INVESTIGATION 5.2.1 MOLAR ENTHALPY OF A CHEMICAL CHANGE

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Experimental Design

(a) $n_{NaOH} = C_{NaOH}V_{NaOH}$

$= 1.0 \text{ mol/L} \times 50 \text{ mL}$

$n_{NaOH} = 50$ mmol, which would require 25 mmol of acid to be completely consumed

$n_{H_2SO_4} = C_{H_2SO_4}V_{H_2SO_4}$

$= 1.0 \text{ mol/L} \times 30 \text{ mL}$

$n_{H_2SO_4} = 30$ mmol

Analysis

(b) (i) $m_{total} = m_{NaOH_{(aq)}} + m_{H_2SO_{4(aq)}}$

$= 30 \text{ g} + 50 \text{ g}$

$m_{total} = 80 \text{ g}$

(ii) temperature change, ΔT

(Sample answer)

$\Delta T = 8.0°\text{C}$

(iii) $q = 80\ (4.18)\ \Delta T$ J

$= 2675$ kJ

$q = 2.7$ kJ

(iv) $n_{NaOH} = 50$ mmol or 0.050 mol

(v) $\Delta H_{neut} = (2.7 \text{ kJ})/0.050 \text{ J/mol} = –54 \text{ kJ/mol}$

Evaluation

(c) $\% \text{ difference} = \frac{|\text{accepted value} - \text{experimental value}|}{\text{accepted value}} \times 100\%$

The accepted value is –57 kJ/mol, which would imply an experimental error of about 5%.

(d) Errors could occur in measurements of mass or temperatures, or as a consequence of heat loss to the air.

Synthesis

(e) (i) The acid would still be in excess, so that the ΔH would be unchanged.

(ii) The base solution would be less than fully reacted, so that the ΔT and ΔH values would be low.

INVESTIGATION 5.3.1 COMBUSTION OF ALCOHOLS

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Prediction

(a) (Sample answer) The ΔH_{comb} values would become greater because the reactant molecules are larger. (The trend is correctly guessed but the rationale is not. In fact, bond breakage in larger molecules requires more energy input but this is more than compensated for by the larger number of bonds formed exothermically in water and carbon dioxide products.)

Analysis

(b) **Ethanol**:

(i) $q = (m_{water})\ (4.18 \text{ J/g•°C})\ (\text{T})$

$= 100 \text{ g} \times 4.18 \text{ J/g•°C} \times 20.0°\text{C}$

$q = 8200 \text{ J, or } 8.2 \text{ kJ}$