| Centre Number | | | | | | Candidate Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Surname | | | | | | Other Names | | | | |

**Notice to Candidate.** The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

**Candidate Declaration.** I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

| Candidate Signature | | Date | |
|---|---|---|---|

| For Examiner's Use | |
|---|---|
| Examiner's Initials | |
| Section A Task 1 | |
| 1(a) | |
| 1(b)(i) | |
| 1(b)(ii) | |
| 1(c)(i) | |
| 1(c)(ii) | |
| 2(a) | |
| 2(b) | |
| Section A Task 2 | |
| 1(a) | |
| 1(b) | |
| 1(c) | |
| Section B | |
| 1(a)(i) | |
| 1(a)(ii) | |
| 1(b)(i) | |
| 1(b)(ii) | |
| 1(b)(iii) | |
| 1(b)(iv) | |
| 1(c) | |
| 2(a) | |
| 2(b)(i) | |
| 2(b)(ii) | |
| 2(c) | |
| 2(d)(i) | |
| 2(d)(ii) | |
| Total | |

AQA

General Certificate of Education
Advanced Level Examination
June 2015

# Physics (Specifications A and B)

# PHA6/B6/X

## Unit 6 Investigative and Practical Skills in A2 Physics
## Route X Externally Marked Practical Assignment (EMPA)

## Section B Written Test

| **For this paper you must have:** | **Instructions** |
|---|---|
| • your completed Section A Task 2 question paper / answer booklet.<br>• a ruler<br>• a pencil<br>• a calculator. | • Use black ink or black ball-point pen.<br>• Fill in the boxes at the top of this page.<br>• Answer **all** questions.<br>• You must answer the questions in the space provided. Do not write outside the box around each page or on blank pages.<br>• Show all your working.<br>• Do all rough work in this book. Cross through any work you do not want to be marked. |
| **Time allowed**<br>• 1 hour 15 minutes | **Information**<br>• The marks for questions are shown in brackets.<br>• The maximum mark for this paper is 24. |

**Details of additional assistance (if any).** Did the candidate receive any help or information in the production of this work? If you answer yes, give the details below or on a separate page.

Yes ☐ No ☐

| **Practical Skills Verification**<br>Teacher Declaration: I confirm that the candidate has met the requirement of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification. | **Yes** ☐ |
|---|---|

Signature of teacher ..... Date .....

## 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) (i)** Determine the gradient, $G$, of your graph (**Figure 7**) of $V_2$ against $t$ at the point where $V_1 = V_2$.

**[2 marks]**

$G$ = .....

**1 (a) (ii)** $V_e$ is the potential difference (pd) when $V_1 = V_2$.

Evaluate $\frac{V_e}{G}$.

**[2 marks]**

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

**1 (b)** $R_1$ and $R_2$ are the resistances of resistors R1 and R2 respectively.

When $V_2$ is at its maximum value, $\frac{V_2}{V_1} = \frac{R_2}{R_1}$.

**1 (b) (i)** Use your graph to determine $\frac{R_2}{R_1}$.

**[1 mark]**

$\frac{R_2}{R_1}$ = .....

**1 (b) (ii)** State which of the two measurements made from your graph contributes most to the percentage uncertainty in your result for $\frac{R_2}{R_1}$. Give **two** reasons to support your answer.

**[2 marks]**

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**1 (b) (iii)** Identify, by putting a tick in the right-hand box, the statement below that best describes the current in the circuit when $V_2$ reaches a maximum value.

**[1 mark]**

| | |
|---|---|
| **Current is from terminal Y to capacitor C2.** | |
| **Current is from capacitor C2 to terminal Y.** | |
| **There is no current between capacitor C2 and terminal Y.** | |

**1 (b) (iv)** Explain your answer to part (b)(iii).

**[2 marks]**

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**1 (c)** You should refer to **Figure 6** in Section A Task 2 when answering this question.
A student performs the experiment without realising that a connection has failed so that there is **no current** to or from C2.
**Figure 8** shows the student's graph for $V_1$ against $t$.

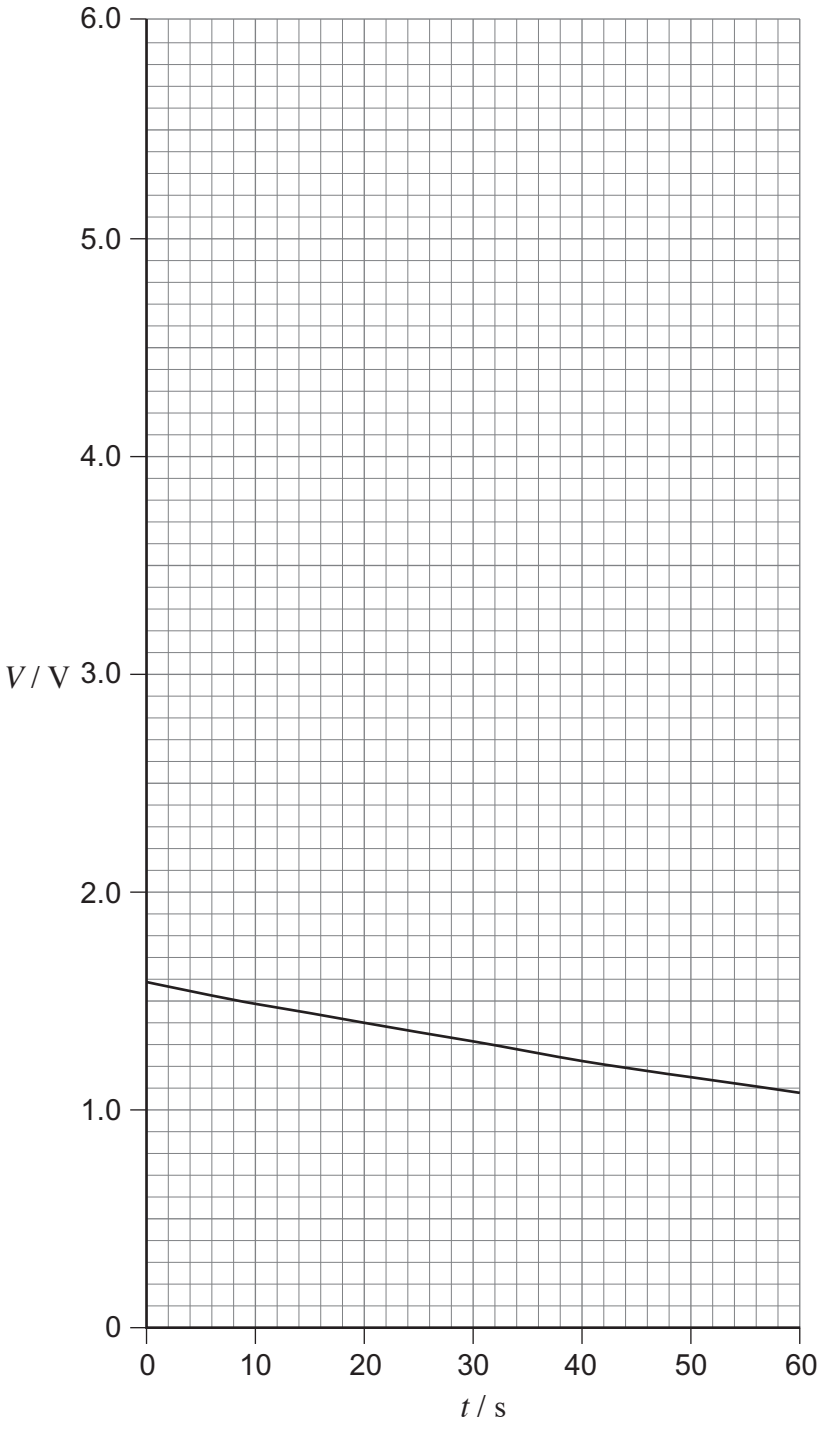
For this student's experiment $\frac{R_2}{R_1} = 2.5$

Draw on **Figure 8** the graph that this student produces for $V_2$ against $t$.

**[2 marks]**

12

**Figure 8**



**Turn over for the next question**

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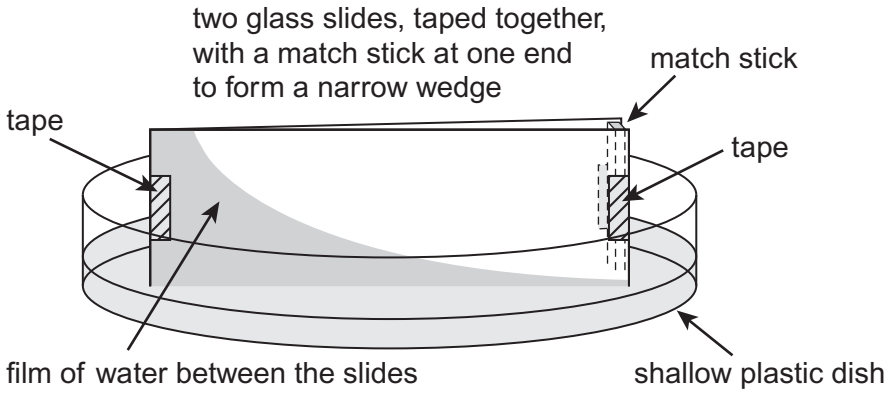
**ANSWER IN THE SPACES PROVIDED**

**2** A student positions a match stick between two microscope slides then secures the arrangement with tape to produce a narrow wedge.

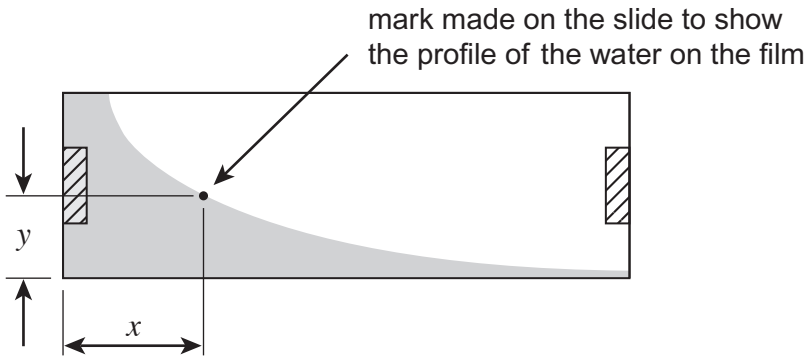
The slides are placed in a shallow plastic dish then some water is added until a film of water appears in the gap between the slides, as shown in **Figure 9**.

**Figure 9**




The student removes the slides from the dish and measures the profile of the water film, recording values of $y$ and $x$ that are defined in **Figure 10**.

**Figure 10**




**2 (a)** The student plots a graph of $y$ against $\frac{1}{x}$ which confirms that $y$ is inversely proportional to $x$.

State any feature of the student's graph that would reveal a systematic error in the data for $y$.

**[1 mark]**

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**2 (b)** It can be shown that $y = \frac{2s\gamma}{gt\rho x}$, where

$g$ is the gravitational field strength,
$\rho$ is the density of water,
$s$ is the length of the longest edge of the microscope slide,
$t$ is the thickness of the match stick used to produce the wedge-shaped gap between the slides.

$\gamma$ is a property of the water surface trapped between the slides.

**2 (b) (i)** Deduce an appropriate unit for $\gamma$.

**[1 mark]**

unit for $\gamma$ = .....

**2 (b) (ii)** The experiment is repeated using a match stick of **smaller** thickness.
State and explain how the graph produced in this experiment is different from that obtained for the thicker match stick.

**[2 marks]**

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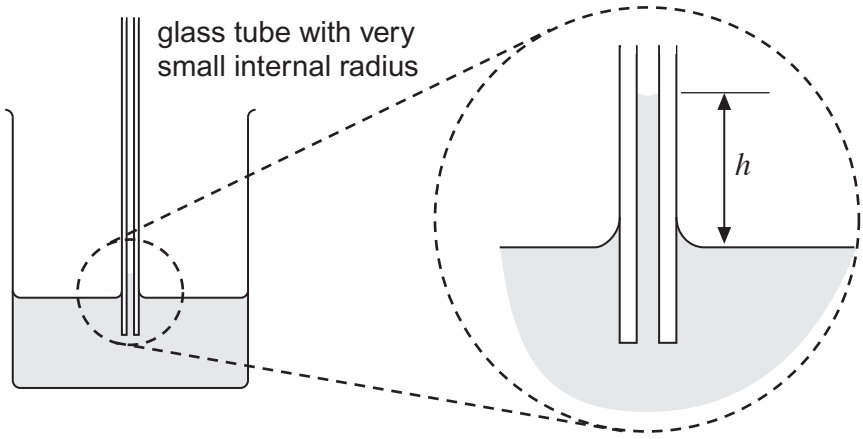
**Question 2 continues on page 8**

**2 (c)** A glass tube with a very small internal radius is placed vertically upright in a beaker of water. The water rises up the tube through a process known as capillary action, as shown in **Figure 11**.

**Figure 11**




It can be shown that $\gamma = \frac{1}{2} g\rho r\left(h + \frac{r}{3}\right)$, where

$g$ and $\rho$ are as defined in part (b) of this question,
$h$ is the vertical height defined in **Figure 11**, and
$r$ is the internal radius of the glass tube.

A student obtains a range of glass tubes with known values of $r$ and measures $h$ for each tube.
Explain how the student should process the data to produce a graph, the gradient of which will enable a value for $\gamma$ to be calculated.
You may assume that the values of $g$ and $\rho$ are known.

**[2 marks]**

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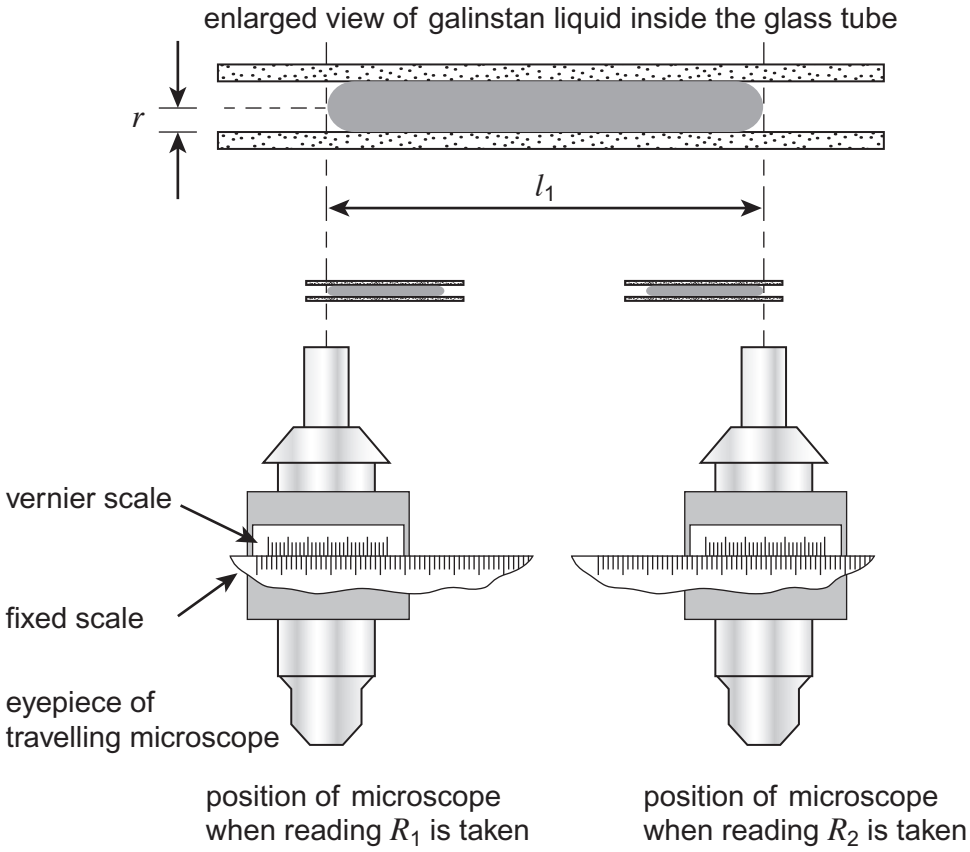
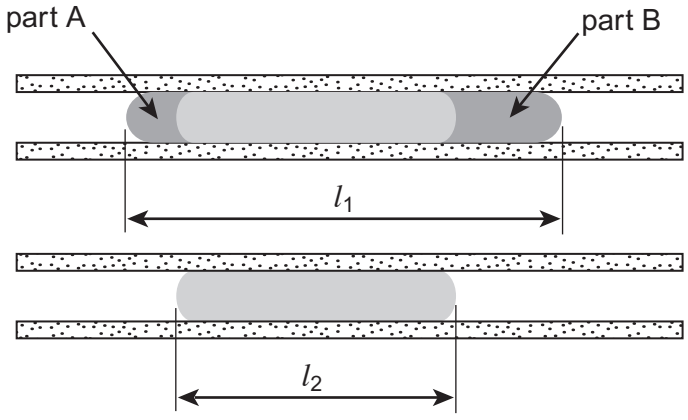
**2 (d)** The student uses the following method to determine the internal radius of each tube.
A small quantity of galinstan, a metal alloy that is liquid at room temperature, is drawn into one of the tubes.
The length of the liquid, $l_1$, is determined using a travelling microscope by making readings $R_1$ and $R_2$ at each end of the liquid.
This arrangement is shown in **Figure 12**.

**Figure 12**




Some of the liquid is allowed to run out of the tube and is collected in a container placed on an electronic balance.
New readings, $R_3$ and $R_4$, are made to determine the new length $l_2$ of the liquid remaining in the tube. The volume of the liquid transferred to the balance is represented by the **darker** shaded parts (ie part A and part B) in **Figure 13**.

**Figure 13**

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**2 (d)** The student uses the balance to determine the mass, $m$, of the liquid collected in the container.
The mass $m$ is given by

$$m = \rho\pi r^2(l_1 - l_2)$$

where $\rho$ is the density of the liquid.

The student records the results in **Table 1**.

**Table 1**

| $R_1$ / cm | $R_2$ / cm | $R_3$ / cm | $R_4$ / cm | $m$ / g |
|---|---|---|---|---|
| 2.92 | 11.51 | 3.85 | 9.07 | 1.26 |

**2 (d) (i)** Calculate $r$, the internal radius of the tube.
$\rho = 6440 \text{ kg m}^{-3}$

**[3 marks]**

$r$ = .....

**2 (d) (ii)** The uncertainty in each of the microscope readings $R_1$ to $R_4$ is $0.05$ cm.
Determine the percentage uncertainty in $r$.
You may assume that the percentage uncertainties in $m$ and in $\rho$ are negligible.

**[3 marks]**

percentage uncertainty in $r$ = .....

**END OF QUESTIONS**

12

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