CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

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.

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 *m* is the independent variable and *E* is the dependent variable or vary *m* and measure *E*.
Do not allow time. [1]

P Keep the <u>temperature change</u> of water <u>constant</u>. Allow two specified temperatures.
Do not allow "keep temperature constant". [1]

P Keep the mass or volume of water <u>constant</u>. [1]

Methods of data collection (5 marks)

M Labelled diagram including labelled thermometer with bulb in water and at least one other label. [1]

M Workable circuit diagram to determine *E*: power supply, heater and ammeter and voltmeter, or joulemeter or wattmeter. [1]

M <u>Method</u> to determine change in temperature: measure initial temperature, measure final temperature and subtract, or measure initial temperature and specific temperature change. [1]

M Use balance/scales to measure <u>mass of blocks</u>. [1]

M Stir water (so that metal is in thermal equilibrium). [1]

Method of analysis (2 marks)

A Plot a graph of *E* against *m*.
Do not allow log–log graphs. [1]

A *a* = gradient <u>and</u> *b* = *y*-intercept; must be consistent with suggested graph. [1]

Safety considerations (1 mark)

S Precaution linked to hot heater/water, e.g. use gloves **or** use tongs for hot blocks.
Do not allow goggles. [1]

Additional detail (4 marks)

D Relevant points might include [4]
1 Method to ensure that e.m.f. of the power supply is constant/current in heater is constant, e.g. adjust variable power supply/variable resistor to ensure p.d./current is constant
2 Keep the starting temperature of water/metal <u>constant</u>
3 <u>Wait</u> for water and metal temperatures to equalise
4 Add insulation to sides of beaker/lid (to prevent energy losses)
5 Use of timer and equation, e.g. $E = Pt = ItV$ for candidate's method
6 Use large temperature change <u>to reduce percentage uncertainty</u>
7 Relationship is valid if the graph is a straight line that does not pass through the origin

Do not allow vague computer methods.

2 Analysis, conclusions and evaluation (15 marks)

	Mark	Expected Answer	Additional Guidance
(a)	A1	gradient = $\frac{Pg}{m}$	
(b)	T1	T/s, v/ms^{-1} and v^2/m^{2}s^{-2}	Allow T(s), v(ms^{-1}) and v^2(m^{2}s^{-2}).
	T2	8.7 or 8.74 19 or 19.3 27 or 27.4 37 or 36.6 45 or 44.9 52 or 52.3	Must be values of v^2 in table (if v not rounded). All values of v^2 must be 2 s.f. or 3 s.f. Allow a mixture of significant figures.
	U1	From ± 0.9 or ± 1 to ± 3	Allow more than one significant figure.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Do not allow “blobs”. ECF allowed from table.
	U2	Error bars in v^2 plotted correctly	All error bars to be plotted. Must be accurate to less than half a small square. Length of bar must be accurate to less than half a small square.
(ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (0.16, 10) and (0.18, 10) **and** upper end of line should pass between (0.70, 50) and (0.72, 50). Line should not go from top to bottom points.
	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. Examiner judgement on worst acceptable line. Lines must cross. Mark scored only if error bars are plotted.
(iii)	C1	Gradient of line of best fit	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 72.)
	U3	Absolute uncertainty in gradient	Method of determining absolute uncertainty: difference in worst gradient and gradient.
(d) (i)	C2	$P = \frac{m}{g} \times$ gradient $= 2.55 \times 10^{-3} \times$ gradient	Must use gradient. Should be about 0.19.
	C3	kg	
(ii)	U4	Percentage uncertainty in P	Must be greater than 4%.

(e) (i)	C4	*v* in the range 4.70 to 4.90 and given to 2 or 3 s.f.	
(ii)	U5	Percentage uncertainty in *v*	Allow credit if absolute uncertainty in mass used correctly.

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) (ii) [U4]

$$\text{percentage uncertainty} = \left(\frac{\Delta\,\text{gradient}}{\text{gradient}} + \frac{0.001}{0.025}\right) \times 100 = \left(\frac{\Delta\,\text{gradient}}{\text{gradient}} + 0.04\right) \times 100$$

$$\text{max. } P = \frac{0.026}{9.81} \times \text{max. gradient}$$

$$\text{max. } P = \frac{0.024}{9.81} \times \text{min. gradient}$$

(e) (ii) [U5]

$$\text{percentage uncertainty} = \frac{1}{2} \times \left(\frac{\Delta P}{P} + \frac{0.005}{0.5}\right) \times 100$$

$$\text{max. } v = \sqrt{\frac{\text{max. } P \times 9.81 \times 0.505}{0.040}}$$

$$\text{min. } v = \sqrt{\frac{\text{min. } P \times 9.81 \times 0.495}{0.040}}$$