Version 1.0: 0809

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5451

Specification A

PHA3/W Current Electricity and Elastic Properties of Solids

Mark Scheme

2009 examination - June 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.

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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.

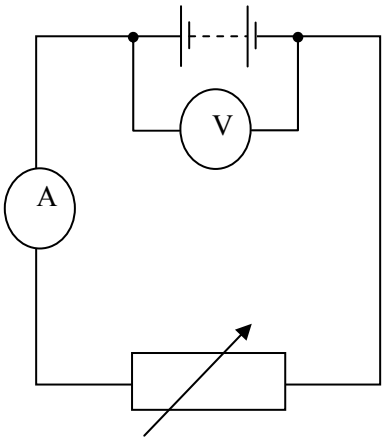
5 No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. 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)	I (= $\frac{P}{V} = \frac{32\text{W}}{12\text{V}}$) = 3(.0) A ✓ R = $\frac{V}{I} = \frac{12\text{V}}{3.0\text{A}}$ = 4(.0) Ω ✓	**3**
	(ii)	total resistance (= ($4.0^{-1} + 4.0^{-1} + 4.0^{-1})^{-1}$) = 1.3(3) Ω ✓ **or** R =(12 / (3 × 3.0)) = 1.3(3) Ω (✓)	
(b)	(i)	battery current = 3.0 A ✓ charge supplied Q (= $I t$ = 3.0 × 21 × 3600) = 2.3 × 10^5 C ✓	**3**
	(ii)	energy supplied E (= $Q V$ = 2.27 × 10^5 × 12) = 2.7(2) MJ ✓ **or** E = (Pt = 36 × 21 × 3600) = 2.7(2) MJ (✓)	
(c)		battery current = 9 A (as the lamps are in parallel) ✓ full battery charge = 2.3 × 10^5 C (or same as in b)(i)) ✓ time = charge/current (= 2.3 × 10^5/9 = 2.5(6) × 10^4s) = 7 hours ✓ (alternative for last 2 marks; 3 A for 21 hours is same charge as 9 A for 7 hours (✓✓)) **or** current is 3 times greater (✓), charge is same (✓), as time = charge/ current, time is 3 times smaller (✓)	**3**
		Total	**9**

Question 2			
(a)	(i)	measure the pd and current using the ammeter and voltmeter ✓ repeat for at least 5 different pairs of values of I and V (using the potential divider) ✓ plot a graph of V against I ✓ measure the gradient to obtain resistance (of chosen length) ✓	**5**
	(ii)	resistivity = resistance × area of cross–section/length ✓	
(b)	(i)	pd across W (= 6.0 – 1.1) = 4.9 V ✓ resistance = pd/current = 4.9/0.82 A = 6.0 Ω ✓	**6**
	(ii)	resistance of resistor R (= 1.1 V/0.82 A) = 1.34 Ω ✓ resistance of half-length = 3.0 Ω ✓ ammeter reading (= battery pd/total resistance = 6.0/(3.0 + 1.34) = 1.4 A ✓ voltmeter reading (= current × resistance of R) = 1.4 × 1.3(4) = 1.9 V ✓	
		Total	**11**

Question 3			
(a)	(i)	emf is the (electrical) energy produced (or generated) in the cell per unit charge ✓	**5**
	(ii)	 ✓ for ammeter correct ✓ for variable resistor correct ✓ for voltmeter correct ✓ for suitable method (eg use VR to give different currents; read ammeter and voltmeter for each current	
(b)	(i)	correct measurement off the graph of pd and current at 2 points at least 3A apart ✓ correct calculation of gradient (= change of pd/change of current) = 0.54 (Ω) ✓ identification of internal resistance (r) as gradient gives r = 0.54 Ω ✓	**6**
	(ii)	power supplied by cell (= 5.0 × 6.0) = 30 W ✓ power wasted due to internal resistance (= 5.0^2 × 0.54) = 13.5 W ✓ % wasted (= 13.5/30 × 100) 45% ✓	
		Total	**11**

Question 4			
(a)	(i)	(1 cycle = 3.0 cm so) time T for 1 cycle = 6.0 ms ✓ frequency (= $\frac{1}{T}$) = $\frac{1}{6.0\times10^{-3}}$ = 170 Hz (167 Hz) ✓	**4**
	(ii)	peak height of trace = 2.0 cm ✓ peak voltage = 5.0 × 2.0 = 10.0 V ✓	
(b)	(i)	peak current = peak pd/resistance = 6.2/1.5 = 4.1(3) A ✓ rms current = peak current/√2 = 2.9(2) A ✓	**3**
	(ii)	mean power (= ½ × peak current × peak pd = 0.5 × 4.1(3) × 6.2) = 13 W (or 12.8 W) ✓ [or = $I_{rms}^2 R$ = 2.92^2 × 1.5 = 13 W ✓]	
		Total	**7**

Question 5			
(a)	(i)	tension (or force or load weight) per unit (cross-sectional) area needed to break the wire ✓	**3**
	(ii)	any **two** from: wire undergoes a permanent extension ✓ elastic limit of wire is exceeded ✓ wire does not return to its original length when stretching force is removed ✓ atoms in the wire slide past each other as it deforms ✓ stretching forces breaks bonds between atoms ✓	
(b)	(i)	increase in strain = extension/length ✓ (or = 0.5/810) = 6.2×10^{-4} (or 6.17×10^{-4}) ✓	**7**
	(ii)	increase in stress = $E \times$ increase in strain ✓ (= $2.1 \times 10^{11} \times 6.17 \times 10^{-4}$) = 1.3×10^{8} Pa ✓ increase in tension = increase in stress × csa ✓ (= $1.3 \times 10^{8} \times 2.3 \times 10^{-7}$) = 30 N ✓ assumption; any **one** from: limit of proportionality (or elastic limit) not exceeded ✓ wire does not slip at tension key ✓ cross sectional area remains constant ✓	
		Total	**10**

Quality of Written Communication Q2 (a) and/or Q5 (a)	**2**