CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9702 PHYSICS

9702/51 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 (3 marks)

P *h* is the independent variable or vary *h*. [1]

P *Q* is the dependent variable or measure *Q* (allow *t*). [1]

P Keep l constant. [1]

Methods of data collection (5 marks)

M Labelled diagram of apparatus: including labelled measuring cylinder/calibrated beaker to receive water. (Measurement may be credited in the text.) [1]

M Vary position of vertical/larger tube. [1]

M Measure *h* and l with a rule/caliper. [1]

M Measure *d* with a travelling microscope or vernier calipers. [1]

M Measure *t* with stopwatch. [1]

Method of analysis (2 marks)

A Plot a graph of *Q* against *h*. [Allow lg *Q* against lg *h*] [1]

A $\eta = \dfrac{2\pi\rho g d^4}{l \times \text{gradient}}$

Must include gradient and η must be subject of formula. [1]

Safety considerations (1 mark)

S Reasoned method to prevent spills, e.g. use tray/sink/cloths on floor. Reasoned method to prevent injury when adjusting metal/glass tubes by wearing protective gloves. Mark may not be scored from the diagram. [1]

Additional detail (4 marks)

D Relevant points might include [4]

1 Repeat experiment for same *h* and average
2 Method to determine the density of water including method to measure mass and volume and equation
3 Take many readings of *d* and average
4 Relationship is valid if straight line passing through origin [if lg-lg graph allow straight line with gradient = 1]
5 Method to check that tube is horizontal
6 Detail on measuring *h* to the centre of the horizontal tube e.g. add radius of tube
7 Keep temperature of water constant

Do not allow vague computer methods.

[Total: 15]

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2 Analysis, conclusions and evaluation (15 marks)

	Mark	Expected Answer	Additional Guidance
(a)	A1	Gradient = 1 / *EW* *y*-intercept = 1 / *E*	
(b)	T1	$\frac{1}{V}$ / V^{-1}	Column heading. Allow equivalent unit. e.g. V^{-1} / V^{-1} or 1/V / 1/V or 1/V (V^{-1})
	T2	0.20 or 0.196 0.22 or 0.222 0.25 or 0.250 0.30 or 0.303 0.33 or 0.333 0.37 or 0.370	A mixture of 2 s.f. and 3 s.f. is allowed.
(c) (i)	G1	Six points plotted correctly	Must be less than half a small square. Ecf allowed from table. Penalise 'blobs'.
	U1	All error bars in *C* plotted correctly	Must be within half a small square. Ecf allowed from table. Horizontal.
(c) (ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (0.75, 0.200) and (0.75, 0.205) **and** upper end of line should pass between (3.0, 0.352) and (3.0, 0.358). 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.
(c) (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.
	U2	Uncertainty in gradient	Method of determining absolute uncertainty Difference in worst gradient and gradient.
(c) (iv)	C2	*y*-intercept	Expect to see point substituted into $y = mx + c$ FOX does not score. Do not penalise POT. Should be about 0.15.
	U3	Uncertainty in *y*-intercept	Difference in worst *y*-intercept and *y*-intercept. FOX does not score. Allow ecf from **(c)(iv)**.

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(d) (i)	C3	E = 1/ y-intercept and V	Method required. Do not check calculation. Allow ecf from **(c)(iv)**.
	U4	Absolute uncertainty in E	
(d) (ii)	C4	Between 2.00×10^{-3} F and 2.40×10^{-3} F and given to 2 or 3 s.f.	Must be in range. Allow use of mF.
(d) (iii)	U5	Percentage uncertainty in W	%uncertainty in E + %uncertainty in gradient

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U2]

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

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

(c) (iv) y-intercept [U3]

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

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

(d) (i) [U4]

Absolute uncertainty = max E – E = E – min E = $\dfrac{\max E - \min E}{2}$

Absolute uncertainty = $\dfrac{\Delta c}{c} \times E$

(d) (iii) [U5]

Percentage uncertainty = $\dfrac{\Delta W}{W} \times 100$

ΔW = max W – W = W – min W = $\dfrac{\max W - \min W}{2}$

max W = $\dfrac{1}{\min E \times \min m}$

min W= $\dfrac{1}{\max E \times \max m}$

Percentage uncertainty = $\left(\dfrac{\Delta m}{m} + \dfrac{\Delta E}{E}\right) \times 100 = \left(\dfrac{\Delta m}{m} + \dfrac{\Delta c}{c}\right) \times 100$

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