UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

8919475811

PHYSICAL SCIENCE **8780/04**

Paper 4 Advanced Practical Skills **October/November 2012**

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, graphs or rough working.
Do not use staples, paper clips, highlighters, 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.
You are advised to show all working in calculations.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 12 and 13.

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 **11** printed pages and **5** blank pages.

UNIVERSITY *of* CAMBRIDGE International Examinations

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1 You are going to investigate the potential difference across a resistor using the circuit shown in Fig. 1.1.

(a) Set up the circuit as shown in Fig. 1.1. The switch **S** may be an integral part of the power supply.

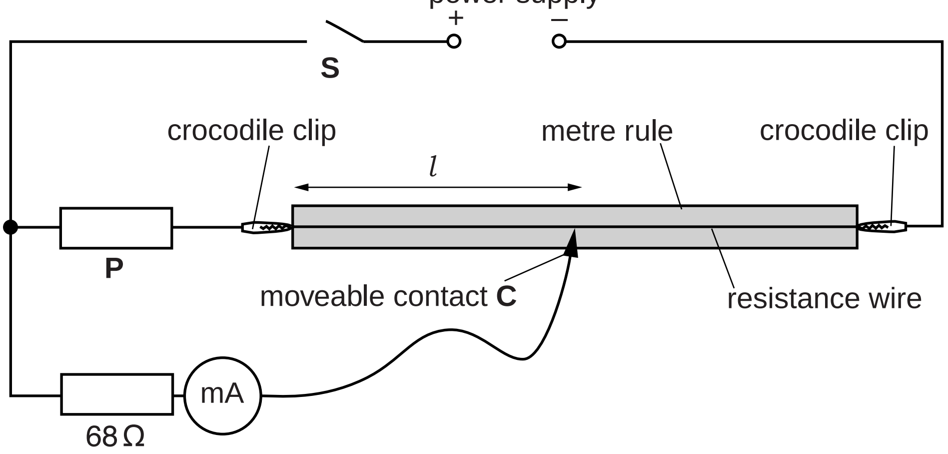

Fig. 1.1

Ask your Supervisor if you need help to set up the circuit. You may lose one mark.

(b) **(i)** Press the moveable contact **C** on the resistance wire and adjust the position so that l is approximately 0.25 m.

Close switch **S** and record your value of l and the current I through the ammeter.

Open switch **S** as soon as you have taken your reading.

l = ... m

I = ... mA

(ii) Calculate the potential difference V across the 68 Ω resistor using the equation $V = IR$, where $R = 68\,\Omega$.

V = ... V

(c) You are going to measure I at five further values of l between 0.10 m and 0.90 will need to choose appropriate values.

(i) Construct a table in which to record all six sets of measurements of l and I. Include an extra column for V.

(ii) Record in the table your values of l and I and V from part **(b)**.

(iii) Adjust the position of the contact **C**.
Close switch **S**. Measure and record the new values of l and I.
Repeat until all six sets of readings are completed.
Open switch **S**.

(iv) For each value of l, calculate the potential difference V across the 68 Ω resistor.
Use the equation $V = IR$, where $R = 68\,\Omega$.
Record these values in your table.

(d) **(i)** On the grid provided, plot your values of V on the y-axis against l on the x-axis.
Draw the straight line of best fit.

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

gradient = ...

(iii) Determine the y-intercept.

(e) It is suggested that the relationship between V and l is

$$V = 0.76rl + 0.76R$$

where r is the resistance per metre of the resistance wire and R is the resistance of the resistor **P**.

Use the results from **(d)(ii)** and **(iii)** to calculate the value of

(i) r,

r = ... Ωm^{-1}

(ii) R.

R = ... Ω

(f) Identify one significant source of experimental uncertainty or limitation of the procedure in this experiment.

....

....

....

[Total: 15]

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2 **(a)** You are to carry out a titration to determine the concentration of hydrochloric solution **X**.

You are provided with the following:

solution **X**, dilute hydrochloric acid of unknown concentration,
solution **Y**, 0.100 mol dm^{-3} sodium hydroxide,
phenolphthalein indicator.

Titration

(i) Fill the burette with solution **Y**, 0.100 mol dm^{-3} sodium hydroxide.

Use the pipette to transfer 25.0 cm^3 of solution **X**, dilute hydrochloric acid, into the conical flask and add 2 to 3 drops of phenolphthalein indicator.

Titrate the acid in the flask with solution **Y** until the first **permanent** pale pink colour.

Perform a rough (trial) titration and sufficient further titrations to obtain accurate results.

Record your titration results in a suitable table in the space below. Make certain that your recorded results show the precision of your working.

(ii) From your titration results obtain a volume of solution **Y** to be used in your calculations. Show clearly how you obtained this volume.

volume of **Y** = ... cm^3

Calculation

Show your working and appropriate significant figures in all of your calculations.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

(iii) Calculate the concentration of hydrochloric acid in solution **X**.

concentration of hydrochloric acid in **X** = ... mol dm^{-3}

(iv) This experiment could have been carried out using 10.0 cm^3 of dilute hydrochloric acid rather than 25.0 cm^3.

Explain why using 25.0 cm^3 is likely to give a more accurate value for the hydrochloric acid concentration.

....

....

....

....

....

(b) **P** is an aqueous solution of a metal nitrate. The cation is unknown.

Carry out the specified tests to enable you to identify the unknown cation.

At each stage of any test you are to record details of the following:

- colour changes seen
- the formation of any precipitate
- the solubility of such precipitates in an excess of the reagent added.

You should indicate clearly at what stage in a test a change occurs.

Record all of your observations in the table below.

	test	*observations*
(i)	To 0.5 cm depth of solution in a test-tube, add a few drops of 2.0 mol dm^{-3} aqueous sodium hydroxide. Continue adding aqueous sodium hydroxide until there is no further change.	
(ii)	To 0.5 cm depth of solution in a test-tube, add a few drops of aqueous ammonia. Continue adding aqueous ammonia until there is no further change.	

(iii) Conclusions

Use the Qualitative Analysis Notes on page 12 to identify the unknown cation giving supporting evidence from your observations.

The unknown cation is ....

evidence ....

....

....

....

[Total: 15]

Qualitative Analysis Notes

Key: [ppt. = precipitate]

1 Reactions of aqueous cations

ion	*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
lead(II), Pb^{2+}(aq)	white ppt. soluble in excess	white 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

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), CrO_4^{2-} (aq)	yellow solution turns orange with H^+(aq); gives yellow ppt. with Ba^{2+}(aq); gives bright yellow ppt. with Pb^{2+}(aq)
chloride, Cl^- (aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
bromide, Br^- (aq)	gives pale cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
iodide, I^- (aq)	gives yellow ppt. with Ag^+(aq) (insoluble In NH_3(aq)); gives yellow ppt. with Pb^{2+}(aq)
nitrate, NO_3^- (aq)	NH_3 liberated on heating with OH^-(aq) and A*l* foil
nitrite, NO_2^- (aq)	NH_3 liberated on heating with OH^-(aq) and A*l* foil, NO liberated by dilute acids (colourless NO → (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 acid)
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 dichromate(VI) from orange to green

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