Core practical: neutralisation calorimetry

Student activity • practical and reasoning

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The question

How can a temperature rise estimate energy per mole?

Measure the heat released when dilute hydrochloric acid and sodium hydroxide react. Relate the solution temperature rise to a negative reaction enthalpy with explicit approximations.

Equipment

- Eye protection, insulated cup supported in a beaker, loose lid, thermometer/probe and stirrer
- Two labelled measuring cylinders; calculator
- 25.0 cm^3 each of staff-prepared 0.500 mol dm^{-3} HCl and NaOH

Wear eye protection; avoid acid/alkali splashes and report spills. Use staff-prepared dilute solutions; no flames or sealed vessels.

Course coverage: Shared core: 3.2–3.4 and 3.8, neutralisation calorimetry. No titration or Chemistry-only concentration assessment is required.

Plan, model or apparatus sketch

Draw the insulated cup, supported probe and loose lid; label energy transfer between reaction and surroundings.

Method and reasoning

Read the whole sequence before starting

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1. Wear eye protection. Measure acid and alkali separately with labelled cylinders. Let them reach the same room temperature; record both starting temperatures.

2. Place the acid in the supported insulated cup. Record the stable initial temperature and probe resolution.

3. Add the alkali, replace the loose lid and stir gently. Start timing and record temperature every 15 seconds for three minutes in a separate time table.

4. Record the maximum and calculate ΔT. If initial temperatures differed appreciably, discuss the invalid single-temperature baseline with your teacher rather than silently averaging.

5. Approximate solution mass from total volume using density 1.00 g cm^{-3}. Use c=4.18 J g^{-1} $°C^{-1}$ to calculate q(solution)=mcΔT.

6. Use the reacting amount from HCl + NaOH → NaCl + H_2O and calculate ΔH≈−q(solution)/n, converting J to kJ. State heat-loss and heat-capacity assumptions.

Cleanup

- Staff assess the mixed solution and direct waste disposal under the local plan; rinse equipment and wash hands.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Invented practice example only: 25.0 cm^3 each of 0.500 mol dm^{-3} acid/alkali, both initially 22.0 °C; maximum 25.0 °C. Assume density 1.00 g cm^{-3} and specific heat capacity 4.18 J g^{-1} $°C^{-1}$. Use total solution mass, and n=0.0125 mol water formed. These figures are not experimental results.

Quantity	Actual value / units	Calculation / limitation
Initial / maximum T		
Total mass / q		
Amount / ΔH		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Calculate ΔT and q for your actual data or clearly label the invented example.

2. Calculate the reacting amount and identify the 1:1 ratio.

3. Calculate the approximate molar enthalpy change including its sign.

4. Why does a rising solution temperature correspond to negative ΔH?

5. Explain the effect of heat lost to the cup/air on the magnitude.

6. State two approximations made in using $q=mc\Delta T$.