OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE **G482/01**

Electrons, Waves and Photons

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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Question			Expected Answers	M	Additional Guidance
1					
	a		current moves from + to – (of battery in circuit) **and** electrons move from – to +	B1	
	b		$C\ s^{-1}$ $V\ \Omega^{-1}$	B1 B1	2 correct 2 marks; 1 correct 1 mark, withhold a mark for each additional answer given
	c	i	statement of Kirchhoff's first law or conservation of charge	B1	**accept** wires are in <u>series</u> or current is the same (at every point) in a <u>series</u> circuit/AW **not** current in = current out
		ii1	R = ρl/A calculation to justify R = 72 Ω	B1 A1	accept R α l and R α 1/A **or** similar method/argument must be convincing **accept** 3/½ x12 but **not** 3 x 2 x 12
		ii2	R = sum of Rs R = 84 Ω	C1 A1	**accept** Rs in series **ecf (c)(ii)1**
		iii	select I = nAev $v = 4.0 \times 10^{-5}$ ($m\ s^{-1}$)	B1 B1	**allow** v α 1/A **accept** 4×10^{-5} ($m\ s^{-1}$) **no** SF error
			Total question 1	**10**	

Question			Expected Answers	M	Additional Guidance
2					
	a	i	When connected/using/AW to the 230 V supply the power/energy per second from supply/output/dissipated/AW is 25 W	B1 B1	**accept** when working normally/AW **not** 230 V (going) through/into lamp/AW **accept** transferred from electrical (into other) form(s) is 25 W
		ii	$25 = 230^2/R$ R = 2100 Ω **or** 2.1 kΩ	C1 A1	**accept** I = 25/230 = 0.11 A R = 230/0.11 = 2100 Ω (2116 Ω)
		iii	Using the equation in the form P = VI, for larger P need larger I so 60 W	M1 A1	accept $P = V^2/R$, for larger P need smaller R so larger I; do **not** allow any argument using 880 Ω unless this value is calculated here
		iv1	1/R = 1/2100 + 1/880 R = 620 Ω	C1 A1	substitution into formula for Rs in parallel **ecf (a)(ii)**
		iv2	I = 230/620 I = 0.37 (A)	C1 A1	**ecf (a)(iv)1** using 1/R gives 143 kA accept total P = 85 W so I = 85/230 ;= 0.37 (A)
	b		the resistivity/resistance (of a metal) increases with temperature **or** R is greater when hot(ter) at 6V/low I little heating effect **or** at 230 V/high I large heating effect	B1 A1	**ora** less when colder **QWC mark**: explanation linked to observations
	c	i	(a unit of) energy equal to 3.6 MJ **or** 1 kW for 1 h/AW	B1	**eg** 1000 W for 3600 s or similar
		ii	0.06 x 8 = 0.48 (kWh) or 60 x 8 = 480 (Wh) 0.48 x 21 = 10(.1) p	C1 A1	no marks for using s instead of h POT error e.g. 100 or 10000 p
			Total question 2	**15**	

Question			Expected Answers	M	Additional Guidance
3					
	a	i	correct symbols (variable) R in series with ammeter and cell voltmeter correctly in parallel with variable R	B1 B1 B1	variable R and voltmeter needed **ecf** variable resistor symbol **accept** voltmeter in parallel with cell
		ii1	V decreases as I increases caused by R decreasing V is large when R is large **or** V is small when R is small V = e.m.f. when R is infinite/open circuit **or** V = 0 when R = 0 3.14 Ω at A; 0.88 Ω at B and 0.19 Ω at C any correct reference to internal resistance of cell	B1 B1 B1	**max 3 marks** with 2 marks for first two or second two marking points or three numbers and 1 mark for reference to r **allow** as R increases (decreases) V increases (decreases) for 1 mark but **not** as V increases R increases; **award 0/2** if reason given as V α R or I is constant
		ii2	at A I is small or V is much bigger than I/AW at C V is small or I is much bigger than V/AW product of V. and I is largest when the values of both quantities are about equal/half of the maximum value	B1 B1 B1	**accept** numerical answers, e.g. 0.39 W at A, 0.33 W at C 0.56 W at B for 2 marks comment on values for third mark
		ii3	1.4 (V)	B1	
		ii4	appreciating V against I is a straight line graph with gradient –r; giving r = 0.88 ± 0.02 Ω	C1 A1	**accept** using V = E – Ir **not** just quoting formula **allow** 0.8 ± 0.02 for calculation using any point on line N.B. can also have **ecf(ii)3**
	b	i	intensity is the (incident) energy <u>per</u> unit area <u>per</u> second	B1	**accept** power per unit area or power per m^2 or (total) power/(surface) area
		ii	efficiency = power out/power in = 0.25/(800 x 2.5 x 10^{-3}) = 0.125 or 12.5%	C1 C1 A1	**not** energy out/energy in **accept** 13%
			Total question 3	**16**	

Question			Expected Answers	M	Additional Guidance
4					
	a		resistance decreases with increase in light intensity	B1	**ora**
	b	i	3.0 (V)	B1	**accept** 3 V, no SF error
		ii	3.0 = I.1.2 x 10^3 giving I = 2.5 x 10^{-3} A 6.0 /2.5 10^{-3} = R = 2400 Ω 2.4 kΩ	C1 C1 A1	**accept** 6 = (R/ R + 1.2 k).9 2R + 2.4 k = 3R or similar R = 2.4 k ;**give** 2 with POT error **accept** ratio of resistors 6/3 x 1.2 good candidates can do this by inspection with no working – full marks **allow** 2400 written on answer line rather than 2.4 if 2400 Ω within body of text
		iii	49 **or** 50 (W m^{-2})	B1	**ecf (b)(ii)** if on R within graph range
	c	i	2.2 (kΩ)	B1	**allow** any value from 2.1 to 2.2
		ii	large(r) changes in R at low light intensities relating change in R to change in V	B1 B1	**allow** greater sensitivity of LDR at low light **or** steeper gradient/AW **e.g.** bigger change in I so in V **or** use of V = R/(R + 1200) V_s **or** bigger change in V ratio across Rs
	d		V across 1.2 kΩ falls so V across LDR rises because ratio of Rs changes in favour of LDR/ potential divider argument **or** total V is constant	B1 B1 B1	**alternative** I increases because total R is less so V across LDR rises do **not** award B marks where there is CON e.g. V across 1.2 k rises so V across LDR rises
	e		continuous record for very long time scale of observation can record very short time scale signals (at intervals) automatic recording/remote sensing data can be fed directly to computer (for analysis)	B1 B1	**allow** any two sensible suggestions which fall within the 4 categories listed for 2 marks
			Total question 4	**14**	

Question			Expected Answers	M	Additional Guidance
5					
	a	i	travel through a vacuum	B1	**allow** travel at c (in a vacuum)
	b	ii	A gamma; C uv; F microwave	B3	**allow** 1 mark for A radio; C ir; F X-ray
	c	i	$3.0 \times 10^8 = 1.0 \times 10^9 \lambda$ $\lambda = 0.30$ m	C1 A1	 **allow** 0.3 no SF error
		ii	aerial length = $\lambda/2 = 0.15$ m	A1	**ecf (c)(i)**
		iii	emitted wave is (plane) polarised detecting aerial will receive weaker signal/cos θ component when it is rotated (through angle θ)/AW signal falls to zero at 90° and then rises to max again at 180°	B1 B1 B1 	**allow** max signal initially/at 0° **max 3 marks** from 4 marking points
	d	i	UV-A causes tanning or skin ageing ; most of (99%) uv light; 400-315 nm UV-B causes damage or sunburn or skin cancer; 315-260 nm UV-C is filtered out by atmosphere/ozone layer; 260-100 nm	B1 B1 B1	accept values within ranges with tolerance of 20 nm **allow** $\lambda_A > \lambda_B > \lambda_C$ for 1 mark **max 3 marks** from 7 marking points
		ii	filters out/blocks/reflects/absorbs UV(-B)	B1	**allow** chemicals prevent sunburn/skin cancer **not** stops UV penetrating skin
	e		energy of the infra-red photon is less than the work function of the metal surface	B1 B1	**accept** frequency and threshold frequency **or** wavelength and threshold wavelength used correctly in place of energy and work function **1 mark** only: energy of the uv photon greater than work function with no mention of ir
			Total question 5	**16**	

Question			Expected Answers	M	Additional Guidance
6					
	a		oscillation/vibration of <u>particles/medium</u> in direction of travel of the wave example: sound wave, etc. oscillation/vibration of <u>particles/medium</u> (in the plane) at right angles to direction of travel of the wave example: surface water waves, string, electromagnetic, etc	B1 B1 B1 B1	**allow** direction of energy transfer of the wave **not** direction of wave motion **allow** direction of energy transfer of the wave **allow** RE mark for weaker descriptions with same omissions as in longitudinal wave
	b		the incident wave is reflected at the end of the pipe <u>reflected</u> wave <u>interferes/superposes</u> with the incident wave to produce (a resultant wave with) nodes and/or antinodes	B1 B1 B1	 **QWC mark** **accept** resultant wave with no energy transfer
	c	i	at 0 oscillation with max amplitude along tube at 0.2 m (oscillation along tube with) smaller amplitude at 0.6 m no motion/node	B1 B1 	**not** displacement (penalise only once) all 4 correct for 2 marks; 2 correct for 1 mark
		ii	oscillation at 3 times the frequency of c(i) at 0 (oscillation with) max amplitude (along tube)/antinode at 0.2 m no motion/node at 0.4 m motion as at 0 (but in antiphase/opposite direction)	B1 B1 	 3 correct for 2 marks; 2 correct for 1 mark
	d	i	λ/2 sketch with zero at 0.3 m	M1 A1	**accept** 1 or 2 lines, solid or dotted
		ii	$2f_0$	B1	**no ecf from d(i)**
			Total question 6	**14**	

Question			Expected Answers	M	Additional Guidance
7					
	a	i	light emitted from (excited isolated) atoms produces a line spectrum a series of (sharp/bright/coloured) lines against a dark background	B1 B1	**max 2 marks** from 3 marking points
		ii	in an absorption spectrum a series of dark lines (appears against a bright background/within a continuous spectrum)	B1	**accept** black
	b	i	$\varepsilon = hc/\lambda$ $= 6.63 \times 10^{-34} \times 3.00 \times 10^{8} / 436 \times 10^{-9}$ $= 4.56 \times 10^{-19}$ (J)	C1 C1 A1	**apply** SF error if all numbers not to 3+ figures 4.54 if use 6.6
		ii	3.64×10^{-19} (J)	A1	**allow** mark if repeated error from **b(i)**
	c	i	correct vertical lines; correct labels arrow(s) downwards	B1 B1 B1	**1 mark** for 1 vertical line + correct label
		ii	$-8.86 + 4.56 = -4.3 \times 10^{-19}$ (J) $-7.94 + 3.64 = -4.3 \times 10^{-19}$ (J)	B1 B1	**ecf b(i)** **do** calculation for one line only correctly scores 2 marks; give answer as 4.3×10^{-19} **or** -4.3 scores 1 mark **do** calculation for both lines and give answer as 4.3×10^{-19} **or** -4.3 scores both marks
N.B. Before marking 7d check pages 18, 19 and 20 for additional answers by scrolling down. Extra answers MUST be annotated to show that they have been seen and credited back in the relevant question when appropriate. **✓ = 1 extra mark** **x = incorrect; scores 0** **NBOD = no added value or no further action needed; scores 0** **CON = if reference is made to the additional answer in the main text and this answer contradicts the other then deduct the original mark; = if NO reference is made to the additional answer in the main text and this answer contradicts the other then do NOT change the original mark**					
	d		(d sin θ = λ) $3.3 \times 10^{-6} \sin\theta = 546 \times 10^{-9}$ sin θ = 0.165 $\theta = 9.5^{o}$	C1 C1 A1	
			Total question 7	**15**	

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