Mark scheme
January 2004

GCE

Physics A

Unit PHA3/W

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.

AQA

Unit 3

1

(a)(i)   5 V ✓

   (ii) $R_T = 36 \,(\Omega)$ ✓
         (use of $V = IR$ gives) $15 = I \times 36$ and $I = 0.42$ A ✓   (*3*)

(b)(i)   equivalent resistance of the two lamps $\dfrac{1}{R} = \dfrac{1}{12} + \dfrac{1}{12} = \dfrac{1}{6}$ ✓

         $R_T = 6 + 12 = 18 \,(\Omega)$ and $15 = I \times 18$ ✓ (to give $I = 0.83$ A)

   (ii)   current divides equally between lamps (to give $I = 0.42$ A)
         (or equivalent statement) ✓   (*3*)

(c)   same brightness ✓
         (because) same current ✓   <u>(*2*)</u>
                                                                                  <u>(*8*)</u>

2

(a)   constantan (wire) ✓
         $I \propto V$
         [or straight line through origin]
         [or constant gradient]
         [or V and I increasing proportionally]✓   (*2*)

(b)(i) (for $V = 1$ V, use of $V = IR$ gives) $R = \dfrac{1}{0.68\pm.01} = 1.5\,\Omega$ ✓ $(1.47 \pm 0.02\,\Omega)$

(for $V = 10$ V) $R = \dfrac{10}{2.24\pm.01} = 4.4$ or $4.5\,(\Omega)$ ✓ $(4.46 \pm 0.02\,(\Omega))$

(ii) as current increases ✓
greater heating effect (or temperature of filament increases) ✓
R <u>increases</u> with temperature ✓   max(*4*)
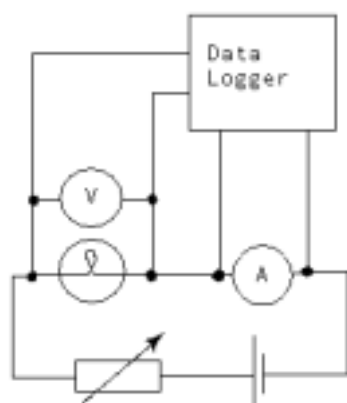
(c) $\rho = \dfrac{RA}{l}$ ✓

($R = 1$/gradient, or use of values gives) $R = \dfrac{12}{2.2} = 5.5\,(\Omega)$ ✓ $(5.45\,(\Omega))$

$\rho = \dfrac{5.45 \times 6.8 \times 10^{-8}}{0.8} = 4.6 \times 10^{-7}\,\Omega\,m$ ✓ $(4.63 \times 10^{-7}\,\Omega\,m)$
(allow C.E. for value of R (*3*)

(d)

variable supply or rheostat, (in series with
      filament) or pot. divider ✓
filament and current sensor in series ✓
voltage sensor across filament ✓
connections to <u>datalogger</u> ✓

                                                                    max(*3*)
                                                                       (*12*)

3

(a)(i) (use of $V\text{rms} = \dfrac{V_0}{\sqrt{2}}$ gives) $V_0 = 7.1\sqrt{2} = 10$ V ✓

(ii) $T = 10$ (ms) ✓
(use of $f = \dfrac{1}{T}$ gives) $f = \dfrac{1}{10 \times 10^{-3}} = 100$ Hz ✓   (*3*)

(b)   control 1: time base ✓ (or time period)
(use of $T = \dfrac{1}{f}$ gives) $T = \dfrac{1}{200} = 5 \times 10^{-3}$ (s) ✓
setting $= 2.5$ ms (div^{-1}) ✓

control 2: voltage sensitivity or Y-plate setting ✓ (or Y-gain)
setting $= 20$ V (div^{-1}) ✓   (*5*)
                                                                              (*8*)

AQA   13

4

(a)(i)   energy changed to electrical energy per unit charge/coulomb passing through
[or electrical energy produced per coulomb or unit charge]
[or pd when no current passes through/or open circuit] ✔

(ii) $I = \dfrac{6}{2.4} = 2.5\,\text{A}$ ✔

(iii) (use of $\epsilon = I(R + r)$ gives) $\epsilon = V + Ir$ and $8 = 6 + Ir$ ✔
substitution gives $8 - 6 = 2.5r$ ✔ (and $r = 0.8\,\Omega$)   (4)

(b)(i)   (use of $P = I^2R$ gives) $P_R = 2.5^2 \times 2.4 = 15\,\text{W}$
[or $P = VI$ gives $P = 6 \times 2.5 = 15\,\text{W}$] ✔
(allow C.E. for value of I from (a))

(ii) $P_T = 15 + (2.5^2 \times 0.8)$ ✔
$= 20\,(\text{W})$ ✔
(allow C.E. for values of P_R and I)

(iii) $E = 5 \times 2 \times 60 = 600\,\text{J}$ ✔
(allow C.E. for value of P from (i) and P_T from (ii))   (4)
(8)

5

(a)   tensile stress: (stretching) force (applied) per unit <u>cross-sectional</u> area ✔
tensile strain: extension (produced) per unit length ✔   (2)

(b)   Hooke's law (or stress $\propto$ strain) obeyed up to point A ✔
A is limit of proportionality ✔
elastic limit between A and region B ✔
region C shows plastic behaviour or wire is ductile ✔
region B to C wire will not regain original length ✔
beyond region C necking occurs (and wire breaks) ✔   max(5)
(7)

6

(a)   density $= \dfrac{\text{mass}}{\text{volume}}$ ✔   (1)

(b)(i)   volume of copper $= \dfrac{70}{100} \times 0.8 \times 10^{-3}$ ✔ $(= 0.56 \times 10^{-3}\,\text{m}^3)$

(volume of zinc $= 0.24 \times 10^{-3}\,\text{m}^3$)
$m_c\,(= \rho_c V_c) = 8.9 \times 10^3 \times 0.56 \times 10^{-3} = 5.0\,\text{kg}$ ✔   (4.98 kg)
$m_z = \dfrac{30}{100} \times 0.8 \times 10^{-3} \times 7.1 \times 10^3 = 1.7\,(\text{kg})$ ✔
(allow C.E. for incorrect volumes)

AQA

(ii) $m_b \; (= 5.0 + 1.7) = 6.7 \,(\text{kg})$ ✓
           (allow C.E. for values of m_c and m_z)

$\rho_b = \dfrac{6.7}{0.8 \times 10^{-3}} = 8.4 \times 10^3 \text{ kg m}^{-3}$ ✓
           (allow C.E. for value of m_b)

[or $\rho_b = (0.7 \times 8900) + (0.3 \times 7100)$ ✓ $= 8.4 \times 10^3 \text{ kg m}^{-3}$ ✓] $_{max}$*(4)*
                                                                                                          (5)

Quality of Written Communication (Q2(b)(ii) and Q5(b)) ✓✓   *(2)*
                                                                                     (2)