

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

Draw the Lewis structure for each compound in the table and then answer the questions on the reverse side of this sheet.

Molecule	Lewis Structure	Bond of Interest	Bond Order	Bond Length (nm)	Bond Energy (kJ/mol)
H ₂	H-H	H-H	1	0.074	436
Cl ₂	:Cl-Cl:	Cl-Cl	1	0.198	243
H ₂ O	H-O-H	O-H	1	0.103	464
H ₃ CCH ₃	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	C-C	1	0.154	346
H ₂ CCH ₂	$\begin{array}{c} \text{H} \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{H} \quad \text{H} \end{array}$	C-C	2	0.133	615
HCCH	H-C≡C-H	C-C	3	0.120	835
CO ₂	:O=C=O:	C-O	2	0.120	804
H ₂ CO	$\begin{array}{c} \text{H} \\ \diagdown \\ \text{C}=\text{O} \\ / \\ \text{H} \end{array}$	C-O	2	0.120	799
N ₂	:N≡N:	N-N	3	0.116	945
O ₂	:O=O:	O-O	2	0.121	498

The bond order between two atoms is equal to the number of shared pairs of electrons making up the particular bond. In a single bond, for example, a single pair of electrons is shared, giving a bond order of one. When two electron pairs are shared we have a double bond, or a bond order of two. A triple bond, of course, involves the sharing of three pairs of electrons and a bond order of three. What is the bond order for the bond of interest in the compounds for which you drew Lewis structures?

Answers shown on reverse side of this page.

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

As 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.

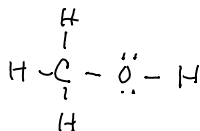
The bond energy for Cl_2 is shown on the other side of this page. The bond energy for the $Br-Br$ bond in Br_2 is 224 kJ/mol and that for the $I-I$ bond in I_2 is 151 kJ/mol. What correlation, if any, does this suggest between bond length and bond strength. Briefly summarize your reasoning.

As bond length increases the bond becomes weaker; we know that the bond length in I_2 is greater than that in Br_2 , which is greater than that in Cl_2 and we see that the weakest of the bonds is for I_2 and the strongest is for Cl_2 .

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

The more important predictor of bond strength is 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 it will be easier to break the $C-O$ bond in methanol.