



# GCE

## Physics A

Advanced Subsidiary GCE **G482/01**

Electrons, Waves and Photons

# Mark Scheme for June 2010

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Question		Expected Answers	M	Additional Guidance
<b>1</b>				
	<b>a</b>	current moves from + to – (of battery in circuit) <b>and</b> electrons move from – to +	B1	
	<b>b</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
	<b>c</b>	<b>i</b> statement of Kirchhoff's first law or conservation of charge	B1	<b>accept</b> wires are in <u>series</u> or current is the same (at every point) in a <u>series</u> circuit/AW <b>not</b> current in = current out
		<b>ii1</b> $R = \rho l/A$ calculation to justify $R = 72 \Omega$	B1 A1	accept $R \propto l$ and $R \propto 1/A$ <b>or</b> similar method/argument must be convincing <b>accept</b> $3/1/2 \times 12$ but <b>not</b> $3 \times 2 \times 12$
		<b>ii2</b> $R = \text{sum of } R_s$ $R = 84 \Omega$	C1 A1	<b>accept</b> $R_s$ in series <b>ecf (c)(ii)1</b>
		<b>iii</b> select $I = nAev$ $v = 4.0 \times 10^{-5} (m s^{-1})$	B1 B1	<b>allow</b> $v \propto 1/A$ <b>accept</b> $4 \times 10^{-5} (m s^{-1})$ <b>no</b> SF error
		<b>Total question 1</b>	<b>10</b>	

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<b>2</b>				
	<b>a</b>	<b>i</b>		
			B1	<b>accept</b> when working normally/AW <b>not</b> 230 V (going) through/into lamp/AW
			B1	<b>accept</b> transferred from electrical (into other) form(s) is 25 W
		<b>ii</b>	C1	<b>accept</b> $I = 25/230 = 0.11$ A
			A1	$R = 230/0.11 = 2100 \Omega$ (2116 $\Omega$ )
		<b>iii</b>	M1	accept $P = V^2/R$ , for larger P need smaller R so larger I; do <b>not</b> allow any argument using 880 $\Omega$ unless this value is calculated here
			A1	
		<b>iv1</b>	C1	substitution into formula for Rs in parallel
			A1	<b>ecf (a)(ii)</b>
		<b>iv2</b>	C1	<b>ecf (a)(iv)1</b> using $1/R$ gives 143 kA
			A1	accept total $P = 85$ W so $I = 85/230 ;= 0.37$ (A)
	<b>b</b>		B1	<b>ora</b> less when colder
			A1	<b>QWC mark:</b> explanation linked to observations
	<b>c</b>	<b>i</b>	B1	<b>eg</b> 1000 W for 3600 s or similar
		<b>ii</b>	C1	no marks for using s instead of h
			A1	POT error e.g. 100 or 10000 p
		<b>Total question 2</b>	<b>15</b>	

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

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

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

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Question		Expected Answers	M	Additional Guidance
<b>6</b>				
	<b>a</b>	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	<b>allow</b> direction of energy transfer of the wave <b>not</b> direction of wave motion  <b>allow</b> direction of energy transfer of the wave <b>allow</b> RE mark for weaker descriptions with same omissions as in longitudinal wave
	<b>b</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	<b>QWC mark</b> <b>accept</b> resultant wave with no energy transfer
	<b>c</b>	<b>i</b> 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	<b>not</b> displacement (penalise only once)  all 4 correct for 2 marks; 2 correct for 1 mark
		<b>ii</b> 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
	<b>d</b>	<b>i</b> $\lambda/2$ sketch with zero at 0.3 m	M1 A1	<b>accept</b> 1 or 2 lines, solid or dotted
		<b>ii</b> $2f_0$	B1	<b>no ecf from d(i)</b>
		<b>Total question 6</b>	<b>14</b>	



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<b>7</b>			
<b>a</b>	<b>i</b> light emitted from (excited isolated) atoms produces a line spectrum a series of (sharp/bright/coloured) lines against a dark background	B1 B1	<b>max 2 marks</b> from 3 marking points
	<b>ii</b> in an absorption spectrum a series of <u>dark</u> lines (appears against a bright background/within a continuous spectrum)	B1	<b>accept</b> black
<b>b</b>	<b>i</b> $\epsilon = hc/\lambda$ $= 6.63 \times 10^{-34} \times 3.00 \times 10^8 / 436 \times 10^{-9}$ $= 4.56 \times 10^{-19}$ (J)	C1 C1 A1	<b>apply</b> SF error if all numbers not to 3+ figures 4.54 if use 6.6
	<b>ii</b> $3.64 \times 10^{-19}$ (J)	A1	<b>allow</b> mark if repeated error from <b>b(i)</b>
<b>c</b>	<b>i</b> correct vertical lines; correct labels arrow(s) downwards	B1 B1 B1	<b>1 mark</b> for 1 vertical line + correct label
	<b>ii</b> $- 8.86 + 4.56 = - 4.3 \times 10^{-19}$ (J) $- 7.94 + 3.64 = - 4.3 \times 10^{-19}$ (J)	B1 B1	<b>ecf b(i)</b> <b>do</b> calculation for one line only correctly scores 2 marks; give answer as $4.3 \times 10^{-19}$ <b>or</b> -4.3 scores 1 mark <b>do</b> calculation for both lines and give answer as $4.3 \times 10^{-19}$ <b>or</b> -4.3 scores both marks
<p><b>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.</b>  ✓ = 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>			
<b>d</b>	( $d \sin \theta = \lambda$ ) $3.3 \times 10^{-6} \sin \theta = 546 \times 10^{-9}$ $\sin \theta = 0.165$ $\theta = 9.5^\circ$	C1 C1 A1	
<b>Total question 7</b>		<b>15</b>	

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