Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2018**

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 October/November 2018 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Cambridge Assessment International Education

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.

Question	Answer	Marks
1	**Defining the problem**	
	P is the independent variable and θ is the dependent variable, or vary P and measure θ. (Allow θ is the independent variable and P is the dependent variable.)	**1**
	keep density of salt solution constant or keep σ <u>constant</u>	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • sealed container e.g. bell jar, sealed conical flask • tube connected to pump (for changing pressure) or other workable method • salt solution, labelled	**1**
	workable method to heat salt solution within the sealed container, e.g. hot plate/(electrical) heater	**1**
	description of pressure gauge or manometer to measure P	**1**
	use of a thermometer to measure θ **or** labelled thermometer (in salt solution) in diagram	**1**
	Method of analysis	
	plot a graph of lg θ against lg P (or ln θ against ln P)	**1**
	q = gradient	**1**
	$k = 10^{y\text{-intercept}} / \sigma$ (for ln θ against ln P: $k = e^{y\text{-intercept}} / \sigma$)	**1**

Question	Answer	Marks
	Additional detail including safety considerations	**Max. 6**
	D1 safety precaution relating to pressure, e.g. safety screen	
	D2 use of (protective) gloves to handle hot salt solution/beaker/flask	
	D3 density of salt solution or ρ given by m/V	
	D4 measuring cylinder to measure volume **and** difference in top pan balance/scales readings to measure mass of salt solution	
	D5 slowly/gradually increase/decrease the temperature/pressure	
	D6 measure P and θ when salt solution starts to boil	
	D7 $\lg\theta = q\lg P + \lg k\sigma$	
	D8 relationship valid if a straight line	
	D9 identification of when (salt solution) starts to boil, e.g. wait until (vapour) bubbles are on the surface or surface moves or temperature remains constant (for heating methods)	
	D10 recheck that density of salt solution is constant/add water to keep density constant/take multiple solutions from a large volume	

Question	Answer	Marks
2(a)	gradient = $4\pi\varepsilon_0 / Q$ y-intercept = $4\pi\varepsilon_0 a / Q$	1
2(b)	0.800 or 0.8000 0.952 or 0.9524 1.1 or 1.11 1.3 or 1.25 1.4 or 1.43 1.7 or 1.67	1
	absolute uncertainties in $\frac{1}{V}$: ±0.03 to ±0.05 or ±0.06	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 $\frac{1}{V}$ 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 should pass to the right of (0.019, 0.800) **and** line should pass between (0.104, 1.6) and (0.108, 1.6).	1
	Worst acceptable line drawn (steepest or shallowest possible line that passes through all the error bars). All error bars must be plotted.	1

Question	Answer	Marks
2(c)(iii)	Gradient determined with clear substitution of points from line of best fit into $\Delta y / \Delta x$. Distance between 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 by substitution into $y = mx + c$.	**1**
	y-intercept of worst acceptable line determined by substitution into $y = mx + c$. uncertainty = y-intercept of line of best fit – y-intercept of worst acceptable line **or** uncertainty = ½ (steepest worst line y-intercept – shallowest worst line y-intercept) Do not allow if false origin used.	**1**

Question	Answer	Marks
2(d)(i)	*Q* calculated using gradient. Correct substitution of numbers required. $Q = \frac{1.11\times10^{-10}}{\text{gradient}} = \frac{1.11\times10^{-10}}{\text{(c)(iii)}}$	**1**
	a calculated using *y*-intercept. Correct substitution of numbers required. $a = \frac{Q\times y\text{-intercept}}{1.11\times10^{-10}}$ **or** $a = \frac{y\text{-intercept}}{\text{gradient}}$	**1**
	Q and *a* determined using correct method with: • Unit of *Q* with correct power of ten – C, F V • Correct power of ten for *a* • *Q* and *a* given to 2 or 3 significant figures.	**1**

Question	Answer	Marks
2(d)(ii)	Percentage uncertainty in *a* determined. Correct substitution of numbers required. %uncertainty in *Q* + %uncertainty in *y*-intercept **or** %uncertainty in gradient + %uncertainty in *y*-intercept Maximum/minimum methods: $\max a = \dfrac{\max y\text{-intercept} \times \max Q}{1.11 \times 10^{-10}}$ $\max a = \dfrac{\max y\text{-intercept}}{\min \text{gradient}}$ $\min a = \dfrac{\min y\text{-intercept} \times \min Q}{1.11 \times 10^{-10}}$ $\min a = \dfrac{\min y\text{-intercept}}{\max \text{gradient}}$	**1**