Chem!stry

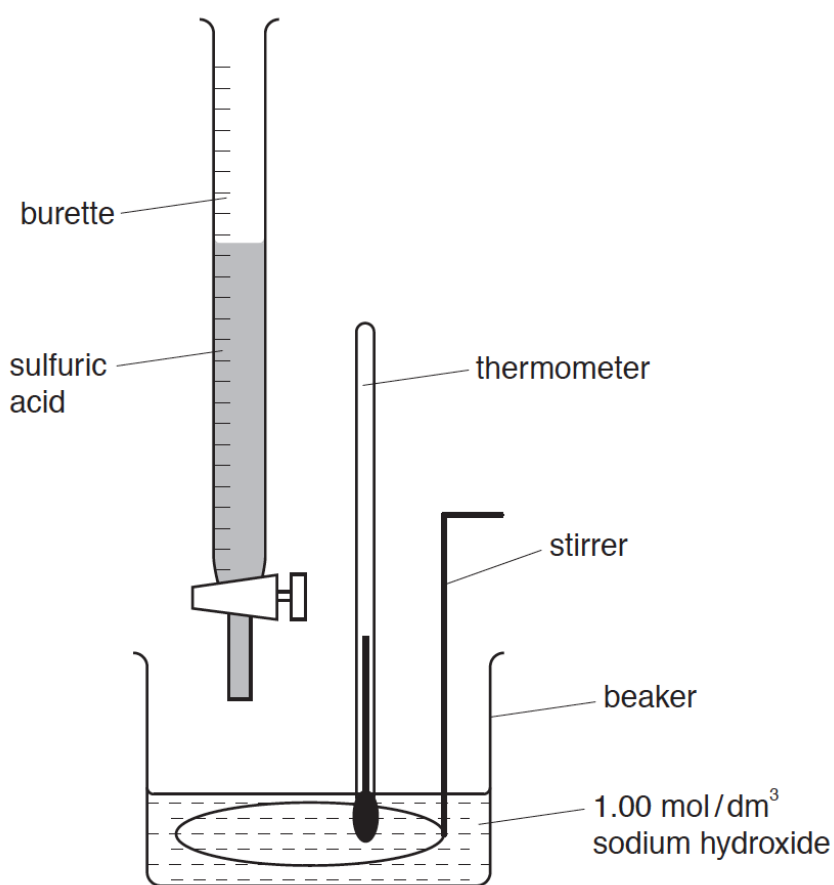## Thermometric Titration

Question:

A student investigated the rise in temperature when sulfuric acid was added to a solution containing 1.00 mol/dm³ sodium hydroxide, using the apparatus shown below:


20.0 cm³ of 1.00 mol/dm³ sodium hydroxide was poured into a beaker. The initial temperature (T_i) of both this solution and the sulfuric acid was 25.0°C.

Next, 5.0 cm³ 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 cm³ volumes of sulfuric acid from the burette, further temperature readings (T_m) were taken.
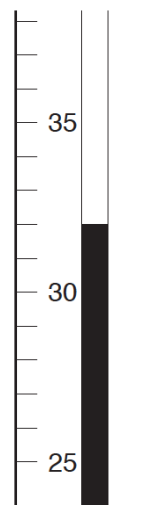
The diagrams below show parts of the thermometer stem giving the temperature after the addition of 5.0, 15.0 and 25.0 cm³ of sulfuric acid.
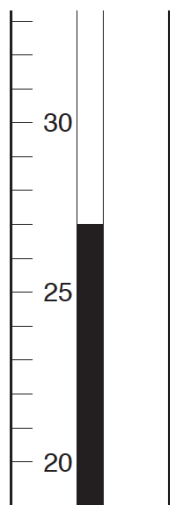
addition of
5.0 cm³ of
sulfuric acid
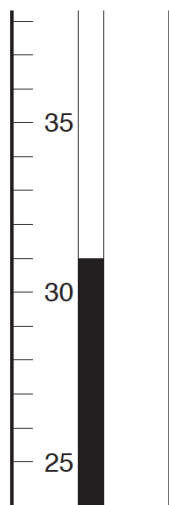
addition of
15.0 cm³ of
sulfuric acid

addition of
25.0 cm³ 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 cm³ volume of sulfuric acid added to the aqueous sodium hydroxide. Complete this on the table of results.

[1]

Volume of Sulfuric Acid / cm³	Maximum Temperature T_m / °C	Change in Temperature $T_m - T_i$ / °C
5.0		
10.0	29.0	
15.0		
20.0	33.0	
25.0		
30.0	29.0	
35.0	26.0	

2

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.
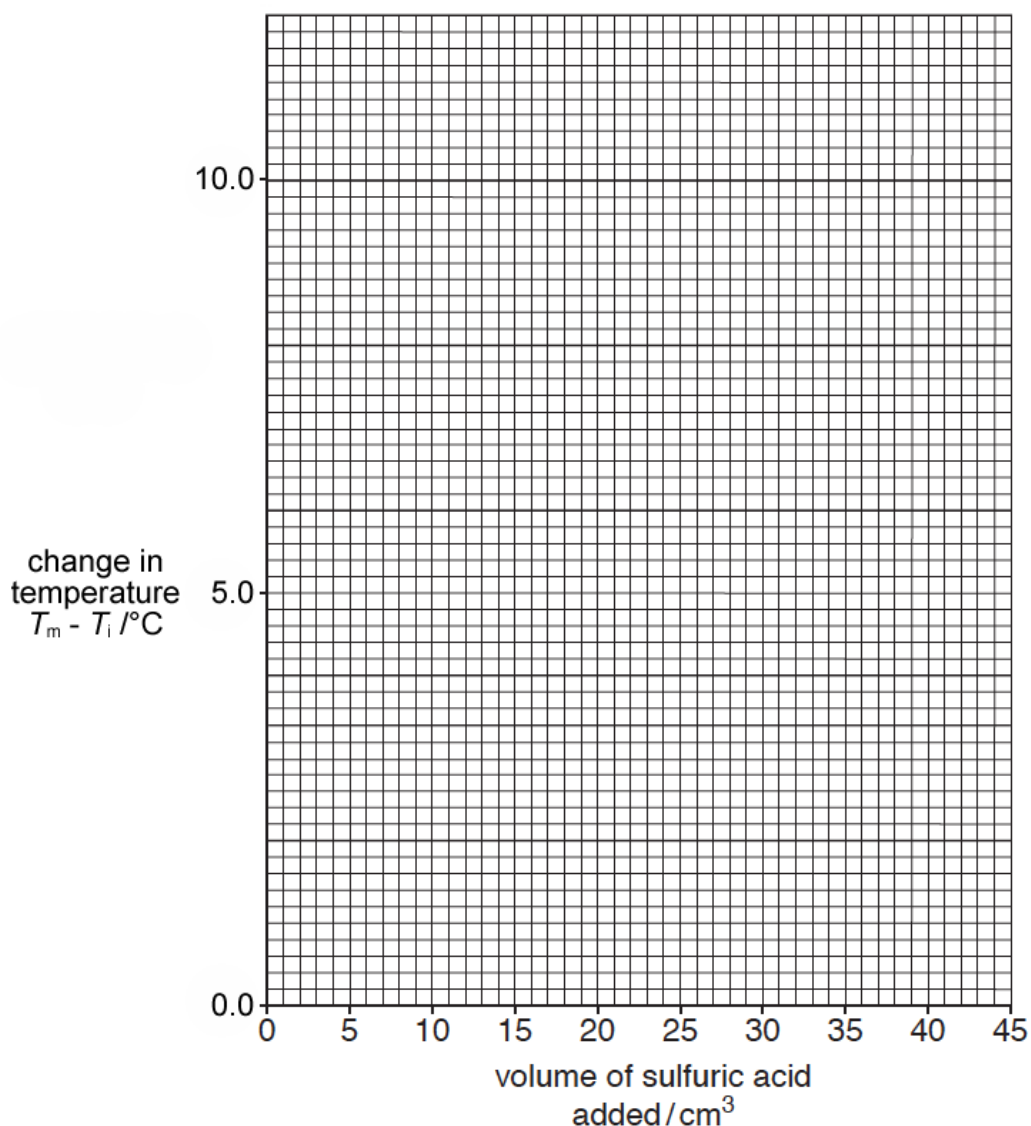
[3]

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^3

[2]

d) 20.0 cm^3 of 1.00 mol/dm^3 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^3

[2]

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

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

ΔH = enthalpy change / J

m = mass of solution / g

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

ΔT change in temperature / °C

Note: Assume the density of the solution = 1.00 g/cm^3

………………………… 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]

4

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

http://www.chemist.sg/energy_changes/thermometric_titration_ans.pdf