1. It takes 78.2 J to raise the temperature of 45.6 g of lead by 13.3 °C. What are the specific and molar heat capacities of lead?

2. In a coffee cup calorimeter, 100 mL of 1.0 M HCl and 100 mL of 1.0 M NaOH are mixed. Before mixing, both solutions are at 24.6 °C. After the reaction, the temperature is 31.3 °C. Assuming no density change, and that the heat capacity of the solution is that of water, calculate the standard enthalpy of neutralisation of H+(aq) by OH−(aq). (Assume a perfect calorimeter where no heat is lost to the surroundings.)

3. A 0.0100 mol sample of propane was placed into a bomb calorimeter with excess oxygen and ignited. The equation for the reaction is:

   \[ \text{C}_3\text{H}_8(g) + 5\text{O}_2(g) \rightarrow 3\text{CO}_2(g) + 4\text{H}_2\text{O}(l) \]

   The initial temperature of the calorimeter was 25.000 °C and its total heat capacity was 96.5 kJ °C⁻¹. The reaction raised the temperature of the calorimeter to 27.828 °C. Calculate the energy (in kJ and in kJ mol⁻¹) liberated by the combustion of the propane.

4. 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: \text{CH}_3(\text{CH}_2)_{14}\text{COOH}.

   (a) Write a balanced equation for the complete oxidation of palmitic acid producing \text{CO}_2(g) and \text{H}_2\text{O}(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.

5. Methyl stearate, \text{CH}_3(\text{CH}_2)_{16}\text{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.

6. Calcium carbide reacts with water as follows:

   \[ \text{CaC}_2(s) + 2\text{H}_2\text{O}(l) \rightarrow \text{C}_2\text{H}_2(g) + \text{Ca(OH)}_2(s) \]

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

   \[ \Delta H^\circ_{298}, \text{in kJ mol}^{-1}: \quad \text{CaC}_2(s) –60; \quad \text{H}_2\text{O}(l) –285; \quad \text{C}_2\text{H}_2(g) +227; \]

   \[ \text{Ca(OH)}_2(s) –986; \quad \text{CO}_2(g) –393.5 \]