# Cambridge International AS & A Level

**PHYSICS** **9702/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2021**

MARK SCHEME

Maximum Mark: 30

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **10** printed pages.

 

**Annotations**

| | |
|---|---|
| ✓ | Correct point<br>Method of analysis marks in **Question 1** |
| $✓_{1–10}$ | Additional detail marks in **Question 1** |
| **X** | Incorrect point |
| **^** | Omission |
| **BOD** | Benefit of the doubt |
| **NBOD** | No benefit of the doubt given |
| **ECF** | Error carried forward |
| **P** | Defining the problem marks in **Question 1**<br>Power of ten error in **Question 2** |
| **M0** | Methods of data collection marks in **Question 1** |
| **SF** | Incorrect number of significant figures |

| Question | Answer | Marks |
|---|---|---|
| 1 | **Defining the problem** | |
| | $A$ is the independent variable and $t$ is the dependent variable **or** vary $A$ and measure $t$ | **1** |
| | keep $\Delta\theta$ <u>constant</u> | **1** |
| | **Methods of data collection** | |
| | labelled diagram of workable experiment including:<br>• beaker of water<br>• cylinder in water<br>• electrical heater in water<br>• thermometer in water<br>• minimum of three labels from heater, thermometer, cylinder, water, beaker | **1** |
| | circuit diagram to determine power of the heater e.g. ammeter and voltmeter correctly positioned with a power supply **or** wattmeter correctly connected to power supply and heater | **1** |
| | method to determine time for temperature of water to increase or $t$, e.g. use a stopwatch/timer | **1** |
| | method to determine $A$, e.g. micrometer/calipers to determine <u>diameter</u> of cylinder **and** $A = \pi d^2/4$ | **1** |
| | **Method of analysis** | |
| | plot a graph of $t$ against $A$ (**not** logarithmic graphs) | **1** |
| | $W = \dfrac{\text{gradient} \times P}{h\Delta\theta}$ | **1** |
| | $Z = \dfrac{y\text{-intercept} \times P}{\Delta\theta}$ | **1** |

| Question | Answer | Marks |
|---|---|---|
| 1 | **Additional detail including safety considerations** | **6** |
| | D1 wear (heat proof) gloves to prevent burns from hot beaker/cylinder/heater/water | |
| | D2 keep *P* and *h* constant | |
| | D3 check that/ensure/keep initial temperature of the water constant **or** volume/mass of water constant | |
| | D4 use calipers/ruler to measure *h* | |
| | D5 repeat measurements of diameter in different directions/at different positions along cylinder and average | |
| | D6 method to calculate power of heater e.g. $P = VI$ linked to correct circuit diagram for ammeter/voltmeter method | |
| | D7 repeat measurements of *t* for same *A* and average *t* | |
| | D8 ensure heater and cylinder are (totally) submerged/immersed<br>**or**<br>stir water (using a glass rod/stirrer) | |
| | D9 relationship valid if a straight line (not passing through the origin) | |
| | D10 method to insulate beaker, e.g. use of a lid on the beaker or foam/insulation around outside of beaker | |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | gradient = $\frac{1}{E}$<br>$y$-intercept = $\frac{r}{E}$ | 1 |
| 2(b) | <table><tr><th>$(R_1 + R_2)$ / Ω</th><th>$\frac{1}{I}$ / $A^{-1}$</th></tr><tr><td>55</td><td>58.1 or 58.14</td></tr><tr><td>69</td><td>70.4 or 70.42</td></tr><tr><td>78</td><td>78.1 or 78.13</td></tr><tr><td>80</td><td>80.6 or 80.65</td></tr><tr><td>89</td><td>87.7 or 87.72</td></tr><tr><td>103</td><td>99.0 or 99.01</td></tr></table>Values of $(R_1 + R_2)$ and $\frac{1}{I}$ as shown above. | 1 |
| | Absolute uncertainties in $(R_1 + R_2)$ from ± (2.75 or 2.8 or 3) to ± (5.15 or 5.2 or 5). | 1 |
| 2(c)(i) | Six points plotted correctly.<br>Must be accurate to the nearest half a small square. Diameter of points must be less than half a small square. | 1 |
| | Error bars in $(R_1 + R_2)$ plotted correctly.<br>All error bars must be plotted. Total length of bar must be accurate to less than half a small square and symmetrical. | 1 |

| Question | Answer | Marks |
|---|---|---|
| 2(c)(ii) | Line of best fit drawn covers all points.<br>Points must be balanced. Do not allow line from top point to bottom point.<br>Line must pass between (61.0, 65.0) and (63.5, 65.0) **and** between (96.5, 95.0) and (98.5, 95.0). | **1** |
| | Worst acceptable line drawn (steepest or shallowest possible line that passes through all error bars).<br>All error bars must be plotted. | **1** |
| 2(c)(iii) | Gradient determined with clear substitution of data points into $\Delta y / \Delta x$.<br>Distance between data points must be at least half the length of the drawn line. | **1** |
| | Gradient of worst acceptable line determined.<br><br>uncertainty = (gradient of line of best fit – gradient of worst acceptable line)<br>**or**<br>uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient) | **1** |
| 2(c)(iv) | *y*-intercept determined by substitution of correct point into $y = mx + c$. | **1** |
| | *y*-intercept of worst acceptable line determined by substitution into $y = mx + c$.<br><br>uncertainty = (*y*-intercept of line of best fit – *y*-intercept of worst acceptable line)<br>**or**<br>uncertainty = ½ (steepest worst line *y*-intercept – shallowest worst line *y*-intercept)<br><br>Do not allow ECF from false origin method. | **1** |
| 2(d)(i) | *E* determined using gradient **and** *E* <u>and</u> *r* given to two or three significant figures.<br><br>$E = \frac{1}{\text{gradient}}$ | **1** |
| | *r* determined using *y*-intercept with correct substitution **and** units with correct power of ten for *E* <u>and</u> *r*.<br><br>$r$ = *y*-intercept / gradient **or** $r = E \times$ *y*-intercept | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2(d)(ii) | Absolute uncertainty in *E* determined with method shown e.g.<br>$\Delta E = \frac{\Delta \text{gradient}}{\text{gradient}} \times E$<br>**or**<br>correct substitution for max/min methods e.g.<br>$\Delta E = \frac{1}{\text{min gradient}} - E$<br>$\Delta E = E - \frac{1}{\text{max gradient}}$ | **1** |
| 2(e) | Value of $R_2$ determined from **(d)(i) or (c)(iii)** and **(c)(iv)**, with correct substitution <u>and</u> correct power of ten.<br>$R_2 = \frac{E}{0.0075} - (22 + r)$<br>**or**<br>$R_2 = \frac{1}{0.0075 \times \text{gradient}} - (22 + r)$ | **1** |