



# Chem!stry

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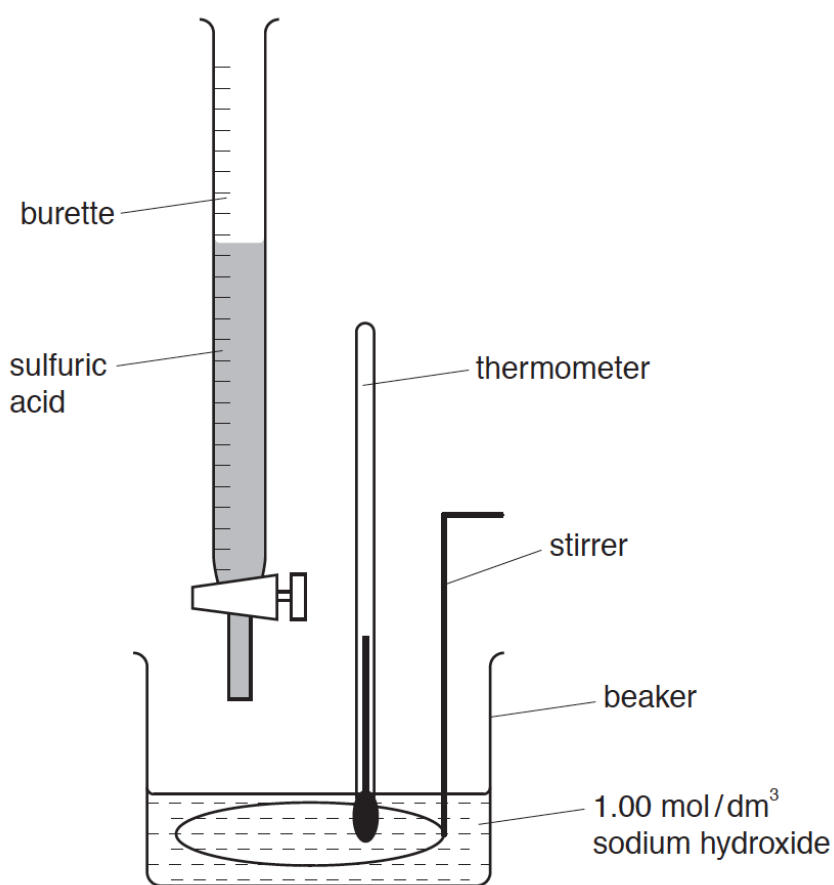
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## Thermometric Titration

### Question:

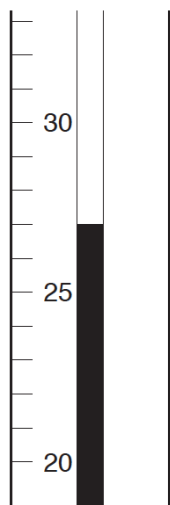
A student investigated the rise in temperature when sulfuric acid was added to a solution containing  $1.00 \text{ mol/dm}^3$  sodium hydroxide, using the apparatus shown below:



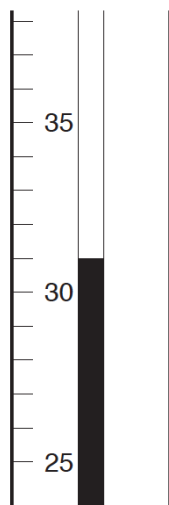
$20.0 \text{ cm}^3$  of  $1.00 \text{ mol/dm}^3$  sodium hydroxide was poured into a beaker. The initial temperature ( $T_i$ ) of both this solution and the sulfuric acid was  $25.0^\circ\text{C}$ .

Next,  $5.0 \text{ cm}^3$  of sulfuric acid was added to the aqueous sodium hydroxide from the burette. The reaction mixture was stirred gently and the maximum temperature ( $T_m$ ) was taken. Following successive additions of  $5.0 \text{ cm}^3$  volumes of sulfuric acid from the burette, further temperature readings ( $T_m$ ) were taken.

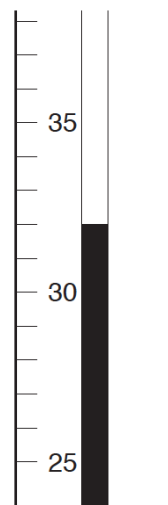
The diagrams below show parts of the thermometer stem giving the temperature after the addition of 5.0, 15.0 and 25.0 cm<sup>3</sup> of sulfuric acid.



addition of  
5.0 cm<sup>3</sup> of  
sulfuric acid



addition of  
15.0 cm<sup>3</sup> of  
sulfuric acid

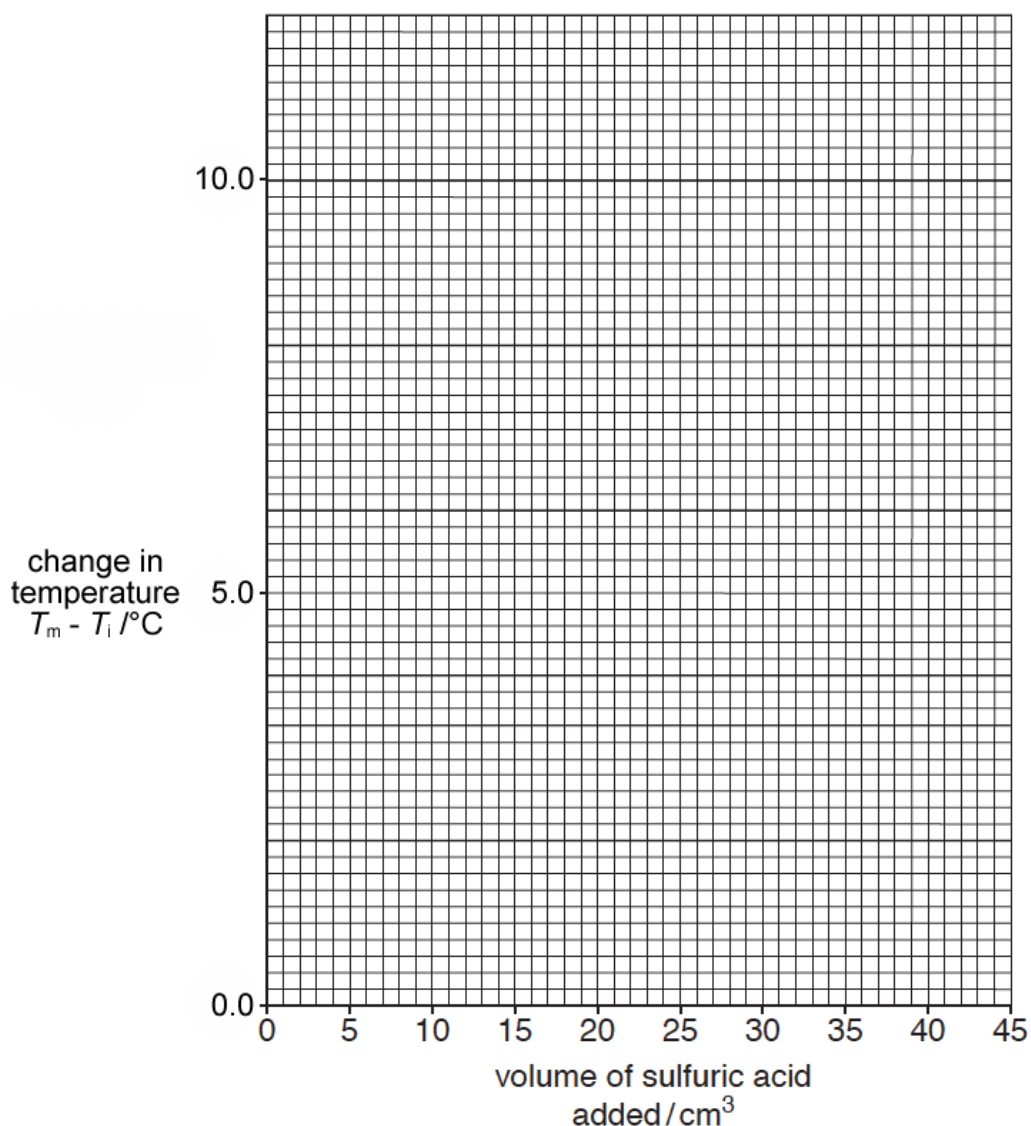


addition of  
25.0 cm<sup>3</sup> of  
sulfuric acid

- a) i) Use the diagrams to complete the following table of results. [1]
- ii) Calculate the change in temperature ( $T_m - T_i$ ) for each 5.0 cm<sup>3</sup> volume of sulfuric acid added to the aqueous sodium hydroxide. Complete this on the table of results. [1]

Volume of Sulfuric Acid / cm <sup>3</sup>	Maximum Temperature $T_m / ^\circ\text{C}$	Change in Temperature $T_m - T_i / ^\circ\text{C}$
5.0		
10.0	29.0	
15.0		
20.0	33.0	
25.0		
30.0	29.0	
35.0	26.0	

- b) Plot the change in temperature,  $T_m - T_i$  against volume of sulfuric acid on the grid below. Connect the points with **two** intersecting straight lines.



[3]

Use the graph to answer the following questions.

- c) i) State the change in temperature at the intersection of the two lines.

..... °C

- ii) What volume of sulfuric acid produced this temperature?

..... cm<sup>3</sup>

[2]

- d) 20.0 cm<sup>3</sup> of 1.00 mol/dm<sup>3</sup> sodium hydroxide was used in the experiment.

- i) Write an equation for the reaction between sodium hydroxide and sulfuric acid.

.....

[1]

ii) Using your answer to c) ii), calculate the concentration of the sulfuric acid.

..... mol/dm<sup>3</sup>

[2]

e) Use the formula given below to calculate the enthalpy change of this reaction to three significant figures.

$$\Delta H = m \times c \times \Delta T$$

$\Delta H$  = enthalpy change / J

m = mass of solution / g

c = specific heat capacity of water = 4.18 J/g/°C

$\Delta T$  change in temperature / °C

Note: Assume the density of the solution = 1.00 g/cm<sup>3</sup>

..... J

[3]

f) After the highest temperature was reached, explain why the temperature of the solution decreased as more sulfuric acid was added.

.....  
.....  
.....

[2]

g) Identify a possible source of error for this experiment and clearly state how the error affects the results of the experiment.

.....  
.....  
.....

[2]

[Total: 17]

- Scan the QR Code below for the answers to this assignment.



[http://www.chemist.sg/energy\\_changes/thermometric\\_titration\\_ans.pdf](http://www.chemist.sg/energy_changes/thermometric_titration_ans.pdf)