Using Bond Energies

If you know the amount of energy needed to break a bond, and the amount of energy released when a new bond forms, it is possible to approximate the energy change of a reaction. The energy change of the reaction is the sum of the energies required for breaking the bonds minus the sum of the energies released making the bonds.

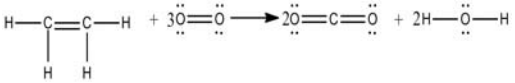
$$\Delta H = \Sigma \Delta H_{BOND\ BREAKING} - \Sigma \Delta H_{BOND\ MAKING}$$

Bond energies are obtained from a table such as the one shown to the right.

Sample Problem

What is the energy change associated with the reaction: $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

Step 1: Draw Lewis structures to identify the bonds



Step 2: Sum the energies of the bonds broken.

Bond	Bond Energy	Number	Total
C=C	614	1	614
C–H	413	4	1652
O=O	495	3	1485
		TOTAL	3751

Step 3: Sum the energies of the bonds formed.

Bond	Bond Energy	Number	Total
C=O	799	4	3196
O–H	467	4	1868
		TOTAL	5064

Step 4: Find the difference

$3751\ ^{kj}/_{mol} - 5064\ ^{kj}/_{mol} = -1313\ ^{kj}/_{mol}$

Average Bond Energies (kj/mol)

Single Bonds

H—H	432	N—H	391	I—I	149	C=C	614
H—F	565	N—N	160	I—Cl	208	C≡C	839
H—Cl	427	N—F	272	I—Br	175	O=O	495
H—Br	363	N—Cl	200			C=O*	745
H—I	295	N—Br	243	S—H	347	C≡O	1072
		N—O	201	S—F	327	N=O	607
C—H	413	O—H	467	S—Cl	253	N=N	418
C—C	347	O—O	146	S—Br	218	N≡N	941
C—N	305	O—F	190	S—S	266	C≡N	891
C—O	358	O—Cl	203			C=N	615
C—F	485	O—I	234	Si—Si	340		
C—Cl	339			Si—H	393		
C—Br	276	F—F	154	Si—C	360		
C—I	240	F—Cl	253	Si—O	452		
C—S	259	F—Br	237				
		Cl—Cl	239				
		Cl—Br	218				
		Br—Br	193				

Multiple Bonds

*C=O (CO_2) =799

Find the energy changes associated with the reactions below using the procedures described in the *Sample Problem* and the data table provided above.

1. $CH_3COOH + 2O_2 \rightarrow 2CO_2 + 2H_2O$

2. $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

3. $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$

4. $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$