Cambridge International AS Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

* 4 7 5 9 2 1 9 8 8 6 *

PHYSICAL SCIENCE **8780/04**

Paper 4 Advanced Practical Skills **October/November 2017**

1 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Give details of the practical session and laboratory, where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **both** questions.
You will be allowed to work with the apparatus for a maximum of 45 minutes for each question.
Electronic calculators may be used.
You are advised to show all working in calculations.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Session
Laboratory

For Examiner's Use	
1	
2	
Total	

This document consists of **12** printed pages.

DC (SC/SW) 139277/4

CAMBRIDGE International Examinations

[Turn over

1 In this experiment you will use a potential divider circuit to determine the resistance of an unknown resistor **N**.

The circuit in Fig. 1.1 has been set up for you. A uniform resistance wire is taped to a metre rule.

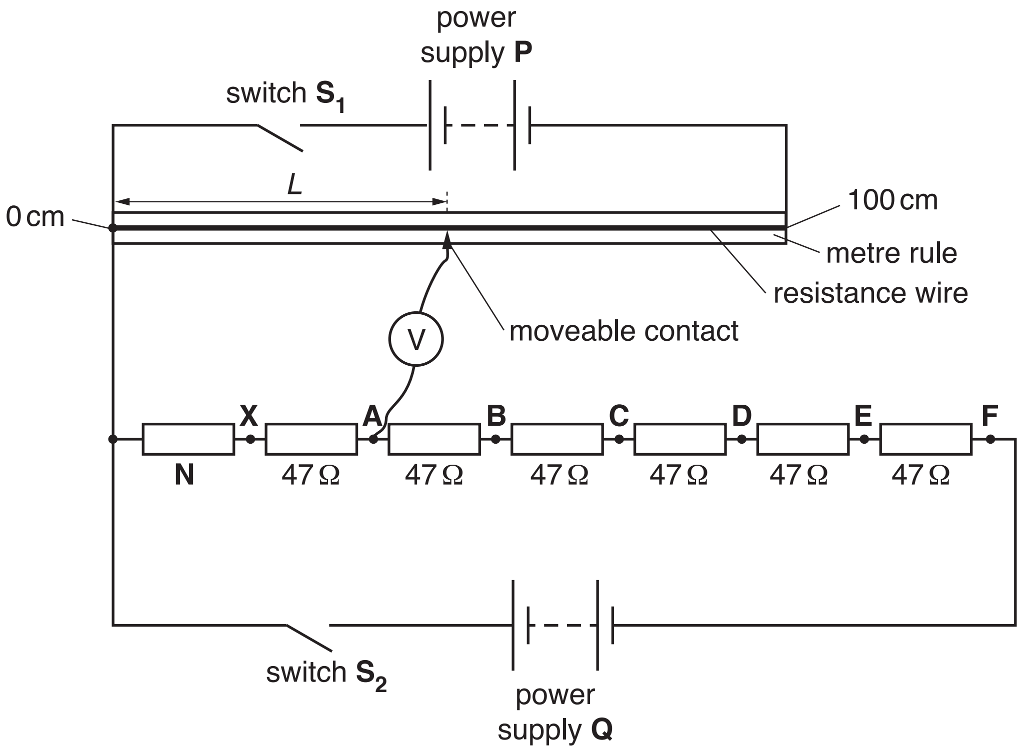


Fig. 1.1

(a) The voltmeter is initially connected at point **A**. Close both switches S_1 and S_2.

Place and hold the moveable contact on to the resistance wire at the 10 cm mark on the metre rule.

Record the reading shown on the voltmeter.

voltmeter reading V

Place and hold the moveable contact on to the wire at the 90 cm mark on the metre rule.

Record the reading shown on the voltmeter.

voltmeter reading V
[1]

(b) Length L is the length of resistance wire between the 0 cm mark on the metre rule and the moveable contact when the voltmeter, connected at point **A**, has a reading of zero.

(i) Adjust the position of the moveable contact on the resistance wire until you find the position at which the voltmeter reading is zero.

Measure and record the length L.

L = ... cm [1]

(ii) Use your apparatus to find the range of values of L for which the voltmeter reading is zero.

range is from .... cm to .... cm.

Use this range to determine the uncertainty in the value of L recorded in **(b)(i)**.

uncertainty = ± .... cm
[2]

Open both switches $\mathbf{S_1}$ and $\mathbf{S_2}$.

(c) You are going to determine the value of L with the voltmeter connected at points **B**, **C**, **D**, **E** and **F**.

(i) There is a significant uncertainty in the measurement of length L.

Describe how you will proceed to ensure that, for each position of the voltmeter, the distance L is as accurate as possible.

....

....

....

....[1]

(ii) Table 1.1 has been partly prepared, with the values of the resistance R between point **X** and the points **A**, **B**, **C**, **D**, **E** and **F** already recorded.

Extend Table 1.1 to allow you to record **all** the readings you take and the accurate readings of L. [1]

Table 1.1

voltmeter position	resistance R/Ω	
A	47	
B	94	
C	141	
D	188	
E	235	
F	282	

(iii) Close both switches $\mathbf{S_1}$ and $\mathbf{S_2}$.

Take appropriate measurements with the voltmeter connected at each of the points **B**, **C**, **D**, **E** and **F** to enable you to complete your extended Table 1.1. Include your readings for the voltmeter positioned at **A**, from **(b)**. [2]

Open both switches $\mathbf{S_1}$ and $\mathbf{S_2}$.

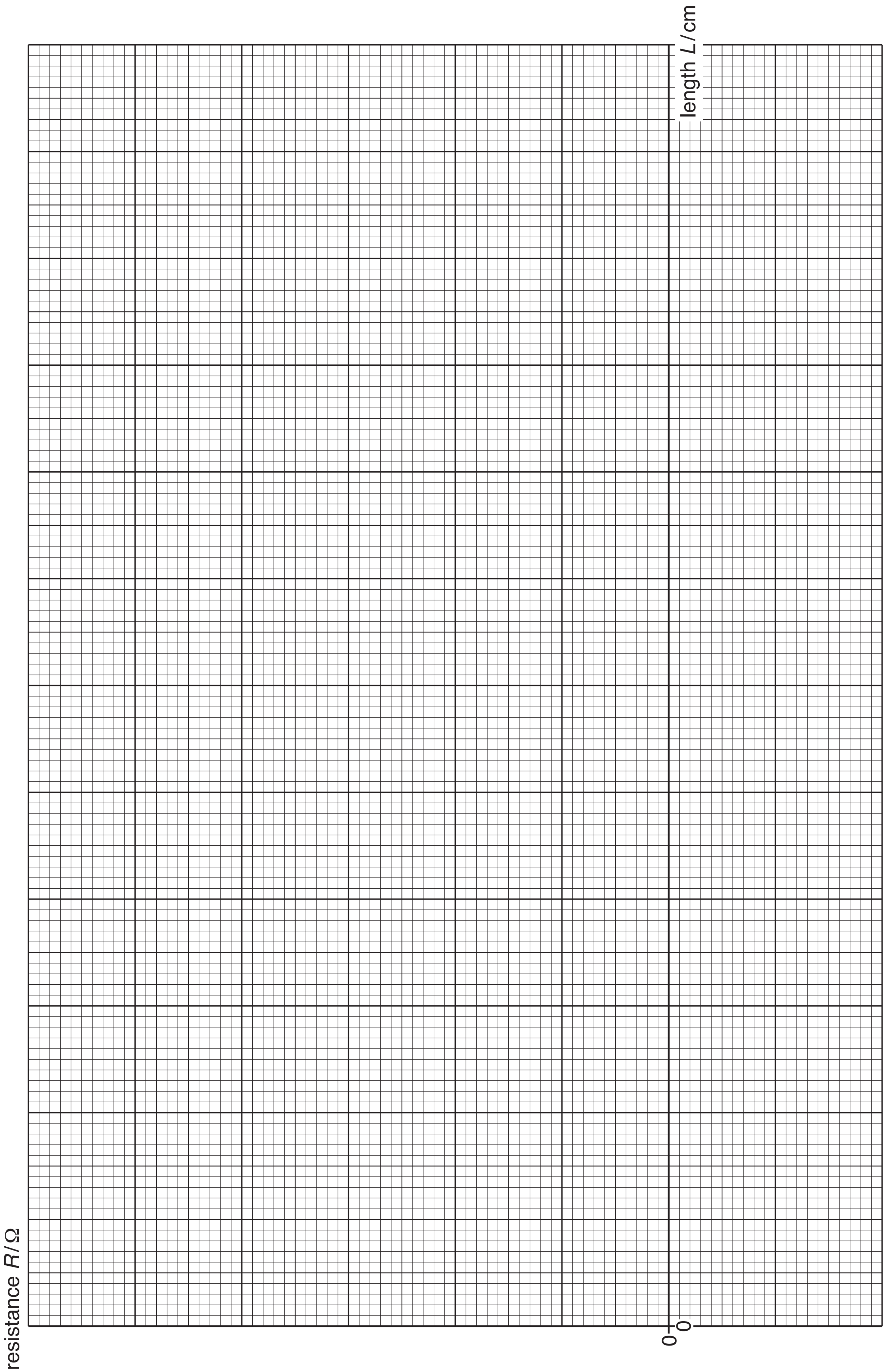
(d) **(i)** On the grid provided, the axes have already been drawn and the origin has been labelled for you.

Plot your accurate values of R/Ω on the y-axis and L/cm on the x-axis.

Draw the straight line of best fit. [3]

(ii) Calculate the gradient of the graph.
Show your working.

gradient = ... [1]



[Turn over

(e) The relationship between R and L is of the form shown, where T and U are constants.

$$R = TL + U$$

Determine the values of T and U.
Give appropriate units for each.

T = ... unit ....

U = ... unit ....
[2]

(f) From **(e)** deduce the resistance of the unknown resistor **N**.

resistance = ... Ω [1]

[Total: 15]

2 **(a)** Solution **P** contains either chloride or sulfate ions.

(i) Carry out tests on a 1 cm depth sample of solution **P** in a test-tube, to test for chloride ions.

In a clean test-tube, carry out tests on a 1 cm depth sample of solution **P**, to test for sulfate ions.

Record details of the reagents you used in the tests and your observations for each test in Table 2.1.

Table 2.1

anion	reagents used	observations
chloride		
sulfate		

Identify the anion present in solution **P**.

anion present ....

[2]

[Turn over

(ii) Solution **P** contains magnesium ions and ions of a second metal.

Test a 1 cm depth sample of solution **P** in a clean test-tube with aqueous sodium hydroxide.

In a clean test-tube, test a 1 cm depth sample of solution **P** with aqueous ammonia.

Record your observations for each test in Table 2.2.

Table 2.2

reagent	observations
aqueous sodium hydroxide	
aqueous ammonia	

Identify the second metal ion present in solution **P**.

second metal ion present ....

[3]

(b) You are provided with solutions **X**, **Y** and **Z**.

Solution **X** is 1.00 mol dm^{-3} sulfuric acid.
Solution **Y** is alkaline.
Solution **Z** is acidic.

(i) **Experiment 1**.

Step 1. Place a clean polystyrene cup into a 250 cm^3 beaker. The beaker is to prevent the cup from falling over.

Step 2. Use a 50 cm^3 measuring cylinder to transfer 40.0 cm^3 of **X** into the polystyrene cup.

Step 3. Measure the temperature of **X** to 0.2 °C and record this initial temperature in Table 2.3.

Step 4. Use a clean measuring cylinder to add 50.0 cm^3 of **Y** into the polystyrene cup.

Step 5. Stir the mixture with the thermometer and measure the highest temperature reached. Record this in Table 2.3.

Table 2.3

experiment	initial temperature / °C	highest temperature / °C	temperature rise / °C
1			
2			

[4]

(ii) **Experiment 2**.

Repeat steps 1 to 5 of experiment 1 using solution **Z** instead of solution **X**.

Complete Table 2.3 by calculating the temperature rises for experiments 1 and 2.

Suggest why the temperature rises in experiments 1 and 2 are different.

....

....

....[1]

(c) Suggest what effect using a glass beaker instead of a polystyrene cup in experiment 1 might have on the temperature rise.

Give a reason for your answer.

....

....[1]

(d) There is 1.00 mol of sulfuric acid in 1000 cm^3 of solution **X**.

Solution **Y** is in excess in both experiments.

Solution **Z** was prepared by reacting magnesium ribbon with 1.00 mol dm^{-3} sulfuric acid.

The equation for the reaction is shown.

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

(i) Calculate the concentration of sulfuric acid in **Z** by using the ratio of temperature rises in experiments 1 and 2.

concentration of sulfuric acid in **Z** .... mol dm^{-3} [1]

(ii) Calculate the number of moles of sulfuric acid in 100 cm^3 of **Z**.
This is the remaining sulfuric acid which did not react with the magnesium ribbon when solution **Z** was prepared.

moles of sulfuric acid in 100 cm^3 of **Z** .... [1]

(iii) Calculate the number of moles of sulfuric acid in 100 cm^3 of **Z** that reacted with the magnesium ribbon.

moles of sulfuric acid that reacted with magnesium ribbon .... [1]

(iv) Calculate the mass of the magnesium ribbon used to make 100 cm^3 of **Z**.

mass of magnesium ribbon .... g [1]

[Total: 15]

Qualitative Analysis Notes

Key: [ppt. = precipitate]

1 Reactions of aqueous cations

cation	*reaction with*	
	NaOH(aq)	NH_3(aq)
aluminium, Al^{3+}(aq)	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, NH_4^+(aq)	no ppt. ammonia produced on heating	–
barium, Ba^{2+}(aq)	no ppt. (if reagents are pure)	no ppt.
calcium, Ca^{2+}(aq)	white ppt. with high [Ca^{2+}(aq)]	no ppt.
chromium(III), Cr^{3+}(aq)	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), Cu^{2+}(aq)	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), Fe^{2+}(aq)	green ppt. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air insoluble in excess
iron(III), Fe^{3+}(aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, Mg^{2+}(aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn^{2+}(aq)	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc, Zn^{2+}(aq)	white ppt. soluble in excess	white ppt. soluble in excess

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, $Cl^-(aq)$	gives white ppt. with $Ag^+(aq)$ (soluble in $NH_3(aq)$)
bromide, $Br^-(aq)$	gives (pale) cream ppt. with $Ag^+(aq)$ (partially soluble in $NH_3(aq)$)
iodide, $I^-(aq)$	gives yellow ppt. with $Ag^+(aq)$ (insoluble in $NH_3(aq)$)
nitrate, $NO_3^-(aq)$	NH_3 liberated on heating with $OH^-(aq)$ and Al foil
nitrite, $NO_2^-(aq)$	NH_3 liberated on heating with $OH^-(aq)$ and Al foil NO liberated by dilute acids (colourless NO $\rightarrow$ (pale) brown NO_2 in air)
sulfate, $SO_4^{2-}(aq)$	gives white ppt. with $Ba^{2+}(aq)$ or with Pb^{2+} (insoluble in excess dilute strong acids)
sulfite, $SO_3^{2-}(aq)$	SO_2 liberated with dilute acids, gives white ppt. with $Ba^{2+}(aq)$ (soluble in excess dilute strong acid)

3 Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless