



A2 5.1/B

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HESS'S LAW 2



Aim

The aim of this experiment is to find ΔH for the following reaction: $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$

You cannot do this reaction directly but you can use an energy cycle using Hess's law to find ΔH for this reaction. You will need the following enthalpy changes:

$\text{NH}_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{NH}_4\text{Cl}(\text{aq})$	to be calculated in part (1)
ΔH solution of $\text{NH}_4\text{Cl}(\text{s})$	to be calculated in part (2)
ΔH solution of $\text{NH}_3(\text{g})$	- 40.3 kJ mol ⁻¹
ΔH solution of $\text{HCl}(\text{g})$	- 73.1 kJ mol ⁻¹

Safety



Hydrochloric acid
Ammonia

Method

Finding ΔH for reaction of $\text{NH}_3(\text{aq})$ with $\text{HCl}(\text{aq})$

- 1) Pipette 25 cm³ of 1.0 mol dm⁻³ ammonia solution in a polystyrene cup.
- 2) Pipette 25 cm³ of 1.0 mol dm⁻³ hydrochloric acid solution in a polystyrene cup.
- 3) Measure the temperature of both solutions for 4 minutes to find the starting temperatures (take an average if the temperatures are not the same).
- 4) Mix the solutions in the cup, stir well and read the temperature at half minute intervals for 7 minutes.

Finding ΔH solution of $\text{NH}_4\text{Cl}(\text{s})$

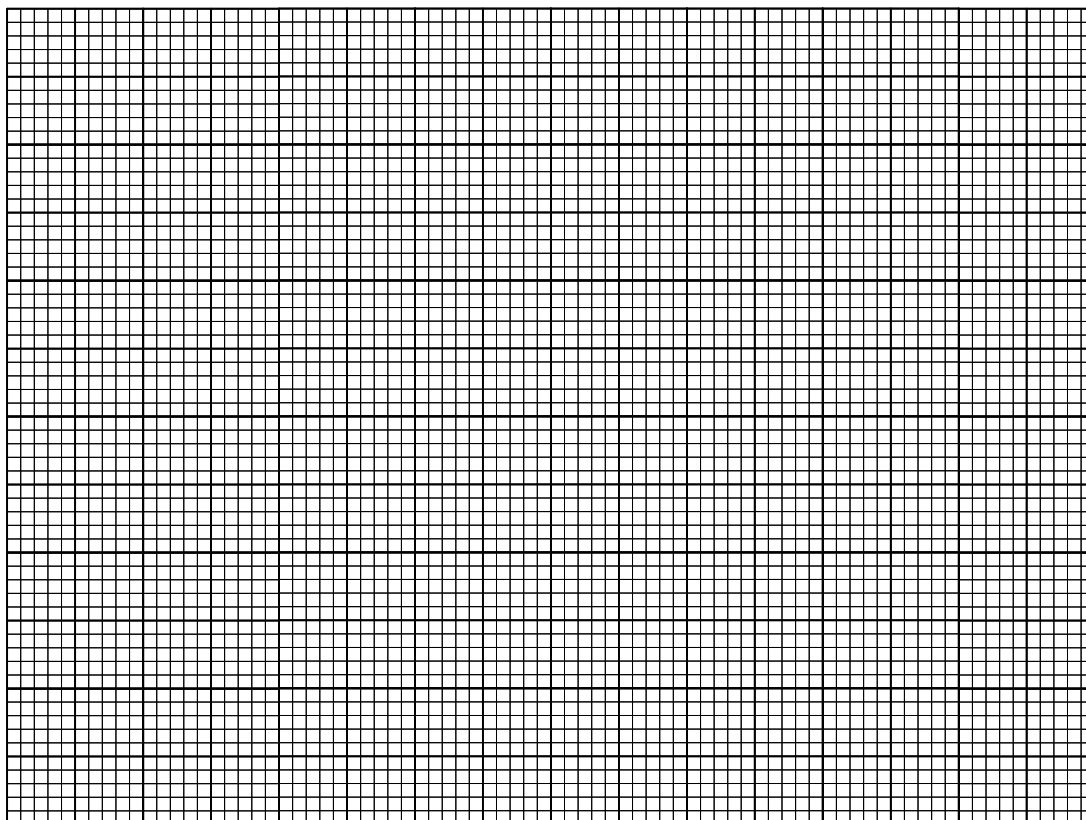
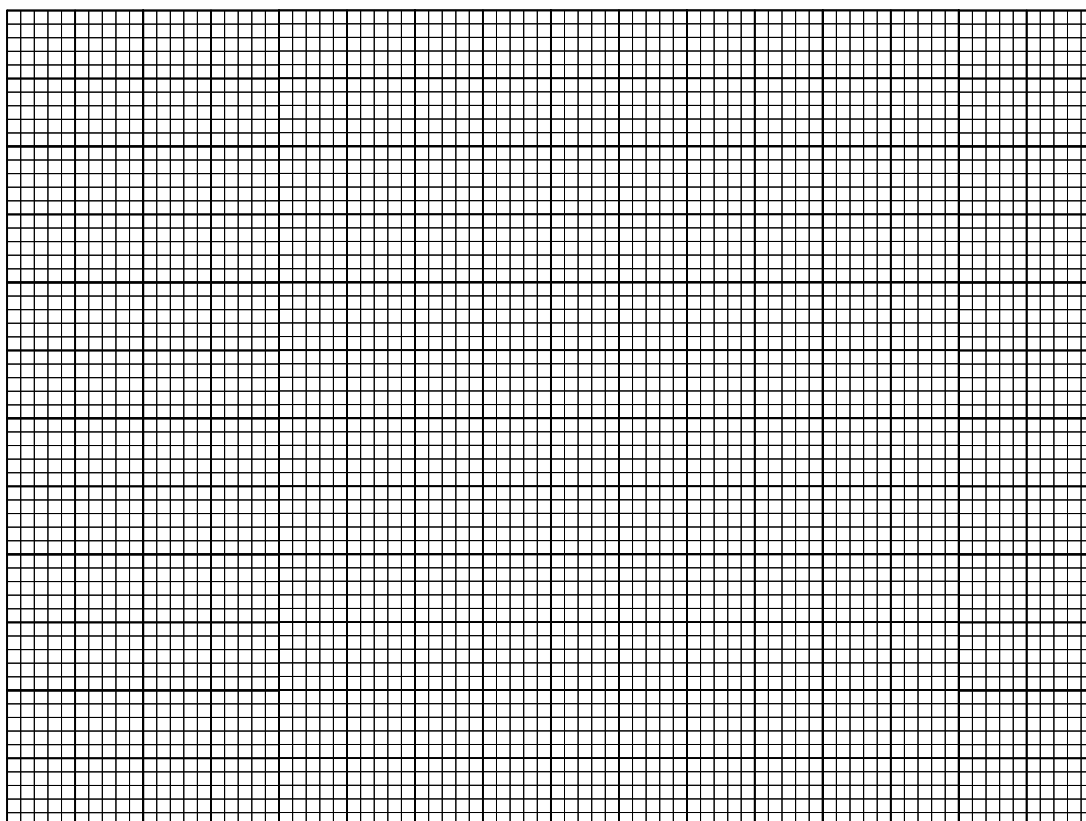
- 5) Weigh out about 7.0 g of ammonium chloride into a weighing bottle.
- 6) Place 100 cm³ of water into a polystyrene cup using a measuring cylinder.
- 7) Measure the temperature of the water for 4 minutes. At 4 minutes, add the ammonium chloride and measure the temperature every half minute for 7 minutes. Ensure good stirring. You must use a 0.1°C thermometer in this part.
- 8) Re-weigh the bottle to find the mass added accurately.

Results

- 9) Record your results in suitable tables.

Analysis

- 9) Plot temperature-time graphs to find the maximum temperature change in each experiment. You should extrapolate each graph back to the moment that the reagents were mixed.



Evaluation

13) Calculate the actual value of ΔH give that: ΔH_f : $\text{NH}_3(\text{g}) -46.2$; $\text{HCl}(\text{g}) -92.3$; $\text{NH}_4\text{Cl}(\text{s}) -315 \text{ kJ mol}^{-1}$.

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14) Calculate your percentage experimental error.

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15) Taking the apparatus error for this experiment to be the larger apparatus error calculated in (12), state whether your results are accurate and explain your answer.

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16) Identify the major source of error in this experiment and suggest ways to reduce it.

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17) Identify two other sources of error in this experiment and suggest ways to reduce them.

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