OCR
Oxford Cambridge and RSA

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.

Annotations available in Scoris

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
FT	Follow through
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error
SF	Error in number of significant figures
	Correct response
AE	Arithmetic error
	Wrong physics or equation
L1	Level 1
L2	Level 2
L3	Level 3
TE	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
(a) **4**	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 V × 50 Ω /150 Ω) = 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 A evaluation **accept** $I^2 R = 0.08^2 \times 50 = 0.32$ (W)
	Total	4	

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

Section B

Question	Answer	Marks	Guidance
8 (a)	$A = \pi r^2 = \pi (38 \times 10^{-6}\ m)^2 = 4.5(4) \times 10^{-9}\ m^2$ $R = \rho L / A = (1.10 \times 10^{-7}\ \Omega\ m \times 0.40\ m) / (4.54 \times 10^{-9}\ m^2)$ $= 9.7\ \Omega$	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 $\rho = 1.13 \times 10^{-7}\ \Omega\ m$ for full marks
(b)	sensible scaling of *T* axis i.e. more than ½ 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 $(13.5\ \Omega - 9.7\ \Omega) / 100°C$ or $3.8\ \Omega / 100°C$ $= 0.038$; $\Omega\ °C^{-1}$	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)	$\Delta T = \Delta R$ / sensitivity or $= 0.01\ \Omega / 0.038\ \Omega\ °C^{-1}$ $= \pm 0.26$ (°C)	H H	method evaluation **accept** 0.3 (°C)
	Total	**11**	

Section B

Question	Answer	Marks	Guidance
9 (a)	1200 × 900 × 24 × 15 = 389 Mbit s^{-1} = 390 Mbit s^{-1}	L	**accept** 389 Mbit s^{-1}
(b)	(cycles s^{-1} = cycles bit^{-1} x bit s^{-1}) (= 350 × 10^6 × 40) = 14 × 10^9 Hz / 14(.0)GHz	 H	 evaluation **accept** 15.6/16 GHz (using 389 GHz) / 1.4 x 10^{10}
(c) (i)	bit rate = samples s^{-1} × bits $sample^{-1}$ or 20 × 10^4 × 12 = 0.24 Mbit s^{-1} 0.24 Mbit s^{-1} << 390 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_{total} / V_{noise} = 4096 or V_{total} = 4096 × V_{noise} or V_{total} = 0.03 V so when the V_{total} < 0.03 V or < V_{max} / 10 then V_{noise} > 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 × 10^{-3} m principal focus at 1 / 250 = 4.0 × 10^{-3} m so Δ = 0.07 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)	ε = 0.0122 $x = \varepsilon L$ / = 0.0122 x 2.0 = 2.44/2.4 x 10^{-2} 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) x 10^{-2} m
(d)	e.g. 0.0015 , 96 x 10^6 Pa $E = \sigma / \varepsilon$ from $\propto$ region or = 96 x 10^6 Pa/ 0.0015 = 6.4 x 10^4 (MPa)	**S** **H** **H**	any pair σ , ε values from $\propto$ region give 2 marks method evaluation **accept** in range (5.4 to 7.2) x 10^{10} Pa
(e)	**bonding**: is metallic / non-directional / by delocalised electrons in a lattice of + ions and is strong / stiff **arrangement** : is regular / crystalline / polycrystalline / with grains / grain boundaries with atoms in stacked planes / layers which are discrete **elastic region** strong / stiff bonds stretch and return after stress removed / return to zero strain **plastic region** at larger stress layers of atoms slip / slide over each other and do not return after stress removed / use ideas of dislocation motion and metal ends up permanently deformed / strained		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 specialist vocabulary 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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