UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 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 p is the independent variable or vary p [1]
P2 q is the dependent variable or measure q [1]
P3 Keep (horizontal) velocity (v) constant [1]

Methods of data collection (5 marks)

M1 Labelled diagram of apparatus including method to vary p. [1]
M2 Method to determine position of ball on surface e.g. carbon paper/dye/video/sand. [1]
M3 Use ruler/caliper to measure p and/or q. [1]
M4 Method to ensure velocity is constant e.g. releasing ball from same height on a track/ spring loaded device or impulse device set to a constant value. [1]
M5 Method to ensure that the moved surface remains horizontal, e.g. spirit level/check height at different places. [1]

Method of analysis (2 marks)

A1 q^2 against p q against $\sqrt{p}$ p against q^2 $\sqrt{p}$ against q [1]

A2 $v = \sqrt{\frac{g \times \text{gradient}}{2}}$ $v = \text{gradient} \times \sqrt{\frac{g}{2}}$ $v = \sqrt{\frac{g}{2 \times \text{gradient}}}$ $v = \frac{1}{\text{gradient}} \times \sqrt{\frac{g}{2}}$ [1]

Allow valid logarithmic graph e.g. lg q against lg p, lg $2p$, lg $2p/g$ and valid calculation of v from y-intercept.

Safety considerations (1 mark)

S Reasoned method to prevent ball rolling on floor e.g. box below/storage box for balls/ sand box.
Reasoned method to prevent ball causing injury e.g. goggles/safety screen [1]

Additional detail (4 marks)

D Relevant points might include [4]
1 Method to ensure that velocity of ball is horizontal only when it reaches table, e.g. curved track.
2 Ensure that the ball leaves the table at 90°, e.g. set square/protractor on upper surface.
3 Detail on measuring q – location of landing position e.g. centre of crater/start of track.
4 Detail on determining location of zero position for p and q e.g. set square, plumb line.
5 Detail on method of determining position of ball e.g. slow motion playback including scale.
6 Take many readings of q for each p and average.
7 Straight line through the origin shows that p is proportional to q^2/relationship is valid – this mark may only be awarded when A1 is given.
8 Use of high density ball to minimise the effects of air resistance.

Do not allow vague computer methods.

[Total: 15]

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2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	*F*	
(b)	T1 T2	6.7 or 6.67 9.0 or 9.00 4.5 or 4.55 6.5 or 6.50 3.0 or 3.03 4.6 or 4.63 2.1 or 2.13 3.5 or 3.50 1.5 or 1.47 2.8 or 2.75 1.2 or 1.16 2.4 or 2.38	T1 for 1/*R*. T2 for *V*/*E*. Must be 2sf or 3sf; a mixture is allowed
	U1	From ± 0.6 or ± 0.7, to ± 0.2	Allow more than one significant figure.
(c) (i)	G1	Six points plotted correctly	Check second and fifth plots and other anomalous plots. Must be less than half a small square. Ecf allowed from table.
	U2	All error bars in *V*/*E* plotted correctly	Half square or greater loses the mark. Ecf allowed from table.
(ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (0, 0.9) **and** (0, 1.1) and upper end of line should pass between (7, 9.3) and (7, 9.5). Allow ecf from points plotted incorrectly – examiner judgement.
	G3	Worst acceptable straight line. Steepest or shallowest possible line that passes through all 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.
	U3	Uncertainty in gradient	Method of determining absolute uncertainty. Difference in worst gradient and gradient.
(d)	C2	(Gradient value) Ω	Gradient must be used correctly. Expect about 1200 Ω Allow ecf from **(c)(iii)** but penalise POT. Do not penalise sf or rounding errors.
	U4	Determines uncertainty in *F*	Allow ecf from POT.
(e) (i)	C3	Determines *V*/*E* correctly.	Answer should be approximately 11; *F* from **(d)** must be used. $\frac{F}{R}+1$
	U5	Determines absolute uncertainty	Should be approximately 15% of R_F/R_1 (about 1.5). Several possible methods.
(ii)	C4	In the range 17.2 to 18.0 given to 2 or 3sf	Allow 17 or 18 to 2sf. Must be **(e)(i)** × 1.6

[Total: 15]

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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)

(d) [U4]
Uncertainty = uncertainty in gradient

(e) [U5]
Uncertainty = worst $V/E - V/E$
Note worst V/E is calculated either by max V/min E or by min V/max E
Or max gradient of WAL/114 or min gradient of WAL/126

Uncertainty = $\left(0.05 + \frac{\Delta m}{m}\right) \times \frac{F}{R}$ [Allow V/E instead of F/R]

Uncertainty = $\left(0.05 + \frac{\Delta F}{F}\right) \times \frac{F}{R}$ [Allow V/E instead of F/R]

Uncertainty = $\left(\frac{6}{120} + \frac{\Delta m}{m}\right) \times \frac{F}{R}$ [Allow V/E instead of F/R]

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