AQA

# A-LEVEL
# Physics

## Investigative and Practical Skills in A2 Physics – PHY6T/P15
## Final Marking Guidelines

Specification 2450/2455
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Version/Stage: Final Marking Guidelines

## Guidance for teachers marking Physics ISAs

The marking guidelines have been devised by a team of experienced examiners. They have tried to anticipate all possible responses worthy of credit. In order to establish consistency it is essential that all centres mark exactly to this scheme.

For ease of use the mark scheme has been presented in tabular form. Concise answers are given in the left-hand column. More detailed explanatory notes for some questions are included in the right-hand column.

Marking of Stage 1 of the ISA – student data and graph – should ideally be completed before the ISA written test to ensure that candidates do not change any data. (Alternatively, centres should take other steps to ensure that candidates do not change any information on their data script/graph). The marking of this section should be annotated with a red tick at the point where the mark has been awarded together with the letter referring to this mark scheme, eg '✓b'. **No other comments or feedback should be written on the candidates' scripts**. The total mark for this section should be written at the top of the paper. This will be transferred to the grid on the front page of the ISA test booklet.

Marking of the ISA test should be done using a red tick to represent each mark awarded. Further annotated comments **can** be added where necessary as an explanation as to why a particular point has been awarded which will greatly aid the moderation process. The total mark for each question should be entered on the grid on the front cover of the ISA booklet and the total mark calculated. Assessment Advisers are allocated to each centre and they can advise on the marking process. You should receive the contact details for the Assessment Advisor through the post. If you have not received them, please contact the AQA subject team.

| Stage 1 | | Mark | Additional guidance notes |
|---|---|---|---|
| (a) | Supervisor verifies that the circuit was **set up without help** *including correct capacitor polarity and with the 56 kΩ and 120 kΩ resistors connected in parallel with the voltmeter* ✓ | 1 | This mark cannot be awarded if any help was given in setting up the circuit unless this was because of faulty apparatus. |
| (b) | Table with column headings, including appropriate units, showing at least **six values** of *R,* together with values for $T_{1/3}$ ✓ | 1 | Column headings can be either in words or appropriate symbols. Units can be in words or the correct abbreviation. Do not allow *T*/3 for $T_{1/3}$.<br>Do not allow secs for seconds.<br>There must be a suitable separator between the quantity and its unit. e.g. *R*/kΩ or *R*(kΩ)<br>*This mark cannot be awarded to candidates who include units in the body of the table.* |
| (c) | All raw data recorded (including $V_0$) to the precision of the instruments provided **and** ch*eck the value of* $T_{1/3}$ *for* ***the largest value of R*** *shown in the table.*✓ | 1 | Award the mark for *R* = 340 kΩ if $T_{1/3}$ is in the range 66-98 s.<br>**If largest value of R in the table is not 340 kΩ**<br>award mark if $T_{1/3}$ (in seconds) = 0.241 x (*R* in kΩ) ± 20% |
| (d) | All six values for R given in the table are valid. ✓<br>Valid values of *R*/kΩ: **38 and 340** together with four from 45, 56, 78, 120, 176, 220 and 276 | 1 | The values given for *R* need not be in sequence but they all must be quoted to the nearest kΩ. |
| (e) | A graph of $T_{1/3}$ against *R* with $T_{1/3}$ on the vertical axis. Suitably large graph scale (do not award if scale on either axis could have been doubled). Scale must have 'sensible' divisions which can be easily read: e.g. scales in multiples of 3,6,7,9 etc are not acceptable: both axes must be labelled with quantity and unit. ✓ | 1 | For axes labels, the same convention as for table headings is required. Allow ecf from (b) for an incorrect unit or no unit. If the axis label and the corresponding table heading have different unit errors then penalise both.<br>A scale division in 4's might sometimes be acceptable. |
| (f) | Points accurately plotted to within 1 mm ✓<br>*Markers should check the* ***first and third*** *plotted points on the graph* | 1 | This mark is independent of mark (e). i.e. if candidates have used an unsuitable scale they can still achieve the mark for accurately plotting the points. |
| (g) | Accurate best straight line well drawn. ✓ | 1 | It is expected that the plotted points will be evenly scattered about the line of best fit and that the line is not forced through the origin. |
| | **Total** | **7** | |

| Question | Written Test: Section A | Mark | Additional guidance notes |
|---|---|---|---|
| 1(a)(i) | Comment to the effect that the theory predicts that $T_{1/3}$ is (directly) proportional to $R$✓<br><br>Correct comment on the candidate's own graph✓ | 2 | The second mark can only be awarded if the candidate has drawn a best straight line.<br>*Note: The graph only supports the theory if it passes through the true origin. However a candidate with a straight line that just misses the origin can be awarded the mark if he/she states that the theory is supported within experimental error.* |
| 1(a)(ii) | Triangle drawn with smallest side ≥ 8 cm and correct values read from the line of best fit✓<br>Correct calculation of gradient ✓ | 2 | (Gradient is expected to be in the range 0.20 to 0.28 (s $k\Omega^{-1}$)<br>A unit is not required here and (2.4 ± 0.4) x $10^{-4}$ is correct if the candidate has calculated the gradient with $R$ in ohms. |
| 1(a)(iii) | Answer to 1(a)(ii) equated to ln 3 x $C$ ✓<br>Correct calculation of C based on candidate's answer to 1(a)(ii)✓<br>Correct unit ✓ | 3 | Expected value around 220 μF (220 x $10^{-6}$ F, 2.2 x $10^{-4}$ F, 0.22 mF)<br>The unit mark can be awarded even if the numerical answer is incorrect *but not if it is of the wrong order of magnitude.* |
| 1(a)(iv) | Reference to the scatter of the points about the line of best fit together with a reasonable comment on reliability✓ | 1 | Acceptable answers:<br>*The points are close to the line so the result is reliable.* ***or***<br>*The points are widely scattered about the line so the value is not reliable.* |
| 1(b)(i) | When $R$ is small the measured value for $T_{1/3}$ is also small✓<br>This results in a greater percentage uncertainty in $T_{1/3}$ than with large values of $R$ ✓ | 2 | |
| 1(b)(ii) | Points below the line suggest that the capacitor is discharging more quickly than the theory predicts ✓<br>Since $T_{1/3}$ increases with $R$ there is a longer time for charge leakage to have an effect ✓ | 2 | For the second mark, a mark can be awarded for correct physics, such as "when $R$ is large the current in the external circuit is smaller so that any leakage current will be more significant". |
| 1(b)(iii) | Voltmeter resistance✓<br>This acts as a resistor in parallel with $R$ effectively decreasing $R$ and hence $T_{1/3}$ ✓ | 2 | For the second mark, an alternative valid answer in terms of current is acceptable. |
| | **Total** | **14** | |

| Question | Written Test: Section B | Mark | Additional guidance notes |
|---|---|---|---|
| 2(a)(i) | <table><tr><th>*t*/s</th><th>*V*/V</th></tr><tr><td>10</td><td>3.68</td></tr><tr><td>15</td><td>4.26</td></tr><tr><td>20</td><td>4.55</td></tr></table> ✓ | 1 | Exact answers only. |
| 2(a)(ii) | Half the range = (4.79 – 4.68)/2 = 0.055 ✓<br>Error = ± (0.055/4.75) x 100 = ( ± ) 1.2 (%) ✓ | 2 | First mark for correctly finding half the range.<br>Second mark for correct final answer: 2 s.f max, but ± sign not necessary. |
| 2(b)(i) | All three points plotted within 1 mm ✓<br>A single smooth curve drawn from the origin to $t$ = 45 s with an even scatter of points on either side of the line ✓ | 2 | |
| 2(b)(ii) | $t_{max}$ in range 25 to 27 s ✓ (2 or 3 sf only)<br>$V_{max}$ in range 4.70 to 4.85 V ✓ (3 sf only) | 2 | Must have correct unit for each mark. |
| 2(b)(iii) | ( ± ) 1 s ✓ | 1 | 1 s.f only, ± sign not required but *unit is required*. |
| 2(b)(iv) | Curve does not have a sharp peak/ has a flat region ✓ | 1 | Or words to this effect. |
| 2(c)(i) | $t_{max}$ = (1030/93) x ln10.3<br>= 25.8 s ✓ | 1 | Exact answer only including unit. |
| 2(c)(ii) | My two answers for $t_{max}$ agree/do not agree ✓<br>Within the estimated experimental error ✓ | 2 | The first mark is for a justifiable statement of agreement or not.<br>The second mark is for a valid reference to the estimated uncertainty as given in the answer to question 2(b)(iii).<br>**The second mark cannot be awarded if the candidate has not answered question 2(b)(iii).** |

| Question | Written Test: Section B | Mark | Additional marking guidance |
|---|---|---|---|
| 2(c)(iii) | (a) The curve would have a longer/flatter peak<br>(b) The curve would peak later/ $t_{max}$ would be greater<br>(c) The formula gives $t_{max}$ = 46.5 s<br>(d) The peak would be higher/$V_{max}$ would be greater<br>(e) Because $C_1$ would discharge more slowly<br>(f) The charging pd across $C_2$ would not have decreased so much by the time the peak voltage was reached<br>✓✓✓✓ **4 marks max** | 4 | ***Award up to four from the six marks available***<br>*Place a tick clearly near the appropriate point in the text for each mark awarded, and annotate the tick with the corresponding letter (eg. ✓a )* |
| | **Total** | **16** | |

| Question | Written Test: Section B | Mark | Additional guidance notes |
|---|---|---|---|
| 3 | Connect the voltmeter in parallel with both the battery and the capacitor (this arrangement can be credited if shown on a diagram) **and** then measure and record the pd across the capacitor✓<br><br>Disconnect the voltmeter and *then* disconnect the battery✓<br><br>Leave the charged capacitor for a period of time equal to $T_{1/3}$ *for the largest value of R* and then reconnect the voltmeter and immediately measure and record the pd across the capacitor✓<br><br>If the two values of the pd are the same then charge leakage cannot explain her results<br>**Or**<br>If the two pds are not the same then charge leakage probably contributed to her results✓ | **4** | *The first three marks are for the method and the last mark for the explanation*<br><br>Allow credit for any other **correct** alternative response. |
| | **Total** | **4** | |