

**Chemistry**  
**Standard level**  
**Paper 1B**

Practice paper

**Topic: Thermodynamics**

1. A student performed a calorimetry experiment to determine the enthalpy of neutralization of hydrochloric acid (HCl) with sodium hydroxide (NaOH).

(a) 50.0 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> HCl was mixed with 50.0 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> NaOH in a polystyrene cup. The starting temperature was 21.0 °C and the maximum temperature reached was 27.5 degrees C. Calculate the heat energy change (q) in kJ, assuming the specific heat capacity of the solution is 4.18 J g<sup>-1</sup> K<sup>-1</sup> and its density is 1.00 g cm<sup>-3</sup>. **[2]**

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(b) Calculate the enthalpy of neutralization,  $\Delta H_{\text{neut}}$ , in kJ mol<sup>-1</sup>. **[2]**

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(c) Another student repeated the experiment using double the concentration of both reactants. Predict, with a reason, the effect on: **[2]**

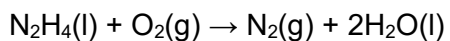
(i) The temperature change ( $\Delta T$ ):

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(ii) The enthalpy of neutralization ( $\Delta H_{\text{neut}}$ ):

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2. Hydrazine ( $\text{N}_2\text{H}_4$ ) is used as a rocket fuel. It reacts with oxygen as follows:



The following standard enthalpy changes of formation are available:

$$\Delta H_f^\ominus(\text{N}_2\text{H}_4(\text{l})) = +50.6 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\ominus(\text{H}_2\text{O}(\text{l})) = -285.8 \text{ kJ mol}^{-1}$$

(a) Define standard enthalpy of formation.

[2]

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(b) Establish a Hess cycle to calculate the enthalpy of the reaction provided above.

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(c) Calculate the value for the enthalpy of the reaction in  $\text{kJ mol}^{-1}$ .

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