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

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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 and other end of cord fixed (e.g. stand and clamp or hook) and 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 $\frac{(h-L)^2}{h}$ 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 passing through the origin. [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. measure 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 if cord breaks
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 ± 10 to ± 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 $\min c_m = \frac{\min gradient\ x\ min\ power}{\max temperature\ change} = \frac{\min gradient\ x45}{20..5}$