

## Drawing Lewis Structures and Correlating with Bond Orders, Bond Lengths, and Bond Energies

Complete the Lewis structures for the compounds shown in the following table and answer questions on the other side.

Molecule	Lewis Structure	Bond of Interest	Bond Order	Bond Length (nm)	Bond Energy (kJ/mol)
H <sub>2</sub>	H-H	H-H	1	0.074	436
Cl <sub>2</sub>	:Cl-Cl:	Cl-Cl	1	0.198	243
H <sub>2</sub> O	H-O-H	O-H	1	0.103	464
H <sub>3</sub> CCH <sub>3</sub>	<pre>       H   H             H - C - C - H                   H   H           </pre>	C-C	1	0.154	346
H <sub>2</sub> CCH <sub>2</sub>	<pre>       H   H        \ /         C = C        / \       H   H           </pre>	C-C	2	0.133	615
HCCH	H-C≡C-H	C-C	3	0.120	835
CO <sub>2</sub>	:O=C=O:	C-O	2	0.120	804
H <sub>2</sub> CO	<pre>       H        \         C = O        /       H           </pre>	C-O	2	0.120	799
N <sub>2</sub>	:N≡N:	N-N	3	0.116	945
O <sub>2</sub>	:O=O:	O-O	2	0.121	498

Bond order is equal to the number of shared pairs of electrons making up a particular bond. A single bond between two carbon atoms, for example, involves the sharing of a single pair of electrons between the atoms, giving a bond order of 1. When two electron pairs are shared we have a double bond, or a bond order of 2. A triple bond, of course, involves the sharing of three pairs of electrons and a bond order of 3. What is the bond order for the bond of interest in each Lewis structure?

What correlation, if any, do you find between bond order and bond strength. Briefly summarize your reasoning.

*As the bond order increases the strength of the bond increases as well. The compounds  $H_3CCH_3$ ,  $H_2CCH_2$ , and  $HCCH$  show this trend nicely.*

Bond lengths for single bonds can be estimated using covalent radii. Using the data in Figure 3.26 on page 100 of your text (given in nm), estimate the bond length for the bond of interest in each of your Lewis structures. For double bonds, use the following values: C-C double bond, 0.133 nm; C-C triple bond, 0.120, C-O double bond, 0.120, C-O triple bond, 0.113, O-O double bond, 0.121, and N-N triple bond, 0.116.

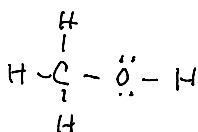
The bond energy for  $Cl_2$  is given on the other side of this page. The bond energy for the Br-Br bond in  $Br_2$  is 224 kJ/mol and that for the I-I bond in  $I_2$  is 151 kJ/mol. What correlation, if any, do you find between bond length and bond strength. Briefly summarize your reasoning.

*As the bond length increases the bond becomes weaker.*

Which do you think is more important when it comes to predicting a bond's energy – the bond order or the bond length? Briefly explain.

*The more important predictor of bond strength is the bond order. The two compounds with triple bonds have stronger bonds than the four compounds with double bonds, which, in turn, have stronger bonds than the four compounds with single bonds.*

Draw a Lewis structure for methanol,  $H_3COH$ , and predict whether it will take more energy to break the C-O bond in methanol or that in formaldehyde,  $H_2CO$  (see table on other side).



*Methanol has a single bond between C and O while formaldehyde has a double bond between C and O. Given the importance of bond order, we predict that it will be easier to break the C-O bond in methanol.*