SL & HL Answers to Measuring energy changes questions

1. Amount of hydrochloric acid = amount of sodium hydroxide = 100/1000 x 1.00 = 0.100 mol

Mass of solution = 200 g (Assuming the volumes are additive and that the density is 1.0 g cm^{-3})

Assuming the specific heat capacity of the solution = 4.18 J g^{-1} $^oC^{-1}$

Heat evolved = 200 x 4.18 x (26.1 – 19.3) = 5685 J for neutralizing 0.100 mol

Enthalpy change of neutralization = – 56850 J mol^{-1} = – 56.9 kJ mol^{-1}

2. i. By extrapolating the graph back to when the zinc was added (t = 120 s) the temperature increase = 26.1 – 19.1 = 7.0 ^oC.

Amount of copper sulfate reacting = 50/1000 x 0.140 = 7.00 x 10^{-3} mol

Heat evolved by reacting 7.00 x 10^{-3} mol of $CuSO_4$ = 50 x 4.18 x 7.0 = 1463 J

Enthalpy of reaction = – 210 kJ mol^{-1} to 2 sig. figs. (as both mass and ΔT are to 2 sig. figs.)

ii. Assumptions (*any two from*)

50 cm^3 of solution has a mass of 50 g (i.e. density of solution = 1 g cm^{-3} or 1 kg dm^{-3}).

Extrapolation accounts for all the heat loss.

Specific heat capacity of the solution is the same as that for pure water.

The energy required to heat the excess zinc and the copper produced and the stirrer is zero.

3. i. M_r for ethanol = [(2 x 12.01) + (6 x 1.01) + 16.00] = 46.06

Amount of ethanol combusted = 1.21/46.06 = 2.627 x 10^{-2} mol

Heat produced by burning 2.627 x 10^{-2} mol of ethanol 400 x 4.18 x (29.9 – 17.0) = 21570 J

The enthalpy change = 21570 x 1/2.627 x 10^{-2} = – 821000 J mol^{-1} = – 821 kJ mol^{-1}

ii. *Any four from*

Reaction not carried out under standard conditions.

The ethanol was not completely combusted.

All the heat produced was transferred to the water.

No heat used to heat up the glass beaker, thermometer and stirrer.

No heat lost from warmed water to surroundings.

4. i. The formation of the hydrogen-hydrogen bond in the gaseous state from its gaseous atoms.

ii. E*nthalpy* is the total energy of a system measured at a constant pressure. In simple terms it is the heat content of the system at constant pressure. More precisely it is the sum of the internal energy of the system plus the work done on the system by contracting it (where the volume decreases during the reaction) or the sum of the internal system minus the work done by the system as it expands (where the volume increases during the reaction).

iii. The products are more thermodynamically stable (by 436 kJ mol^{-1}) as more energy is required to break them down compared to the reactants.