CHEM1612 Problem Sheet 2 (Week 2)

1. Calcium carbide reacts with water as follows:

$$CaC_2(s) + 2H_2O(l) \rightarrow C_2H_2(g) + Ca(OH)_2(s)$$

Use the data at the foot of the page to calculate the enthalpy change when calcium carbide (10.0 g) reacts with excess water at 298 K.

2. During exercise, fat molecules react with water (hydrolyse) to form a group of compounds called fatty acids. These fatty acids are then converted to carbon dioxide and water releasing energy to power the muscles. A typical human fatty acid is palmitic acid: $CH_3(CH_2)_{14}COOH$.

   (a) Write a balanced equation for the complete oxidation of palmitic acid producing $CO_2(g)$ and $H_2O(l)$.
   (b) The direct combustion of palmitic acid in a calorimeter yields the same products as in the body together with the production of 9980 kJ of heat per mole of palmitic acid. Using the data at the foot of the page, calculate the standard enthalpy of formation of palmitic acid?
   (c) Carbohydrates yield about 17 kJ g^{-1} of energy in the body. Calculate the equivalent energy value of fat using palmitic acid as the example.

3. Methyl stearate, $CH_3(CH_2)_{16}COOCH_3$, is a significant component of some biodiesel formulations. Its heat of formation is –945.6 kJ mol^{-1}.

   (a) Calculate its heat of combustion using the data at the foot of the page.
   (b) Convert the heat of combustion into the nett calorific value, in kJ g^{-1}, and compare this with the value for conventional diesel of 42.5 kJ g^{-1}.

4. For a particular chemical reaction, ΔH = 5.5 kJ mol^{-1} and ΔS = 25 J K^{-1} mol^{-1} and do not vary greatly with temperature. Under what temperature condition(s) is the reaction spontaneous?

5. What are the signs of ΔG, ΔH and ΔS for the freezing of liquid water at –10 °C?

$\Delta_f H°_{298}$, in kJ mol^{-1}: $CaC_2(s)$ –60; $H_2O(l)$ –285; $C_2H_2(g)$ +227; $Ca(OH)_2(s)$ –986; $CO_2(g)$ –393.5