9-12. Why is $D_e(N_2) > D_e(N_2^+)$, but $D_e(O_2^+) > D_e(O_2)$?

$N_2$: $\ldots \underbrace{2\sigma_g^2}_{2s} \underbrace{2\sigma_u^2}_{2p} \underbrace{3\sigma_g^2}_{1\Pi_u} \underbrace{1\Pi_u^4}_{2p}$

$N_2^+$: one of the electrons is removed from the $3\sigma_g$ or $1\Pi_u$ orbitals which are bonding.

$BO(N_2) = 3$, $BO(N_2^+) = 2.5$

$\Rightarrow D_e(N_2) > D_e(N_2^+)$

$O_2$: $\ldots \underbrace{2\sigma_g^2}_{2s} \underbrace{2\sigma_u^2}_{2p} \underbrace{3\sigma_g^2}_{1\Pi_g} \underbrace{1\Pi_g^4}_{2p}$

$O_2^+$: An electron is removed from the $1\Pi_g$ orbital which is antibonding.

$BO(O_2) = 2$, $BO(O_2^+) = 2.5$

$\Rightarrow D_e(O_2) < D_e(O_2^+)$

9-17 Compare NO and NO$^+$

NO: $\ldots \underbrace{1\sigma_g^2}_{1s} \underbrace{2\sigma_g^2}_{2p} \underbrace{3\sigma_g^2}_{2s} \underbrace{4\sigma_g^2}_{2p} \underbrace{5\sigma_g^2}_{2s} \underbrace{1\Pi_g^4}_{2p}$ $BO = 3$

NO$^+$: $\ldots \underbrace{1\sigma_g^2}_{1s} \underbrace{2\sigma_g^2}_{2p} \underbrace{3\sigma_g^2}_{2s} \underbrace{4\sigma_g^2}_{2p} \underbrace{5\sigma_g^2}_{2s} \underbrace{1\Pi_g^4}_{2p}$ $BO = 2.5$

iso electronic with $N_2$. Bonding antibonding
9-19. | Molecule | $k$ (N/m) | BO |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_2$</td>
<td>350</td>
<td>1</td>
</tr>
<tr>
<td>$C_2$</td>
<td>930</td>
<td>2</td>
</tr>
<tr>
<td>$N_2$</td>
<td>2260</td>
<td>3</td>
</tr>
<tr>
<td>$O_2$</td>
<td>1140</td>
<td>2</td>
</tr>
<tr>
<td>$F_2$</td>
<td>450</td>
<td>1</td>
</tr>
</tbody>
</table>

The force constants correlate with the bond orders as expected.

9-22. How does the orbital energy diagram of $OH$ differ from that of $HF$?

$BO = 1$

$OH$ also has a bond order $= 1$, since the electron that is “missing” (relative to $HF$) has been removed from a non-bonding orbital.
9-31. What are the term symbols of $O_2$, $N_2$, $O_2^+$, $N_2^+$?

$O_2$ \[ \sigma_g^2 \pi_u^2 \pi_g^2 \pi_u \rightarrow \Sigma_g^+ \]

$O_2^+$ \[ \sigma_g^2 \pi_u^2 \pi_g^2 \pi_u \rightarrow \Sigma_g' \]

$N_2$ \[ \sigma_g^2 \pi_u^2 \pi_g^2 \pi_u \rightarrow \Sigma_u^+ \]

$N_2^+$ \[ \sigma_g^2 \pi_u^2 \pi_g^2 \pi_u \rightarrow \Sigma_u^+ \]

9-36. Dipole moment of LiH if 100% ionic?

\[ \mu = q_1 R = (1.602 \times 10^{-19} \text{ C})(1.59 \times 10^{-10} \text{ m}) \]

\[ = 2.55 \times 10^{-20} \text{ C} \cdot \text{m} \]

What is the percentage of ionic character?

\[ \frac{\text{Expt. dipole}}{\text{ideal dipole}} = \frac{q_1 R}{q_2 R} = \frac{q_1}{q_2} = \frac{19.62}{25.5} \]

$q_1 = 0.77 \text{ e} \text{m}$, 77% ionic character.