New concept

\[ \text{[O - H]}^- \]
New concept

\[ \left[ \overset{\cdot}{\overset{\cdot}{\overset{\cdot}{\overset{\cdot}{O}}}}{-H} \right]^- \]

\[ \left[ \overset{\cdot}{\overset{\cdot}{\overset{\cdot}{\overset{\cdot}{O}}} \cdot \overset{\cdot}{\overset{\cdot}{H}}} \right]^- \]

Formal Charge
Covalent assumption
Electrons shared, one to each
New concept

\[ [\begin{array}{c}
\text{O} \\
\text{H}
\end{array} ]^- \]

Formal Charge
Covalent assumption
Electrons shared, one to each

Oxidation Number
Ionic assumption
Both electrons transferred to the one who wants them more
Formal charge = \(-1\) = \(6 - [6 + \frac{1}{2}(2)]\)

Sum of formal charges = \(-1\)

Formal charge = \(0\) = \(1 - [0 + \frac{1}{2}(2)]\)

Assume an ionic bond

Oxidation number = \(-2\)

Sum of oxidation numbers = \(-1\)

Oxidation number = \(+1\)
• **Octet Rule - double count** shared electrons
  – assumes both atoms get both electrons
<table>
<thead>
<tr>
<th>Octet Rule - double count</th>
<th>Formal Charge - Evenly</th>
</tr>
</thead>
<tbody>
<tr>
<td>shared electrons</td>
<td>split electrons in a bond</td>
</tr>
<tr>
<td>– assumes both atoms get both electrons</td>
<td>– one to one atom, one to the other</td>
</tr>
</tbody>
</table>

Formal charge for $\text{OH}^-$:

- Octet Rule: $-1 = 6 - [6 + \frac{1}{2}(2)]$
- Oxidation number: $-2$
- Sum of formal charges: $-1$

Formal charge for $\text{OH}$:

- Octet Rule: $0 = 1 - [0 + \frac{1}{2}(2)]$
- Oxidation number: $+1$
- Assume an ionic bond
- Sum of oxidation numbers: $-1$
• **Octet Rule - double count** shared electrons
  — assumes both atoms get both electrons

• **Formal Charge - *Evenly*** split electrons in a bond
  — one to one atom, one to the other

• **Oxidation Number - *Unevenly*** split electrons in a bond
  — the atom that wants electrons more, gets both
  shared electrons (as in ionic bonds). The other one
  loses out. *An extreme view.*
Back to Octet Rule
Alternative Ways of Drawing the Ozone Structure

Double bond on the left: \[ \begin{array}{c}
\cdot \\
\cdot \\
\cdot
\end{array} = \begin{array}{c}
\cdot \\
\cdot \\
\cdot
\end{array} - \begin{array}{c}
\cdot \\
\cdot \\
\cdot
\end{array} : \]

Double bond on the right: \[ \begin{array}{c}
\cdot \\
\cdot \\
\cdot
\end{array} - \begin{array}{c}
\cdot \\
\cdot \\
\cdot
\end{array} = \begin{array}{c}
\cdot \\
\cdot \\
\cdot
\end{array} \]
Ozone molecule \( \text{O}_3 \)

Alternative Ways of Drawing the Ozone Structure

Double bond on the left: \( \text{O} = \text{O} - \text{O} : \)

Double bond on the right: \( : \text{O} - \text{O} = \text{O} \)

Which side gets the double bond?
Real molecule - equal bond lengths!! (not interconverting)
Nitrite anion - \( \text{NO}_2^- \)

Formal charge of nitrogen (N)

\[
\begin{align*}
0 &= 6 - [4 + \frac{1}{2}(4)] \\
-1 &= 6 - [6 + \frac{1}{2}(2)] \\
0 &= 5 - [2 + \frac{1}{2}(6)]
\end{align*}
\]
Nitrite anion - NO₂⁻

Formal charge = 0 = 6 - [4 + \frac{1}{2}(4)]

Formal charge = -1 = 6 - [6 + \frac{1}{2}(2)]

\[
\begin{array}{c}
\text{Resonance Structure - two views; neither fully correct}
\end{array}
\]

\[
\begin{array}{c}
\text{© Brooks/Cole, Cengage Learning}
\end{array}
\]

Example 8-4, p. 363
Nitrite anion - NO$_2^-$

Unified Structure - one view; more correct

Resonance Structure - two views; neither fully correct
Nitrite anion - $\text{NO}_2^-$

Unified Structure - one view; more correct

[Diagram showing the unified structure with a mention that it's harder to implement the octet rule]

Resonance Structure - two views; neither fully correct

[Diagram showing two resonance structures]
Exceeding the Octet Rule

using near-energy d orbitals

$(5 \times 7) + 1 = 36$ electrons brought to the party

The last two electron pairs are added to the central Cl atom.

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coordinate covalent bond
<table>
<thead>
<tr>
<th>Group 4A</th>
<th>Group 5A</th>
<th>Group 6A</th>
<th>Group 7A</th>
<th>Group 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiF$_5^-$</td>
<td>PF$_5$</td>
<td>SF$_4$</td>
<td>ClF$_3$</td>
<td>XeF$_2$</td>
</tr>
<tr>
<td>[Si(\text{F}_5)]^-</td>
<td>[PF(\text{F}_5)]^-</td>
<td>[SF(\text{F}_4)]^-</td>
<td>[Cl(\text{F}_3)]^-</td>
<td>[Xe(\text{F}_2)]^-</td>
</tr>
<tr>
<td>SiF$_6^{2-}$</td>
<td>PF$_6^-$</td>
<td>SF$_6$</td>
<td>BrF$_5$</td>
<td>XeF$_4$</td>
</tr>
<tr>
<td>[Si(\text{F}_6)]^{2-}</td>
<td>[PF(\text{F}_6)]^-</td>
<td>[SF(\text{F}_6)]^-</td>
<td>[Br(\text{F}_5)]^-</td>
<td>[Xe(\text{F}_4)]^-</td>
</tr>
</tbody>
</table>

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Table 8-6, p. 365