UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9702 PHYSICS

9702/53 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.

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1 Planning (15 marks)

Defining the problem (3 marks)

P1 Frequency or period of rotation or ω is the independent variable and θ is the dependent variable or vary f or T or ω and measure θ. [1]

P2 $\omega = 2\pi f = 2\pi/T$ [1]

P3 Keep the length of the rigid rod <u>constant</u>; ignore reference to mass. [1]

Methods of data collection (5 marks)

M1 Labelled diagram of apparatus: small <u>object</u>, pole attached to a <u>rotating device</u> (motor, turntable). [1]

M2 Method to change the speed of the rotating device. [1]

M3 Method to determine frequency or time period (e.g. stop watch to time a number of rotations, rev counter/tachometer, light gates connected to a timer/frequency meter). [1]

M4 Use fiducial mark or light gates perpendicular to motion of object. [1]

M5 Method to measure angle – use protractor or rule for measurements for trigonometry methods. This must be shown correctly on diagram or explained in text. [1]

Method of analysis (2 marks)

A1 Plot a graph of cos θ against $1/\omega^2$. [1]

A2 Relationship is valid if straight line through the origin [1]

Safety considerations (1 mark)

S1 Use a protective screen in case mass detaches from the pole. Do not use goggles. [1]

Additional detail (4 marks)

Relevant points might include [4]

1 Large motor speed to produce measurable θ.
2 Additional detail on measuring angle e.g. <u>large</u> protractor fixed to pole.
3 Projection method, slow motion freeze frame video, camera <u>with detail</u>.
4 cos $\theta = h/l$ or equivalent.
5 Method of checking pole is vertical – use a set square.
6 Additional detail on measuring angular velocity, e.g. time at least 10 rotations.
7 Wait for motion to become stable.

Do not allow vague computer methods.

[Total: 15]

2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	Gradient = *r* *y*-intercept = lg *s*	Allow log or ln
(b)	T1 T2	1.70 or 1.699 0.41 or 0.415 1.78 or 1.778 0.53 or 0.531 1.85 or 1.845 0.64 or 0.643 1.90 or 1.903 0.73 or 0.732 1.95 or 1.954 0.82 or 0.820 1.98 or 1.978 0.86 or 0.857	Ignore significant figures. A mixture is allowed.
	U1	From ± 0.03 or ± 0.04, to ± 0.01 (±0.012)	Allow more than one significant figure.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Penalise 'blobs' (more than half a small square). Ecf allowed from table.
	U2	Error bars in lg (*y* / mm) plotted correctly.	Must be accurate within half a small square.
(ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (1.655, 0.35) and (1.665, 0.35) **and** upper end of line should pass between (2.00, 0.89) and (2.00, 0.90). 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 at least half the length of the drawn line. Check the read offs. Work to half a small square. Do not penalise POT. (Should be about 1.6)
	U3	Uncertainty in gradient	Method of determining absolute uncertainty. Difference in worst gradient and gradient.
(iv)	C2	Negative *y*-intercept	Must be negative. FOX does not score. Expect to see point substituted into $y = mx + c$ Allow ecf from (c)(iii)
	U4	Uncertainty in *y*-intercept	Uses worst gradient and point on WAL. Do not check calculation. FOX does not score.

(d)	C3	r = gradient <u>and</u> is given to 2 or 3 s.f. <u>and</u> in the range 1.57 to 1.64	Allow 1.6 to 2 s.f. Penalise 1 s.f. or >3 s.f.
	C4	$s = 10^{y\text{-intercept}}$	*y*-intercept must be used. (Should be about 0.005 or 5×10^{-3}) Allow ecf for method from **(c)(iv)**.
	U5	Absolute uncertainty in *r* and *s*	Uncertainty in *r* should be the same as the uncertainty in the gradient. Difference in worst *s* and *s*.

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U3]
Uncertainty = gradient of line of best fit – gradient of worst acceptable line
Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(iv) [U4]
Uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line
Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(d) [U5]
Uncertainty = best *s* –worst *s*