Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2009

Physics PHA3/B3/X
(Specifications A and B)

Unit 3 Investigative and Practical Skills in AS Physics
Route X Externally Marked Practical Assignment (EMPA)

Section B

For this paper you must have:
- a calculator
- a pencil
- a ruler
- your completed Section A Task 2 question paper/ answer booklet.

Time allowed
- 1 hour 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for Section B is 25.

SECTION B

Answer all the questions in the spaces provided.

Time allowed 1 hour 15 minutes.

You will need to refer to the work you did in Section A Task 2 when answering these questions.

1 (a) Determine the gradient, G, of your graph.

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G =.....

(2 marks)

1 (b) Evaluate $\frac{L}{G}$

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$\frac{L}{G}$ = ...

(2 marks)

2 (a) Use your answer to (a)(iii) in Section A Task 2 to calculate the percentage uncertainty in L.

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(1 mark)

2 (b) Assuming the percentage uncertainty in G is double the percentage uncertainty in L, calculate the percentage uncertainty in your result for $\frac{L}{G}$.

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(1 mark)

3 Describe the procedure you used to measure *d*.
You may wish to use a sketch to illustrate your answer.

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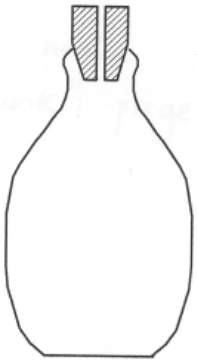
(2 marks)

Turn over for the next question

4 In Section A Task 1 you calculated the density of the rubber stopper. The accuracy of your result depends on whether the water in which the stopper was submerged contained dissolved impurities.

The density of a sample of water of unknown purity can be compared with the density of pure water using an instrument known as a *pyknometer* or density bottle. The density bottle has a glass stopper, which has a fine hole through it so when the bottle is filled the excess liquid rises through the hole and drains away. This ensures the bottle will always contain the same volume of whatever liquid is put in it.
This type of density bottle is illustrated in **Figure 7**.

Figure 7



glass stopper (shown shaded) with fine hole to allow excess liquid to escape

A student makes the following measurements in order to determine the density of a liquid.

Mass of empty density bottle = 18.07 g
Mass of density bottle when filled with pure water = 44.12 g
Mass of density bottle when filled with liquid of unknown density = 45.20 g

Use the student's data to show the density of the liquid ≈ 1040 kg m^{-3}.
The density of pure water = 1000 kg m^{-3}.

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(5 marks)

Turn over for the next question

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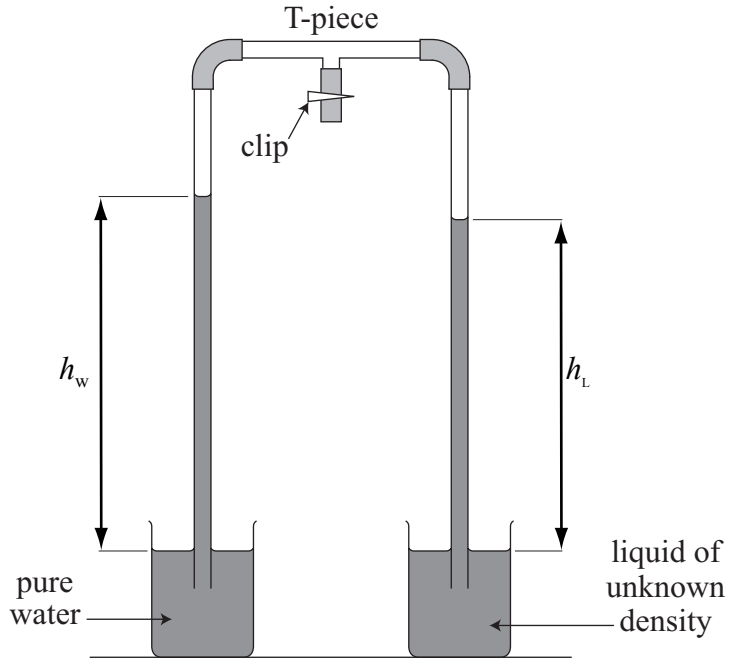
ANSWER IN THE SPACES PROVIDED

5 Another student researches methods of comparing the densities of two liquids and discovers a method known as *Hare's* apparatus.
The apparatus, shown in **Figure 8**, includes two vertical glass tubes connected at the top by a glass T-piece.

Figure 8



These tubes dip into separate beakers containing the liquid of unknown density and pure water. Air is sucked through the centre limb of the T-piece and the clip closed. Removal of the air causes the liquids to rise up their respective tubes but the difference in the densities means that the liquids are raised through different heights, shown by h_L and h_w in **Figure 8**. By briefly opening and then closing the clip the student acquires the data shown below.

h_L/cm	h_w/cm
71.0	74.2
65.9	68.9
51.2	53.5
40.9	42.8
37.7	36.0
24.1	25.2

The formula for Hare's apparatus is

$$density\ of\ water \times h_w = density\ of\ the\ liquid \times h_L.$$

5 (a) The student suspects that one row of data may contain an unreliable measurement. State and explain which row contains the unreliable data.

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(2 marks)

5 (b) (i) Showing your method clearly and rejecting the unreliable data, use the remaining data produced by the student to determine the density of the liquid.

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(5 marks)

5 (b) (ii) State and explain how the student could use the data to determine the density of the liquid by a graphical method.

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(2 marks)

5 (b) (iii) Explain how the presence of unreliable data would be identified on the graph.

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(1 mark)

Turn over ▶

5 (c) Identify one possible source of random error in the measurements in the student's experiment and explain how this error can be overcome.
You may wish to use a sketch to illustrate your answer.

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(2 marks)

END OF QUESTIONS