**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

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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

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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]**

## 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 $\rho$
Candidate's gradient value = ρ/V. May be implicit from working. [1]
ρ in range 10.3 -10.6 [1]

**(d)** Unit of $\rho$. Must be consistent with previous answer e.g. Ω cm [1]

**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 $\rho$ (e.g. (worst gradient × volume) - $\rho$) [1]
Value for error in $\rho$ 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]**