

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491**: Physics in Action

Mark Scheme for January 2013

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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.

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Annotations

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

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
;	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

Question			Answer	Marks	Guidance
1	(a)		As	1	not any equivalent non-listed units eg C ; V ; S
	(b)		J C^{-1}	1	
	(c)		A V^{-1}	1	
			Total	3	

Question			Answer	Marks	Guidance
2	(a)		wavefronts are plane / flat / not curved OR rays from a point are parallel not divergent	1	not object is not visible / very little curvature not wavefronts are parallel accept beams are parallel
	(b)		converging on F ; constant wavelength same as incident waves	1 1	credit any convergence by eye Check overlay centered on F judge to within marker circles on the optic axis overlay accept 2 OR 3 wavefronts drawn
			Total	3	

Question			Answer	Marks	Guidance
3	(a)		225 ± 4 (MPa)	1	not 220 / 230 (MPa)
	(b)		$225 \times 10^6 / 0.001$ $= 2.25 \times 10^{11}$ (Pa)	1 1	correct value substitution accept other points from graph below strain 0.001 accept within range $(2.2 \text{ to } 2.3) \times 10^{11}$ (Pa) accept ecf on value from (a) / 10^{-3} (Pa) for 2 marks accept correct answer no method for 2 marks allow one POT error e.g. $2.25 \times 10^{9/8/7/5}$ for 1 mark 2 POT errors scores 0 / 2
			Total	3	

Question			Answer	Marks	Guidance
4	(a)		method : use of one peak with n = 2 / 3 / 4 / 5 for better precision	1	accept evidence from averaging two or more peaks accept evidence value labelling on graph for method not just straight estimate / ruler method from first peak
			estimation: accept frequency in range 77 ± 2 (Hz)	1	ignore more than 2 SF correct bare answer without method scores 1 / 2
	(b)		peaks at <u>same</u> frequencies	1	not spectrum is the same / frequency is same / waves
			peaks with smaller amplitude(s) / p.d.(s) / height(s)	1	accept voltage / p.d. is lower for this mark
			Total	4	

Question			Answer	Marks	Guidance
5	(a)		3 (bits per sample) / 1000 (samples per second) / bits per sample x samples per second	1	credit either piece of information used from graph or full equation for bit rate in words not bare 3 or 1000 on answer line correct evaluation
			3000 (bits per second)	1	
	(b)		more bits (per sample) more sampling levels / alternatives / improve voltage resolution / precision	1 1	not sampling more frequently / increasing bit rate accept / increase or decrease resolution not just improves accuracy
			Total	4	

Question			Answer	Marks	Guidance
6	(a)		250 (Ω)	1	
	(b)		12 / 250	1	method ecf 12 / (a)
			= 4.8 x 10 ⁻² (A) / = 0.048 (A)	1	evaluation
			Total	3	

Question			Answer	Marks	Guidance
7	(a)		$f = v / \lambda \quad / \quad 1500 / 3 \times 10^{-4}$ $= 5 \times 10^6 \text{ (Hz)}$	1 1	transposed equation in words / numbers
	(b)		method 1: $\Delta T \times f \quad / \quad 0.8 \times 10^{-6} \times 5 \times 10^6$ method 2: pulse length / wavelength $\quad / \quad = v \times \Delta T / \lambda \quad /$ $= 1500 \times 0.8 \times 10^{-6} / 3 \times 10^{-4}$ method 3: pulse time / period $\quad / \quad 0.8 \times 10^{-6} / 2 \times 10^{-7}$ $= 4$	1 1	allow ecf on incorrect frequency from (a) for full marks not $1 / \Delta T$ not just pulse length = 0.0012 m
			Total	4	
			Total Section A	24	

Section B

Question			Answer	Marks	Guidance
8	(a)		$I = P / V$ / $8 / 230$	1	method: transposed equation in algebra / numbers
			= 0.035 (A) / 0.03 (A) / 0.0348 (A)	1	penalise 4 or more S.F. and RE 0.0347 / 0.034
	(b)		$\lambda = c / f$ / $3 \times 10^8 / 5 \times 10^9$ = 0.06(0) (m)	1 1	method: : transposed equation in algebra / numbers evaluation POT error scores 1 mark
	(c)	(i)	time = info / rate / $2 \times 10^9 \times 8 / 300 \times 10^6$ = 53.(3) (s)	1 1	method: equation in words / numbers accept 1 S.F. answer 50 (s) penalise RE for 54 / 53.4 (s) ignore recurring decimal symbol accept binary kilo = 1024 gives 54.6 (s) for 2/2 allow 6.7 / 6.67 (s) for 1 mark total penalise RE 6.6 allow POT error 1 mark total
		(ii)	suggest problem e.g. lower bit rate somewhere in system / more information has to be sent / resent explanation : possible bottleneck in named part of system / recognise possible need for error checking / laptop busy with other traffic	1 1	e.g. bandwidth of internet connection < hubs max rate for 2 marks not signal takes longer to travel / bit rate changes hub / server / internet link may be busy with other users traffic / downloads / some information lost from signal not just signal weakens with distance
	(d)		any 3 points: signal decreases in amplitude as it spreads / covers a wider area / signal gets absorbed by walls etc. ; radio noise is present in environment ; signal / noise ratio decreases as distance from hub increases ; noise may trigger false bits / degrade the signal information / data link becomes inaccurate	1 1 1	not signal takes longer to travel not noise as sound ignore reference to signal picking up more noise as it travels accept don't want other laptops to use this hub connection accept low power to avoid possible health issues QoWC only award 3 rd mark if ideas on signal / noise have been used and explanation is clear
			Total	11	

Question			Answer	Marks	Guidance
9	(a)	(i)	many small crystals whose close packed planes have different alignments / grain boundaries	1 1	accept many grains / lattices accept if clear from diagrams or text
		(ii)	(ductile): can be drawn into a wire ; any 2 further points: in metal dislocation identified ; free to move through a regular crystal ; slip occurs easily / atomic planes slide over each other ; in alloy impurity atom pins dislocation ; slip more difficult so less ductile	1 1 1	accept deforms plastically / AW ignore can be bent not atoms move easily in iron
	(b)	(i)	1 hardness: difficult to scratch / dent / wear away ; 2 so lasts longer / does not blunt so easily / gives cleaner / more accurate cut	1 1	not hard means not soft / how easily dented / scratched treat a correct and incorrect definition as CON no mark e.g. hard to indent and crack / break accept keeps its cutting edge / can now cut steel / durable / resistance to scratching inhibits crack propagation not gets less damaged / just prevents breaking ignore incorrect explanations
		(ii)	any 2 points: metals have <u>free electrons</u> / <u>delocalised electrons</u> / <u>non-directional</u> bonds ; which hold <u>+ ions</u> in <u>lattice</u> / <u>+ ions</u> can <u>slip</u> / <u>dislocate</u> ; any 2 points: in diamond <u>bound</u> / <u>localised electrons</u> ; form strong ; <u>directional</u> bonds ; <u>giant lattice</u> hence hard to displace / move atoms	1 1 1 1	diamond credit well labelled diagrams illustrating this allow any geometry for ball and stick type diamond structure / electron structure implying directionality not electrons complete outer shell accept lack of dislocation movement in diamond QoWC awarded for use at least <u>3 terms</u> correctly and none incorrectly and clear <u>comparison</u> of ease of movement of atoms or breaking of bonds in each material
			Total	11	

Question			Answer	Marks	Guidance
10	(a)	(i)	so layers can bend / allow conducting films to touch	1	accept so do not crack / so returns after pressure released
		(ii)	(to hold conducting films apart) preventing electrical contact (with no applied pressure)	1	accept to prevent shorting / permanent connection not to prevent damage not to prevent 2 icons being activated
	(b)	(i)	intermediate conductivity between metals and insulators / with a (much) lower density of charge carriers (than metals)	1	not it conducts fairly well take conductor = metal and non-conductor = insulator ignore its conductivity increases with temperature
		(ii)	by doping (with an element) with more/less bonding electrons / more/less free electrons / more doping raises conductivity	1 1	accept add impurity not add metal not change temperature accept with different number of bonding electrons / holes not more free electrons from heating
		(iii)	$0.17 \times 0.06 / 2.5 \times 10^{-6}$ $= 4.1 \times 10^3 (\Omega)$ / $= 4.08 \times 10^3 (\Omega)$	1 1	correct substitution evaluation accept POT error for 1 / 2 marks
	(c)	(i)	$V_{\text{out}} \propto \text{x-position}$; $R_{\text{left}} \propto \text{x-position}$ with constant divider current / $R_{\text{left}} \propto \text{x-position}$ and constant $(R_{\text{left}} + R_{\text{right}})$ / OR $V_{\text{out}} = R_{\text{left}} \times V_{\text{in}} / (R_{\text{left}} + R_{\text{right}})$; $R_{\text{left}} \propto \text{x-position}$	1 1	for either method allow R_{left} / V_{out} increases with x-position ORA for 1 max allow use of R_1 and R_2 for R_{left} and R_{right}
		(ii)	1 $(\Delta V / \Delta x) = 1200 / 60 (= 20 \text{ mV mm}^{-1})$ units not needed OR $1.2 / 60 \times 10^{-3} = 20 \text{ V m}^{-1} (= 20 \text{ mV mm}^{-1})$ units needed 2 $(\Delta x = \Delta V / \text{sensitivity} / = 0.005 / 0.02) = 0.25 (\text{mm})$	1 1	handling of units and multipliers must be clear OR $1.2 / 60 = 0.020 \text{ V mm}^{-1} (= 20 \text{ mV mm}^{-1})$ units needed evaluation needed not method allow ecf on answer from 1 accept 1sf answer 0.3 (mm)
		(iii)	(number of alternatives / levels) = $60(\text{mm}) / 0.25(\text{mm}) = 240$ $2^7 = 128$ and $2^8 = 256$ / $\log_2(240) = 7.9$ so 8 bits needed	1 1 1	accept $1.2(\text{V}) / 0.005(\text{V}) = 240$ ecf on $60 / \Delta x$ from (ii) for full credit must have a complete argument for full marks bare answer 8 bits scores 1/3
			Total	14	
			Total Section B	36	
			Paper Total	60	

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