ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2002

GCE

Physics A

Unit PHA3W

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 Awardsmeeting 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 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 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 '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.

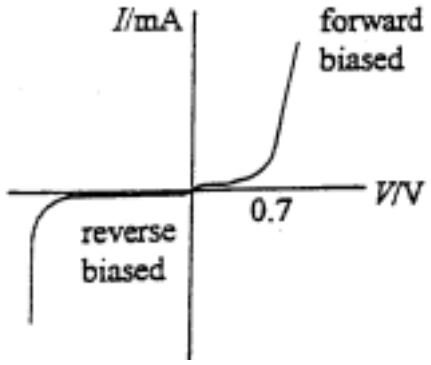
Current Electricity and Elastic Properties of Solids

1(a) only 30 Ω in the circuit ✓
(use of $V = IR$ gives) $6 = I \times 30$ and $I = 0.20$ A ✓ (*2*)

(b) two resistors in parallel gives $\frac{1}{R} = \frac{1}{60} + \frac{1}{30}$ ✓
and $R = 20$ (Ω) ✓
total resistance = 20 + 30 = 50 (Ω) ✓
(allow C.E. for value of R)
$I = \frac{6}{50} = 0.12$ A ✓ (allow C.E. for total resistance) (*4*)

(*6*)

2(a)



forward bias:
zero current rising gradually ✓
sharp increase at ≈ 0.7 V ✓

reverse bias:
zero or slightly less than zero current ✓
sharp negative increase at breakdown ✓
breakdown value >50 V indicated ✓
max (*4*)

(b) forward bias: high resistance (initially gives small current) ✓
at ≈ 0.7 V, resistance decreases rapidly (current increases) ✓

reverse bias: high resistance (gives ≈ zero or slightly negative current) ✓
at breakdown, resistance ≈ zero (and very large current) ✓ max (*3*)

(*7*)

3(a)(i) $\epsilon = I(R + r)$ ✓

(ii) $V_R = IR$ gives $V_R = \epsilon - Ir$ ✓ (*2*)

(b)(i) $P = VI$ gives $30 = 120\ I$ ✓
$I = 0.25$ A ✓

(ii) I through lamp = 0.25 (A) and p.d. across it = 240 V ✓
p.d. due to 1 cell = $1.5 - (0.25 \times 1.2) = 1.2$ (V) ✓
number of cells = $\frac{120}{1.2} = 100$ ✓
[or R_L given by $30 = 0.25^2 R_L$ and $R_L = 480\ (\Omega)$ ✓
$1.5n = 0.25(480 + 1.2n)$ ✓
$1.2n = 120$ and $n = 100$ ✓]

[or $\epsilon = V + Ir$ gives $1.5n = 120 + 0.25 \times 1.2n$ ✓ ✓
$n = 100$ ✓] (*5*)

(*7*)

4(a)(i) $P = \frac{V^2}{R}$ gives $40 = \frac{144}{R_T}$ ✓
$R_T = 3.6\ \Omega$ ✓
[or $P = VI$ to give $I = 3.3$ (A) ✓ and $R = P/I^2 = 3.7\ \Omega$ $(3.67\ \Omega)$ ✓]

(ii) three resistors in parallel ✓
$\frac{1}{R_T} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}$ ✓
$R = 3.6 \times 3 = 10.8\ (\Omega)$ ✓ (*5*)
(allow C.E. for R_T from (i))

(b) (use of $R = \frac{\rho l}{A}$ gives) $10.8 = \frac{4.0 \times 10^{-5}\, l}{2.6 \times 10^{-3} \times 1.1 \times 10^{-3}}$ ✓
$l = \frac{10.8 \times 2.6 \times 10^{-3} \times 1.1 \times 10^{-3}}{4.0 \times 10^{-5}}$ ✓
= 0.77 m ✓ (allow C.E for R from(a)(ii) (*3*)

(*8*)

5(a) $V\text{rms} = (5 \times 10^{-3}) \times (2.0 \times 10^{3}) = 10\,(\text{V})$ ✓
$V_{\text{peak}} = 10 \times \sqrt{2} = 14\ \text{V}\ (14.1)$ ✓
[or correct value of I_{peak} to give V_{peak}] (*2*)

(b)(i) period $= \frac{1}{f} = \frac{1}{50} = 20\,\text{ms}$ ✓

(ii) oscilloscope trace:
correct ac. waveform (for more than 1 cycle) ✓
correct peak value ✓ (allow C.E. for value from (a))
correct period ✓ (allow C.E. for value from (b)(i)) (*4*)

(*6*)

6(a)(i) diagram to show:
(long) wire fixed at one end ✓
mass/weight at other end ✓
measuring scale ✓
mark on wire, or means to measure extension ✓ max (*3*)
[alternative for two vertical wires:
two wires fixed to rigid support ✓
mass/weight at end of one wire ✓
other wire kept taut ✓
spirit level and micrometer or sliding vernier scale ✓]

(ii) measurements:
length of the wire between clamp and mark ✓
diameter of the wire ✓
extension of the wire ✓
for a known mass ✓ max (*3*)

(iii) length measured by metre rule ✓
diameter measured by micrometer ✓
at several positions and mean taken ✓
(known) mass added and extension measured ✓
by noting movement of fixed mark against vernier scale
(or any suitable alternative) ✓
repeat readings for inreasing (or decreasing) load ✓ max (*5*)

(iv) graph of mass added/force against extension ✓
gradient gives $\frac{F}{e}$ or $\frac{m}{e}$ ✓
correct use of data in $E = \frac{Fl}{eA}$ where A is cross-sectional area ✓
[if no graph drawn, then <u>mean</u> of readings
and correct use of data to give 2_{max})✓ max (*2*)

(*13*)

(b)(i) for steel $\left(\text{use of } E = \frac{Fl}{eA} \text{ gives}\right)$ $e = \frac{Fl}{EA}$ ✓

$e = \frac{125 \times 2}{2.0 \times 10^{11} \times 2.5 \times 10^{-7}}$ ✓

$= 5.0 \times 10^{-3}$ m ✓

(ii) extension for brass would be 10×10^{-3} (m) (or twice that of steel) ✓
end A is lower by 5 mm ✓ (allow C.E. from (b)(i)) max (*3*)

(*16*)

The Quality of Written Communication marks are awarded primarily for the quality of answers to Q6(a) and Q2(b).