Bond Energies

1. Read pages 586 – 587 in your textbook.
2. Which process releases energy: breaking a bond or forming a bond?
3. Which process requires energy: breaking a bond or forming a bond?
4. Define bond energy.
5. If the energy used to break bonds is greater than the energy released in the formation of new bonds, is the reaction endothermic or exothermic?
6. If the energy used to break bonds is less than the energy released in the formation of new bonds, is the reaction endothermic or exothermic?
7. Look at the table of selected bond energies to the right.
   a. Which is the strongest single bond on this table?
   b. Which is the weakest single bond on this table?

Bond type	Energy kJ/mol
Br–Br	193
C–Br	288
C–C	348
C=C	614
C≡C	839
C–Cl	330
C–F	488
C–H	413
C–I	216
C–N	308
C–O	360
C=O	799
C–S	272
Cl–Cl	243
F–F	158
H–Br	366
H–Cl	432
H–F	568
H–H	436
H–I	298
H–N	391
H–O	459
I–I	151
N–N	170
N≡N	945
O–O	145
O=O	498

8. (Note: <u>This is not a question</u>. It is an explanation of how to calculate the total energy from a reaction, based on bond energies. There are supposed to be empty spaces in the table.)

   Let's examine the electrolysis of water (fig 4 on page 587). The general reaction is

   $$2H_2O \rightarrow 2H_2 + O_2 \quad \text{or} \quad \text{H–O–H H–O–H} \rightarrow \text{H–H H–H + O=O}$$

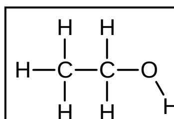
   The overall heat of reaction can be calculated as follows:

Bond	Bond energy (kJ/mol)	Number of bonds broken	Energy required (kJ)	Number of bonds formed	Energy Released (kJ)
H–O	459	4	1836		
H–H	436			2	872
O=O	498			1	498
		Sum	1836		1370
		Result	466		

   Thus, this is an endothermic reaction (energy required) that absorbs 466 kJ.
   The thermochemical equation is $2H_2O + 466\ \text{kJ} \rightarrow 2H_2 + O_2$

9. Calculate the heat of reaction for $H_2 + Cl_2 \rightarrow 2HCl$ (fig. 5 on page 587) by completing a table similar to the one above. Write the thermochemical equation for this reaction.
10. In yesterday's lab we found the molar heat of reaction for burning paraffin in oxygen. You will now calculate the theoretical value and compare it to the experimental value.
   a. Draw Lewis structures for O_2, H_2O, and CO_2.
   b. Write the balanced equation for the combustion of $C_{25}H_{52}$.
   c. Fill in this table to calculate the theoretical molar heat of combustion for $C_{25}H_{52}$.

Bond	Bond energy (kJ/mol)	Number of bonds broken	Energy required (kJ)	Number of bonds formed	Energy Released (kJ)
C–C					
C–H					
C=O					
H–O					
O=O					
		Sum			
		Result			



C_2H_5OH

   d. How does your theoretical value (calculated above) compare to your experimental value (measured in yesterday's lab)? What can account for the discrepancy between these values?
11. Calculate the molar heat of combustion & the specific heat of combustion for C_2H_5OH (shown above).