RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE

Unit **G482:** Electrons, Waves and Photons

Mark Scheme for January 2013

Oxford Cambridge and RSA Examinations

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Annotations

Available in Scoris

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error or repeat error
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation

The abbreviations, annotations and conventions used in the detailed Mark Scheme are:

Annotation	Meaning
/	Alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions

CATEGORISATION OF MARKS

The marking scheme categorises marks on the MABC scheme

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answer.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answer. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows that the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:
If the data given in a question is to 2 SF, then allow answers to 2 or more SF.
If an answer is given to fewer than 2 SF, then penalise once only in the entire paper. **N.B.** Also penalise RE only once per paper.
Any exception to this rule will be mentioned in the Guidance.

Please put ticks and crosses against all sub-sections marked AAA (7 in total)

Question			Answer	Marks	Guidance
1	(a)		V is not proportional to I the characteristic/line is a curve/not a straight line	B1 B1	**accept** statement of Ohm's law for 1 mark **not** resistance is not constant/AW
	(b)	(i)	variable power supply **or** fixed supply + potential divider ammeter in series with and voltmeter in parallel with lamp	B1 B1	value of power supply **not** required **accept** cross or Ω in circle for lamp symbol **penalise** each extra component connected (up to two)
A A A		(ii)	vary p.d. (across lamp)/current (in circuit) by changing voltage supply/moving contact on the potential divider take/record set of values of V and I	B1 B1 B1	 **accept** increase voltage in steps of 1 V/AW **accept as ecf** changing variable resistor in series in circuit QWC mark
	(c)		From Fig. 1.1 lamp I_L = 0.25 A for R I_R = 6/20 = 0.30 A so I_P = 0.55 (A)	C1 C1 A1	1 mark for each current; 1 mark for $I_R + I_L$ **or** R_L = 6/0.25 = 24 Ω; Rs in // gives R_{tot} = 10.9; so I_P = 6.0/10.9 = 0.55 A
	(d)	(i)	straight line through origin and 300,6	B1	
		(ii)	appreciation that p.d.s across both components add to 6 V attempt to find where current is the same in both components I_S = 0.16 to 0.17 (A) **or** 165 ± 5 x 10^{-3} A **or** 165 ± 5 mA	B1 B1 B1	**accept** answers in terms of lines drawn on fig.1.1 **or** description of using ruler horizontally on graph and adding squares across graph,etc. **ecf (d)(i)**
			Total	**14**	

Question			Answer	Marks	Guidance
2	(a)	(i)	I = 230/(42.5 + 2.5) I = 5.11 (A)	C1 A1	 **accept** 5.1 A
		(ii)	$P = I^2R = 5.11^2 \times 45$ = 1175.0 W **or** use P = VI or $P = V^2/R$ answer given to 3 SF i.e. 1180 (W)	C1 A1 B1	**ecf(a)(i)** and **allow** $5.00^2 \times 45 = 1125$ W $5.1^2 \times 45 = 1170$ W **give** 1 mark for 65.3 W (wires only) or 1110 W (heater only) **any** follow through answer given to 3 SF gains third mark
		(iii)	6 to 10 A (integer values only)	B1	**ecf(a)(i)** ; **allow** 13 A
	(b)		1180 x 21 x 4/1000 = 99 p	C1 A1	**ecf(a)(ii)** **allow** 99.1(2) **or** 100 p
	(c)		R = ρl/A $A = 1.70 \times 10^{-8} \times 9.50/2.50$ $A = 6.46 \times 10^{-8}$ (m^2)	C1 C1 A1	select formula mark correct substitution **allow** correct answer to 2 SF, i.e. 6.5×10^{-8} (m^2) **special case** 2/3 marks for: l = 4.75 m; $A = 3.23 \times 10^{-8}$ (m^2)
A **A** **A**	(d)		resistance of wires increases so smaller current (in heater) power dissipation in <u>heater</u> less	B1 B1 B1	**N.B.** wires can be implied by e.g. A reduces so R increases **or** lower voltage across heater/greater voltage across wires **or** power dissipation in wires greater/wires get hotter/melt **N.B.** any statement implying constant or increased current invalidates second and third marking points
		•	**Total**	**14**	

Question			Answer	Marks	Guidance
3	(a)	(i)	energy transferred from source/changed from some form to electrical energy; per unit charge (to drive charge round a complete circuit)	M1 A1	**allow** chemical
		(ii)	(some) energy is transferred into thermal energy /lost as heat in (driving charge through) the battery. It behaves as if it has an (internal) resistance/AW **or** there is a voltage drop across/decrease in voltage from the battery when a current is drawn from it/AW	B1	**allow** any description which uses E = V + Ir with symbols defined but **not** just the formula alone **or** e.g. statement about 'lost volts'/current
	(b)	(i)	correct substitution into resistors in parallel formula R = 90 Ω	C1 A1	1/R = 1/90 or 0.011 correct answer
		(ii)	using $V_{out} = R_2/(R_1 + R_2)\ V_{in}$: **alt:** 16 = I x 120 V_{out} = 90/(30 + 90) 16 so I = 0.133 A V_{out} = 12 V V_{out} = 0.13 x 90 = 12 V	C1 C1 A1	**ecf (b)(i)** **accept** V_{out} = (90/120) x 16 = 12 V for full marks **N.B.** beware of false ratios, e.g. 360/(120 + 360) giving correct answer; give first marking point only
A A A		(iii)	resistance (of thermistor) decreases (with temperature increase) current <u>in circuit</u> increases **or** as <u>total</u> resistance is less so current in thermistor increases voltage ratio between 30 Ω and combination changes so voltage across thermistor falls	B1 M1 A1 M1 A1	**max** 4 marks QWC mark is either of the M marks
	(c)	(i)	Q = It = 1.2 x 8 x 60 x 60 Q = 34560 (C) correct unit,	C1 A1 B1	**accept** 3.5 or 3.46 x 10^4 **allow** 1 mark for answer of 9.6 or 576 **allow** C, kC, A s; **N.B.** 9.6 A h or 576 A min score 3/3
		(ii)	energy = 34560 x 16 = 552960 J **or** I = 1.4/16 = 00875 A time = 552960/1.4 = 394970 s **then** t = 34560/I time = 394970/3600 = (109.7 h) = 110 h	C1 C1 A1	**ecf (c)(i)** **allow** full marks for 1.2 x 8 x 16/1.4 = 110 h **allow** 111 h when using 3.5 x 10^4 C
			Total	**18**	

Question			Answer	Marks	Guidance
4	(a)	(i)	f = 1000/2 f = 500 (Hz)	C1 A1	**give** 1 mark for ½ (POT error)
		(ii)	v = fλ giving 340 = 500 x λ λ = 0.68 (m)	C1 A1	**ecf(a)(i)**
	(b)		sinusoidal curve of same frequency and amplitude ± cosine curve	B1 B1	**must** be drawn for 2 full cycles to score this mark **allow** drawn as sine curve from t = 0.5 ms
A A A	(c)		relates to the oscillation of two points on the (same) wave how far 'out of step' one oscillation is from the other/AW λ/4 means a phase difference of 90^o or π/2 (rad)	B1 B1 B1	**accept** vibration **N.B.** statements about oscillations of two waves can only score the third marking point
	(d)		sine wave of same frequency with increased amplitude realisation that intensity is proportional to $(\text{amplitude})^2$ giving amplitude increase by √2, i.e.2.8 mm	B1 B1 B1	
A A A	(e)	(i)	the wave reflected at the end of the pipe interferes/superposes with the incident wave to produce a resultant wave with nodes and antinodes both ends must be antinodes the pipe must be nλ/2 in length for this to happen	 B1 B1 B1 B1	**max** 3 marks
		(ii) 1	air molecules oscillate along the axis of the tube with maximum amplitude	B1 B1 B1	**max** 2 marks; **allow** vibrate; if transverse wave is clearly implied then can only score third marking point
		(ii) 2	no motion/nodal point	B1	**allow** zero displacement/amplitude
			Total	**18**	
			SCAN DOWN TO CHECK NO ANSWERS ON PAGE 11		

Question			Answer	Marks	Guidance
5	(a)		when two(or more) waves meet/cross/interact (at a point) the (resultant) <u>displacement</u> is the (vector) sum of the (individual) <u>displacements</u>	B1 B1	**do not allow** for two waves travelling in opposite directions **allow** as a special case: the <u>resultant wave</u> is…..
	(b)	**(i)**	<u>constant</u> phase difference/relationship (between the waves)	B1	**allow** fixed
		(ii)	6 x (2n + 1)/2 x10^{-7} (m) where n = 0, 1,2, etc.	B1	**expect** 3 x 10^{-7}; next values: 9 x 10^{-7}, 15 x 10^{-7} allow 300 nm, etc
		(iii)	select λ = ax/D 6.00 x 10^{-7} = 1.20 x 10^{-3} x/2.50 x = 1.25 x 10^{-3} (m)	C1 C1 A1	
		(iv) 1	fringes move closer together a smaller distance is required between the rays from the slits to produce λ/2 /π phase change	B1 B1	**allow** (use of formula) x α λ as (a and D fixed) and λ decreases
		(iv) 2	fringes same distance apart paths of rays unchanged/slit centres same distance apart	B1 B1	**allow** (use of formula) x unchanged as a (λ and D) fixed
		(iv) 3	fringes move closer together the angle at which the dark fringes appear from the slits is the same, but the distance to the screen is much less	B1 B1	**allow** (use of formula) x α D (as λ and a fixed)
			Total	**13**	

Question			Answer	Marks	Guidance
6	(a)	(i)	3 correct labels	B1	
		(ii)	the (three) colours add up/superpose to give white light **or** no dispersion/diffraction of incident white light/AW	B1	**allow** use of formula d sin θ = nλ so constructive interference at θ = 0 for all λ
		(iii)	select λ = d sin θ λ = 1.67 x 10^{-6} sin 19.1 λ = 546 x 10^{-9} (m)	C1 C1 A1	**allow** 547 x 10^{-9} as answer is 546.46 x 10^{-9} **do not allow** 550 x 10^{-9} unless SF mark already deducted
	(b)		select E = hc/ λ E = 6.63 x 10^{-34} x 3.0 x 10^{8}/436 x 10^{-9} E = 4.56 x 10^{-19} (J)	C1 C1 A1	**do not allow** 4.6 x 10^{-19} unless SF mark already deducted
	(c)	(i)	1 arrow correctly labelled 2 more arrows correctly labelled	B1 B1	
			Total	**10**	

Question			Answer	Marks	Guidance
7	(a)		the energy of an electron✓ equals the energy of the (emitted) photon✓	B1 B1	**alt:** the electron energy✓ is converted into the energy of the emitted photon✓ **or** the minimum energy✓ of an electron required to produce a photon✓/AW
A A A	(b)		Adjust the potential divider to low/zero voltage connect flying lead to one LED increase voltage until LED just lights/strikes repeat several times and average to find V_{min} repeat for each LED shield LED inside opaque tube to judge strike more accurately	B1 B1 B1 B1 B1 B1	**max** 3 marks
A A A	(c)	(i)	values of 1/λ calculated correctly: 2.14 and 2.43 2 points plotted correctly line of best fit drawn through origin gradient = 1.24×10^{-6} (V m)	B1 B1 B1 B1	**not** 2.13 unless this is second rounding error in paper **ecf** calculated values in table working **must be shown** to score the mark **allow ecf** for correct gradient from line drawn
		(ii)	gradient of line = V λ from eV = hc/ λ Vλ = hc/e	B1 B1	**must have** clear indication that V λ is gradient of graph
		(iii)	1.24×10^{-6} = hc/e h = $1.24 \times 10^{-6} \times 1.6 \times 10^{-19} / 3.0 \times 10^{8}$ h = 6.6(1) $\times 10^{-34}$ (J s)	 M1 A1	**ecf (c)(i)** correct substitution into equation mark ans = 5.3 x grad (ignoring all powers of 10)
			Total	**13**	
			SCAN DOWN TO CHECK NO ANSWERS ON PAGE 18		

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