| 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 Teacher's Use | |
|---|---|
| Section | Mark |
| PSA | |
| Stage 1 | |
| Section A | |
| Section B | |
| TOTAL (max 50) | |

General Certificate of Education
Advanced Level Examination
June 2015

# Physics (Specification A & B) PHY6T/P15/test

## Unit 6T A2 Investigative Skills Assignment (ISA) P

## For submission by 15 May 2015

| **For this paper you must have:** | **Time allowed** |
|---|---|
| • your documentation from Stage 1<br>• a ruler with millimetre measurement<br>• a calculator. | • 1 hour |
| **Instructions:** | **Information** |
| • 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>• Do all rough work in this book. Cross through any work you do not want to be marked.<br>• Show all working. | • The marks for questions are shown in brackets.<br>• The maximum mark for this paper and Stage 1 is 41. |

**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 ☐

**Teacher Declaration:**
I confirm that the candidate's work was conducted under the conditions laid out by the specification. I have authenticated the candidate's work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate.

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

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## Section A

Answer **all** questions in the spaces provided.
You should refer to your documentation from Stage 1 as necessary.

**1 (a)** Theory predicts that the relationship between $T_{\frac{1}{3}}$ and $R$ in the experiment that you carried out in Stage 1 is given by

$$T_{\frac{1}{3}} = RC\ln 3$$

where $C$ is the capacitance of the capacitor used in the experiment.

**1 (a) (i)** State and explain whether or not your graph from Stage 1 supports the theory.

**[2 marks]**

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**1 (a) (ii)** Determine the gradient of your graph.

**[2 marks]**

gradient = .....

**1 (a) (iii)** Use your answer to part (a)(ii) to find a value for $C$.

**[3 marks]**

$C$ = .....

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**1 (a) (iv)** Referring to your graph, comment on the reliability of your value for $C$. Mention both the plotted points and the line of best fit in your answer.

**[1 mark]**

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**1 (b) (i)** In the experiment that you carried out in Stage 1, the measured values for $T_{\frac{1}{3}}$ are likely to be less reliable when $R$ is small than when $R$ is large. Explain why this is so.

**[2 marks]**

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**Question 1 continues on the next page**

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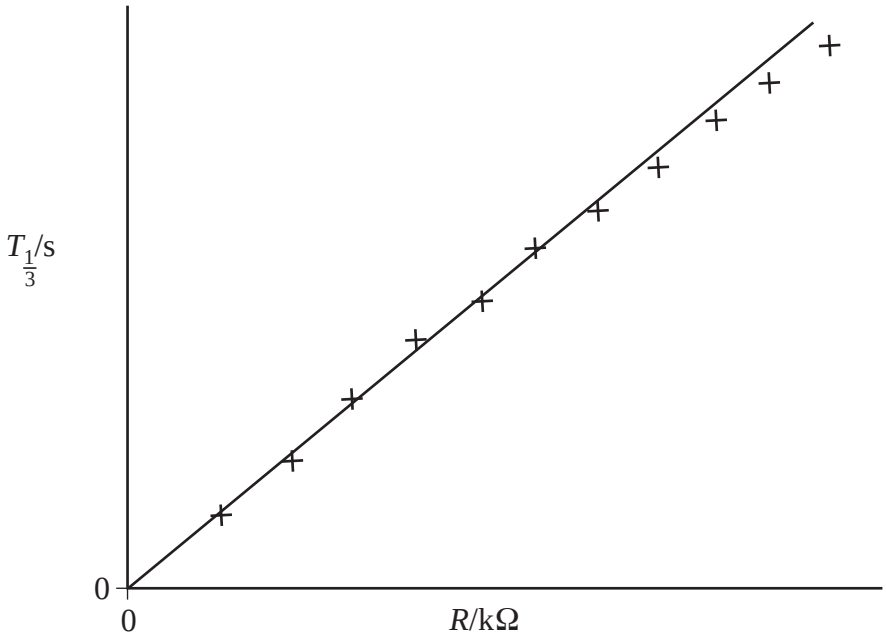
**1 (b) (ii)** A charged capacitor tends to lose its charge over time even when it is not connected to an external circuit. This is called **charge leakage** and is due to a small flow of charge between the plates.
When plotting a graph for Stage 1 a student noticed that for large values of $R$, the points were all just below her straight line of best fit, and tended to curve away from it as $R$ increased. This is shown in **Figure 1**.

**Figure 1**




Explain why charge leakage could be the explanation for this student's observation.

**[2 marks]**

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**1 (b) (iii)** A teacher suggests that the effect shown in **Figure 1** for large values of $R$ could be due to a property of the voltmeter.
State the property of the voltmeter and explain how the property could produce this effect.

**[2 marks]**

Property .....

Explanation .....

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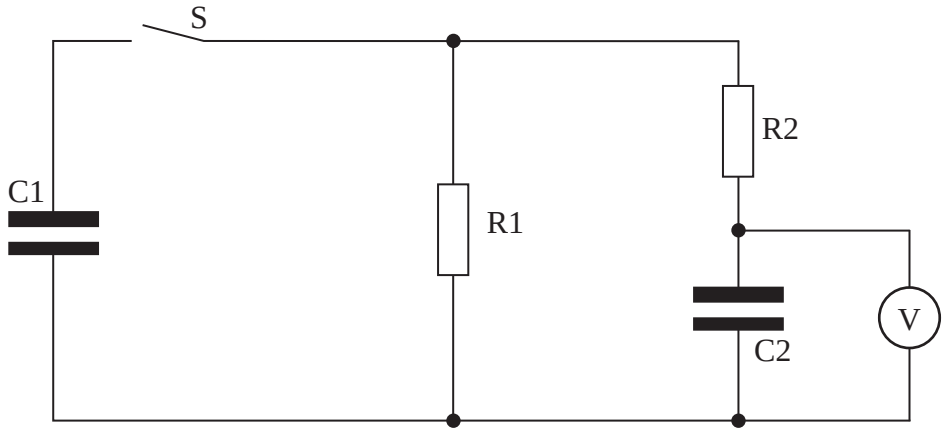
## Section B

Answer **all** questions in the spaces provided.

**2** **Figure 2** shows part of a circuit used for another investigation of the discharge of a capacitor C1.

**Figure 2**




- C1 is initially charged to 6 V
- C2 is initially uncharged
- When the switch S is closed, C1 discharges
- While C1 is discharging, capacitor C2 initially charges and then discharges again
- Voltmeter readings $V_1$ are taken every 5 seconds during the discharge process
- The whole procedure is repeated to obtain repeat values $V_2$ and $V_3$.

**Table 1** shows measurements taken using this circuit and a hand-operated digital stopclock.

$t$ is the elapsed time from the moment S is closed and the discharge of C1 starts.

$V$ is the mean of $V_1$, $V_2$ and $V_3$.

**Table 1**

| $t$/s | $V_1$/V | $V_2$/V | $V_3$/V | $V$/V |
|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 2.13 | 2.18 | 2.17 | 2.16 |
| 10 | 3.72 | 3.73 | 3.59 | |
| 15 | 4.20 | 4.30 | 4.27 | |
| 20 | 4.55 | 4.62 | 4.49 | |
| 25 | 4.68 | 4.79 | 4.78 | 4.75 |
| 30 | 4.65 | 4.71 | 4.74 | 4.70 |
| 35 | 4.57 | 4.52 | 4.56 | 4.55 |
| 40 | 4.37 | 4.37 | 4.39 | 4.38 |
| 45 | 4.17 | 4.15 | 4.19 | 4.17 |

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**2 (a) (i)** Complete **Table 1**.

**[1 mark]**

**2 (a) (ii)** Estimate the percentage uncertainty in $V$ when $t = 25$ s.

**[2 marks]**

percentage uncertainty = ..... %

**2 (b) (i)** Complete the graph in **Figure 3** by plotting the missing points and drawing the line of best fit for the plotted points.

**[2 marks]**

**2 (b) (ii)** After a time $t_{max}$, the potential difference (pd) across C2 reaches its maximum value $V_{max}$.
Use the graph in **Figure 3** to determine $t_{max}$ and $V_{max}$.

**[2 marks]**

$t_{max}$ = .....

$V_{max}$ = .....

**2 (b) (iii)** From the graph, estimate the uncertainty $\Delta t_{max}$ in your answer for $t_{max}$.

**[1 mark]**

$\Delta t_{max}$ = .....

**2 (b) (iv)** Explain the reason for your answer to part (b)(iii).

**[1 mark]**

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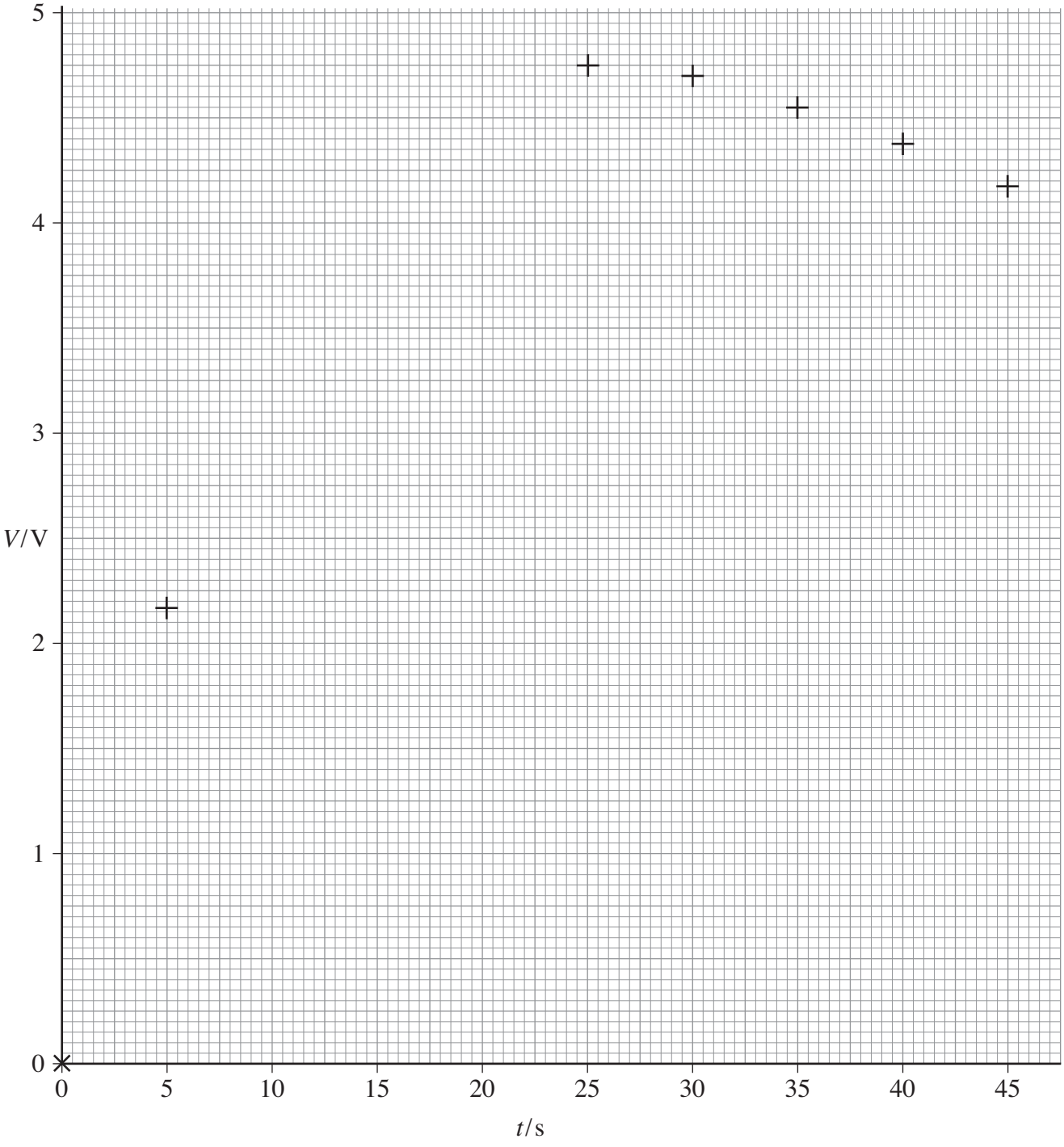
**Figure 3**



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**2 (c)** Theory predicts that

$$t_{\max} = \frac{T_1 T_2}{(T_1 - T_2)} \ln\left(\frac{T_1}{T_2}\right)$$

$T_1$ is the time constant for the discharge of capacitor C1 through resistor R1.
$T_2$ is the time constant for the discharge of capacitor C2 through resistor R2.

For the components used in the experiment, $T_1 = 103$ s and $T_2 = 10.0$ s.

**2 (c) (i)** Calculate a value for $t_{\max}$ using this formula.

**[1 mark]**

$t_{\max}$ = .....

**2 (c) (ii)** State and explain whether the calculated value for $t_{\max}$ agrees with the value you obtained from the graph in **Figure 3**.

**[2 marks]**

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**2 (c) (iii)** The components in the circuit are changed so that $T_1$ is $1000$ s and $T_2$ is unchanged.

Describe and explain how a graph of $V$ against $t$ would compare with your graph in **Figure 3**. You may assume that the data for the new graph are recorded until $V$ falls to a value well below the new $V_{max}$.

**[4 marks]**

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**3** The student mentioned in question 1(b)(ii) decides to test the suggestion that her results, illustrated in **Figure 1**, could be explained by charge leakage (see question 1(b)(ii)) rather than a property of the voltmeter used in the experiment.

Describe and explain an experiment she could carry out, using the same voltmeter, battery and capacitor, to test the suggestion.

The blank space is for a circuit diagram should you wish to draw one.

**[4 marks]**

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**END OF QUESTIONS**