Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **February/March 2022**

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 February/March 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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.

Examples of how to apply the list rule
State **three** reasons…. [3]

A

1	Correct	✓	**2**
2	Correct	✓	
3	Wrong	×	

B
(4 responses)

1	Correct, Correct	✓, ✓	**3**
2	Correct	✓	
3	Wrong	ignore	

C
(4 responses)

1	Correct	✓	**2**
2	Correct, Wrong	✓, ×	
3	Correct	ignore	

D
(4 responses)

1	Correct	✓	**2**
2	Correct, CON (of 2.)	×, (discount 2)	
3	Correct	✓	

E
(4 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct, Wrong	✓	

F
(4 responses)

1	Correct	✓	**2**
2	Correct	✓	
3	Correct CON (of 3.)	× (discount 3)	

G
(5 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct Correct CON (of 4.)	✓ ignore ignore	

H
(4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	CON (of 2.) Correct	(discount 2) ✓	

I
(4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	Correct CON (of 2.)	✓ (discount 2)	

Question	Answer	Marks
1	**Defining the problem** θ is the independent variable and v is the dependent variable, or vary θ and measure v.	**1**
	Keep d constant	**1**
	Methods of data collection Labelled diagram of workable experiment including: • sheet supported by stand / jack • light gate positioned at X • support, light gate and X labelled.	**1**
	Light gate connected to timer / datalogger.	**1**
	Measure length (L) (of card) interrupted by beam for single light gate.	**1**
	Method to measure θ, e.g. use protractor or Method to determine θ, e.g. use a rule(r) to measure two appropriate distances to use in a trigonometrical ratio	**1**
	Method of Analysis Plots a graph of v^2 on y-axis and sin θ on x-axis. **Allow** other valid graphs, e.g. sin θ against v^2 Do not accept log graphs.	**1**
	$p = \frac{\text{gradient}}{2d}$ for v^2 against sin θ or $p = \frac{1}{2d \times \text{gradient}}$ for sin θ against v^2	**1**

Question	Answer	Marks
1	$q = -\dfrac{m \times y - \text{intercept}}{2Bd}$ for v^2 against sin θ or $q = \dfrac{mp \times y - \text{intercept}}{B} = \dfrac{m \times y - \text{intercept}}{2dB \times \text{gradient}}$ for sin θ against v^2	**1**
	Additional detail including safety considerations Any six from:	**6**
	D1 Method to <u>stop</u> the trolley once the trolley passes X, e.g. place a block / stop on the bench near the end of the sheet Ignore trolley falls	
	D2 Keep *B* <u>and</u> *m* constant	
	D3 Use a rule(r) to measure *d*	
	D4 Method to keep *d* constant, e.g. mark distance *d* on the sheet or the starting position of the trolley on the sheet	
	D5 Method to measure mass of trolley (and magnet), e.g. use balance or use newton meter to measure weight and divide by *g* <u>and</u> Measure *B* using a (calibrated) Hall probe	
	D6 Additional detail on use of Hall probe, e.g. adjust probe until <u>maximum</u> value or measure *B* using Hall probe first in one direction, then in the opposite direction and average	
	D7 Determine *v* (the velocity at X) from *L* / *t* (for a single light gate)	
	D8 Additional detail on measuring θ, e.g. protractor drawn in correct position on diagram, or additional detail on determining θ, e.g. relationship between measured lengths and θ	

Question	Answer	Marks
1	D9 Relationship valid <u>if</u> a straight line is produced (not passing through the origin)	
	D10 Repeat experiment for each θ <u>and</u> average v.	

Question	Answer	Marks
2(a)	Gradient = $\dfrac{1}{2\pi fC}$	**1**
2(b)	<table><tr><th>$\dfrac{1}{R}$ / $10^{-3}\,\Omega^{-1}$</th><th>tan θ</th></tr><tr><td>83 or 83.3</td><td>6.17 or 6.174</td></tr><tr><td>63 or 62.5</td><td>4.51 or 4.511</td></tr><tr><td>45 or 45.5</td><td>3.27 or 3.271</td></tr><tr><td>30 or 30.3</td><td>2.16 or 2.164</td></tr><tr><td>26 or 25.6</td><td>1.86 or 1.857</td></tr><tr><td>23 or 23.3</td><td>1.68 or 1.684</td></tr></table>	**1**
	Absolute uncertainties in $\dfrac{1}{R}$ from ± 4 to ± 1	**1**

Question	Answer	Marks
2(c)(i)	Six points from **(b)** plotted correctly. Must be within half a small square. Diameter of points must be less than half a small square.	**1**
	Error bars in $\frac{1}{R}$ plotted correctly. All error bars to be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.	**1**
2(c)(ii)	Straight line of best fit drawn. Points must be balanced. Do not accept line from top plot to bottom plot. Line must pass between (33.5, 2.5) and (35.0, 2.5) and (74.0, 5.5) and (76.0, 5.5)	**1**
	Worst acceptable line drawn. Steepest or shallowest possible line that passes through all the error bars. All error bars must be plotted.	**1**
2(c)(iii)	Gradient determined with clear substitution of data points into $\Delta y/\Delta x$; distance between data points must be greater than half the length of the drawn line.	**1**
	Gradient determined of WAL with clear substitution of data points into $\Delta y/\Delta x$; 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(d)	99 ± 2 (Hz)	**1**
2(e)(i)	C determined using gradient and C given to two or three significant figures. $C = \frac{1}{2\pi f \times \text{gradient}} = \frac{1}{2\pi \times \textbf{(d)} \times \textbf{(c)(iii)}}$	**1**
	C determined using gradient with correct SI unit and power of ten for C: F or s Ω^{-1}	**1**

Question	Answer	Marks
2(e)(ii)	Percentage uncertainty in C determined with method shown. $\%\text{uncertainty} = \left(\frac{\Delta f}{f} + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times 100$ OR Correct substitution for max/min methods $\max C = \frac{1}{2\pi \times \min f \times \text{mingradient}}$ $\min C = \frac{1}{2\pi \times \max f \times \text{maxgradient}}$	**1**
2(f)	R determined to at least two significant figures with appropriate power of ten from **(c)(iii)** OR **(d)** and **(e)(i)** with correct substitution seen. $R = \frac{\text{gradient}}{\tan\theta} = \frac{\textbf{(c)(iii)}}{0.839}$ OR $R = \frac{1}{2\pi f C \tan\theta} = \frac{1}{2\pi \times \textbf{(d)} \times \textbf{(e)(i)} \times 0.839}$	**1**
	Absolute uncertainty in R determined. Method must be consistent with determination of R and correct substitution must be seen. For R determined by using the gradient: $\Delta R = \frac{\Delta\text{gradient}}{\text{gradient}} \times R$ OR For R determined by using **(d)** and **(e)(i)**: $\Delta R = \left(\frac{\Delta f}{f} + \frac{\Delta C}{C}\right) \times R$ OR ΔR determined by max / min methods.	**1**