Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2020**

MARK SCHEME

Maximum Mark: 30

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

Mark schemes should usually be read together with the Principal Examiner Report for Teachers. However, because students did not sit exam papers, there is no Principal Examiner Report for Teachers for the June 2020 series.

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

Cambridge International is publishing the mark schemes for the June 2020 series for most Cambridge IGCSE™ and Cambridge International A & AS Level components, and some Cambridge O Level components.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form, (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Annotations

✓	Correct point 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** Power of ten error in **Question 2**
M0	Methods of data collection marks in **Question 1**

Question	Answer	Marks
1	**Defining the problem**	
	A is the independent variable and *k* is the dependent variable **or** vary *A* and measure *k*	**1**
	keep *N* constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • spring fixed at one end to a support • load attached to the other end of the spring • labelled load	**1**
	method to measure mass or weight of load: use top-pan balance to measure mass or newton meter to measure weight	**1**
	use of a micrometer/calipers to determine *t* **and** rule/calipers to measure the diameter of the spring	**1**
	method to measure extension, e.g. labelled ruler drawn parallel to spring, equilibrium position and displaced position indicated and *x* indicated **or** description of use of ruler to measure equilibrium position and displaced position and difference determined	**1**
	Method of analysis	
	plot a graph of *k* against $1 / A^{3/2}$ (or $A^{-3/2}$) or equivalent e.g. lg *k* against lg *A*	**1**
	relationship valid if a straight line passing through the origin is produced (for lg *k* against lg *A*, relationship valid if a straight line with gradient –3/2)	**1**
	$\beta = \dfrac{\text{gradient} \times N}{\rho t^4}$ [for lg *k* against lg *A*, $\beta = 10^{y\text{-intercept}} \times N / (\rho t^4)$]	**1**

Question	Answer	Marks
1	**Additional detail including safety considerations**	**6**
	D1 use safety goggles/safety screen <u>to prevent injury to eyes from (moving) spring/load</u> **or** use cushion/sand box <u>in case load falls</u>	
	D2 keep *t* constant	
	D3 $k = \frac{mg}{x}$ or $\frac{F}{x}$	
	D4 use of set square when taking measurements to determine extension of spring	
	D5 repeat measurement of *t* <u>along wire/spring</u> and average	
	D6 repeat measurement of diameter *D* of spring (to determine *A*) <u>in different directions</u> and average	
	D7 use of $A = \frac{\pi D^2}{4}$	
	D8 method to ensure clamped rule to measure extension is vertical, e.g. correctly positioned set square indicated at right angles between the rule and the horizontal surface **or** plumb line shown in appropriate position	
	D9 method to determine the density of the wire **or** additional detail on construction of coil	
	D10 method to determine the mean diameter of the spring, e.g. subtract *t* from external diameter of spring	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = $\frac{-1}{CR}$

y-intercept = ln $\frac{Q_0}{C}$</td><td>1</td></tr>
<tr><td rowspan="2">2(b)</td><td><table><tr><td>ln (V / V)</td></tr><tr><td>1.82 or 1.825</td></tr><tr><td>1.53 or 1.526</td></tr><tr><td>1.22 or 1.224</td></tr><tr><td>0.96 or 0.956</td></tr><tr><td>0.69 or 0.693</td></tr><tr><td>0.34 or 0.336</td></tr></table></td><td>1</td></tr>
<tr><td>Absolute uncertainties in ln V from ± 0.03 or ± 0.04 to ± 0.13 or ± 0.14 or ± 0.15.</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>Six points plotted correctly.
Must be within half a small square. Diameter of points must be less than half a small square.</td><td>1</td></tr>
<tr><td>Error bars in ln V plotted correctly.
All error bars to be plotted. Length of bar must be accurate to less than half a small square and symmetrical.</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(ii)</td><td>Line of best fit drawn.
Points must be balanced. Do not accept top point to bottom point.
Line must pass between (4.0, 1.6) and (5.0, 1.6) and between (26.5, 0.5) and (28.0, 0.5)</td><td>1</td></tr>
<tr><td>Worst acceptable line drawn (steepest or shallowest possible line that passes through all the error bars).
All error bars must be plotted.</td><td>1</td></tr>
</table>

Question	Answer	Marks
2(c)(iii)	Gradient determined with clear substitution of data points into $\Delta y / \Delta x$. Distance between data points must be at least half the length of the drawn line. Gradient must be negative.	1
	uncertainty = (gradient of line of best fit – gradient of worst acceptable line) or uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)	1
2(c)(iv)	*y*-intercept read from *y*-axis to less than half a small square **or** *y*-intercept determined from substitution into $y = mx + c$.	1
2(d)(i)	*C* determined using gradient **and** *C* and Q_0 given to two or three significant figures. Correct substitution of numbers required. $C = \frac{-1}{39 \times 10^3 \times \text{gradient}} = \frac{-1}{39 \times 10^3 \times \textbf{(c)(iii)}}$	1
	Q_0 determined using *y*-intercept. $Q_0 = C \times e^{y\text{-intercept}} = C \times e^{\textbf{(c)(iv)}}$	1
	C determined using gradient **and** Q_0 determined using *y*-intercept **and** dimensionally correct units for *C* (F or $\text{s}\,\Omega^{-1}$) and Q_0 (C or $\text{V s}\,\Omega^{-1}$ or A s).	1
2(d)(ii)	Absolute uncertainty in *C*. $\Delta C = \left(0.05 + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times C$	1

Question	Answer	Marks
2(e)	V determined from **(d)(i)** (**or (c)(iii)** and **(c)(iv)**) with correct substitution shown and correct power of ten. $V = \frac{Q_0}{C} \times e^{\frac{-60}{CR}} = e^{y\text{-intercept}} \times e^{(\text{gradient} \times 60)}$ **or** $\ln V = -(t / RC) + \ln(Q_0 / C) = -(60 / 39\,000) \times$ **(d)(i)** $+ \ln(Q_0 / C)$ $\ln V = 60 \times$ gradient $+ y$-intercept $\ln V = 60 \times$ **(c)(iii)** + **(c)(iv)**	**1**