RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE

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

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

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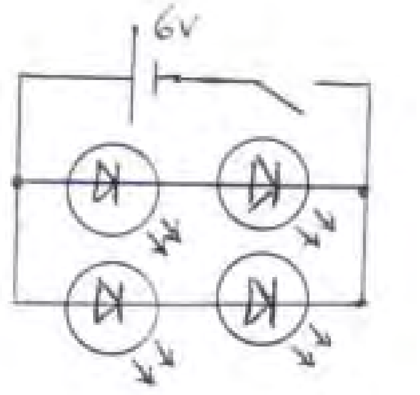
Question			Expected Answers	M	Additional Guidance
1					
	a	**i**	read off value of current (at V = 6.0 V) calculate R using V/I	B1 B1	any reference to using gradient scores 0/2 **accept** I = 0.25 (A) or 250 (mA) **accept** R = 24 Ω
		ii	V is not proportional to I	B1	**accept** not a straight line; R is not constant
	b	**i** **ii** **iii**	Q = It = 0.25 x 1 = 0.25 C E = VIt or QV = 6 x 0.25 = 1.5 J E = VIt = 1.5 x 4 x 60 x 60 = 2.16 $\times 10^4$ J	B1 B1 C1 A1	 **ecf(b)(i)** **ecf b(ii)** **accept** 2.2 x 10^4 J; **allow** 360 J for 1 mark only
	c	**i** **ii** **iii**	energy transfer per unit charge from electrical to other forms 30 mA Use of P = VI suitable method (may be expressed purely in numerical form) = 0.36 W	B1 B1 A1 M1 A1 A0	**or** energy transfer/charge; work done /charge **or** across LED 3 x 0.030 = 0.090 W per LED so 0.090 x 4 **or** 30 mA in two branches at 6 V **or** total current is 60 mA from 6 V battery
		iv		B1 B1 B1	symbol for LED correct orientation of LED correct circuit
	d		draws a lower current/ light lasts longer (before battery discharged/)AW **or** LEDs more efficient (at converting electrical energy into light) **or** if one LED fails there are still two lit **or** more robust/longer working life	B1	 **allow** lower power consumption/AW
			Total question 1	**16**	

Question			Expected Answers	M	Additional Guidance
2					
	a	**i**	12/2.0 = 6.0 (Ω)	B1	**allow** 6; do not apply the SF penalty (N.B. applied only once per paper) for any answer where the second SF is 0
		ii	attempt to use resistors in parallel formula 1/R = 8/6 R = 0.75 (Ω)	C1 C1 A1	no mark for just quoting formula **ecf (a)(i)** **allow** ¾ (Ω)
		iii	$P = V^2/R = 12^2/0.75$ **or** 8VI = 8 x 12 x 2 **or** $I^2R = 16^2 \times 0.75$ = 192 W	C1 A1	**ecf (a)(ii)**
	b		ρ = RA/l $= 6.0 \times 0.24 \times 2.0 \times 10^{-6}/0.9$ $= 3.2 \times 10^{-6}$ Ω m	C1 C1 A1 B1	correct rearrangement of formula **ecf (a)(i);** substitution into a correct formula 2/3 marks for one or more POT errors **accept** 3.2 Ω μm; 4×10^{-7} scores 2/3
	c	**i**	(As V is the same) then R must be the same to give same P	B1	**accept** alternative wording producing same argument, e.g. same I, same V so same R
		ii	0.75/8 = 0.094 (Ω)	B1	**ecf (a)(ii)**/8; **accept** 3/32 but NOT 0.09
		iii	for parallel circuit with break in one wire rest still work **or** series strips very wide (if use material of same resistivity as such low resistance/ giving poor visibility))	B1	any sensible statement
	d	**i**	14 V	B1	
		ii	e.g. V = 12 V; I = 20 A substitution into E = V + Ir, e.g. 14 = 12 + 20 r r = 0.1 Ω	C1 C1 A1	**or** any suitable pair of readings from graph **ecf(d)(i); accept** r = gradient; = (14 – 10)/40 or similar ; = 0.1 Ω
			Total question 2	**17**	

Question			Expected Answers	M	Additional Guidance
3					
	a		energy per unit area per unit time	B1	**accept** power per unit area; **allow** second for unit time
	b		Small <u>changes</u> in R for high light intensities/daylight conditions Large <u>changes</u> in R for low light intensities/dim light/night time conditions to change circuit state need a significant change in R to be useful/reliable	B1 B1 B1	**accept** low R by day, high R by night for 1 mark **NOT** comparison e.g. R by day smaller than R at night **max 2 marks** from 3 marking points
	c	**i** **ii** **iii**	2.5 (kΩ) 5.0 = I x 2.5 kΩ giving I = 2.0 x 10^{-3} A 4.0 = 2.0 x 10^{-3} x R **or** potential divider argument giving R = 2.0 x 10^{3} Ω	A1 C1 A1 M1 A0	**allow** 2.4 to 2.6 **ecf (c)(i)** **accept** 2.0 mA **ecf (c)(ii) or ecf (c)(i)** **accept** 2.0 kΩ
	d		R (of LDR) = 1(.0 kΩ) potential divider of 1.0 kΩ and 2.0 kΩ giving 3.0 V across LDR	B1 C1 A1	 **accept** I = 3.0 (mA) so V = 3.0 (mA) x 1.0 (kΩ) = 3.0 V
	e		light shining on the LDR will cause it to switch the illumination off causing an ON/OFF oscillation/AW	B1 B1	two suitable qualifying statements for the 2 marks
			Total question 3	**12**	

Question			Expected Answers	M	Additional Guidance
4					
	a	**i**	photoelectric effect/emission	B1	
		ii1 **ii2**	the <u>minimum</u> energy (required) to release an electron (from the surface of the metal) $3.5 \times 10^{-19} = 6.6 \times 10^{-34}$ f f = 5.3×10^{14} (Hz)	B1 C1 A1	
		iii	$\varepsilon = hc/\lambda = 6.6 \times 10^{-34} \times 3.0 \times 10^{8} / 4.2 \times 10^{-7}$ $= 4.7 \times 10^{-19}$ (J)	C1 A1	no second mark unless there is evidence of the calculation being done
		iv	$\frac{1}{2}mv^2 = 4.7 \times 10^{-19} - 3.5 \times 10^{-19}$ $= 1.2 \times 10^{-19}$ (J)	C1 A1	mark for using the p.e. equation **accept** 1.5×10^{-19} from those using 5×10^{-19} J
	b	**i1** **ii2**	12 (eV) $\varepsilon = eV = 12 \times 1.6 \times 10^{-19} = 1.92 \times 10^{-18}$ (J)	B1 A1	 **ecf(b)(i)1**
		ii	$\frac{1}{2}mv^2 = 2.0 \times 10^{-18}$ $v^2 = 2 \times 2.0 \times 10^{-18}/9.1 \times 10^{-31} = 4.4 \times 10^{12}$ $v = 2.1 \times 10^{6}$ (m s^{-1})	C1 C1 A1	$\frac{1}{2}mv^2 = 12$ scores 0/3 **accept** 1.9×10^{-18} from **(b)(i)2** giving v = 2.0(5) x 10^{6}
	c		e's emitted/s = $1.2 \times 10^{-8}/5 \times 10^{-19} = 2.4 \times 10^{10}$ current = $2.4 \times 10^{10} \times 1.6 \times 10^{-19}$ $= 3.8 \times 10^{-9}$ (A) to 4.1×10^{-9} (A)	C1 C1 A1	using 4.7×10^{-19} gives 2.55×10^{10} omitting 1% scores as a POT error allow 4 nA as the question states 'estimate'
			Total question 4	**16**	

Question			Expected Answers	M	Additional Guidance
5					
	a	**i**	0.60 m	B1	**allow** 0.6 another example of SF comment Q2
		ii1 **ii2**	the wave has moved along 0.5 wavelengths in 0.75 ms so will move one wavelength in 1.5 ms which is the period/AW f = 670 Hz so v = fλ = 670 x 0.60 = 400 (m s^{-1})	 B1 C1 A1	can be answered in terms of phase **ecf(a)(i)** **accept** v = λ/T = 0.60/1.5 x 10^{-3}
	b		0	B1	
	c	**i**	*displacement* any distance moved from equilibrium of a point/particle (on a wave) *amplitude* <u>maximum</u> possible <u>displacement</u> (caused by wave motion)	 B1 B1	**allow** alternatives for equilibrium, e.g. mean/rest/undisturbed position
		ii	*progressive* a wave which transfers energy *stationary* a wave which <u>traps/stores</u> energy (in pockets) **OR** *progressive* : transfers shape/information from one place to another *stationary* where the shape does not move along/which has nodes and antinodes/AW	B1 B1 B1 B1	**accept** phase relationship descriptions between different points on wave; must be a comparison for same property to score both marks
	d	**i**	the incident wave is <u>reflected</u> at the fixed ends of the wire reflected wave <u>interferes/superposes</u> with the incident wave to produce a resultant wave with nodes and antinodes/no energy transfer	B1 B1 B1	must have reference to an end of the wire QWC mark
		ii1 **ii2** **ii3**	0.70 (mm) 0.15 (m)/0.45 (m) x = 0.2, y = -1.7	B1 B1 B1	**allow** 0.60 to 0.80 mm anywhere on vertical line x = 0.15 or 0.45
			Total question 5	**15**	

Question			Expected Answers	M	Additional Guidance
6					
	a	**i**	method of producing coherent sources at S_1 and S_2 light (waves) from the two slits/sources must be coherent; that is, they must have a constant phase relationship/difference slits must be narrow/close together (so that diffraction patterns overlap) light (waves) from two slits must have similar amplitudes/intensities	B1 B1 B1 B1 B1	e.g. initial single slit **max 3 marks** from 5 marking points
		ii	*bright*: constructive interference occurs/waves add to give a maximum amplitude at the screen path difference between slits and screen is a whole/integer number of wavelengths/waves arrive in phase at screen *dark*: destructive interference occurs/waves add to give a minimum amplitude/zero at the screen path difference between slits and screen is an odd half number of wavelengths/waves arrive out of/in antiphase at screen	B1 B1 B1 B1	 **accept** explanation in terms of distance or phase **accept** explanation in terms of distance or phase
	b	**i**	$7.4/5 = 1.48 \times 10^{-3}$ (m)	B1	**accept** 1.5 mm
		ii	$\lambda = xd/L$ $= 1.48 \times 10^{-3} \times 0.6 \times 10^{-3}/1.5$ $= 5.9(2) \times 10^{-7}$ (m)	C1 C1 A1	using 1.5 mm gives 600 nm **ecf(b)(i)** e.g. 4 92 x 10^{-7} for 1.23 mm **accept** 590 nm
	c		pattern/fringes vanish because there is now no interference from light from the two slits/AW light spreads out over whole/similar region light intensity (at screen) is less diffraction spreads light simple description of single slit pattern further features of single slit pattern	B1 B1 B1 B1 B1 B1 B2	 e.g. bright in middle and dim at edges/sketch of bell shape **max 3 marks** from 8 marking points
			Total question 6	**14**	

Question			Expected Answers	M	Additional Guidance
7					
	a		reference to a transverse wave or to vibrations in plane normal to the direction of (energy) propagation oscillations/vibrations in one direction only/confined to single plane (containing the direction of propagation)	B1 B1	can be answered with suitable diagram(s) NOT the wave oscillating in one plane
	b		set up apparatus, e.g. tray of water on table with lamp/light from window rotate the filter rotation of filter changes the image intensity/brightness/AW correct orientation for maximum and minimum intensities of image move head up or down to change angle of reflected light observed use of protractor to measure angles image/reflection becomes partially plane polarised/ image changes from bright to dim but does not disappear	B1 B1 B1 B1 B1 B1 B1	QWC mark essential for full marks **allow** from bright to zero or vice versa transmission axis parallel to water surface for maximum and perpendicular for minimum can hold head still and move lamp **max 3** from 6 marking points **+ QWC mark**
	c		$I = I_0 \cos^2\theta$ where I_0 is the maximum intensity (of the polarised beam) when θ is zero maximum intensity transmitted/ image bright when θ is 90^o minimum/zero intensity transmitted/image dim/vanished	B1 B1 B1 B1	**allow** incident/original/initial for maximum
			Total question 7	**10**	

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