Exercise 4.24 – Enthalpy of neutralisation

Examples use the following values: specific heat capacity = 4.2 kJ kg^{-1} $^oC^{-1}$ and the density of all solutions = 1g cm^{-1}

Q424-01 Calculate the temperature change expected when 50cm^3 of 2M strong monoprotic acid is neutralised by 50cm^3 of 2M sodium hydroxide.

Q424-02 Calculate the new temperature when 100 cm^3 2M HCl at 25ºC is mixed with 100 cm^3 2M NaOH at the same temperature.

Q424-03 Separate solutions of HCl(aq) and H_2SO_4(aq) of the same concentration and the same volume were completely neutralised by NaOH(aq). X kJ and Y kJ of heat were evolved respectively. Which statement is correct?

A. X = Y
B. Y = 2X
C. X = 2Y
D. Y = 3X

Q424-04 A sodium hydroxide solution is reacted with excess hydrochloric acid. What information is not needed to calculate the molar heat of neutralisation of sodium hydroxide?

A. The initial temperature of both solutions
B. The volume of both solutions
C. The concentration of the hydrochloric acid solution
D. The maximum temperature of the mixture

Q424-05 25cm^3 of 1.0 mol dm^{-3} NaOH is added to 25cm^3 of 1.0 mol dm^{-3} HCl. The temperature rise is 6ºC. Which of the following combinations will also give a temperature rise of 6ºC?

A. 25cm^3 of 2.0 mol dm^{-3} NaOH and 25cm^3 of 2.0 mol dm^{-3} HCl
B. 50cm^3 of 1.0 mol dm^{-3} NaOH and 50cm^3 of 1.0 mol dm^{-3} HCl
C. 50cm^3 of 0.5 mol dm^{-3} NaOH and 50cm^3 of 0.5 mol dm^{-3} HCl
D. 100cm^3 of 0.25 mol dm^{-3} NaOH and 100cm^3 of 0.25 mol dm^{-3} HCl

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Q424-06 In aqueous solution, potassium hydroxide and hydrochloric acid react as follows:

$$KOH(aq) + HCl(aq) \longrightarrow KCl(aq) + H_2O(l)$$

The data below is from an experiment to determine the enthalpy change of this reaction.
50.0 cm^3 of a 0.500 mol dm^{-3} solution of KOH was mixed rapidly in a glass beaker with 50.0 cm^3 of a 0.500 mol dm^{-3} solution of HCl.

- Initial temperature of each solution = 19.6ºC
- Final temperature of the mixture = 23.1ºC

State with a reason whether the reaction is exothermic, or endothermic. Explain why the solutions were mixed rapidly. Calculate the enthalpy change of this reaction in kJ mol-1. Assume that the specific heat capacity of the solution is the same as that of water = 4.18 kJ kg^{-1} k^{-1}.

Q424-07 Identify the major source of error in the experimental procedure described in question 6 above. Explain how it could be minimised.

Q424-08 The experiment in question 8 above, was repeated, but with an HCl concentration of 0.510 mol dm^{-3} instead of 0.500 mol dm^{-3}. State and explain what the temperature change would be.