Exercise 6.2a
Bond Energy

Name: _____

Date: _____ Per: _____

Bond energy is defined as the amount of energy required to break a bond. These values are positive, indicating that bond breaking requires an input of energy (endothermic). Bond energies are reported in kilojoules per mole (kJ/mol). The energy for breaking a hydrogen-hydrogen bond is 432 kJ/mol so when a hydrogen-hydrogen bond is formed the process releases 432 kJ/mol (exothermic).

In a chemical reaction several bonds are broken and formed. For example, in the reaction below a hydrogen-hydrogen bond is broken and a fluorine-fluorine bond is broken. Two hydrogen-fluorine bonds are formed. The overall energy change for this process is calculated below.

$$H - H + F - F \rightarrow H - F + H - F$$

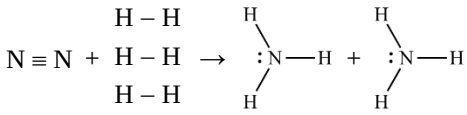
ΔH_{rxn} = [energy used to break bonds] – [energy released when bonds form]

ΔH_{rxn} = [432 kJ/mol + 154 kJ/mol] – [2(565 kJ/mol)] = -544 kJ/mol

DIRECTIONS: Answer the following in the space provided:

1. Use bond energy values from the table to estimate ΔH for each of the following reactions in the gas phase.

a. $H - H + Br - Br \rightarrow H - Br + H - Br$

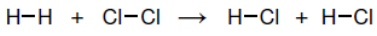
b. 

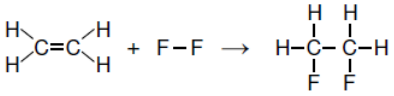
Average Bond Energies (kJ/mol)

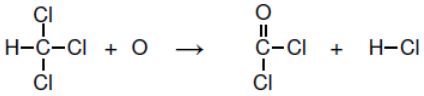
Single Bonds						Multiple Bonds	
H—H	432	N—H	391	I—I	149	C=C	614
H—F	565	N—N	160	I—Cl	208	C≡C	839
H—Cl	427	N—F	272	I—Br	175	O=O	495
H—Br	363	N—Cl	200			C=O*	745
H—I	295	N—Br	243	S—H	347	C≡O	1072
		N—O	201	S—F	327	N=O	607
C—H	413	O—H	467	S—Cl	253	N=N	418
C—C	347	O—O	146	S—Br	218	N≡N	941
C—N	305	O—F	190	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				

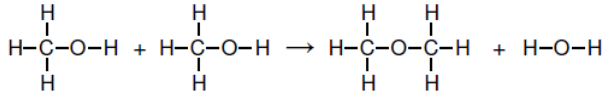
*C=O(CO_2) = 799

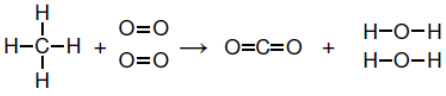
2. Estimate the enthalpy change (ΔH_{rxn}) of the following reactions using the bond energies above.

a. 

b. 

c. 

d. 

e. 

*

Answers: 1a) -101 kJ/mol 1b) -109 kJ/mol 2a) -183 kJ/mol 2b) -549 kJ/mol 2c) -420 kJ/mol 2d) 0 kJ/mol 2e) -824 kJ/mol