OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B

Advanced GCE **G491**

Physics in Action

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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Section A

Question			Expected Answers	Marks	Additional Guidance
1	a		J s^{-1}	1	**not** W
	b		C s^{-1}	1	**not** A
2	a		1.7(1) x 10^{8} (Pa)	1	**accept** 170 / 171 MPa **allow** inappropriate SF
	b		Method: evidence of using largest *F* smallest *A* e.g. 148 / (0.76 x 10^{-6}) evaluation = 1.9 x 10^{8} (Pa)	1 1	**accept** words / numbers **not** any credit for *F* x *A* **accept** 1.95 x 10^{8} for 2/2 **allow** 190 / 195 scores 1/2 **not** 194
	c		area because greatest relative or % uncertainty / ± 12% / 11% / 10%	1	**accept** diameter as measurement **not** just largest uncertainty **accept** area because force uncertainty is only ± 0.7% / ± 1% mark for reasoning not for choosing just area
3	a		Sun's diameter (4.5 / 8.25) x 710 pixels = 390 pixels / 1.4 x 10^{6} km / 390 pixels = 3600 km $pixel^{-1}$	1 1	**accept** range 350 to 430 pixels for first mark **accept** range (3200 to 4000) km $pixel^{-1}$ for 2/2 **allow** 1/2 for evidence of length / number of pixels **not** any credit for areas
	b		220 000 km	1	method not required **accept** in range 170 000 to 280 000 km **ecf** on their resolution x 60 pixels (**allow** 54 to 66 pixels for the ecf)
4			1 / *u* is negligible for Sun's distance / 1 / *f* ≈ 1 / *v* evaluation: *P* = 1 / *f* ≈ 1 / 0.012 = 83.(3) (D)	1 1	method **accept** curvature of wavefronts from Sun is negligible **accept** 83.(3) for 2/2 **allow** -83.(3) for 1/2 **accept** full calculation with *P* = 1/ *v* – 1/ *u*

Question			Expected Answers	Marks	Additional Guidance
5	a		1 turn on voltage is 1.2 ± 0.05V /no current below 1.2 V 2 no current for reverse voltage / bias 3 current grows at increasing rate after 1.2V 4 linear / rapid increase in current after 1.4 V or 5mA	1 1	**accept** any two separate features **not** comparison with other temperatures **accept** exponentially **accept** straight line after 1.4 V or 5mA **or** ΔI α ΔV **not** I α V
	b		turn on / threshold voltage decreases (when the temperature increases) / above 1.3 V current at a given voltage increases (with temperature) / voltage for same current is lower	1	**accept** alternative wording e.g. less voltage needed to drive a current **not** sensitivity
6	a		($Q = I t$ = 0.29 x 5) = 1.5 (C)	1	**accept** 1.45 (C)
	b		$N = Q / e$ / = 1.45 / 1.6 x 10^{-19} = 9.1 x 10^{18}	1 1	method in words / numbers **ecf** from part a) evaluation **accept** 9.06 x 10^{18} / 9.4 x 10^{18} / 9.38 x 10^{18} / 9.375 x 10^{18} **allow** I / e = 1.8 x 10^{18} for 1/2 (electrons s^{-1})
7			(total characters) = 2 x 26 + 10 + 12 = 74 reasoning: $2^{bits} \geq 74$ / $2^6 = 64$ / $2^7 = 128$ so 7 bits	1 1 1	correct arithmetic **ecf** on number of characters for 2/3 max **accept** bits ≥ log 74 / log 2 = 6.2 bare 7 scores 1/3
			Total section A	**20**	

Section B

Question			Expected Answers	Marks	Additional Guidance
8	a	i	(1 at 500 lux R_{LDR} =) 570 ± 20 (Ω) (2 at 2500 lux R_{LDR} =) 130 ± 30 (Ω)	1	both within tolerance for the mark **accept** 550 to 590 (Ω) **accept** 100 to 160 (Ω)
		ii	greater confidence at 500 lux: because within data / 2500 beyond data at 2500 lux graph has to be predicted beyond data / reading error from graph has greater ± % at 2500 lux	1 1	**accept** interpolation **accept** extrapolation, estimation, greater uncertainty **accept** for 2/2 greater confidence at 2500 lux because sensitivity is more at 500 lux ora
	b		all circuit symbols correct R and LDR in series with 6 V battery V meter in parallel with R	1 1 1	**allow** any reasonable dc supply symbol **not** LDRs with arrows through symbol (variable Rs) , thermistor symbol **allow** LDR without circle **ignore** additional series ammeter, variable resistor V in series max 1/3 for symbols
	c		$V_{out} = V_{in} \times R / (R + R_{LDR})$ / V / R ratio argument $1.6 (R + R_{LDR}) = 6 R$ / $4.4 R = 1.6 R_{LDR}$ $R = 1.6 \times 570 / 4.4 = 210$ (Ω) For R_{LDR} value 550 expect R = 200 560 204 570 207 580 211 590 215 600 218(ecf)	1 1 1	correct potential divider equation for circuit drawn correctly substituted **allow** full credit for correct V / R ratio argument e.g. $R / 1.6 = 570 / 4.4 \Rightarrow R \approx 210\ \Omega$ evaluation **ecf** on R_{LDR} from (a) **ecf** on about 1600 Ω (2.75 x R_{LDR}) if V meter across LDR in circuit **allow** 1/3 for finding total circuit resistance (about 780 Ω or 2100 Ω if V meter across LDR) as final answer **allow** methods calculating current through LDR 7.7 mA, max 1/3 for correct current only
			Total question 8	**9**	

Section B

Question			Expected Answers	Marks	Additional Guidance
9	a		current = 2.7 ± 0.1 (A) power = 2.7 x 6 = 16.2 (W)	1 1	 evaluation **expect** in range 15.6 to 16.8 (W) ecf on their current x 6
	b	i	0.35 , 0.62 / 0.619 (Ω)	1	**both** values correct in table for the mark
		ii	2 points correctly plotted reasonable line of best fit near / through plotted points, (allow ± 2 vertical graph squares by points)	1 1	tolerance ± ½ graph square each way **allow** ecf table values **expect** flat at start then kinked **allow** continuous curve **not** single straight line of best fit **allow** ecf on plotted values
		iii	resistance increases as current increases / temperature increases as current rises / resistance increases as temperature increases ; conductivity decreases with increasing temperature	1 1	**accept** resistivity increases as current increases **accept** filament heats as current rises senses of changes must be clear **allow** conductivity constant for small temperature rises for 1/2
	c	i	($I = V / R$) = 12 / 0.30 (= 40)	1	requires numerical answer
	c	ii	battery has internal resistance (in series with filament) / contact resistance in circuit reducing current / filament starts to heat up quickly and its resistance rises / response time / sampling interval of data logger means true peak current is missed	1	any valid suggestion or AW **accept** resistance in connecting wires **not** just internal resistance / internal resistance of lamp / resistance of circuit / internal resistance uses up current
		iii	1 current levels (at 4.0 A / after 1.5 s) once filament at working resistance / temperature 2 surge current decreases as filament heats for first 1.5 ± 0.5 second 3 surge current decreases at a decreasing rate as filament approaches working temperature for first 1.5 ± 0.5 second	1	any correct quantitative statement with explanation for **one** mark **not** no current for 0.05 s because battery not connected
			Total question 9	**10**	

Section B

Question			Expected Answers	Marks	Additional Guidance
10	a		crystalline metal: regular square / hexagonal packing of identical spheres / circles in 2-d amorphous glass: irregular / random arrangement of one or two sizes of spheres / circles in 2-d **one** appropriate technical label / annotation on **either** diagram (not given for contradictory labelling)	1 1 1	**accept** presence of dislocation(s) **accept** evidence of micro-crystals / polycrystalline nature **not** glass fibres / wiggly polymer diagrams **accept** metal: close-packed planes / free electron gas/glue / + ions / dislocation / metallic / non-directional bonds etc. glass: random arrangement / like liquid / covalent / directional bonds
	b		metals: regularity of atomic planes leading to slip / plastic flow / dislocations which move through metal by a few planes / rows slipping at a time further plausible geometric arguments (without mention of dislocations) can gain credit max 2 glasses: irregular or random arrangement means regular slip cannot occur / cannot relieve stress so stress concentrates and micro-cracks propagate leading to brittle failure max 2 structure leads to movement for metals scores 1 structure leads to lack movement in glasses scores 1 further detail for either scores 1 QoWC scores 1	3+1	4th mark is for **QoWC** answer must correctly use at least one of appropriate technical terms: regular and random packing and how this leads to slip / plastic flow in metals and to brittle crack propagation / stress concentration in glasses **accept** answers based on polycrystalline nature of metals with dislocations piling up on grain boundaries / isotropic properties due to random orientation of micro-crystals for full credit **accept** free electron gas / glue makes the non-directional metal bonding crucial to slip and crack behaviour AW throughout but **NO** credit for use of brittle or ductile If QoWC awarded place tick on technical term credited
	c	i	any example of a composite material with its components clear e.g. glass fibre reinforced plastic	1	**accept** concrete containing mortar and pebbles / gravel steel reinforced concrete etc. **not** alloys
		ii	initial straight line of same gradient judged by eye yield stress of 1350 MPa see overlay plastic region linear of small slope stopping at 10% strain	1 1	any 2 correct points but max 1 for graphs below the original **allow** within graph square between 1320 and 1360 MPa **accept** zero slope for plastic region stopping at 10% strain

P.T.O.

Question			Expected Answers	Marks	Additional Guidance
	c	iii	area = fracture energy / toughness / = 14 / 0.34 x 10^{6}	1	first mark for correct equation in words or numbers
			= 4.1(2) x 10^{-5} (m^2)	1	evaluation **allow** 41.(2) 1/2 multiplier error
			Total question 10	**12**	

Section B

Question			Expected Answers	Marks	Additional Guidance
11	**a**	**i**	16 x 44.1 x 10^3 = 7.1 x 10^5 (> 500 kbit s^{-1})	1	**allow** 705.6 (kbit s^{-1})
		ii	resolution = 100 x 10^{-3} V / (2^{16} – 1) = 1.5(3) μV	1 1	method **accept** 2^{16} / 65535 / 65536 (subd in equation) evaluation **allow** 1 mark for 1.8(3) μV using full graph scale of 120 mV
	b	**i**	10^6	1	
		ii	1 2 000 (Hz) 2 **A** and **F**	1 1	**accept** 1500 to 2500 (Hz)
N.B. before marking 11 c check additional pages S12 , S13 and S14 for candidates additional answers, the marking tool is there for a reminder. Extra answers MUST be annotated to show they have been seen and credited back in the relevant question, if appropriate. ✓ = 1 extra mark x = wrong scores 0 ^ = no added value scores 0 and NR = no further action.					
	c		rate = frequencies/frame x bits/frequency x frames/s = 32 x 24 x 40 = 30720 / 3.1 x 10^4 bit s^{-1} fraction = 3.1 x 10^4 / (7.1 x 10^5) = 0.044 ≈ 1/23 < 1/20	1 1 1	**QoWC** method must be explicitly clear other than in numbers evaluation fraction shown **ora** 7.1 x 10^5 / 20 = 3.5 x 10^4 bit s^{-1} > 3.1 x 10^4 **allow** ecf on 500 kbit s^{-1} from **(ai)** giving ≈ 1/16 **allow** ecf on other incorrect bit rates **accept** other valid comparisons
			Total question 11	**9**	
			Total section B	**40**	
			Paper total	**60**	

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