UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2007 question paper

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 *r* is the independent variable or vary *r* (accept diameter but not mass or size). [1]

P2 *v* is the dependent variable or determine *v* (accept speed) [1]

P3 A controlled variable – accept temperature, [1]
distance when time is measured, or time when distance measured.
Do not accept volume/height of oil.

Methods of data collection (5 marks)

M1 Diagram of a workable arrangement including a deep container of oil, ball and some measurement indicated for either time or distance. [1]

M2 Measure diameter by using a micrometer (screw gauge)/vernier callipers (and halving to obtain radius). Accept from diagram. Accept travelling microscope. [1]

M3 Measure the time for the ball to fall a set distance in oil (or distance for a set time). [1]

M4 Measure the (constant) distance fallen (constant time) and show how *v* is calculated. [1]

M5 Evidence that ball has reached terminal velocity (e.g. starting mark well below surface of oil) [1]
Reject equations of uniform acceleration ideas.

Method of analysis (2 marks)

A1 Plot a graph of *v* against r^2 or logarithmic equivalent. [1]

A2 Relationship is correct if graph is a straight line through the origin. [1]
An explicit statement is required.
If lg v against lg r is plotted gradient should equal 2.

Safety considerations (1 mark)

S1 Relevant safety precaution related to the oil, [1]
e.g. mop up spillages of oil/wear gloves with reason/keep away from flames.
Do not accept vague answers e.g. goggles/spills/washing hands but allow credit for detailed reasoning e.g. drop ball near surface to avoid splashing.

Additional detail (4 marks)

D1/2/3/4 Relevant points might include: [4]
Allow oil to stand so that air bubbles escape/ball may trap air bubbles.
Wash and dry steel balls/handle steel balls with tweezers/gloves.
Distance marks should be as far apart as possible or use long tube.
Large distance to reduce percentage uncertainty.
Wide tube to reduce edge effects/method to keep long tube vertical.
Discussion of parallax for stop watch methods.
Method of ensuring that terminal velocity has been reached.
Retrieve steel balls using a magnet.
Use clear oil.
Repeat diameter measurements and average.
An additional variable kept constant.

[Total: 15]

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2 *Analysis, conclusions and evaluation (15 marks)*

Approach to data analysis (1 mark)

(a) $R = \frac{\rho l^2}{V} + R_0$ and a correct comment.
This mark is not scored for *R* being proportional to l^2. [1]

Table of results (2 marks)

(b) Column heading for l^2. Allow l^2 / cm^2 and l^2 (cm^2) (or equivalent units). [1]

(b) Values of l^2. [1]
36, 100, 196, 324, 484, 676
3 significant figures needed (except 1st row). Allow 4sf. All correct for one mark.

Graph (3 marks)

(c) (i) Points plotted correctly. [1]
All six required for this mark and must be ⩽ half a small square. Indicate an error.
Ecf from **(b)**

(c) (ii) Line of best fit. [1]
Must be within tolerances. Do not allow a line forced through the origin.

(c) (iii) Worst acceptable straight line. [1]
Must be within tolerances. Line should be clearly labelled. Allow broken line.

Conclusion (4 marks)

(c) (iii) gradient of best-fit line [1]
Gradient should be in the range 0.550 to 0.560.
If **(b)** and/or **(c)(i)** and/or **(ii)** are incorrect then the triangle used should be greater than half the length of the drawn line. Check the read offs and ratio to be correct. Work to half a small square.

(d) Value of ρ
Candidate's gradient value = ρ/V. May be implicit from working. [1]
ρ in range 10.3 -10.6 [1]

(d) Unit of ρ. Must be consistent with previous answer e.g. Ω cm [1]

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Treatment of errors (5 marks)

(b) Errors in l^2 [1]

± 4.6 – 5.0
± 7.8 – 8.2
± 11.0 – 11.4
± 14.2 - 14 or 15
± 17 or 18
± 20 or 21

(c) (i) error bars in l^2 plotted correctly [1]

Must be within tolerances. For ecf check first and last point

(c) (iii) error in gradient [1]
Check method e.g. gradient of best-fit line – gradient of worst acceptable line

(d) correct method for determining error in ρ (e.g. (worst gradient × volume) - ρ) [1]
Value for error in ρ in the range ± 0.4 to ± 0.6. [1]
Last mark is zero if vertical error bars plotted or wrong worst acceptable line plotted.

[Total: 15]

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