Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/52**

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 *f* is the dependent variable **or** vary *A* and measure *f*	**1**
	keep *M* constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • elastic cord fixed at one end to a support • other end passed over a pulley • labelled pulley • labelled load	**1**
	vibrator connected to signal generator	**1**
	increase/decrease the frequency of the signal generator until stationary wave pattern is observed	**1**
	measure diameter of cord with micrometer/calipers	**1**
	Method of analysis	
	plot a graph of f^2 against 1 / *A* or equivalent (e.g. lg *f* against lg *A*)	**1**
	relationship valid if a straight line passing through the origin is produced (for lg *f* against lg *A*, relationship valid if a straight line with gradient –½)	**1**
	$k = \dfrac{M}{\text{gradient} \times 4 \times L^2}$ (for lg *f* against lg *A*, $k = M / [10^{(2 \times y\text{-intercept})} \times 4 \times L^2]$)	**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) elastic cord/load</u> **or** use cushion/sand box <u>in case load falls</u>	
	D2 keep *L* constant	
	D3 use cords of the same material/density	
	D4 use CRO to determine *f* (or *T*)	
	D5 method to determine *T* from CRO, e.g. period = time base × length of one wave	
	D6 $f = 1 / T$	
	D7 repeat measurement of diameter along cord and average	
	D8 use of $A = \frac{\pi d^2}{4}$	
	D9 measure mass of the load on top-pan balance	
	D10 detail on determining frequency at the maximum amplitude, e.g. increase frequency until the amplitude starts to decrease, then decrease frequency	

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

y-intercept = $\ln H$</td><td>1</td></tr>
<tr><td rowspan="2">2(b)</td><td><table><tr><td>ln (η / 10^{-4} Pa s)</td></tr><tr><td>2.510 or 2.5096</td></tr><tr><td>2.28 or 2.282</td></tr><tr><td>2.13 or 2.128</td></tr><tr><td>1.92 or 1.917</td></tr><tr><td>1.72 or 1.723</td></tr><tr><td>1.57or 1.569</td></tr></table></td><td>1</td></tr>
<tr><td>Absolute uncertainties in ln η from ± 0.02 (or ± 0.016) to about ± 0.04</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>Six points plotted correctly.
Must be accurate to nearest 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 η 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 (2.93, 1.65) and (2.96, 1.65) and between (3.38, 2.45) and (3.41, 2.45).</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.	**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 determined from substitution into $y = mx + c$.	**1**
2(d)(i)	*E* determined using gradient **and** given to two or three significant figures. Correct substitution of numbers required. $E = 1.38 \times 10^{-23} \times$ gradient $= 1.38 \times 10^{-23} \times$ **(c)(iii)**	**1**
	H determined using *y*-intercept. $H = e^{y\text{-intercept}} = e^{\textbf{(c)(iv)}}$ $(\times 10^{-4})$	**1**
	E determined using gradient **and** *H* determined using *y*-intercept **and** dimensionally correct units for *E* (J) and *H* (Pa s).	**1**
2(d)(ii)	Absolute uncertainty in *E*. $\Delta E = 1.38 \times 10^{-23} \times$ absolute uncertainty in gradient **or** $\Delta E = \frac{\Delta \text{gradient}}{\text{gradient}} \times E$	**1**

Question	Answer	Marks
2(e)	η determined from **(d)(i)** or **(c)(iii) and (c)(iv)** with correct substitution shown and correct power of ten. $\eta = H \times e^{\frac{E}{k \times 273}} = e^{\textbf{(c)(iv)}} \times 10^{-4} \times e^{\frac{\textbf{(d)(i)}}{1.38 \times 10^{-23} \times 273}}$ **or** $\eta = e^{y\text{–intercept}} \times 10^{-4} \times e^{\frac{\text{gradient}}{273}}$ **or** $\eta = e^{\textbf{(c)(iv)}} \times 10^{-4} \times e^{\frac{\textbf{(c)(iii)}}{273}}$ **or** $\ln\eta = \frac{E}{kT} + \ln H = \frac{\textbf{(d)(i)}}{1.38 \times 10^{-23} \times 273} + \textbf{(c)(iv)}$ **or** $\ln\eta = \frac{\text{gradient}}{273} + y\text{-intercept} = \frac{\textbf{(c)(iii)}}{273} + \textbf{(c)(iv)}$	**1**