GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics A
Unit PHA3/W

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.

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Publications Department, Aldon House, 39, Heald Grove, Rusholme, Manchester, M14 4NA
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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/W
Current Electricity and Elastic Properties of Solids

1

(i) $I = \dfrac{\Delta Q}{\Delta t}$ [or $Q = It$] ✓

$Q = 40 \times 10^{-3} \times 3 \times 60 = 7.2\,\text{C}$ ✓

(ii) number of electrons = $\dfrac{7.2}{1.6 \times 10^{-19}} = 4.5 \times 10^{19}$ ✓

(allow C.E. for value of Q from (i))

(iii) $V = \dfrac{W}{Q}$ ✓

$= \dfrac{8.6}{7.2} = 1.2\,\text{V}$ ✓

(allow C.E. for value of Q from (i))

(iv) (use of $V = IR$ gives) $R = \dfrac{1.2}{40 \times 10^{-3}} = 30\,\Omega$ ✓

(allow C.E. for value of V from (iii)) (*6*)

(*6*)

2

(a)(i) $\dfrac{1}{R} = \dfrac{1}{40} + \dfrac{1}{40} + \dfrac{1}{40}$ ✓

$R = \dfrac{40}{3} = 13\,(\Omega)$ ✓ (13.3)

(ii) two resistors in parallel give 20 (Ω) ✓

R = 20 + 40 = 60 (Ω) ✓ max (*3*)

(b)(i) three resistors in parallel give $\dfrac{1}{6} + \dfrac{1}{6} + \dfrac{1}{6}$ (= 2 (Ω)) and total resistance = 4 (Ω) ✓

total current = $\dfrac{12}{4}$ = 3 (A) ✓

(allow C.E. for value of total resistance)

current in each element 1.0 A ✓

(allow C.E. for value of total current)

[or 6 V across each set

resistance of each set = 2 Ω, gives current through each set = 3 (A)

current in each element = 1.0 A]

[or 6 V across each set/resistor,

resistance of one resistor = 6 Ω, gives current in each element = 1.0 A]

(ii) six resistors in series gives $R = 36\,(\Omega)$ and $I = \frac{12}{36} = 0.3\,(\text{A})$ ✓
heating effect (I^2R) much reduced [or less power] ✓ (*5*)
(*8*)

3

(a) $V = -Ir + \epsilon$ ✓ (*1*)

(b) straight line (within 1st quadrant) ✓
negative gradient ✓ (*2*)

(c) ϵ: intercept on voltage axis ✓
r: gradient ✓ (*2*)
(*5*)

4

(a) $\rho = \frac{RA}{l}$ ✓
R = resistance (of wire), A = **cross-sectional** area, l = length (of wire) ✓ (*2*)

(b)(i) $R = \frac{\rho l}{A} = \frac{4.0 \times 10^{-5} \times 30 \times 10^{-3}}{8 \times 10^{-3} \times 2 \times 10^{-6}}$ ✓
$= 75\ \Omega$ ✓

(ii) length has decreased causing resistance to decrease ✓
area increased, causing resistance to decrease ✓
each changed by factor of 1.5×10^3 ✓ (*4*)
(*6*)

5

(a)(i) at 25 (^{o}C), total resistance = 300 + 200 = 500 (Ω) ✓
$I = \frac{12}{500} = 24\,\text{mA}$ ✓
(allow C.E. for value of total resistance)

(ii) pd across thermistor = $24 \times 10^{-3} \times 300 = 7.2\,\text{V}$ ✓
(allow C.E. for value of current from (i) and R_{th} from graph) (*3*)

(b) as temperature increases, resistance (of thermistor) decreases ✓
total resistance decreases ✓
current in circuit increases ✓
pd across resistor increases ✓
(since battery remains at 12 V) pd across thermistor decreases ✓

[or R_{th} decreases ✓
potential divider situation ✓
$V_{th} = 12 \times \frac{R_{th}}{(R_{th} + R)}$ ✓
denominator decrease less slowly than numerator ✓
V_{th} decreases ✓
or for last two marks, thermistor gets smaller share of voltage
explanation of this] max (*3*)

(c)(i) (use of $P = \frac{V^2}{R}$ gives) at 25 °C $P = \frac{144}{300} = 0.48$ W ✓
at 45 °C correct reading of $R = 30$ (Ω)✓
$P = \frac{144}{30} = 4.8$ (W) ✓

(ii) $E = Pt = 2.64 \times 10 \times 60$ ✓
$= 1.6 \times 10^3$ J ✓
(allow C.E. from part (i))

(iii) rate of decrease of resistance is not linear
[or resistance not directly proportional to temperature] ✓ (*6*)
(*12*)

6

(a) extension proportional to the applied force ✓
up to the limit of proportionality
[or provided the extension is small] ✓ (*2*)

(b)(i) $8 \times 9.81 = 78$ (5) N ✓
(allow C.E. in (ii), (iii) and (iv) for incorrect value)

(ii) (use of $E = \frac{F}{A}\frac{l}{e}$ gives) $2.0 \times 10^{11} = \frac{78.5}{2.8 \times 10^{-7}} \times \frac{2.5}{e}$ ✓
$e = 3.5 \times 10^{-3}$ m ✓

(iii) similar calculation ✓
to give $A_S = 5.6 \times 10^{-7}$ m^2 ✓
[or $A_B = 2A_S$ ✓ and correct answer ✓]

(iv) (use of energy stored = ½*Fe* gives) energy stored = ½ × 78.5 × 3.5 × 10^{-3} ✓
= 0.14 J ✓ (*7*)

(c)(i) end A is lower ✓
(ii) = ½ 3.5 × 10^{-3} = 1.8 × 10^{-3} m ✓ (1.75 × 10^{-3} m) (*2*)
(*11*)

Quality of Written Communication: Q4 (b) (ii) and Q5 (b) ✓✓ (*2*)
(*2*)