

GCE

Physics B (Advancing Physics)

Unit **G491**: Physics in Action

Advanced Subsidiary GCE

Mark Scheme for June 2017

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.



















All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Annotations available in Scoris

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation
	Level 1
	Level 2
	Level 3
	Transcription error

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

All questions should be annotated with ticks to show where marks have been awarded in the body of the text.

Please ensure that rounding errors RE and significant figure errors SF are only penalised a maximum **once** for each candidate. Places where these should be looked for will usually be indicated in the mark-scheme.

Subject-specific Marking Instructions**Note about significant figures:**

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.

If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.

Any exception to this rule will be mentioned in the Additional Guidance

Total	Section A			
	Question	Answer	Marks	Guidance
	1 (a;b;c)	C ; $J s^{-1}$; $C^2 J^{-1} s^{-1}$	LSH	not alternative correct units e.g. As ; W ; S
	Total		3	
Question	Answer	Marks	Guidance	
2 (a;b;c)	A ; C ; A	LSH		
Total		3		
Question	Answer	Marks	Guidance	
3 (a)	shorter focal length ; fewer waves of similar length by eye	LS	accept 3 / 4 / 5 wavefronts in any shorter focal length	
(b)	more powerful since more refraction / convergence at each surface / more curvature added to wave fronts	L	accept more since f is shorter AW but needs more and reason for the mark	
		3		

Section A

Question	Answer	Marks	Guidance
4 (a)	Any two from: noise values are very different from (most) others (1) ; most values are similar to neighbours (1) ; noisy pixels will be more affected by the procedure than 'normal' pixels (1) ; median filter replaces a noise pixel value with that identical to one of its neighbours (1)	L M	
(b)	If there was a white rock on the surface of Mercury of size one / two adjacent pixel(s) on the image it would be falsely removed.	M	accept edge pixels require another rule since they are not surrounded completely not loses / reduces detail
	Total	3	

Question	Answer	Marks	Guidance
5	method $I = \Delta Q / \Delta t$ / = 32 / 0.008 evaluation = 4000 (A) / 4 k(A)	L L	
	Total	2	

Section A

Question	Answer	Marks	Guidance
6 (a)	150 (Ω) ;	L	
(b) (i)	($V_{BC} = 12 \text{ V} \times 50 \text{ } \Omega / 150 \text{ } \Omega$) = 4.0 (V)	S	accept 4 (V)
(b) (ii)	V^2 / R or $4^2 / 50$ = 0.32 (W)	H H	method accept $I = 4 / 50 = 0.08 \text{ A}$ evaluation accept $I^2 R = 0.08^2 \times 50 = 0.32 \text{ (W)}$
	Total	4	

Question	Answer	Marks	Guidance
7	$v = c / n$ or $= 3 \times 10^8 \text{ (m s}^{-1}\text{)} / 1.6$ $1.9 \times 10^8 \text{ (m s}^{-1}\text{)}$	L L	method evaluation not $1.875 \times 10^8 \text{ (m s}^{-1}\text{)}$ SF penalty condone 1.88×10^8
	Total	3	
	Section Total	20	

Section B

Question	Answer	Marks	Guidance
8 (a)	$A = \pi r^2 = \pi (38 \times 10^{-6} \text{ m})^2 = 4.5(4) \times 10^{-9} \text{ m}^2$ $R = \rho L / A = (1.10 \times 10^{-7} \Omega \text{ m} \times 0.40 \text{ m}) / (4.54 \times 10^{-9} \text{ m}^2)$ $= 9.7 \Omega$	L L S	evaluation method accept substitution into $R = \rho L / \pi r^2$ for 2 marks evaluation accept 9.8 Ω with intermediate rounding ORA leading to $\rho = 1.13 \times 10^{-7} \Omega \text{ m}$ for full marks
(b)	sensible scaling of T axis i.e. more than $\frac{1}{2}$ horizontal scale used linearly correct straight line plotted	L L	expect use of ruler for line, accept 10 Ω for R(0) and FT parts (c) and (d)
(c) (i)	11.4 (Ω) read from graph	L	method accept answers in range 11.3 to 11.6 (Ω) allow ecf on poor scales on graph in (b)
(c) (ii)	$= \Delta R / \Delta T$ or $(13.5 \Omega - 9.7 \Omega) / 100^\circ\text{C}$ or $3.8 \Omega / 100^\circ\text{C}$ $= 0.038$; $\Omega \text{ }^\circ\text{C}^{-1}$	L SS	method allow ecf on graph in (b) evaluation ; unit allow in range 0.0345 to 0.0354 for graphs starting at 10 Ω
(d)	$\Delta T = \Delta R / \text{sensitivity}$ or $= 0.01 \Omega / 0.038 \Omega \text{ }^\circ\text{C}^{-1}$ $= \pm 0.26 (^\circ\text{C})$	H H	method evaluation accept 0.3 ($^\circ\text{C}$)
	Total	11	

Section B

Question	Answer	Marks	Guidance
9 (a)	$1200 \times 900 \times 24 \times 15 = 389 \text{ Mbit s}^{-1} = 390 \text{ Mbit s}^{-1}$	L	accept 389 Mbit s ⁻¹
(b)	(cycles s ⁻¹ = cycles bit ⁻¹ x bit s ⁻¹) (= $350 \times 10^6 \times 40$) = $14 \times 10^9 \text{ Hz}$ / 14(.0)GHz	H	evaluation accept 15.6/16 GHz (using 389 GHz) / 1.4×10^{10}
(c) (i)	bit rate = samples s ⁻¹ x bits sample ⁻¹ or $20 \times 10^4 \times 12 = 0.24 \text{ Mbit s}^{-1}$ $0.24 \text{ Mbit s}^{-1} \ll 390 \text{ Mbit s}^{-1}$	L S	method allow in words or numbers comparison to video bit rate must be clear for second mark not comparison to the carrier frequency ecf their value
(c) (ii)	10 kHz at least one sample is needed on each wave peak and one on each wave trough or variation could be missed or at least 2 samples per cycle are needed to record the variation	S H	allow AW and sensibly annotated diagrams accept for 1 mark that even then sampling at each zero point could lead to signal being missed / reasoning about aliasing not just a statement of ½ sampling frequency
(c) (iii)	12 bits gives $2^{12} = 4096$ levels $V_{\text{total}} / V_{\text{noise}} = 4096$ or $V_{\text{total}} = 4096 \times V_{\text{noise}}$ or $V_{\text{total}} = 0.03 \text{ V}$ so when the $V_{\text{total}} < 0.03 \text{ V}$ or $< V_{\text{max}} / 10$ then $V_{\text{noise}} > \text{voltage level resolution}$ or at least one of bits is redundant	S H H H	credit each correct mark point BUT QoWC all elements must be present and in a clear logical order to score 4 marks allow full credit for equivalent answers expressed in log ₂ form
(d) (i)	(-) 4.0 (D)	L	accept (-) 4 (D)
(d) (ii)	curvature out = curvature in + lens power or $1/v = -4.0 + 250$ = 246 D $v = 1 / 246 = 4.07 \times 10^{-3} \text{ m}$ principal focus at $1 / 250 = 4.0 \times 10^{-3} \text{ m}$ so $\Delta = 0.07 \text{ mm}$	S H H H	method accept in words or numbers not just lens formula evaluation
	Total	15	

Section B

Question	Answer	Marks	Guidance
10 (a) (i)	AB ; CD	SH	
(a) (ii)	BC	S	
(b) (i)	96 (M Pa)	L	
(b) (ii)	0.0105	S	
(c)	$\varepsilon = 0.0122$ $x = \varepsilon L \quad / \quad = 0.0122 \times 2.0 = 2.44/2.4 \times 10^{-2} \text{ m}$	L S	strain at C from graph : accept in range (0.0120 – 0.0125) method and evaluation e.c.f. own strain accept in range (2.4 to 2.5) $\times 10^{-2} \text{ m}$
(d)	e.g. 0.0015 , 96 $\times 10^6 \text{ Pa}$ $E = \sigma / \varepsilon$ from ∞ region or $= 96 \times 10^6 \text{ Pa} / 0.0015$ $= 6.4 \times 10^4 \text{ (MPa)}$	S H H	any pair σ , ε values from ∞ region give 2 marks method evaluation accept in range (5.4 to 7.2) $\times 10^{10} \text{ Pa}$
(e)	bonding: is <u>metallic / non-directional / by delocalised electrons</u> in a <u>lattice of + ions</u> and is <u>strong / stiff</u> arrangement : is <u>regular / crystalline / polycrystalline /</u> with <u>grains / grain boundaries</u> with atoms in <u>stacked planes / layers</u> which are discrete elastic region <u>strong / stiff</u> bonds <u>stretch</u> and return after <u>stress</u> removed / return to zero <u>strain</u> plastic region at larger <u>stress</u> <u>layers of atoms slip / slide</u> over each other and do not return after <u>stress</u> removed / use ideas of <u>dislocation</u> motion and metal ends up <u>permanently deformed / strained</u>		should link description of bonding to strength / stiffness of bonds should link description of arrangement to planes of atoms should link description to return to zero strain when stress removed should link description to permanent strain when stress removed QoWC must use 8 <u>specialist vocabulary</u> terms to get this and have a sense of explaining not just describing allow credit ideas from well labelled diagrams accept ball – spring type model if used diagrammatically
	Total	14	
	Total Section B	40	
	Total for paper	60	

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