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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4421716341

PHYSICAL SCIENCE **8780/04**

Paper 4 Advanced Practical Skills **October/November 2013**

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

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UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

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1 You are going to investigate how the turning effect of a force depends on the angle through which it acts.

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The apparatus is set up as shown in Fig. 1.1, with the metre rule pivoted on a pin at point **P**. The metre rule is uniform and point **P** is at the centre of the rule.

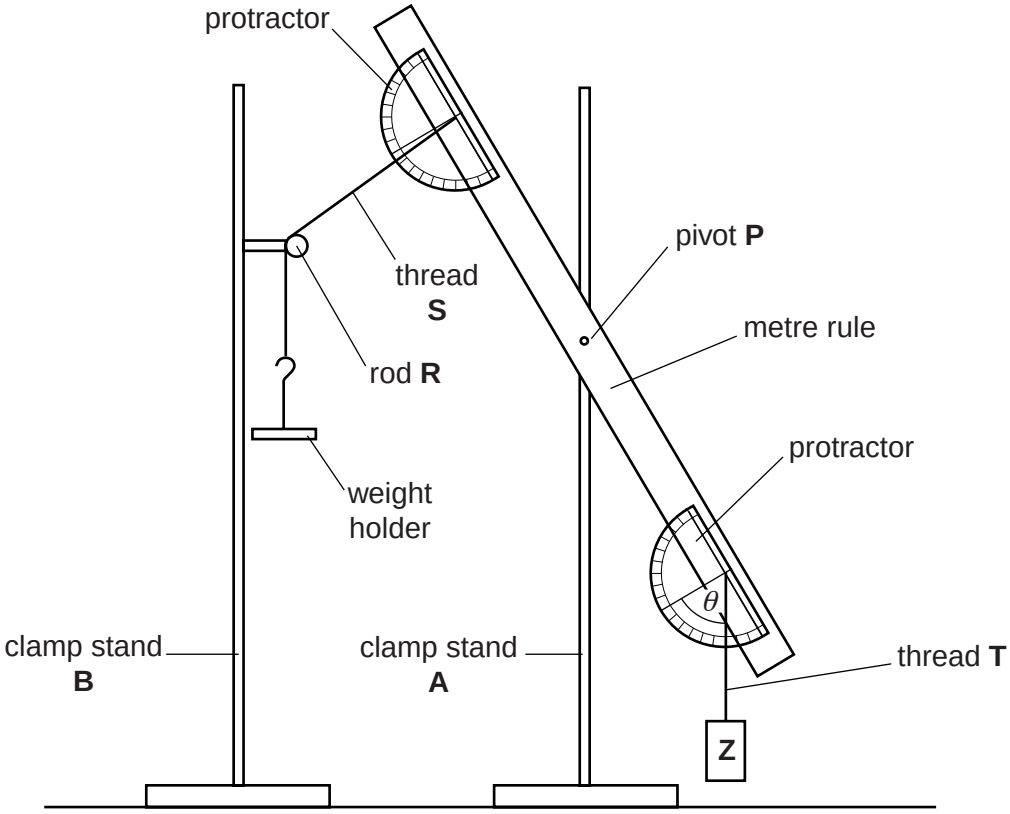

Fig. 1.1

(a) Pull the weight holder down a few centimetres and then release it. The weight holder should move up and down until it comes to rest.

Adjust the position of the rod **R** so that thread **S** is perpendicular to the rule. This may be done by changing the height of the rod **R**, or by moving clamp stand **B** sideways. Both techniques may be useful during this experiment.

The angle between thread **T** and the 90° mark on the lower protractor is θ.

Measure and record the value of the angle θ.

θ = ...

(b) You are going to measure θ at **five** different values of additional weight W added to the weight holder.

For Examiner's Use

Construct a table suitable for recording **six** sets of measurements of W and θ for values of W in the range 0.20 N to 0.90 N. Include a column for values of $\cos\theta$.

(c) (i) Record in the table your value of θ from part **(a)**. For this value of θ, $W = 0$.

(ii) For each weight W repeat the procedure in part **(a)**. Ensure that thread **S** is perpendicular to the metre rule before measuring θ.

Record your values of W and θ in your table.

(iii) Calculate and record $\cos\theta$ for each of the values of θ you have measured.

(d) (i) On the grid provided, plot your values of W on the x-axis and $\cos\theta$ on the y-axis. Do **not** draw the best-fit line at this stage.

(ii) Select one of your plotted points that you wish to repeat to improve the accuracy of your data. Repeat this measurement.

1. Circle the point you are repeating.
2. Give a reason for repeating this measurement.

.....

.....

3. Record the result of your repeated measurement in the space below.
Plot this point on the grid and label it **Q**.

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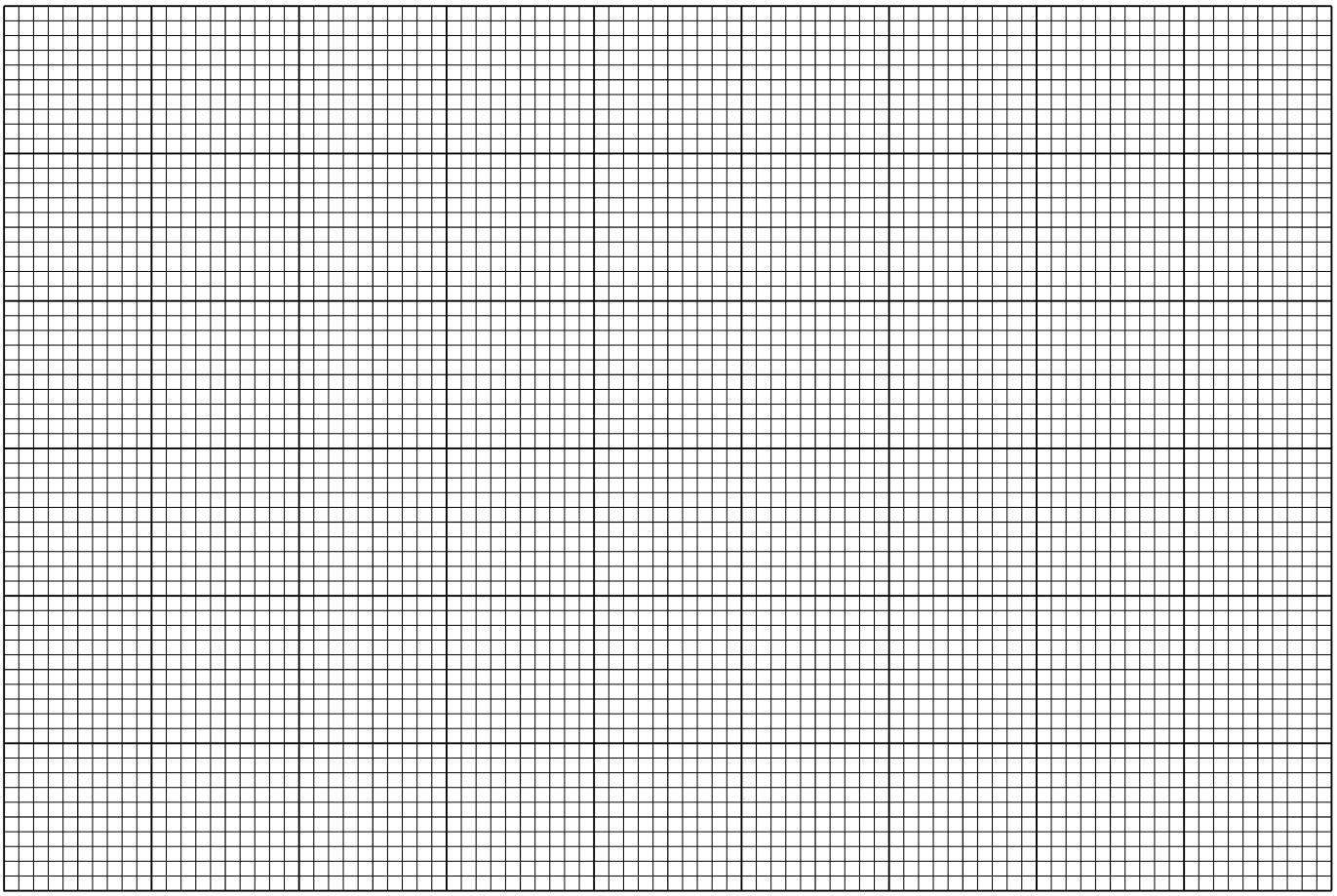

(iii) Draw the straight line of best fit.

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

gradient = ...

Question 1 continues on the next page.

(e) The relationship between W and θ is

$$Z \cos \theta = W + k$$

where k is a constant and Z is the weight of **Z**.

Calculate the value of Z.

For Examiner's Use

Z = ...

(f) Suggest, with a reason, a significant source of error in the experiment.

.....

.....

.....

[Total: 15]

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2 **(a)** You are to carry out a titration to determine the concentration of iron(II) ions in solution **A**.

For Examiner's Use

You are provided with the following:

- **A**, an aqueous solution containing iron(II) ions
- **B**, a solution containing 0.0200 mol dm^{-3} of potassium manganate(VII)
- dilute sulfuric acid

(i) Fill a burette with solution **B**.

Using the pipette, transfer 25.0 cm^3 of **A** into a conical flask.
Add 10 cm^3 of dilute sulfuric acid.

Titrate **A** with **B** until there is a **permanent** pale pink colour.

Perform a rough (trial) titration and two further titrations.

Record your titration results in the space below. Make sure that your recorded results show the precision of your working.

(ii) From your titration results obtain a volume of **B** to be used in your calculations.

Show clearly how you obtained this volume.

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

For Examiner's Use

(iii) Suggest why a separate indicator is not needed in this titration.

.....

.....

Calculations

(iv) Calculate the concentration, in mol dm^{-3}, of iron(II) ions in **A**.

Show your working. Give appropriate significant figures in your answers.

The equation for the reaction is

$$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

concentration = ... mol dm^{-3}

(v) Use your answer from **(a)(iv)** to calculate the concentration of iron(II) ions, in g dm^{-3}, in **A**.

concentration of iron(II) ions in **A** = ... g dm^{-3}

Question 2 continues on the next page.

Chemical Tests

For Examiner's Use

(b) (i) Carry out the following tests on solution **C**.

Record your observations in the table below.

test	observations
Put 1 cm of depth of **C** into a test-tube. Add aqueous sodium hydroxide, drop by drop with shaking, until the test-tube is about half-full. Stand the test-tube in a beaker half-filled with very hot water. Test any gas evolved with both damp red litmus paper and damp blue litmus paper.	
Put 1 cm depth of **C** into a test-tube. Add 10 drops of aqueous hydrogen peroxide. (You may see bubbles of oxygen.)	

(ii) Identify the two cations present in **C**. Give evidence to support your conclusions.

cation 1 .....

evidence .....

.....

cation 2 .....

evidence .....

.....

(iii) Explain the effect of adding aqueous hydrogen peroxide to **C**.

.....

.....

[Total: 15]

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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
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.]

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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 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 dichromate(VI) (aq) from orange to green

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