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General Certificate of Education

Physics 5451
Specification A

PHA3/W Current Electricity and Elastic Properties of Solids

Mark Scheme

2009 examination - January series

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 to download from the AQA Website: www.aqa.org.uk

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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.

GCE Physics, Specification A, PHA3/W, Current Electricity and Elastic Properties of Solids

Question 1			
(a)	(i)	cell, battery or (variable) low voltage power supply in series with an ammeter and lamp ✓ variable resistor (or reference to 'variable' power supply above) or potential divider to alter the current or pd ✓ voltmeter across the lamp ✓	**8**
	(ii)	line from origin ✓ curves towards the pd axis ✓	
	(iii)	**any three points from** increase in current causes increase of filament temperature ✓ resistance increases as filament temperature increases ✓ atoms vibrate more and resist flow of conduction electrons ✓ increased resistance means the pd/current increases as the current increases (owtte) ✓	
(b)	(i)	$R = 20\,\Omega$ (= 6.0 V/0.3 A) ✓	**3**
	(ii)	$L = \frac{RA}{\rho}$ ✓ $= \frac{20 \times 1.1 \times 10^{-8}}{1.2 \times 10^{-6}}$ = 0.18(3) m ✓	
		Total	**11**

Question 2		
(a) (i)	resistance of the parallel combination = (1/30 + 1/60)-1 = 20 Ω ✓ total circuit resistor = 20 Ω + 20 Ω = 40 Ω ✓	
(ii)	the current through the parallel combination is the same as the current through the 20 Ω resistor and the resistance of the parallel combination is the same as the series resistance ✓ ∴ pd across the parallel combination is the same as across the series resistor ✓ battery pd is shared equally (at 6.0 V across the parallel combination and across the series resistor) ✓ **or** battery current = 12.0 V/40 Ω = 0.3 A ✓ pd across 20 Ω resistor = 0.30 A × 20 Ω = 6.0 V ✓ ∴ pd across the parallel combination = 12.0 V – 6.0 V (or 0.30 A × 20 Ω) = 6.0 V ✓	**5**
(b)	power supply to each resistor = V^2/R ✓ parallel combination resistance and current are the same as for the 20 Ω resistor ✓ (therefore power supplied to parallel combination is the same as that supplied to the 20 Ω resistor) **or** power = I^2R ✓ parallel combination resistance and current are the same as for the 20 Ω resistor ✓ (therefore power supplied to parallel combination is the same as that supplied to the 20 Ω resistor) **or** power = IV ✓ I and V are the same for the parallel combination and the 20 Ω resistor ✓ (therefore power supplied to parallel combination is the same as that supplied to the 20 Ω resistor)	**2**
	Total	**7**

Question 3			
(a)	(i)	peak pd (= 230 × √2) = 330 V (to 2 sf) ✓ (accept 325 V)	3
	(ii)	rms current ($\frac{\text{power}}{\text{rms pd}}$) = $\frac{5300}{230}$ ✓ = 23 A ✓	
(b)	(i)	cable resistance = 0.020 × 5.2 = 0.1(4) (Ω) ✓ rms pd along cable (= rms current × cable resistance = 23 × 0.104) = 2.4 V ✓ (accept 2.3 V)	6
	(ii)	power in the cable or rms current × rms pd along the cable ✓ (= 23 × 2.4) = 55 W ✓ or V^2/R ✓ (= 2.4^2/0.10(4)) = 55 W ✓	
	(iii)	any **two** points if the resistance was greater, the heating effect would be greater ✓ more power would be wasted at higher resistance (or less power would be available to the cooker) ✓ the insulation of the wires could melt so exposing the livewire (or creating a fire risk) ✓	
		Total	**9**

Question 4			
(a)	(i)	R_T (= V/I = 1.2 V/0.6 mA) = 2.0 kΩ ✓	4
	(ii)	pd across R = 30 – 1.2 = 1.8 V ✓ $\frac{R}{R_T} = \frac{\text{pd across R}}{\text{pd across T}} = \frac{1.8\text{V}}{1.2\text{V}}$ = 1.5 ✓ R (= 1.5 × 2.0) = 3.0 kΩ ✓ or (alternative for last two marks) current through R = 0.60 mA ✓ R (= V/R) = 1.8 V/60 mA = 3.0 kΩ ✓	

(b)	thermistor resistance increases with decrease of temperature ✓ total circuit resistance increases (and the battery pd is the same) ✓ current = battery pd/total resistance so the current decreases ✓ voltmeter reading increases ✓ (because) pd across R decreases (as pd proportional to current) ✓ (and) thermistor pd = battery pd – resistor pd ✓ or (alternative for last two marks) (because) pd across T/pd across R = R_T/R ✓ (and) R_T increases as the temperature is reduced ✓	**max 5**
	Total	**9**

Question 5		
(a) (i)	elastic energy stored (= ½ Fe) = ½ × 30 × 1.28 × 10^{-3} ✓ = 1.9(2) × 10^{-2} J ✓	**8**
(ii)	length of the wire ✓ measure to nearest mm using a metre rule ✓ diameter of the wire ✓ use a micrometer at several places to gain an average value ✓	
(iii)	calculate area of cross-section A of the wire using A = ¼ π(diameter)^2 or π (radius)^2 ✓ calculate Young modulus $E = \dfrac{\text{load} \times \text{length of wire}}{\text{extension} \times \text{cross} - \text{sectional area}}$ ✓	
(b)	Hooke's law states force ∝ extension ✓ limit of proportionality is exceeded at 60 N ✓ cannot tell from data how far below 60 N it was exceeded ✓ elastic limit not exceeded as wire regained its initial length ✓ wire behaves elastically up to 60 N ✓	**max 4**
	Total	**12**

Quality of Written Communication Q1 (a) (iii) and/or Q4 (b)	**2**