Cambridge International **AS Level**

Cambridge International Examinations
Cambridge International Advanced Subsidiary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICAL SCIENCE **8780/04**

Paper 4 Advanced Practical Skills **October/November 2016**

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 9 and 10.

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 **10** printed pages and **2** blank pages.

CAMBRIDGE International Examinations

[Turn over

1 In this experiment you will investigate how the period T of a pendulum changes as the distance d between two points is varied. The period T is the time for one complete oscillation of the pendulum.

You have been provided with the apparatus shown in Fig. 1.1. You have also been provided with a metre rule and a stopwatch.

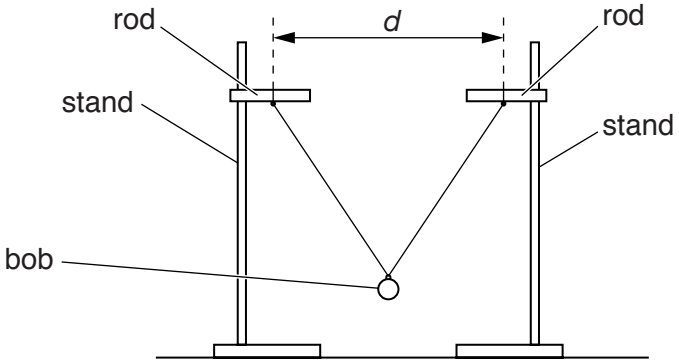


Fig. 1.1

You will determine the time t for 20 complete oscillations of the pendulum for six different values of distance d.

(a) Construct a suitable table in the space below to record all your results for d and t. Include columns for d^2, T and T^4.

[1]

(b) (i) Adjust the position of the stands so that d is approximately 35 cm.

(ii) Record the value of d to the nearest 0.1 cm in your table in **(a)**. Calculate d^2 and record it in your table. [1]

(iii) Pull the bob a short distance towards you and release it. This will set the bob swinging with small oscillations.

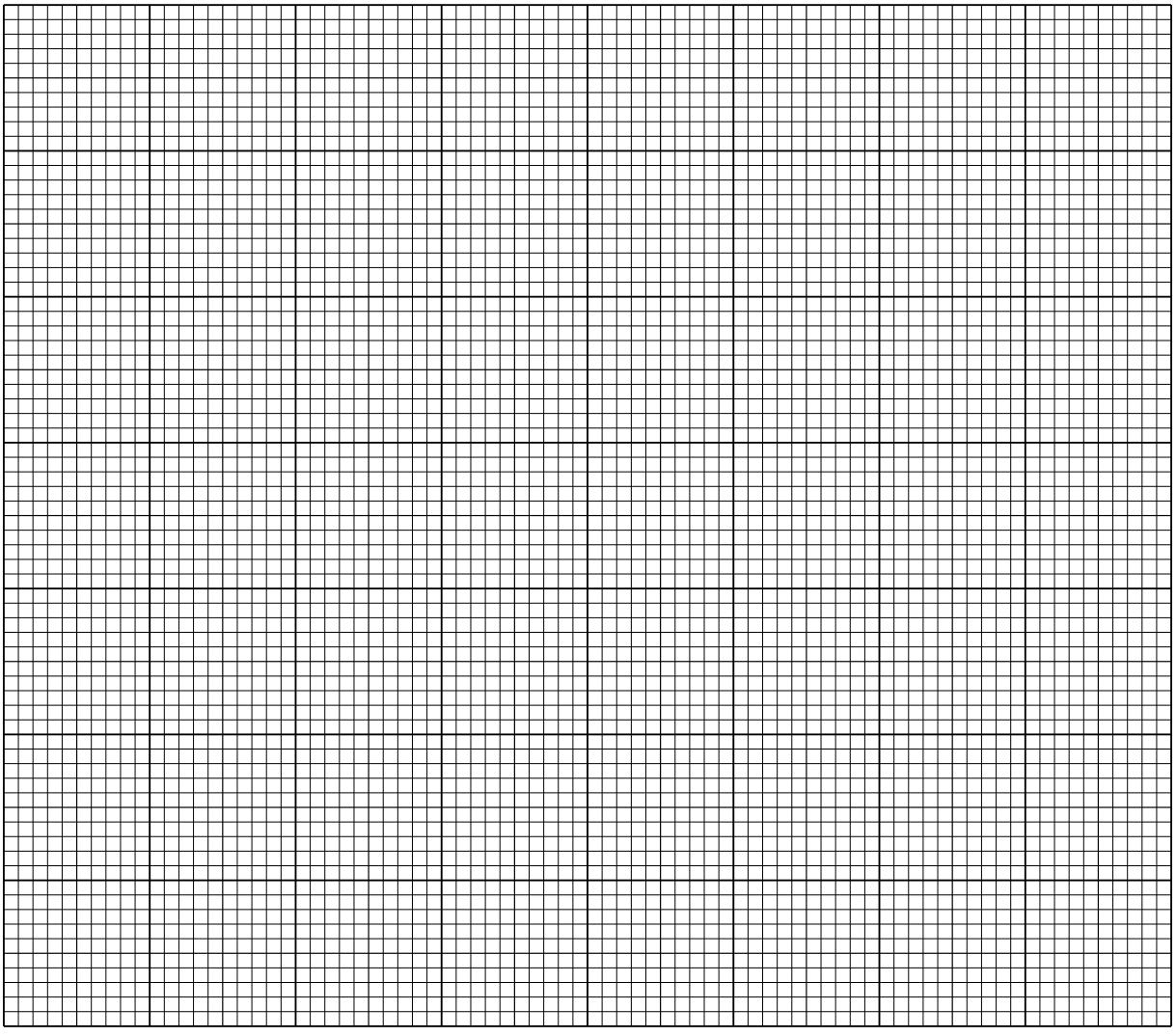
Measure the time t for 20 complete oscillations and record this in your table.
Record t to the nearest 0.1 s.

Calculate T and T^4 and record these in your table. [1]

(c) Repeat **(b)(ii)** and **(b)(iii)** with five different values of d up to about 90 cm.
Record all results in your table. [5]

(d) On the grid below, plot a graph of T^4 on the y-axis against d^2 on the x-axis.
Start your axes at (0,0).

Draw the best-fit line.



[4]

(e) (i) Use your graph to determine the gradient of the line.
Show clearly how you determined the gradient.

gradient = ... [1]

(ii) Use your graph to determine the value of T when d is zero.

T = ...s [2]

[Total: 15]

2 **(a)** You are provided with a solution of sodium carbonate, Na_2CO_3.

(i) Carry out the following procedure and record your observations in the table below.

procedure	*observations*
Use a 25 cm^3 measuring cylinder to transfer 25 cm^3 of the sodium carbonate solution into the beaker labelled **Q**. Use a different measuring cylinder to add 75 cm^3 of 1.00 mol dm^{-3} sulfuric acid to the beaker labelled **Q**. Stir the mixture with the glass rod. The beaker now contains solution **Q**.	

(ii) The equation for the reaction between sodium carbonate and sulfuric acid is shown.

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$$

Use this equation to explain **one** of your observations recorded in **(a)(i)**.

.....

.....

.....

[1]

(b) (i) Solution **Q** contains an excess of sulfuric acid.

You are going to carry out titrations to find the concentration of sulfuric acid in solution **Q**.

- Fill a clean burette with solution **Q**.
- Use the pipette to transfer 25.0 cm^3 of 0.500 $mol\,dm^{-3}$ sodium hydroxide to a clean conical flask.
- Add a few drops of methyl orange indicator to the flask.
- The end-point is the formation of the first permanent orange/red colour.
- Carry out sufficient titrations to obtain consistent results.

Record below, in a suitable form, all your burette readings and the volume of solution **Q** added in each titration.

Record your results to a suitable level of precision.

[4]

(ii) From your titration results, obtain an average volume of solution **Q** added.
Show clearly how you obtained this volume.

average volume of solution **Q** added = ... cm^3 [1]

(c) (i) Suggest a significant source of error in making solution **Q**.

.....

..... [1]

(ii) Suggest and explain **one** way of reducing this source of error.

.....

.....

.....

..... [1]

(d) (i) The equation for the reaction between sulfuric acid and sodium hydroxide is shown.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of sulfuric acid in solution **Q**.

Show your working and give your answer to an appropriate number of significant figures.

concentration = ... $mol\,dm^{-3}$ [3]

(ii) Calculate the amount, in moles, of sulfuric acid in 100 cm^3 of solution **Q**.

amount of sulfuric acid = ...mol [1]

(iii) Calculate the amount, in moles, of sulfuric acid that reacted with 25.0 cm^3 of the sodium carbonate solution.

[75 cm^3 of 1.00 mol dm^{-3} sulfuric acid contains 0.075 moles of sulfuric acid.]

amount of sulfuric acid = ...mol [1]

(iv) Use your answer to **(d)(iii)** to calculate the mass of Na_2CO_3 in 25.0 cm^3 of the sodium carbonate solution.

[Na, 23.0; C, 12.0; O, 16.0]

mass of Na_2CO_3 = ...g [2]

[Total: 15]

Qualitative Analysis Notes

Key: [ppt. = precipitate]

1 Reactions of aqueous cations

	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

[Turn over

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 → (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 manganate(VII) from purple to colourless

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