CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the March 2016 series

9702 PHYSICS

9702/52 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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.

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1 Planning (15 marks)

Defining the problem (2 marks)

P *k* is the independent variable and *h* is the dependent variable, or vary *k*, measure *h*. [1]

P Keep mass of object constant. [1]

Methods of data collection (4 marks)

M Labelled diagram (minimum two labels) showing object (mass) attached to cord <u>and</u> other end of cord fixed (e.g. stand and clamp or hook) <u>and</u> rule(r) drawn vertically next to cord. [1]

M Method of measuring mass e.g. balance / scales. [1]

M *k* = (weight or force) / extension or *mg* / *extension*; allow graphical methods.
Allow any subject e.g. $mg = k \times extension$. [1]

M Use of rule to measure *h* or maximum distance / length (fallen by the object).
Allow clear indication on diagram (i.e. dotted lines) linking distance *h* to rule.
Do not credit length of cord. [1]

Method of analysis (3 marks)

✓ Plot a graph of $\dfrac{(h-L)^2}{h}$ against 1 / *k* [Allow 2 / *k* or 2*m* / *k* or *m* / *k*] [1]

✓ *g* = gradient / 2m [gradient / *m* or gradient or gradient / 2] [1]

✓ Relationship is valid if the graph is a straight line <u>passing through the origin</u>. [1]

Additional detail (6 marks)

D Relevant points [6]

1 Keep starting point constant/drop object from same position / use of electromagnet to drop object / ensure mass is dropped from fixed point / check object falls vertically
2 Rule(r) fixed e.g. retort stand
3 Method to determine extension, e.g. <u>measure</u> length of stretched cord and subtract original length / 50.0 cm. [Accept from a diagram]
4 Safety precaution linked to prevention of mass / cord hitting a person – use safety screen / goggles; sand tray to catch falling object <u>if cord breaks</u>
5 Trial experiment to locate approximate point of *h* / to prevent object hitting surface
6 Detailed use of video camera with slow motion or frame by frame playback / motion sensor clearly explained
7 Cord obeys Hooke's law or must not exceed elastic limit
8 Use set square to ensure ruler is vertical
9 For each cord, repeat experiment determine average *h*

Do not allow vague computer methods.

[Total: 15 marks]

2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer
(a)	A1	Gradient = $\dfrac{c_m \Delta\theta}{P}$ y-intercept = $\dfrac{m_w c_w \Delta\theta + k}{P}$
(b)	T1	Column heading m_m / g 100 200 300 400 500 600
	U1	From $\pm$ 10 to $\pm$ 60
(c)(i)	G1	Six points plotted correctly
	U2	Error bars in m_m plotted correctly
(ii)	G2	Line of best fit
	G3	Worst acceptable straight line. Steepest or shallowest possible line that passes through <u>all</u> the error bars.
(iii)	C1	Gradient of best fit line
	U3	Difference in worst gradient and gradient.
(iv)	C2	y-intercept
	U4	Uncertainty in y-intercept
(d)(i)	C3	c_m in the range 470 to 530 <u>and</u> given to 2 or 3sf
	C4	k = y-intercept x $P - m_w c_w \Delta\theta$ k = y-intercept x 50 – 21000
	C5	Units for c_m and k
(ii)	U5	Percentage uncertainty in C_m

[Total: 15 marks]

Uncertainties in Question 2

(c) (iii) Gradient [U3]

1 Uncertainty = gradient of line of best fit – gradient of worst acceptable line

2 Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(iv) [U4]

1 Uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line

2 Uncertainty = ½ (steepest worst line *y*-intercept – shallowest worst line *y*-intercept)

(d) (ii) [U5]

1 $$\%uncertainty = \left(\frac{\Delta gradient}{gradient} + \frac{5}{50} + \frac{0.5}{20}\right) x100 = \left(\frac{\Delta gradient}{gradient}\right) x100 + 12.5\%$$

2 $$\max c_m = \frac{\max gradient\ x \max power}{\min temperature\,change} = \frac{\max gradient\ x55}{19.5}$$

3 $$\min c_m = \frac{\min gradient\ x \min power}{\max temperature\,change} = \frac{\min gradient\ x45}{20..5}$$