Bond Energies

Name______________________________________ Section__________

1. Given the information in the table below;

Bond Lengths and Bond Energies

	Bond Length (nm)	Bond Energy (kJ/mol)
H–H	0.074	435
H–Cl	0.127	431
Cl–Cl	0.198	243
H–C	0.109	414
C–Cl	0.177	328
C–C	0.154	331
C=C	0.134	590
C≡C	0.120	812
C–O	0.143	326
C=O	0.120	803
C≡O	0.113	1075
N–N	0.145	159
N=N	0.125	473
N≡N	0.110	941
O_2	0.121	495
H–O	0.096	463

Explain the observed relationship between bond length and bond energy in the three examples of carbon-carbon bonds and in the three examples of carbon-oxygen bonds. Which is stronger and why?

The trend in bond energy for the carbon/carbon single, double and triple bonds demonstrates the increased strength of this of bonds. The same trend is observed in carbon/oxygen bonds and the nitrogen/nitrogen bonds. As the bond length shortens the bond energy increases.

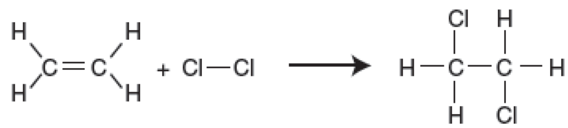
Compare the bond strengths in a dihydrogen molecule and a chlorine molecule. Which is stronger and why?

Comparing the bond strength in H_2 and Cl_2 the chlorine/chlorine bond energy is smaller compared to the hydrogen/hydrogen bond energy. Because of the larger size of the chlorine atom, there are greater electron/electron repulsions.

It should also be pointed out there is no uniform relationship between bond distance and bond energy when the atoms sharing the covalent bond are

different. When two bonds have similar bond distances, they may not have similar bond energies. For example, H–C and N≡N have similar bond distances, but significantly different bond energies.

2. Using bond energies, calculate ΔH° for the reaction



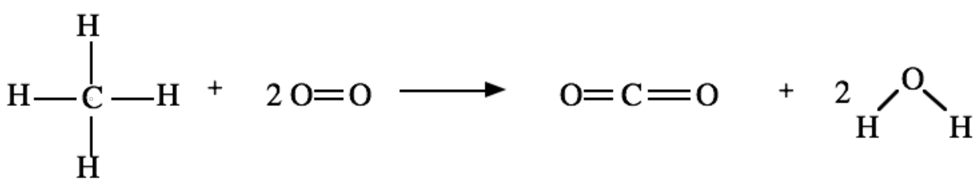
$\Delta H_{reaction} = \Sigma\Delta H(\text{bond breakage}) - \Sigma\Delta H(\text{bond formation})$

$\Delta H_{reaction}$ = [4(C-H) + 1(C=C) + 1(Cl-Cl)] - [4(C-H) + 2(C-Cl) + 1(C-C)]

= [4(414 kJ mol^{-1}) + 1(590 kJ mol^{-1}) + 1(243 kJ mol^{-1})] - [4(414 kJ mol^{-1})+ 2(328 kJ mol^{-1}) + 1(331 kJ mol^{-1})]

$\Delta H_{reaction}$ = -154 kJ mol^{-1}

3. Using bond energies, calculate ΔH° for the reaction



(See your text or other reference book for a more complete table of bond energies needed to solve these types of problems.)

$\Delta H_{reaction} = \Sigma\Delta H(\text{bond breakage}) - \Sigma\Delta H(\text{bond formation})$

$\Delta H_{reaction}$ = [4(C-H) + 2(O_2)] - [2(C=O) + 4(O-H)]

= [4(414 kJ mol^{-1}) + 2(495 kJ mol^{-1})] - [2(799 kJ mol^{-1})+ 4(463 kJ mol^{-1})]

$\Delta H_{reaction}$ = -804 kJ mol^{-1}