RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491:** Physics in Action

Mark Scheme for January 2013

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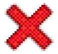
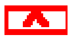
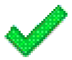
This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

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.

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

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 to 2.3) x 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 x $10^{9/8/7/5}$ 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 estimation: accept frequency in range 77 ± 2 (Hz)	1 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 **ignore** more than 2 SF correct bare answer without method scores 1 / 2
	(b)		peaks at <u>same</u> frequen<u>cies</u> peaks with smaller amplitude(s) / p.d.(s) / height(s)	1 1	**not** spectrum is the same / frequency is same / waves **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 3000 (bits per second)	1 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
	(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 = 4.8×10^{-2} (A) / = 0.048 (A)	1 1	method ecf 12 / (a) evaluation
			Total	**3**	

Question			Answer	Marks	Guidance
7	(a)		$f = v / \lambda$ / 1500 / 3 x10^{-4} = 5 x 10^{6} (Hz)	1 1	transposed equation in words / numbers
	(b)		method 1: ΔT x f / 0.8 x 10^{-6} x 5 x 10^{6} method 2: pulse length / wavelength / = v x ΔT / λ / = 1500 x 0.8 x 10^{-6} / 3 x10^{-4} method 3: pulse time / period / 0.8 x 10^{-6} / 2 x 10^{-7} = 4	1 1	**allow** ecf on incorrect frequency from (a) for full marks **not** 1 / ΔT **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 = 0.035 (A) / 0.03 (A) / 0.0348 (A)	1 1	method: transposed equation in algebra / numbers **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 3rd 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)	$0.17 \times 0.06 / 2.5 \times 10^{-6}$ $= 4.1 \times 10^{3}$ (Ω) / $= 4.08 \times 10^{3}$ (Ω)	1 1	correct substitution evaluation **accept** POT error for 1 / 2 marks
	(c)	**(i)**	$V_{out} \propto$ x-position ; $R_{left} \propto$ x-position with constant divider current / $R_{left} \propto$ x-position and constant ($R_{left} + R_{right}$) / OR $V_{out} = R_{left} \times V_{in} / (R_{left} + R_{right})$; $R_{left} \propto$ 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 mV mm^{-1}) units not needed OR $1.2 / 60 \times 10^{-3}$ = 20 $\underline{\text{V m}^{-1}}$ (= 20 mV mm^{-1}) units needed **2** ($\Delta x = \Delta V$ / sensitivity / = 0.005 / 0.02) = 0.25 (mm)	1 1	handling of units and multipliers must be clear OR 1.2 / 60 = 0.020 $\underline{\text{V mm}^{-1}}$ (= 20 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(mm) / 0.25(mm) = 240 $2^7 = 128$ and $2^8 = 256$ / $\log_2(240) = 7.9$ so 8 bits needed	1 1 1	**accept** 1.2(V) / 0.005(V) = 240 **ecf** on 60 / Δx 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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