Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **March 2020**

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 March 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **11** printed pages.

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> (see examples below) 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.

General Marking Points

When marking at the computer:

- ensure your sitting position is comfortable
- take regular breaks
- don't mark when very tired
- try to mark some scripts every day
- don't leave it all to the last minute
- there may not be sufficient scripts in the pot if you are the last to finish!

Check Blank Pages e.g. pages 2 and 5 and Additional Objects:

Before marking each script check any blank pages at the end for student answers and add some annotation to show the page has been viewed. It is useful to highlight any written notes.

Link 'additional objects'.

Annotations

✓	Tick	Correct point Use in question 1 to represent analysis marks
✗	Cross	Incorrect point
^	^	Omission mark
BOD	BOD	Benefit of the doubt
NBOD	NBOD	No benefit of doubt given
ECF	ECF	Error carried forward
P	P	Defining the problem mark in question 1 Also indicates POT in question 2
M0	M0	Method of data collection mark in question 1

✓1	Tick 1	Additional Detail mark point 1
✓2	Tick 2	Additional Detail mark point 2
✓3	Tick 3	Additional Detail mark point 3
✓4	Tick 4	Additional Detail mark point 4
✓5	Tick 5	Additional Detail mark point 5
✓6	Tick 6	Additional Detail mark point 6
✓7	Tick 7	Additional Detail mark point 7
✓8	Tick 8	Additional Detail mark point 8
✓9	Tick 9	Additional Detail mark point 8
✓10	Tick 10	Additional Detail mark point 8
	Highlighter	Highlighting areas of text
	On-page comment	Allows comments to be entered in speech bubbles on the candidate response.

etc.

Question	Answer	Marks
1	**Defining the problem**	
	x is the independent variable and *E* is the dependent variable, or vary *x* and measure *E.*	**1**
	Keep *B* or *m* constant and keep *k* or *N* constant.	**1**
	Methods of data collection	
	Labelled diagram of workable experiment including: • labelled spring supported by stand and clamp • labelled magnet • labelled coil positioned so that magnet is vertically above the coil by eye in the correct orientation.	**1**
	Circuit diagram showing voltmeter / multimeter set to p.d. range / oscilloscope connected to the ends of the coil. Do not accept other electrical components.	**1**
	Method to measure *x*, e.g. labelled ruler drawn parallel to spring/magnet and equilibrium position and displaced position indicated and *x* indicated or difference determined or description of use of ruler to measure equilibrium position and displaced position and difference determined.	**1**
	Method to measure mass of magnet e.g. use balance or use newton-meter to measure weight and divide by *g*.	**1**
	Method of Analysis	
	Plots a graph of *E* against *x* or equivalent. **Allow** lg *E* against lg *x.*	**1**
	Relationship valid if a straight line passing through the origin is produced. (for lg *E* against lg *x*: relationship valid if a straight line with gradient = 1).	**1**
	$\alpha = \frac{\text{gradient}}{BN}\sqrt{\frac{m}{k}}$ (for lg *E* against lg *x*: $\alpha = \frac{10^{y\text{-intercept}}}{BN}\sqrt{\frac{m}{k}}$)	**1**

Question	Answer		Marks
1	**Additional detail including safety considerations**	**Max 6**	**6**
	Use safety goggles / safety screen to prevent injury (to eyes) from (detached) spring/magnet; do not accept from oscillating magnet or use cushion / sand box <u>in case magnet falls</u> or use g clamp / weights on stand <u>to prevent toppling</u>.	D1	
	Keep distance between equilibrium position and coil <u>constant</u>.	D2	
	Check that the unstretched length of the spring has not changed or is not permanently deformed (after removing load / magnet).	D3	
	Expression to determine k from relevant experiment, e.g. $k = mg$ / extension or gradient of F – extension graph. Weight / force must be defined.	D4	
	Measure B using a (calibrated) Hall probe.	D5	
	Additional detail on use of Hall probe, e.g. adjust probe until maximum value or measure B using Hall probe first in one direction and then in the opposite direction and average.	D6	
	Method to maximise E, e.g. position magnet so that equilibrium position is at the centre of the coil or use a large number of turns.	D7	
	Explanation to determine max E e.g. use of video and slow-motion playback.	D8	
	Repeat experiment for each x and average E.	D9	
	Method to ensure <u>clamped rule to measure x</u> is vertical, e.g. correctly positioned set square indicated at right angles between the rule <u>and</u> the horizontal surface or plumb line supported on a surface shown in appropriate position.	D10	

Question	Answer	Marks
2(a)	Gradient = $\dfrac{-1}{CR}$ y-intercept = $\ln \dfrac{E}{R}$	1
2(b)	3.83 or 3.829 3.69 or 3.689 3.53 or 3.526 3.33 or 3.332 3.18 or 3.178 3.00 or 2.996	1
	Absolute uncertainties in ln I from ± 0.04 to ± 0.1	1
2(c)(i)	Six points plotted correctly. Must be within half a small square. Diameter of points must be less than half a small square.	1
	Error bars in ln I 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)	Line of best fit drawn. Points must be balanced. Line must pass between (5.5, 3.75) and (8.0, 3.75) <u>and</u> between (56, 3.05) and (58, 3.05)	1
	Worst acceptable line drawn. Steepest or shallowest possible line that passes through all the error bars. Mark scored only if all error bars are plotted.	1

Question	Answer	Marks
2(c)(iii)	<u>Negative</u> 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**
	Gradient determined of WAL 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 $y = \text{m}\,x + \text{c}$.	**1**
2(d)(i)	*C* determined using gradient <u>and</u> *C* given to two or three significant figures Correct substitution of numbers must be seen, $C = \frac{-1}{150 \times 10^3 \times \text{gradient}} = \frac{-1}{150 \times 10^3 \times \text{(c)(iii)}}$	**1**
	E determined using *y*-intercept Correct substitution of numbers must be seen, $E = R \times e^{y\text{-intercept}} = 150 \times 10^3 \times \text{e}^{\text{(c)(iv)}} \left(\times 10^{-6}\right)$ Or $\ln E = \ln R + y\text{-intercept}$	**1**
	C determined using gradient <u>and</u> *E* determined using *y*-intercept <u>and</u> dimensionally correct SI unit for C: F or s Ω^{-1} or C V^{-1} or A s V^{-1} and *E*: V or A Ω.	**1**

Question	Answer	Marks
2(d)(ii)	Absolute uncertainty in *C*. $\Delta C = \left(0.05 + \frac{\Delta \text{gradient}}{\text{gradient}}\right) \times C$ OR Correct substitution for max/min methods $\max C = \frac{-1}{142.5 \times 10^3 \times \text{min numerical gradient}}$ $\min C = \frac{-1}{157.5 \times 10^3 \times \text{max numerical gradient}}$	**1**
2(e)	I determined from **(d)(i)** OR **(c)(iii)** and **(c)(iv)** with correct substitution <u>and</u> correct power of ten(s). Do not accept ecf for POT from **(c)(iii)**, **(iv)** or **(d)**. $I = \frac{E}{R} \times e^{\frac{-120}{CR}}$ OR $I = e^{y\text{-intercept}} \times e^{(\text{gradient} \times 120)} \times 10^{-6}$ OR $\ln I = 120 \times \text{gradient} + y\text{-intercept}$ $I = e^{120 \times \text{gradient} + y\text{-intercept}} \times 10^{-6}$	**1**