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

CANDIDATE
NAME

CENTRE
NUMBER

CANDIDATE
NUMBER

**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.

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.

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.
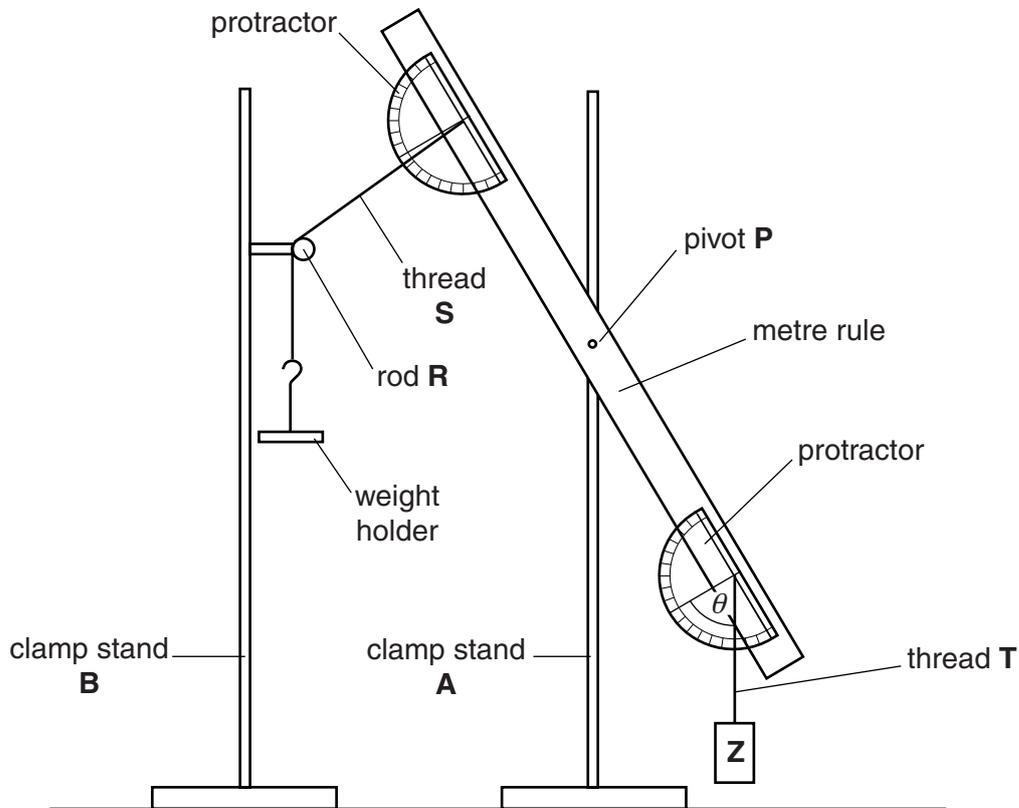


**Fig. 1.1**

**(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 $\theta$.

Measure and record the value of the angle $\theta$.

$\theta =$ ...............................

                                                               **[Turn over**

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

Construct a table suitable for recording **six** sets of measurements of $W$ and $\theta$ 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 $\theta$ from part **(a)**. For this value of $\theta$, $W = 0$.

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

Record your values of $W$ and $\theta$ in your table.

**(iii)** Calculate and record $\cos\theta$ for each of the values of $\theta$ 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.
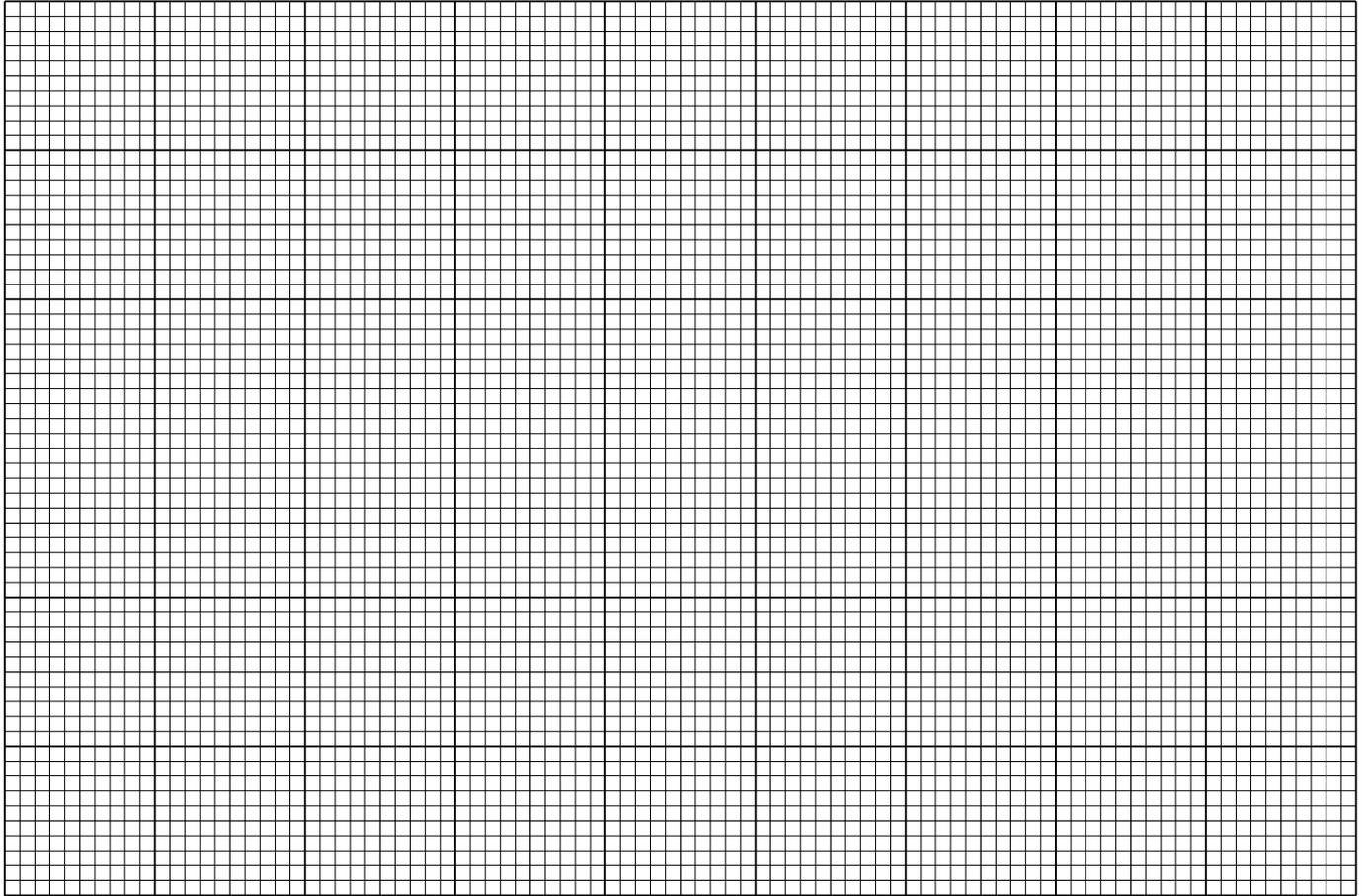
**1.** Circle the point you are repeating.
**2.** Give a reason for repeating this measurement.

....................................................................................................................................

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

**(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 $\theta$ is

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

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

Calculate the value of $Z$.

$Z =$ ......................................................

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

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[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**.

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$^3$

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

.................................................................................................................

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**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

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

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**

**(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.<br><br>Add aqueous sodium hydroxide, drop by drop with shaking, until the test-tube is about half-full.<br><br>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.<br><br>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 ................................................................................................................

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

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[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 |
| 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); <br> gives yellow ppt. with $Ba^{2+}$(aq); <br> gives bright yellow ppt. with $Pb^{2+}$(aq) |
| chloride, $Cl^-$ (aq) | gives white ppt. with $Ag^+$(aq) (soluble in $NH_3$(aq)); <br> gives white ppt. with $Pb^{2+}$(aq) |
| bromide, $Br^-$ (aq) | gives pale cream ppt. with $Ag^+$(aq) (partially soluble in $NH_3$(aq)); <br> gives white ppt. with $Pb^{2+}$(aq) |
| iodide, $I^-$ (aq) | gives yellow ppt. with $Ag^+$(aq) (insoluble in $NH_3$(aq)); <br> 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, <br> NO liberated by dilute acids <br> (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; <br> 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 <br> (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 |