ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2002

GCE

Physics A

Unit PHA3/W

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Unit 3: Current Electricity and Elastic Properties of Solids

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. However, no candidate may be awarded more than the total mark for the paper. Use the following criteria to award marks:

2 marks: Candidates write with almost faultless accuracy (including grammar, spelling and appropriate punctuation); specialist terms are used confidently, accurately and with precision.

1 mark: Candidates write with reasonable and generally accurate expression (including grammar, spelling and appropriate punctuation); specialist terms are used with reasonable accuracy.

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 A.E. 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 C.E. (consequential error).

4 With regard to incorrect use of significant figures, normally a penalty is imposed if the number of significant figures used by the candidate is one less, or two more, than the number of significant figures used in the data given in the question. 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 S.F. and, in addition, write S.F. 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.

1(a)(i) (use of $V = IR$ gives) $V = I(R_1 + R_2)$ ✓

$$I = \frac{V}{R_1 + R_2} = \frac{9}{120 + 60}$$ ✓

= 50 mA ✓

(ii) V_{out} (= IR_2) = 0.05 × 60 = 3 V ✓
(allow C.E. for value of I from (i)) (*4*)

(b) (temperature increases, resistance decreases), total resistance decreases ✓
current increases ✓
voltage across R_2 increases ✓

[or R_2 has increased share of (total) resistance ✓
new current is same in both resistors ✓ larger share of the 9 V ✓]

[or $V_{out} = V_{in} \frac{R_2}{R_1 + R_2}$ ✓ R_1 decreases ✓ V_{out} decreases ✓] (*3*)

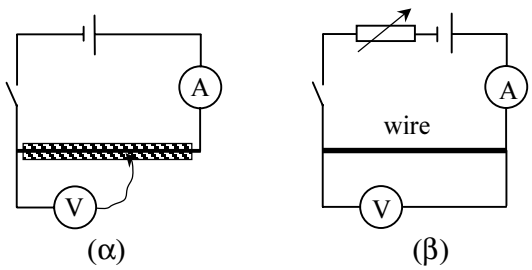
(*7*)

2(a) Ohm's law obeyed (or straight line graph) initially ✓
at a given voltage) current heats filament (to certain temperature) ✓
resistance constant at that temperature ✓
increase in voltage gives increase in current ✓
temperature of filament increases and resistance increases ✓
rate of increase of current less than if resistance was constant ✓
negative voltage and current produces same effect ✓ $_{max}$(*5*)

(b) $P = I^2R$ ✓
$20 = (90 \times 10^{-3})^2 R$ and $R = 2.5 \times 10^3$ Ω ✓ (2470 Ω) (*2*)

(*7*)

3(a)(i)



✓ battery, wire, (variable resistor) and ammeter in series

✓ voltmeter connected across wire

(ii)(α) (with switch closed) measure I and V ✓
move contact along the wire ✓ (or length of wire changed)
measure new (I and) V ✓
measure l each time ✓

or (β) measure I and V ✓
change variable resistor ✓
measure new I and V ✓
l known ✓

(iii) $R = \frac{\rho l}{A}$ or $\rho = \frac{RA}{l}$ or $\rho = \frac{A}{l} \times \frac{V}{I}$ ✓

(α) obtain gradient of graph of V or R vs l ✓
A (and I) known, hence ρ ✓

or (β) gradient of graph of V vs I ✓
A and l known, hence ρ ✓

[or, for both methods, measure $R = \frac{V}{I}$ for each length ✓
take mean and hence ρ ✓] (*9*)

(b) (use of $V = IR$ gives) $R = \frac{240}{2 \times 10^{-3}}$ ✓ ($= 120 \times 10^3$ (Ω))

$\rho = \left(\frac{RA}{l}\right) = \frac{120 \times 10^3 \times 80 \times 80 \times 10^{-6}}{1.5 \times 10^{-3}}$ ✓

(allow C.E. for value of R)

$= 5.1 \times 10^5$ Ω m ✓ (*3*)

(c) four resistors in series ✓
$R = 4 \times (120 \times 10^3) = 4.8 \times 10^5$ Ω ✓ (*2*)

(allow C.E. for value of R) (*14*)

4(a) time elapsed = 8.5 ± 0.2 (ms) ✓
distance travelled = 3 (m) ✓ (allow C.E. if d = 1.5 (m))
speed of sound = $\frac{3}{8.5\times10^{-3}}$ = 350 m s^{-1} (353)✓ (*3*)

(b) connect oscilloscope <u>across</u> ac source (or diagram or ac to Y plates) ✓
adjust time base to give trace ✓
adjust voltage sensitivity ✓
sinusoidal trace shown ✓
how to measure T from trace ✓
$f = \frac{1}{T}$ ✓ max <u>(*5*)</u>
<u>(*8*)</u>

5(a)(i) the Young modulus: tensile stress/tensile strain ✓

(ii) maximum force or load which can be applied without wire being permanently deformed
[or point beyond which (when stress removed,) material does not regain original length] ✓ (*2*)

(b)(i) graph: suitable scale ✓
correct points ✓ ✓
best straight line followed by curve ✓

(ii) indication of region or range of Hooke's law ✓

(iii) (use of $E = \frac{Fl}{Ae}$)
values of F and e within range or correct gradient ✓
to give $E = \frac{6.7}{4\times10^{-3}} \times \frac{1.6}{8.0\times10^{-8}}$ ✓
$= 3.3(5)\times10^{10}$ Pa ✓ (*8*)

(c)(i) work done = force × distance ✓
= <u>average</u> force × extension (= ½Fe) ✓
[or use work done = area under graph
area = ½ base × height]

(ii) energy stored = $\frac{6.7\times4\times10^{-3}}{2}$ ✓
$= 13.(4)\times10^{-3}$ J ✓ <u>(*4*)</u>
<u>(*14*)</u>

The Quality of Written Communication marks are awarded primarily for the quality of answers to Q2(a) and Q3(a)(ii)