
<p>IF<sub>5</sub></p> <p style="text-align: center;"> <math display="block">\begin{array}{r} 35 \\ - 8 \\ \hline 42 \end{array}</math> </p>	<p>PCl<sub>5</sub></p>
<p>XeF<sub>4</sub>O</p> <p style="text-align: center;"> <math display="block">\begin{array}{r} 28 \\ 28 \\ - 6 \\ \hline 42 \end{array}</math> </p>	<p>XeF<sub>2</sub></p> <p style="text-align: center;"> <math display="block">\begin{array}{r} 8 \\ 14 \\ - 2 \\ \hline 22 \end{array}</math> </p>
<p>SF<sub>6</sub></p>	<p>XeF<sub>4</sub></p> <p style="text-align: center;"> <math display="block">\begin{array}{r} 8 \\ 28 \\ - 8 \\ \hline 36 \end{array}</math> </p>

## PART 3: LEWIS STRUCTURES FOR IONS

Lewis Structure	
<p>SO<sub>4</sub><sup>2-</sup></p>	<p>NO<sub>3</sub><sup>1-</sup></p>

Lewis Structure

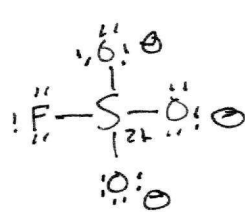
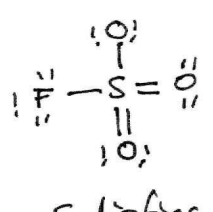
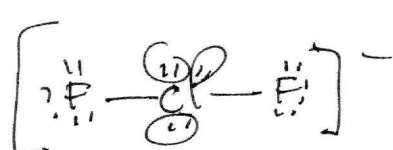
$\text{NO}_2^-$ 	$\text{ICl}_2^-$ 
$[\text{SiF}_6]^{2-}$ 	$\text{BrF}_4^-$ 36 
$\text{NO}^+$ 	$\text{NO}_2^+$ 5 $\frac{12}{17}$ $\frac{-1}{16}$ 
$\text{AlCl}_4^-$ 	$\text{ClO}_2^-$ 7 $\frac{12}{19}$ $\frac{1}{20}$ 

## PART 4: RESONANCE STRUCTURES AND FORMAL CHARGE.

Lewis, resonance, and formal charge	
$N_3^-$	$\left[ \begin{array}{c} \text{:N} \equiv \text{N} - \ddot{\text{N}}\text{:} \\ 0 \quad + \quad 2- \end{array} \right]^- \longleftrightarrow \left[ \begin{array}{c} \ddot{\text{N}} = \text{N} = \ddot{\text{N}}\text{:} \\ - \quad + \quad - \end{array} \right]^- \longleftrightarrow \left[ \begin{array}{c} \ddot{\text{N}} - \text{N} \equiv \text{N}\text{:} \\ - \quad + \quad - \end{array} \right]^-$
$N_2O$ <b>N-N-O</b> • lower FC • ⊖ on oxygen	<p>There are two skeletons for this arrangement. Use formal charge to determine the best central atom. [try comparing the two structures that have the same bonding type. Might I suggest, 2 double bonds] The correct central atom isomer has three resonance structures, two of which are the most dominant. What are they?</p> <p style="text-align: center;">dominant</p> $\begin{array}{c} \text{:N} = \text{N} = \ddot{\text{O}}\text{:} \\ - \quad + \quad 0 \end{array} \longleftrightarrow \begin{array}{c} \text{:N} \equiv \text{N} - \ddot{\text{O}}\text{:}^- \\ - \quad + \quad - \end{array}$ <p style="text-align: center;">2-    +    +    Good!</p> $\begin{array}{c} \ddot{\text{N}} = \text{O} = \ddot{\text{N}} \\ - \quad + \quad - \end{array} \quad \text{yucky!}$ $\begin{array}{c} \text{:N} \equiv \text{O} - \ddot{\text{N}}\text{:} \\ 0 \quad 2+ \quad 2- \end{array}$
$ICl_4^+$	$\left[ \begin{array}{c} \text{:Cl:} \\   \\ \text{:Cl} - \text{I} - \text{Cl:} \\   \\ \text{:Cl:} \end{array} \right]^+$ <p style="text-align: right;">no resonance</p>
$CO_3^{2-}$	<p>This ion has three resonance structures. Draw all three.</p> $\left[ \begin{array}{c} \text{:O:} \\    \\ \text{:C} - \text{O:}^- \\    \\ \text{:O:} \end{array} \right]^{2-} \longleftrightarrow \left[ \begin{array}{c} \text{:O:} \\    \\ \text{:O} - \text{C} \\    \\ \text{:O:}^- \end{array} \right]^{2-} \longleftrightarrow \left[ \begin{array}{c} \text{:O:}^- \\   \\ \text{:O} - \text{C} \\    \\ \text{:O:} \end{array} \right]^{2-}$
$CO_2$	<p>There are three possible structures for carbon dioxide, but only one makes sense. Draw the three structures with the formal charges and explain why the one you chose is the best.</p> $\begin{array}{c} \text{:O} \equiv \text{C} - \ddot{\text{O}}\text{:} \\ + \quad 0 \quad 0 \end{array} \longleftrightarrow \begin{array}{c} \text{:O:}^- - \text{C} \equiv \text{O:}^+ \\ 0 \quad + \quad 0 \end{array} \longleftrightarrow \begin{array}{c} \text{:O:} = \text{C} = \text{:O:} \\ 0 \quad 0 \quad 0 \end{array}$ <p style="text-align: center;">⊕ on oxygen no good!</p> <p style="text-align: right;">FC's zero</p>

Lewis, resonance, and formal charge	
$\text{ClO}_3^-$ 3 resonance structures	
$\text{ONCl}$ FC's zero	<p>There are three structures that can be drawn for this molecular formula, each has a different central atom. Use formal charge to determine the best structure. Each structure has a double bond to satisfy the octet rule. [Hint: one structure has an NO double bond, one has an ON double bond, and one has a NCl double bond] no resonance here!</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <math>\text{O}=\text{N}-\text{Cl}</math>  <math>\text{FCs: } 0, 0, 0</math> </div> <div style="text-align: center;"> <math>\text{O}=\text{Cl}-\text{N}</math>  <math>\text{FCs: } 0, 2+, 2-</math> </div> <div style="text-align: center;"> <math>\text{Cl}=\text{O}-\text{N}</math>  <math>\text{FCs: } 0, 2+, 2-</math> </div> </div> <p>too many FCs <math>\rightarrow</math> <math>\text{O}=\text{N}-\text{Cl}</math>  <math>\text{FCs: } 0, 0, 0</math></p>
$\text{ClO}_2^+$ $\frac{17}{19}$ $\frac{-1}{18}$	<p>Draw the two resonance structures for this ion</p>
$\text{Cl}_2\text{SO}$ $\frac{12}{14}$ $\frac{26}{26}$	<p>(sulfur in the center, why? Draw a structure with O in the center, or Cl in the center to find out!) [SO double bond, vs OS double bond]</p> <p>any other structure FC's too big</p>
$\text{HCO}_2^-$	<p>This has two resonance structures</p>

S goes in center b/c big, ⊕

Lewis, resonance, and formal charge	
$\text{FSO}_3^-$ 7 $6 \times 3$ $18$ $\frac{18}{3} = 6$	 <p>sublstr octet</p>  <p>Satisfies FC</p> <p>2 more structures</p>
$\text{ClF}_2^-$	<p>No resonance</p> 
$\text{ClF}_3$	<p>no resonance</p> 