Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/53**

Paper 5 Planning, Analysis and Evaluation **May/June 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 May/June 2018 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **7** 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.

Question	Answer	Marks
1	**Defining the problem**	
	V is the independent variable and *F* is the dependent variable **or** vary *V* and measure *F*.	**1**
	keep *r* constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • T suspended (clamp or ceiling) • S on top-pan balance vertically below T • T and S labelled and at least one other label.	**1**
	F = difference/change in balance readings when sphere(s) (S) is uncharged and charged.	**1**
	voltmeter across a power supply (with flying lead) **or** read *V* from <u>high</u> voltage power supply/<u>EHT</u> power supply	**1**
	measure *r* with a rule	**1**
	Method of analysis	
	plot a graph of *F* against *V* (allow valid log-log graphs)	**1**
	relationship valid <u>if</u> a straight line passing through the origin is produced	**1**
	α = gradient × r^2 (consistent with graph)	**1**

Question	Answer		Marks
	Additional detail including safety considerations		**Max. 6**
	D1	safety precaution linked to avoiding shock/high voltages, e.g. insulating gloves to hold flying lead/to charge sphere/to avoid electrocution **or** use shrouded leads/ensure that there no bare connections/avoid touching metal parts	
	D2	use of insulator between sphere S and balance or between sphere T and stand	
	D3	discharge sphere(s) by earthing or connecting to the negative of the power supply	
	D4	additional detail to determine *r* e.g. determine radius of each sphere and add distance between spheres **or** measure from top of S to top of T etc.	
	D5	use of calipers/micrometer to measure diameter of spheres (and halve) to determine *r* **or** use of calipers/micrometer to measure diameter of spheres to check that spheres are the same diameter to determine *r* **or** use of fiducial mark and ruler from top of spheres etc.	
	D6	use of Δmg to determine *F*	
	D7	repeat experiment for each value of *V* and average *F*	
	D8	take reading of balance quickly to avoid discharge/keep other charged objects away	
	D9	method to ensure charge on S is constant, e.g. re-charge S periodically/regularly (with initial value of p.d.)/keep S connected to a separate positive terminal	
	D10	avoid draughts to prevent T moving	

Question	Answer	Marks
2(a)	gradient = $\frac{1}{4N^2D^2}$ **and** y-intercept = $-\frac{1}{D^2}$	**1**
2(b)	5.4 or 5.41 — 2.6 or 2.60 4.3 or 4.34 — 1.9 or 1.93 3.6 or 3.56 — 1.5 or 1.49 3.0 or 2.97 — 1.2 or 1.18 2.6 or 2.60 — 0.961 or 0.9612 2.3 or 2.30 — 0.826 or 0.8264	**1**
	Uncertainties in $1/s^2$ from ± 0.16 or ± 0.17 or ± 0.18 or ± 0.2 to ± 0.02 or ± 0.03.	**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 $1/s^2$ plotted correctly. All error bars to be plotted. Length of bar must be accurate to less than half a small square and symmetrical.	**1**
2(c)(ii)	Line of best fit drawn. Line does not pass through bottom point **and** line must pass between (4.70, 2.2) and (4.85, 2.2).	**1**
	Worst acceptable line drawn (steepest or shallowest possible line). All error bars must be plotted.	**1**
2(c)(iii)	Gradient determined with clear substitution of points from the line of best fit into $\Delta y/\Delta x$. Distance between points must be at least half the length of the drawn line.	**1**
	Gradient of worst acceptable line determined. uncertainty = gradient of line of best fit – gradient of worst acceptable line **or** uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)	**1**

Question	Answer	Marks
2(c)(iv)	*y*-intercept determined by substitution into $y = mx + c$.	**1**
	y-intercept determined using gradient from worst acceptable line. 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)	**1**
2(d)(i)	*D* determined using *y*-intercept **and** *N* determined using gradient. *D* **and** *N* given to 2 or 3 significant figures.	**1**
	D determined using *y*-intercept. $D = \frac{1}{\sqrt{-y\text{-intercept}}}$	**1**
	N determined using gradient with correct power of ten **and** units. Correct substitution of numbers must be seen. $N = \sqrt{\frac{1}{4 \times \text{gradient} \times D^2}}$ **or** $\sqrt{\frac{-y\text{-intercept}}{4 \times \text{gradient}}}$	**1**
2(d)(ii)	Percentage uncertainty in *N* determined. Correct substitution of numbers must be seen. % uncertainty in *N* = ½ (% uncertainty in gradient + 2 × % uncertainty in *D*) **or** % uncertainty in *N* = ½ (% uncertainty in gradient + % uncertainty in *y*-intercept)	**1**