GCE 2004

June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics A

Unit PHA3/P

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from:

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or

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Instructions to Examiners

1 Give due credit to alternative treatments which are correct. Give marks for what is correct; do not deduct marks because the attempt falls short of some ideal answer. Where marks are to be deducted for particular errors specific instructions are given in the marking scheme.

2 Do not deduct marks for poor written communication. Refer the script to the Awards meeting if poor presentation forbids a proper assessment. In each paper candidates may be awarded up to two marks for the Quality of Written Communication in cases of required explanation or description. Use the following criteria to award marks:

2 marks: Candidates write legibly with accurate spelling, grammar and punctuation; the answer containing information that bears some relevance to the question and being organised clearly and coherently. The vocabulary should be appropriate to the topic being examined.

1 mark: Candidates write with reasonably accurate spelling, grammar and punctuation; the answer containing some information that bears some relevance to the question and being reasonably well organised. Some of the vocabulary should be appropriate to the topic being examined.

0 marks: Candidates who fail to reach the threshold for the award of one mark.

3 An arithmetical error in an answer should be marked AE thus causing the candidate to lose one mark. The candidate's incorrect value should be carried through all subsequent calculations for the question and, if there are no subsequent errors, the candidate can score all remaining marks (indicated by ticks). These subsequent ticks should be marked CE (consequential error).

4 With regard to incorrect use of significant figures, normally two, three or four significant figures will be acceptable. Exceptions to this rule occur if the data in the question is given to, for example, five significant figures as in values of wavelength or frequency in questions dealing with the Doppler effect, or in atomic data. In these cases up to two further significant figures will be acceptable. The maximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by SF and, in addition, write SF opposite the mark for that question on the front cover of the paper to obviate imposing the penalty more than once per paper.

5 No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. The maximum penalty is **one mark per question**.

6 All other procedures, including the entering of marks, transferring marks to the front cover and referrals of scripts (other than those mentioned above) will be clarified at the standardising meeting of examiners.

Unit 3: PHA3/P: Practical

1 AO3a: Planning

measurements:
(to determine the terminal velocity of the ball bearing),
measure (vertical) distance with a **ruler** and (✓)
transit time (in the oil) with a **stopwatch** (✓)
(to determine the temperature of the oil),
use a (liquid in glass) **thermometer** (can be shown in diagram) (✓)
(to determine the density of the oil),
find volume using a **measuring cylinder** (✓)
mass (accept weight) using a **balance** (accept scales), taking account
of mass (weight) of container (✓) ✓✓✓✓ max (*4*)

strategy:
sensible and safe method of heating the oil
(can be shown in the diagram)(✓)
(use of Bunsen burner allowed, if removed during terminal velocity part)
find v by calculating $\frac{h}{t}$ (**terminal velocity must be reached**) (✓)
and calculate $\rho_0 = \frac{m}{V}$ (✓)
repeat at **different** temperatures, calculate η (from $k\frac{(\rho_{bb} - \rho_0)}{v}$) (✓)
plot graph of η against θ (✓) ✓✓✓ max (*3*)

control:
ensure oil temperature is **uniform**
(room temperature uniform not accepted) (✓)
use same ball bearing throughout (✓) ✓ (*1*)

difficulties:
(*difficulty* + *how overcome* = 2)
any **two** of the following
reduce uncertainty in t [or in v] (✓)
by making h large (✓) and/or
by using ball bearing of small diameter (✓) and/or
by repeating timing and **averaging** (✓) and/or
by repeating timing and identifying anomalous results (✓) and/or
sensible detail about how terminal velocity was confirmed (✓) and/or
ensuring that ball bearing travels away from edge of
container/free of air bubbles (✓)

reduce uncertainty in h (✓)
by making h large (✓) and/or
by suitable procedure to avoid parallax error (✓)

reduce uncertainty in θ (✓)
by using a sensitive thermometer (✓) and/or
using a thermometer with small heat capacity (✓) and /or
avoiding delay between θ and t measurement (✓)

other good detail e.g. use of water bath (✓)
with sensible justification (✓)

(no credit given for unqualified comments, e.g. 'repeating' measurements and averaging/eliminating anomalous results') ✓✓✓✓ max (*4*)

max (*8*)

2 AO3b: Implementing

(a)	*accuracy*	t_1 and t_2 sensible, recorded to nearest 0.1 s, $t_2 > t_1$	✓
(b)	*tabulation*	s/cm t/s	✓✓
	readings	5 sets of s and t	✓
		s range ≥ 60 cm	✓
		t from Σnt, where n ≥ 3	✓
	significant figures	all s to nearest mm, all t to 0.1 s or better, tabulation in parts (a) and (b) consistent	✓
	quality	all 5 points to ± 2 mm of best-fit line (unsuitable scaled graph or curve, loose 1)	✓

(*8*)

3 AO3c: Applying Evidence and Drawing Conclusions

Processing

(c)	*axes*	marked s/cm, t/s (½ deducted for each missing, rounded down)	✓✓
	scale	suitable scale (e.g. 8 × 8) [5 × 5, 2 × 8, 8 × 2 ✓]	✓✓
	points	(at least) 5 points plotted correctly on best-fit line of **positive** gradient	✓

Deductions

(d)(i)	valid statement	✓
	with correct justification	✓
(d)(ii)	difference $(t_2 - t_1)$ calculated correctly, e.g. $s = \frac{s_0}{(t_2 - t_1)}$	✓
	(extrapolation of graph acceptable)	

(*8*)

4 AO3d: Evaluating Evidence and Procedures

(e)(i) used ball bearing with longest transit time ✓
to reducing human/stop-start/percentage/timing error ✓

(e)(ii) repeating readings to find average time and/or
repeating readings to identify anomalies and/or
observing position opposite end of track (minimising parallax error) ✓✓

(e)(iii) measure t from rest to travel through different s ✓

plot s against t^2 (evaluate $\frac{s}{t^2}$ for each set) ✓

check for direct proportion [see if ratios of s/t^2 are constant] ✓

[**Note:** methods based on average speeds are not acceptable as these assume acceleration is constant, thus a circular argument.

possible alternative answers:
use of light gates (and data logger) for instantaneous velocity measurement to find u, v (u can be zero) and t or s,
repeated with ball travelling between different point(s) on the track,
see if results for $\frac{v_2 - v_1}{t}$ or $\frac{{v_1}^2 - {v_2}^2}{2s}$ are constant,
or
measure transit times over **equal** distances, ball initially at **rest** at **different** points on the track
see if transit times are constant] $_{\text{max}}$ *(6)*

<u>*(22)*</u>

