



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 2011**
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 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 **11** printed pages and **1** blank page.

- 1 You are going to investigate the deflection h of a cantilevered hacksaw blade.

You are provided with the apparatus shown in Fig. 1.1.

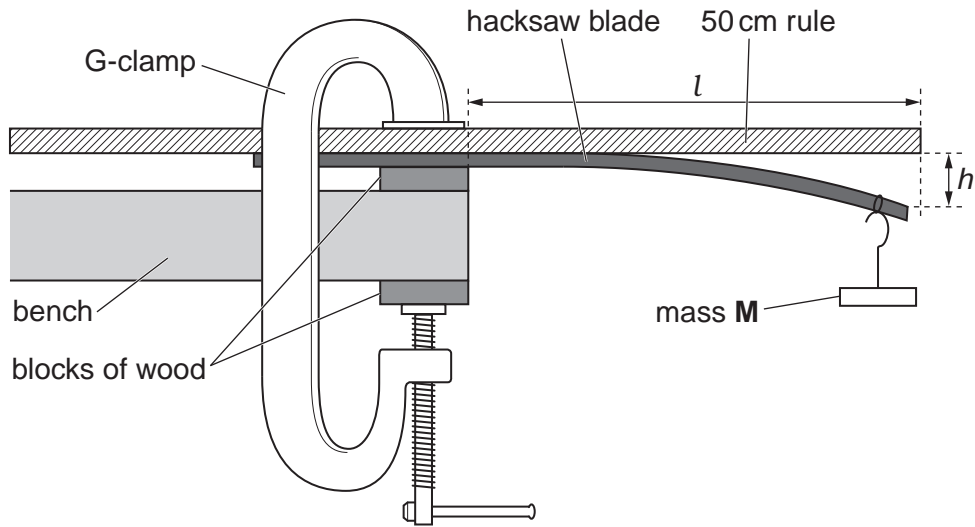


Fig. 1.1

- (a) (i) Measure and record the length l and deflection h .

$l =$

$h =$

- (ii) Estimate the absolute uncertainty in your value of h .

uncertainty = [1]



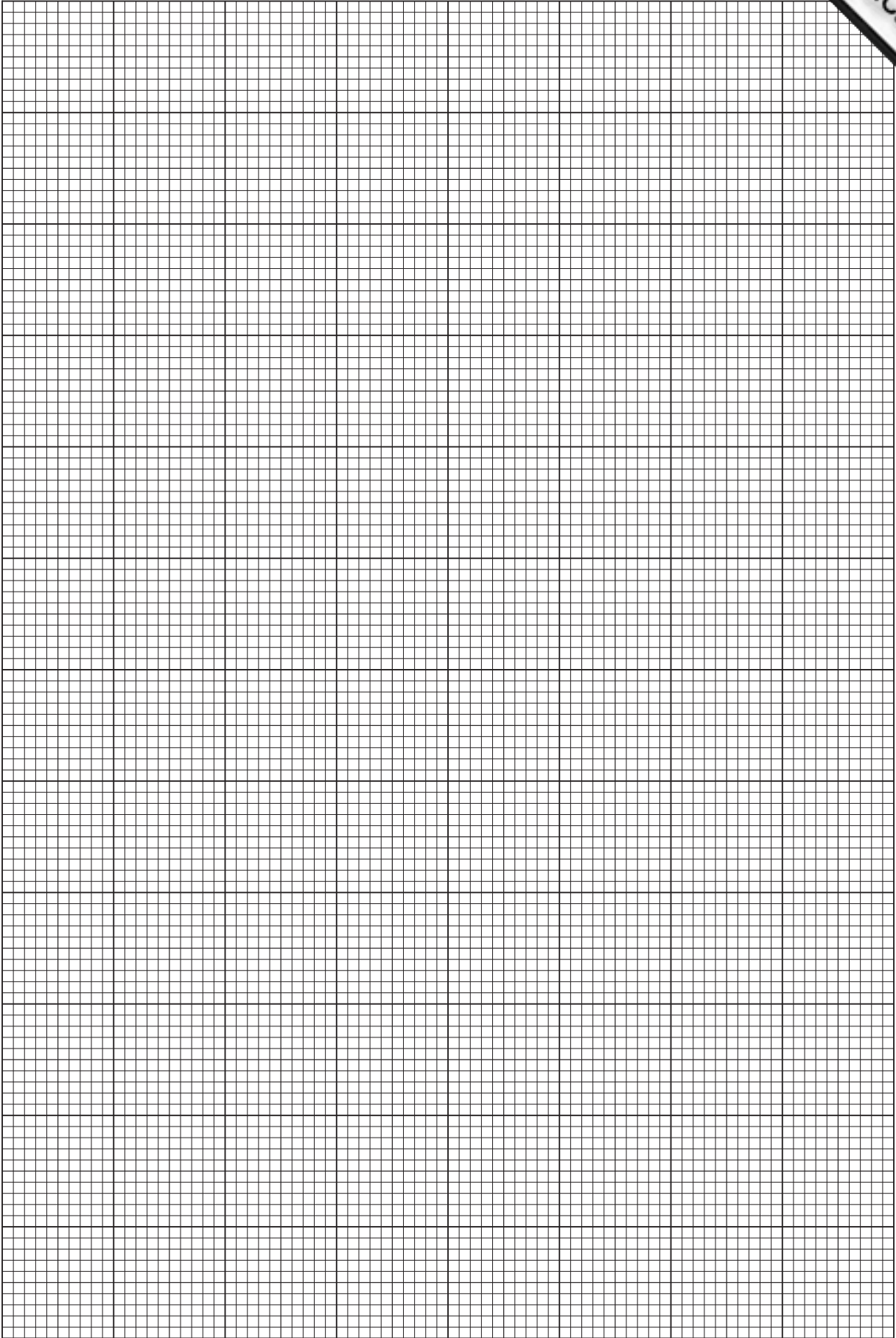
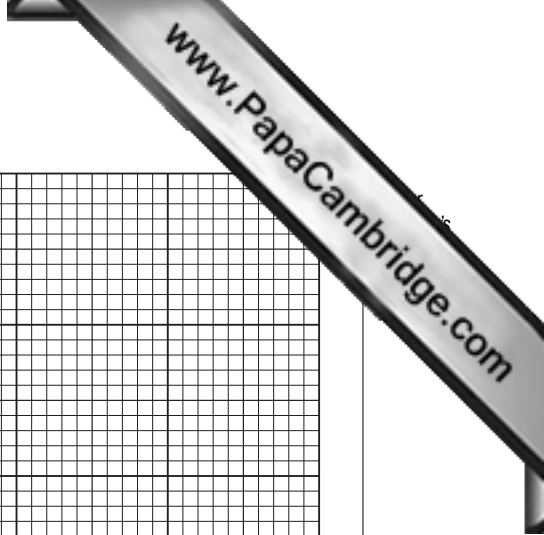
- (b) You are going to measure h at five further values of l between 25.0 and 10.0 cm.
- (i) Construct a table in which to record all **six** sets of measurements of l and h . Include a column for values of l^2 .

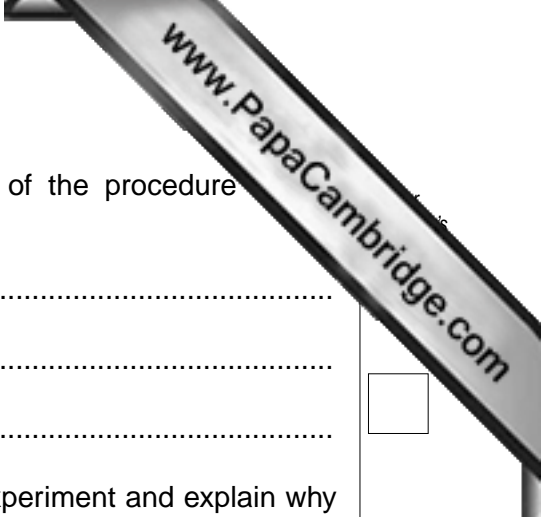
- (ii) Record your first values of l and h from part (a) in the table.
- (iii) Loosen the clamp to slide the ruler and hacksaw blade to a new position. Retighten the clamp. Measure and record the new values of l and h . Repeat until six sets of measurements are completed.
- (iv) Calculate and record values for l^2 .

[6]

- (c) (i) On the grid provided, plot your values of h on the y -axis against l^2 on the x -axis.
- (ii) Decide whether the best-fit line is a curve or a straight line. Draw the best-fit line.
- (iii) Calculate the gradient of the graph when $l^2 = 225 \text{ cm}^2$. Show your working.

gradient =





(d) (i) Describe **one** significant source of error or limitation of the procedure experiment.

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

(ii) Suggest **one** improvement that could be made to the experiment and explain why your suggestion would improve the accuracy of the final answer. You may suggest the use of other apparatus or different procedures.

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

(iii) A student suggests that the deflection h is directly proportional to l^2 . Discuss whether your results support this hypothesis.

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

[3]

[Total: 15]

- 2 You are provided with an acid **Y** and two samples of a solid **X**, labelled **A** and **B**.
Solid **X** is a hydrated metal salt.

Carry out the following tests to enable you to identify acid **Y** and both the ions present in solid **X**.

Record your observations in the spaces provided.

- (a) Strongly heat sample **A** of solid **X**.

Test any gas evolved both with a glowing splint and with limewater.

Record your observations for each gas test.

Describe the appearance of the solid during and after heating.

glowing splint

limewater

appearance of solid

.....[2]

- (b) When solid **X** reacts with acid **Y**, the temperature of the mixture changes.

Follow the instructions below to add a known mass of solid **X** to an excess of acid **Y** and measure the change in temperature.

- (i) Use the measuring cylinder to transfer 50 cm^3 of acid **Y** into the polystyrene cup.
- (ii) Stir the acid with the thermometer and measure its temperature to 0.1°C . Record this temperature in Table 2.1.
- (iii) Record the mass of sample **B** of solid **X** in Table 2.1. Carefully add all of the sample **B** into the cup. Add only a little at a time to prevent excess frothing.
- (iv) When all of sample **B** has been added, stir the mixture and measure the highest temperature reached. Record this in Table 2.1.
- (v) **The mixture in the cup is solution Z. Label it and retain it for use in parts (c) and (d).**
- (vi) Calculate the temperature change ΔT , and record it in Table 2.1.

Table 2.1

mass of solid X /g	initial temperature/ $^\circ\text{C}$	final temperature/ $^\circ\text{C}$	temperature change $\Delta T/^\circ\text{C}$

[2]

- (c) (i) Place about 1 cm depth of solution **Z** into a clean test-tube. Add five drops of aqueous barium nitrate.

Record your observations.

.....

- (ii) Place about 1 cm depth of solution **Z** into a clean test-tube. Add five drops of aqueous silver nitrate.

Record your observations.

.....

[1]

- (d) (i) Put ten drops of solution **Z** into a clean test-tube.
Add a few drops of aqueous ammonia and shake. Repeat until no further changes are seen.

Record your observations.

.....

- (ii) Put ten drops of solution **Z** into a clean test-tube.
Add a few drops of sodium hydroxide and shake. Repeat until no further changes are seen.

Record your observations.

.....

[3]

- (e) Identify acid **Y** and two ions in solid **X**.

acid **Y** =

ions in **X** = and [2]

- (f) (i) Calculate the value for the enthalpy change Q for the reaction in part (b), using

$$Q = m c \Delta T.$$

Assume that the mass m of solution **Z** is 50 g and that the solution has a specific heat capacity c of $4.2 \text{ J g}^{-1} \text{ K}^{-1}$.

$Q =$



- (ii) Use the mass of solid **X** from Table 2.1 and your answer from part (f)(i) to calculate the enthalpy change when 1 mole of solid **X** reacts with excess acid **Y**.

[Relative formula mass of **X** = 341]

enthalpy change = kJ mol⁻¹
[3]

- (g) (i) State **one** significant source of error in the experiment in part (b).

.....
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.....

- (ii) Explain how the value of the enthalpy change calculated in (f)(ii) is affected by this source of error.

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.....
.....

- (iii) Suggest an improvement to reduce the effect of this source of error.

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.....
.....

[2]

[Total: 15]

Qualitative Analysis Notes

Key: [ppt. = precipitate]

1 Reactions of aqueous cations

	<i>reaction with</i>	
	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

<i>ion</i>	<i>reaction</i>
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 $\text{NO} \rightarrow$ (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 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

<i>gas</i>	<i>test and test result</i>
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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