Year 12 Chemistry

Thermochemistry Questions

1. Identify the following as reactions that release energy or reactions that absorb energy:
   (a) combustion /1
   (b) respiration /1
   (c) photosynthesis /1

2. Glucose is produced by photosynthesis according to the following equation:

   $6CO_{2(g)} + 6H_2O_{(l)} \rightarrow C_6H_{12}O_{6(aq)} + 6O_{2(g)}$ $\Delta H = +2820$ kJ mol^{-1}

   Write the thermochemical equation for the aerobic respiration of glucose. /3

3. (a) State whether the following reactions are endothermic or exothermic:
   (i) $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$ $\Delta H = +180$ kJ mol^{-1} /1
   (ii) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta H = -394$ kJ mol^{-1} /1
   (iii) $C_2H_{6(g)} + 3.5O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$ $\Delta H = -360$ kJ mol^{-1} /1
   (iv) $6CO_{2(g)} + 6H_2O_{(l)} \rightarrow C_6H_{12}O_{6(aq)} + 6O_{2(g)}$ $\Delta H = +2820$ kJ mol^{-1} /1

   (b) State which of the reactions in part (a) would cause, per mole of substance reacting:
   (i) the most amount of heat energy absorbed? /1
   (ii) the least amount of heat energy released, ignoring reactions that absorb energy? /1

4. When 50.0 mL of 2.00 mol L^{-1} hydrochloric acid is mixed with 50.0 mL of 2.00 mol L^{-1} sodium hydroxide in a calorimeter, the temperature goes up 22.2°C. (Specific heat of water = 4.18 J g^{-1} K^{-1})
   (a) Calculate the energy change for the reaction. /2
   (b) Calculate the enthalpy of neutralization (energy per mole of H^+ transferred) in kJ mol^{-1}. /3
   (c) Explain why it is preferable to use a polystyrene foam cup as a calorimeter instead of a glass beaker. /2
   (d) State why the solution should be stirred during the reaction. /1

5. Consider the following two thermochemical equations:

   $KOH_{(s)} + H_2O_{(l)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$ $\Delta H = -55$ kJ mol^{-1}

   $KOH_{(aq)} + HCl_{(aq)} \rightarrow KCl_{(aq)} + H_2O_{(l)}$ $\Delta H = -57.1$ kJ mol^{-1}

   (a) Calculate the heat released when 100 g of potassium hydroxide is dissolved in excess water. /2
   (b) Calculate the heat released when 200 mL of 0.500 mol L^{-1} hydrochloric acid is mixed with 300 mL of 0.400 mol L^{-1} potassium hydroxide. /3
   (c) Calculate which releases more heat – dissolving 50 g of potassium hydroxide in excess water, or combining 500 mL of 2 mol L^{-1} potassium hydroxide with excess acid. /3

6. Ammonium nitrate (NH_4NO_3) is a substance commonly used in cold packs athletes use to treat injuries.
   (a) The accepted value for the enthalpy of solution of ammonium nitrate is +26.2 kJ mol^{-1}.
   Write the thermochemical equation for the dissolving of ammonium nitrate in water. /3
   (b) An experiment to determine the enthalpy of solution was carried out in a school laboratory, and the following data was obtained:
   Mass of ammonium nitrate = 3.00 g
   Mass of water = 100 g
   Initial temperature = 21.4°C
   Final temperature = 19.3°C
   (Specific heat of water = 4.18 J g^{-1} K^{-1})
   (i) Calculate the number of moles of ammonium nitrate added. /2
   (ii) Calculate the amount of heat, in kJ, lost by the 100 g of water in the experiment. /2
   (iii) Calculate, from the experiment, the enthalpy of solution of ammonium nitrate (kJ mol^{-1}) /2

   (c) Suggest and explain one possible reason for the difference between the accepted value and the calculated value for the enthalpy of solution of ammonium nitrate. /2