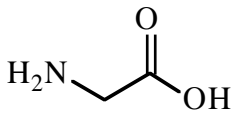
THE LAST CHEM 101 CONFERENCE: THERMOCHEMISTRY
November 28/29, 2007

Bond energies:				***Heats of formation:***	
C–C	348 kJ/mol			$CO_{2(g)}$	-394 kJ/mol
C–H	413 kJ/mol			$H_2O_{(g)}$	-242 kJ/mol
N–H	388 kJ/mol			$C_{20}H_{42(l)}$	-556 kJ/mol
O–H	463 kJ/mol			$C_{19}H_{34}O_{2(l)}$	-605 kJ/mol
C–O	360 kJ/mol				
C=O	743 kJ/mol	(in CO_2	799 kJ/mol)		
C–N	305 kJ/mol				

1. Using average bond energies, estimate ΔH_{rxn} for the formation of a peptide bond between two glycine molecules.



glycine

2. Based on bond energy considerations, which of the following gases has the greater heat of combustion per mole, methane, CH_4, or formaldehyde, CH_2O?

3. (a) Are heats of fusion, ΔH_{fusion}, always endothermic or exothermic? Explain why. (b) Which fatty acid, stearic acid or oleic acid, do you expect to have the larger heat of fusion? Support your prediction with a brief explanation of the chemistry at the molecular level.

4. Given the following reactions:

   $CO_{(g)} + SiO_{2(s)} \rightarrow SiO_{(g)} + CO_{2(g)}$ $\Delta H° = 520.9$ kJ

   $8\ CO_{2(g)} + Si_3N_{4(s)} \rightarrow 3\ SiO_{2(s)} + 2\ N_2O_{(g)} + 8\ CO_{(g)}$ $\Delta H° = 461.1$ kJ

   Calculate $\Delta H°$ for the following reaction:

   $5\ CO_{2(g)} + Si_3N_{4(s)} \rightarrow 3\ SiO_{(g)} + 2\ N_2O_{(g)} + 5\ CO_{(g)}$ $\Delta H° = ?$

5. Although biodiesel is a renewable and generally cleaner-burning fuel than petroleum diesel, the heat content of biodiesel is less than that of petroleum diesel. Both are complex mixtures of compounds. However for the purposes of this problem assume that biodiesel is the methyl ester of linoleic acid ($C_{19}H_{34}O_2$), the main component in soybean oil and that petroleum diesel is the hydrocarbon $C_{20}H_{42}$. Using heats of formation, calculate the heat contents (kJ/g) of each of these fuels.

6. Nitroglycerine, $C_3H_5(NO_3)_{3(l)}$, a powerful explosive used in mining, detonates to produce a hot gaseous mixture of nitrogen, water, carbon dioxide, and oxygen. (a) Write a balanced equation for this reaction using the smallest whole number coefficients. (b) If $\Delta H_{rxn} = -5656$ kJ for the equation as written in part a, calculate the heat of formation for nitroglycerine.