

Physics A

Advanced Subsidiary GCE **G482/01**

Electrons, Waves and Photons

Mark Scheme for June 2010

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Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

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	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	B1 A1	accept $R \propto l$ and $R \propto 1/A$ or similar method/argument must be convincing accept $3/1/2 \times 12$ but not $3 \times 2 \times 12$
		ii2	C1 A1	accept R_s in series ecf (c)(ii)1
		iii	B1 B1	allow $v \propto 1/A$ accept $4 \times 10^{-5} (m s^{-1})$ no SF error
		Total question 1	10	

Question		Expected Answers	M	Additional Guidance
2				
	a	i		
		When <u>connected/using/AW</u> to the <u>230 V</u> supply	B1	accept when working normally/AW not 230 V (going) through/into lamp/AW
		the <u>power/energy per second</u> from supply/output/dissipated/AW is <u>25 W</u>	B1	accept transferred from electrical (into other) form(s) is 25 W
		ii		
		$25 = 230^2/R$ $R = 2100 \Omega$ or 2.1 k Ω	C1 A1	accept $I = 25/230 = 0.11$ A $R = 230/0.11 = 2100 \Omega$ (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		
		$1/R = 1/2100 + 1/880$ $R = 620 \Omega$	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) <u>energy</u> equal to 3.6 MJ or 1 kW for 1 h/AW	B1	eg 1000 W for 3600 s or similar
		ii		
		$0.06 \times 8 = 0.48$ (kWh) or $60 \times 8 = 480$ (Wh) $0.48 \times 21 = 10(.1)$ 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 $V \propto R$ 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 $r = 0.88 \pm 0.02 \Omega$	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 = $0.25/(800 \times 2.5 \times 10^{-3})$ = 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 $3.0 = I.1.2 \times 10^3$ giving $I = 2.5 \times 10^{-3}$ A $6.0 / 2.5 \times 10^{-3} = R = 2400 \Omega$ 2.4 k Ω	C1 C1 A1	accept $6 = (R / R + 1.2 \text{ k}).9$ $2R + 2.4 \text{ k} = 3R$ or similar $R = 2.4 \text{ k}$; give 2 with POT error accept ratio of resistors $6/3 \times 1.2$ 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 (k Ω)	B1	allow any value from 2.1 to 2.2
	ii large(r) <u>changes in</u> 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 k Ω 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 <u>total</u> 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	$3.0 \times 10^8 = 1.0 \times 10^9 \lambda$ $\lambda = 0.30 \text{ m}$	C1 A1	allow 0.3 no SF error ecf (c)(i)
		ii	aerial length = $\lambda/2 = 0.15 \text{ m}$	A1	
		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		<u>energy</u> of the infra-red photon is less than the <u>work function</u> 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 $\lambda/2$ 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 <u>dark</u> lines (appears against a bright background/within a continuous spectrum)	B1	accept black
b	i $\epsilon = hc/\lambda$ $= 6.63 \times 10^{-34} \times 3.00 \times 10^8 / 436 \times 10^{-9}$ $= 4.56 \times 10^{-19}$ (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
<p>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.</p> <p>✓ = 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</p>			
d	($d \sin \theta = \lambda$) $3.3 \times 10^{-6} \sin \theta = 546 \times 10^{-9}$ $\sin \theta = 0.165$ $\theta = 9.5^\circ$	C1 C1 A1	
Total question 7		15	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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