OCR
Oxford Cambridge and RSA

GCE

Physics B (Advancing Physics)

Unit **G491**: Physics in Action

Advanced Subsidiary GCE

Mark Scheme for June 2015

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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

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
BP	Blank page symbol

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

Subject-specific Marking Instructions

Do not penalise RE rounding error more than once on this paper. SF significant figure error apply to Q2 only – penalise 1 or 4 or more SF.
Please annotate scripts as much as possible at the point of application of the mark / error to help checking and review.
Please add BP (Blank Page) annotation to the “last page” appended to Q10 (diii) to show you have checked it before awarding your mark for the last answer. Also add BP to all blank Additional Object pages checked.

Question			Answer	Marks	Guidance
1			**A V** ; **A s** ; **A V^{-1}**	3	**not** any equivalent non-listed units e.g. W ; C ; S **accept** A / V
			Total	**3**	

Question			Answer	Marks	Guidance
2			3.0×10^8 / 1.7 / $= 1.76 \times 10^8$ (m s^{-1}) / 1.8×10^8 (m s^{-1}) / 180000000 (m s^{-1})	1 1	**accept** in words / algebra rearranged for method mark expect answer correct to 2 or 3 SF otherwise SF penalty on 1, 4 or more figures
			Total	**2**	

Question			Answer	Marks	Guidance
3			(40 x 4.5)/280 potential divider method = 0.64(3) (V)	1 1	**allow** one mark for getting I = 16.(1) mA / 0.016(1) A and 2 marks for V = 0.0161 x 40 = 0.64(4) (V) bare correct answer scores 2
			Total	**2**	

Question			Answer	Marks	Guidance
4	(a)		any **ONE** correct point for **1 mark**: e.g. *f* falls and rises again (slow) / lowest in middle mean frequency in range 2.7 to 3.3 kHz the variation lasts in range 0.4 to 0.6 s lowest *f* in range 2.2 to 2.4 kHz highest *f* in range 3.2 to 3.5 kHz bandwidth / frequency range in range 0.8 to 1.3 kHz	**1**	**if** second point is CON scores 0 **accept** rapid / fast / tiny *f* fluctuations / warbles (at ≈ 30 Hz) **ignore** references to noise / bare *f* changes / varies / multiple frequencies
	(b)		method f_{mean} x duration / (≈ 3 kHz) x (≈ ½ s) evaluation 1500 (oscillations)	1 1	**allow** method mark for a *f* x *t* **allow** must be in range 1000 to 2000 (oscillations) **not** counting slow *f* variations e.g. 14
			Total	**3**	

Question			Answer	Marks	Guidance
5	(a)		(equal steps along the *f* axis) represent equal multiples of frequency / increase by a constant factor	1	**accept** frequency increases x 10 (for equal distances) / increases by powers of ten
	(b)		320 (Hz)	1	**accept** 300 to 400 (Hz)
	(c)		e.g. (10 k – 100) = 9900 (Hz) (in range 9890 to 10400 Hz)	1	**expect** the difference to be calculated **not** limits stated **accept** other correctly estimated bandwidths based on: f_{high} in range 10 to 10.5 kHz and f_{low} in range 100 to 110 Hz
			Total	**3**	

Question			Answer	Marks	Guidance
6	(a)		(-) 0.80 (D)	1	evaluation **ignore** second –ve sign if inserted
	(b)		(wave curvature from 0.25 m) = - 4.0 D / - 4 + P = - 0.8 / extra curvature = (- 0.8 - (-4)) = + 3.2 (D)	1 1	method **ignore** answers based on single application of lens formula evaluation **allow** 2 marks + 3.2 (D) without any method **not** - 3.2 (D) / 4.8 (D)
			Total	**3**	

Question			Answer	Marks	Guidance
7	(a)		lower T: reduces voltage (at all times) ORA	1	sense of change must be clear on each statement **accept** starting voltage is lower at lower T / range is lower at lower T
			voltage falls faster / reduces discharge time ORA	1	Must describe the voltage variation with time **accept** correct statements about gradient e.g. lower T steeper fall in first hour
	(b)		1 $I_{av} = V_{av} / R$ = 2.6 / 5 = 0.52 (A) ;	1	**accept** currents in range 0.48 to 0.56 A (0.6 A to 1 S.F.) method **accept** means based on sampling for a method
			2 use of $Q = I_{av} \times t$ / area under V (t)/R graph as formula / word / numbers	1	**allow** an attempt to find area under V (t) graph gets method mark **not** just **quoting** $Q = I \times t$ **accept** 10, 60, 600, 3600, 36000 as evidence of t
			Q = 0.52 x 10 x 60 x 60 = 19 k(C)	1	evaluation **expect** in range 17 to 22 k(C) **allow** ecf on current from 1 x 36000 evaluated correctly
			Total	**5**	
			Total Section A	**21**	

Section B

Question			Answer	Marks	Guidance
8	(a)		not straight line (through origin) / not proportional	1	**accept** *R* not constant / graph curves / not linear / gradient not constant **ignore** not through origin
	(b)	(i)	3.1(4) Ω ; 284 ± 1 mA from graph **;** 21.(1) Ω **and** 1.7 W	1 2	evaluation **allow** *R* and *P* values which round to correct values from "close" but out of range currents
	(b)	(ii)	filament / lamp heats / temperature rises (due to power dissipated) resistivity or resistance increases with *T* / conductivity or conductance decreases with *T*	1 1	**Allow** as filament / lamp heats its resistance / resistivity rises scores 2 / *R* changes with *T* scores 1 **not** just *R* changes , must have correct sense wrt *T* change **ignore** descriptions of microstructure
	(b)	(iii)	$L = RA / \rho$ / 3.1 x 3.2 x 10^{-10} / 5.6 x 10^{-8} = 1.8 x 10^{-2} (m) / 1.796 x 10^{-2} (m) / 0.02 (m to 1 SF) assumption: 35 mA causes negligible heating of filament (so very near room temperature still) / *R* = 3.1 Ω at room temperature	1 1 1	transposed equation in algebra / numbers (any *R* in range 3.1 to 21 Ω) / words evaluation mark only for correct *R* value **allow** ecf on incorrect *R* from first line of table for 2 marks **accept** <u>any</u> statement that conveys the lowest *R* or 3.1 Ω is the resistance at or near to 20 ºC or room temperature **not** just filament is at room temperature
	(b)	(iv)	$R \propto \rho$ **or** *A*/*L* factors cancel **or** $(R_{3000} A / L)/(R_{20} A / L) = R_{3000} / R_{20}$ **or** = 21 / 3.1 = 6.7 / 6.8 (from rounding)	1 1	reasoning **accept** full calculation ρ ratio **allow** ecf on *R* ratio from their table evaluation **allow** 7 i.e. to 1 S.F. and 6 from (rounding 2cm) bare answer max 1
	(c)		metals have a (**high density)** of **free / delocalised electrons ;** which act as **charge carriers** / electrons move ; transfer energy gained to **lattice vibrations** or **positive ions** / electrons collide or scatter with **positive ions** **lattice / positive ion vibrations :** increase (with *T*) / "resist" electron flow (so resistivity rises) / scatter electrons	2 1	any 2 points one mark each **accept cations** = **positive ions** and **oscillations = vibrations** AW QoWC only award 3rd mark if at least **2 terms** correct use and spelling **not** ref to atoms rather than positive ions **not** positive ions move / translate
			Total	**14**	

Question			Answer	Marks	Guidance
9	(a)		**D** ; **A** ; **B**	3	
	(b)	(i)	method e.g. 0.4×10^9 (Pa) / 0.01	1	from graph **allow** one POT error in method mark
			4.0×10^{10} (Pa)	1	**accept** answers in range (3.9 to 4.1) $\times 10^{10}$ (Pa)
	(b)	(ii)	$x = \varepsilon L$ / 0.0075 x 420	1	method in algebra / numbers / words
			= 3.2 (m)	1	evaluation **accept** 3.15 (m) to 3 S.F.
	(c)	(i)	**A** because **strongest /** highest **UTS** or **stiffest** / largest **Young modulus** ;	1	alloy and property identified **not** any other material score 0/3
			to bear load of lift / small **extension** of cable ;	1	desirability of stated property for application explained
			strong bonds / **slip** or **dislocation** motion prevented by **pinning / impurities** in **lattice**	1	explanation by microstructure **accept** slip / slide
		(ii)	**B** because has largest **plastic** region / greatest strain before breaking / is **toughest** / has largest area under graph ;	1	alloy and property identified **allow** 1/3 max if D is chosen and correct microstructure explanation of plastic flow
			to **absorb** or **dissipate energy** from collision ;	1	desirability of stated property for application explained **ignore** any reference to collision time
			as **layers** of atoms **slide** over each other / by **dislocation** motion	1	explanation by microstructure QoWC only max 6 if at least one **bold** term in each of (i) and (ii) and 3/3 in both parts
			Total	**13**	

Question			Answer	Marks	Guidance
10	(a)	(i)	$2^4 = 16$	1	**accept** $\log_2(16) = 4$ / 2x2x2x2=16 / 0000 to 1111 gives 16 alternatives
	(a)	(ii)	500 x 300 x 4 75 k(bytes)	1 1	method to give 600 kbits evaluation need to divide by 8 to convert to bytes
	(a)	(iii)	75 k x 90 x 5 = 34 Mbytes	1	**allow** ecf on a(ii) x 90 x 5 correctly evaluated **accept** binary k = 1024 gives 33 Mbytes
	(b)		image atom / actual atom = 2 mm / 270 pm = 7.4 x10^6	1	**accept** answers in range (7 to 8) x 10^6 **accept** also image atom estimates at about 1 mm giving magnification 3.7 x 10^6 or in range (3.1 to 4.1) x 10^6 (this includes the data that ≈ 100 atoms span image)
	(c)		**atom size / mm** **Resolution m/pixel / x 10^{-11}** 2 2.1 to 2.4 1 4.1 to 5.0 0.8(3) 5.3 to 5.5	2	**award** 2/2 for resolutions in ranges shown (diff. atom size) If resolution out of these ranges then **allow** 1/ 2 for a clear complete method in words **method 1** : (number of atoms x diameter of atom) / number of pixels **method 2** (distance on image / no.of pixels) then divide by Mag **ALLOW** ecf from (b) on "sensible" Mag (above 1000) in method **2** for 2/2 marks

	(d)	**(i)**	gradient: drawn appropriate Δ based on tangent / tangent on graph / intercept values e.g. 320/0.48 / sub values in Δy/Δx (-) 670 (pA nm^{-1})	1 1	method **allow** reasonable tangents for 1 method mark i.e. tangent kisses curve within ± 1 square of *h* = 0.25 nm **only accept** chord if small enough to be in range evaluation **accept** in range 600 to 750 (pA nm^{-1}) **ignore** –ve sign **not** just 160 / 0.25 = 640 (pA nm^{-1}) i.e. no gradient just current / height values scores 0/2 **not** bare 640 (pA nm^{-1}) scores 0 **allow** other bare answers in range 2/2
	(d)	**(ii)**	one single and one double peak aligned with atoms 260 ± 20 pA	1 1	shape of graph **allow** any indication of a min between double peaks / any profile of peaks (e.g. triangular) **not** dips in current / any currents starting from 0 or obviously less than 100 pA peak current in range 240 to 280 pA
	(d)	**(iii)**	raster scan / x-y scan at pixel spacing / produces current value that can be digitised / pixel values determined by size of current / different currents produce different colours / shades / current converted by A to D converter into pixel / binary values (for image)	1	any sensible point: relating pixel values to currents OR mapping / scanning / sampling process details OR relating higher currents to brightness in image
			Total	**12**	
			Total Section B	**39**	
			Paper Total	**60**	

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