UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2009 question paper

for the guidance of teachers

9702 PHYSICS

9702/05 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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1 Planning (15 marks)

Defining the problem (3 marks)

P1 Vary l or l is the independent variable [Allow M] [1]

P2 Determine the period T (for each l [M]) or T is the dependent variable [1]

P3 M is kept constant [l is kept constant] [1]

Methods of data collection (5 marks)

M1 Diagram showing the cantilever is fixed e.g. g-clamp & bench, retort stand & clamp [1]

M2 Many oscillations repeated to determine average T (n $\geqslant$ 10 or $t \geqslant 10$ s for stopwatch) [1]

M3 Weigh M using balance [1]

M4 Measure w and d and measure/record l [1]

M5 Use of vernier caliper/micrometer to measure d and/or w [1]

Method of analysis (2 marks)

A1 Appropriate graph plotted i.e. T^2 against l^3; [T^2 against M] or lg T against lg l or lg M [1]

A2 $E = \dfrac{16\pi^2 M}{wd^3 \times gradient} = \dfrac{k}{gradient}$ $E = \dfrac{16\pi^2 l^3}{wd^3 \times gradient}$

Allow logarithmic solutions e.g. $E = \dfrac{k}{10^{2xy\text{-intercept}}} = \dfrac{k}{100^{y\text{-intercept}}}$ [1]

Safety considerations (1 mark)

S1 Relevant safety precaution related to the use of loads [1]
e.g. cushion/sand in case load falls, keep feet away, keep distance from experiment.

Additional detail (4 marks)

D Relevant points might include [4]

1. Use same rule or keep w and/or d constant.
2. Repeat measurements of d and/or w along rule and average.
3. Discussion of use of motion sensor e.g. orientation or light gates with detail.
4. Use small amplitude or small angle oscillations (to ensure equation is valid).
5. Method of securing load to rule e.g. with tape/glue.
6. Discussion of magnitude of load: large enough to make T large enough.
7. Use of fiducial marker to help to time.
8. Start timing after oscillations have settled.

Do not allow vague use of computers/light gates, video cameras, dataloggers.

[Total: 15]

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2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	gradient = q y-intercept = lg p or log p	
(b)	T1 T2	1.176 or 1.18 | 0.415 or 0.41 1.279 or 1.28 | 0.544 or 0.54 1.362 or 1.36 | 0.643 or 0.64 1.431 or 1.43 | 0.732 or 0.73 1.491 or 1.49 | 0.806 or 0.81	T1 is awarded for correct values lg d T2 is awarded for correct values lg I A mixture of 2dp and 3dp is allowed within each column
	E1	$\pm$ 0.016 or $\pm$ 0.017 or $\pm$ 0.02 decreasing to $\pm$ 0.006 or $\pm$ 0.007 or $\pm$ 0.01	Allow more than one significant figures.
(c) (i)	G1	Five points plotted correctly	Must be within half a small square. Use transparency. Ecf allowed from table.
	E2	Error bars in lg I plotted correctly.	Check first and last point. Must be accurate within half a small square. Ecf allowed from table.
(ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (1.15, 0.370) **and** (1.15, 0.385) and upper end of line should pass between (1.50, 0.815) and (1.50, 0.825). Allow ecf from points plotted incorrectly – examiner judgement.
	G3	Worst acceptable straight line. Steepest or shallowest possible line that passes through <u>all</u> the error bars.	Line should be clearly labelled or dashed. Should pass from top of top error bar to bottom of bottom error bar or bottom of top error bar to top of bottom error bar. Mark scored only if error bars are plotted.
(iii)	C1	Gradient of best fit line	The triangle used should be greater than half the length of the drawn line. Check the "read offs". Work to half a small square. Do not penalise POT.
	E3	Error in gradient	Method of determining absolute error Difference in worst gradient and gradient.
(iv)	C2	y-intercept	Must be negative and the gradient must be used. Check substitution into c = y – mx. Allow ecf from **(c)(iii)**. If gradient within range given, then y-intercept should be about –1.1
	E4	Method of determining error in y-intercept	Determines worst y-intercept using worst gradient and finds difference. Check substitution but do not check calculation. Do not allow ecf from false origin read-off.

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(d)	C3	$p = 10^{\text{candidate's } y\text{-intercept}}$	p should be about 0.08. Allow ecf from **(c)(iv)**. If FO used then p should be about 2.34 to 2.43.
	C4	q = in the range 1.20–1.30 **and** given to 2 or 3 sf.	Candidate's gradient must be used.
	E5	Method for determining errors in values of p and q.	Determines worst p using worst y-intercept and finds difference. Allow ecf from **(c)(iv)**. q error must be same as error in gradient.

[Total: 15]

Uncertainties in Question 2

(c) (iii) Uncertainty in gradient [E3]

1. Uncertainty = gradient of line of best fit – gradient of worst acceptable line
2. Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(c) (iv) Uncertainty in the *y*-intercept [E4]

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)

N.B. Must use gradient from worst acceptable line and a point on the same worst acceptable line to determine y-intercept of worst acceptable line.

(d) Uncertainty in *p* [E5]

1. Uncertainty = p from y-intercept of BFL – p from y-intercept of WAL
2. Uncertainty = ½ (p from y-intercept of shallowest WAL – p from y-intercept of steepest WAL)

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