

Physics B

Advanced GCE **G491**

Physics in Action

Mark Scheme for June 2010

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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	$1.7(1) \times 10^8$ (Pa)	1	accept 170 / 171 MPa allow inappropriate SF
	b	Method: evidence of using largest F smallest A e.g. $148 / (0.76 \times 10^{-6})$ evaluation $= 1.9 \times 10^8$ (Pa)	1 1	accept words / numbers not any credit for $F \times A$ accept 1.95×10^8 for 2/2 allow 190 / 195 scores 1/2 not 194
	c	area because greatest relative or % uncertainty / $\pm 12\%$ / 11% / 10%	1	accept diameter as measurement not just largest uncertainty accept area because force uncertainty is only $\pm 0.7\%$ / $\pm 1\%$ mark for reasoning not for choosing just area
3	a	Sun's diameter $(4.5 / 8.25) \times 710$ pixels = 390 pixels / 1.4×10^6 km / 390 pixels = $3600 \text{ km pixel}^{-1}$	1	accept range 350 to 430 pixels for first mark
			1	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 $\times 60$ pixels (allow 54 to 66 pixels for the ecf)
4		$1/u$ is negligible for Sun's distance / $1/f \approx 1/v$ evaluation: $P = 1/f \approx 1/0.012 = 83.(3)$ (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 $1.2 \pm 0.05\text{V}$ / 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 $\Delta I \propto \Delta V$ not $I \propto V$
	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	$(Q = It = 0.29 \times 5) = 1.5 \text{ (C)}$	1	accept 1.45 (C)
	b	$N = Q/e \quad / \quad = 1.45 / 1.6 \times 10^{-19}$ $= 9.1 \times 10^{18}$	1 1	method in words / numbers ecf from part a) evaluation accept 9.06×10^{18} / 9.4×10^{18} / 9.38×10^{18} / 9.375×10^{18} allow $I/e = 1.8 \times 10^{18}$ for 1/2 (electrons s^{-1})
7		(total characters) = $2 \times 26 + 10 + 12 = 74$ reasoning: $2^{\text{bits}} \geq 74$ / $2^6 = 64$ / $2^7 = 128$ so 7 bits	1 1 1	correct arithmetic ecf on number of characters for 2/3 max accept bits $\geq \log 74 / \log 2 = 6.2$ bare 7 scores 1/3
Total section A			20	

Section B

Question			Expected Answers	Marks	Additional Guidance
8	a	i	(1 at 500 lux $R_{LDR} =) 570 \pm 20 (\Omega)$ (2 at 2500 lux $R_{LDR} =) 130 \pm 30 (\Omega)$	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 \pm % 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	1	allow any reasonable dc supply symbol not LDRs with arrows through symbol (variable Rs) , thermistor symbol allow LDR without circle
			R and LDR in series with 6 V battery V meter in parallel with R	1 1	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 $1.6 (R + R_{LDR}) = 6 R$ / $4.4 R = 1.6 R_{LDR}$	1 1	correct potential divider equation for circuit drawn correctly substituted allow full credit for correct V/R ratio argument e.g. $R / 1.6 = 570 / 4.4 \Rightarrow R \approx 210 \Omega$
			$R = 1.6 \times 570 / 4.4 = 210 (\Omega)$ For R_{LDR} value 550 expect R = 200 560 204 570 207 580 211 590 215 600 218(ecf)	1	evaluation ecf on R_{LDR} from (a) ecf on about 1600 Ω ($2.75 \times R_{LDR}$) 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 = $2.7 \times 6 = 16.2$ (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 $\pm \frac{1}{2}$ 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 ; <u>conductivity</u> 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 <u>with explanation</u> 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	<p>crystalline metal: regular square / hexagonal packing of identical spheres / circles in 2-d</p> <p>amorphous glass: irregular / random arrangement of one or two sizes of spheres / circles in 2-d</p> <p>one appropriate technical label / annotation on either diagram (not given for contradictory labelling)</p>	<p>1</p> <p>1</p> <p>1</p>	<p>accept presence of dislocation(s)</p> <p>accept evidence of micro-crystals / polycrystalline nature</p> <p>not glass fibres / wiggly polymer diagrams</p> <p>accept metal: close-packed planes / free electron gas/glue / + ions / dislocation / metallic / non-directional bonds etc.</p> <p>glass: random arrangement / like liquid / covalent / directional bonds</p>
b	<p>metals: regularity of atomic planes leading to slip / plastic flow / dislocations which move through metal by a few planes / rows slipping at a time</p> <p>further plausible geometric arguments (without mention of dislocations) can gain credit max 2</p> <p>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</p> <p>structure leads to movement for metals scores 1</p> <p>structure leads to lack movement in glasses scores 1</p> <p>further detail for either scores 1 QoWC scores 1</p>	3+1	<p>4th mark is for QoWC answer must correctly use at least one of appropriate technical terms: <u>regular</u> and <u>random</u> packing and how this leads to <u>slip</u> / <u>plastic flow</u> in metals and to brittle <u>crack propagation</u> / <u>stress concentration</u> in glasses</p> <p>accept answers based on <u>polycrystalline</u> nature of metals with <u>dislocations</u> piling up on <u>grain boundaries</u> / isotropic properties due to <u>random orientation</u> of <u>micro-crystals</u> for full credit</p> <p>accept free electron gas / glue makes the <u>non-directional</u> metal bonding crucial to slip and crack behaviour</p> <p>AW throughout but NO credit for use of brittle or ductile</p> <p>If QoWC awarded place tick on technical term credited</p>
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	<p>1</p> <p>1</p>	<p>any 2 correct points but max 1 for graphs below the original</p> <p>allow within graph square between 1320 and 1360 MPa</p> <p>accept zero slope for plastic region stopping at 10% strain</p>

P.T.O.

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

Section B

Question			Expected Answers	Marks	Additional Guidance
11	a	i	$16 \times 44.1 \times 10^3 = 7.1 \times 10^5$ ($> 500 \text{ kbit s}^{-1}$)	1	allow 705.6 (kbit s^{-1})
		ii	resolution = $100 \times 10^{-3} \text{ V} / (2^{16} - 1)$ = 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)
<p>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.</p>					
			rate = frequencies/frame x bits/frequency x frames/s = $32 \times 24 \times 40 = 30720 / 3.1 \times 10^4 \text{ bit s}^{-1}$	1 1	QoWC method must be explicitly clear other than in numbers evaluation
	c		fraction = $3.1 \times 10^4 / (7.1 \times 10^5) = 0.044$ $\approx 1/23 < 1/20$	1	fraction shown ora $7.1 \times 10^5 / 20 = 3.5 \times 10^4 \text{ bit s}^{-1} > 3.1 \times 10^4$ allow ecf on 500 kbit s^{-1} from (ai) giving $\approx 1/16$ 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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