OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491:** Physics in Action

Mark Scheme for January 2012

Oxford Cambridge and RSA Examinations

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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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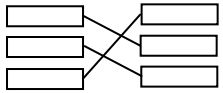
Annotations available in SCORIS

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

Subject-specific Marking Instructions

Annotations on the detailed mark scheme

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

Question			Answer	Marks	Guidance
1	(a)		Pa ; S	2	do **not accept** any ≡ units not listed e.g. N m^{-2} ; A V^{-1} **accept** PA
	(b)		W ; V	2	do **not accept** any ≡ units not listed e.g. J s^{-1} ; J C^{-1}
2	(a)		3800 (Hz)	1	
	(b)		8000 (Hz)	1	**not** 7600 (Hz)
	(c)		2^7 = 128 (≈ V_{total} / V_{noise})	1	**accept** $\log_2(128) = 7$
	(d)		8000 x 7 = 56 x 10^3 (bit s^{-1})	1	**allow** ecf on (b) x 7 e.g. 7600 x 7 = 53.2 x 10^3 (bit s^{-1})
3	(a)		less noise(s) / sharper / contrast changed / brightness changed / edges clearer	1	**ignore** smoother **accept** more details are visible / darker AW **not** less pixelated
	(b)			2	**3** links correct scores 2/2 **1 or 2** link(s) correct scores 1/2 **CON** multiple connections from any box
4	(a)		B and E ringed (or any clear consistent indication)	2	**one** mark for each correct but each extra ring above 2 removes 1 mark
	(b)	(i)	$V = \varepsilon - Ir$ / = 3.0 – 0.45 x 0.38 ; = 2.83 (V)	2	method ; evaluation **requires** 3rd S.F. because show that
		(ii)	($R = V / I$ = 2.83 / 0.45) = 6.3 (Ω)	1	evaluation ecf on voltage from (bi) if less than 3 V **accept** 6.2(2) (Ω) on show that p.d. value of 2.8 V **accept** potential divider calculation
5	(a)		centre of **X** placed at lens focus or <u>vertically</u> aligned within marking tool	1	**accept** labelled point / line / arrow ending at focus ± 1 mm align marking tool to edge of last incoming wavefront
	(b)		adds curvature (to the wavefronts arriving at lens)	1	**accept** zero curvature entering lens and positive curvature leaving lens **accept** curves waves (if correct sense of curve is explicit) e.g. curves waves converging / curves to a focus **not** adds negative curvature / just lens focuses / curves waves **not** bends waves / any credit for refraction explained

Question			Answer	Marks	Guidance
6			$v = c / n$ / $= 3 \times 10^8 / 2.4$ $= 1.25 \times 10^8$ (m s^{-1})	1 1	method **accept** algebraic / numerical evaluation **accept** 1.3×10^8 (m s^{-1}) **not** 1.2×10^8 (m s^{-1})
7	(a)		diameter	1	**accept** 0.25 (± 0.01) mm / *D*
	(b)		has largest % / largest relative uncertainty / has largest % of measurement standalone mark even if error in (a)	1	**not** has largest uncertainty / because diameter squared **accept** ± 4% estimate in diameter if calculated or ± 8% estimate in area if calculated or ± % uncertainty is doubled because D squared
			Total	**22**	

Question			Answer	Marks	Guidance
8	(a)		stiff / high YM ; so does not stretch (too far under stress) / tough / not brittle ; so does not break easily / cracks don't propagate / so does not snap easily	2	**only allow** stiffness / YM / toughness if qualified by explanation that needs large value **explanation** must be linked to the property **accept** compliant ; so flexible to bend around pulley **accept** elastic ; returns to its original length when unstressed **not** strong / hard / ductile / malleable / durable
	(b)		method x-area = F / σ / = $5.4 \times 10^4 / 1.1 \times 10^8$ evaluation = 4.9×10^{-4} (m^2)	1 1	method **accept** algebra / numbers **not** just $\sigma = F / A$ evaluation **accept** 5×10^{-4} m^2 / 4.9 cm^2 / 5 cm^2
	(c)	(i)	method $\varepsilon = \sigma / E$ / = $1.1 \times 10^8 / 2.1 \times 10^{11}$ evaluation = 0.00052(4) ($\approx$ 0.05 %)	1 1	method **accept** algebra / numbers evaluation needs 2 or more S.F. for show that **ignore** attempts to convert to %
		(ii)	method $x = \varepsilon \times L$ / = 0.00052 x 650 evaluation = 0.34 m	1 1	method **accept** algebra / numbers **not** just $\varepsilon = x / L$ If working from YM then must have $x = FL / AE$ for first mark **accept** 0.32(5) m using show that strain 0.05% **accept** ecf on strain from (ci) x 650 **max 1** for calculating with ε % (POT)
	(d)		for safety (margin) / awareness of engineering safety limits / avoid getting near to permanently changing length of the cable	1	**accept** to avoid getting near to plastic / permanent deformation in cable **accept** to stay well below elastic limit **accept** to allow for material / manufacturing defects **accept** to allow for cyclic loading / fatigue / corrosion **not** just elastic limit is yield point **not** just so cable does not break / snap / crack / fail
			Total	**9**	

Question			Answer	Marks	Guidance
9	(a)	(i)	Idea of (two) resistors in series / sharing the (total) p.d. (in proportion to their resistances)	1	AW **accept** algebraic versions e.g. $V_1 / V_2 = R_1 / R_2$
		(ii)	resistance ratio $R_{fixed} / R_{thermistor}$ changes (correct sense) ratio rises (so p.d. across R_{fixed} rises) ORA **OR** total R less ; so current increases through fixed resistor (and p.d. across it rises)	1 1 1	penalise any error of physics **max 1/3** e.g. p.d. through / current across / current remains constant when $R_{thermistor}$ changes $V_{thermistor}$ falls so V_{fixed} rises scores 1 for physics **not** any credit for repeating root of question part explanation without physics errors and no more than 1 error in SPG for 3rd QoWC mark
	(b)	(i)	(sensitivity) decreases (as temperature rises)	1	
		(ii)	gradient / $\Delta V / \Delta T$ / $\Delta y / \Delta x$ / Δoutput / Δinput / change dependent / change independent variables values e.g. 0.5 / 20 evaluation = 0.025 (V ºC $^{-1}$)	1 1 1	method **look at graph below answers** **accept** e.g. (3.7 -1.1) / 70 = (0.037) (V ºC $^{-1}$) for **max 1** **accept** values from graph / linear extrapolation of tangent at 70 ºC / sensible small triangles drawn on graph around 70 ºC **not** any further credit for V / T calculations 0.053 (V ºC $^{-1}$) evaluation **accept** within range 0.021 to 0.029 (V ºC $^{-1}$)
		(iii)	from graph $V_{(\text{fixed at } 70ºC)}$ = 3.7 V method mark: any correctly substituted divider equation e.g. $R / 800 = 3.7 / 2.3$ OR $I = 2.3 / 800 = 2.9$ mA R = 1300 / 1290 / 1287 (Ω)	1 1 1	standalone mark reading from graph **not** any tolerance but credit even if associated with thermistor method **allow** ecf on 3.6 to 3.8 V **accept** $3.7 / 6.0 = R / (R + 800)$ evaluation **accept** other values in range 1275 to 1300 Ω for full credit (due to intermediate rounding); **accept** other values in outer range 1200 to 1400 Ω for **max 2** **not** any further credit for $R = 500 \pm 10$ (Ω)
			Total	**11**	

Question			Answer	Marks	Guidance
10	(a)	(i)	($M = v / u$ = 0.055 / 10) = 0.0055	1	evaluation **accept** 5.5×10^{-3} **ignore** - ve signs
		(ii)	P OR $1/f = 1/v - 1/u$ / = 1 / 0.055 - 1 / (-10)	1	method **accept** clear statement of **approximation** $P \approx 1/v$ / $f \approx v$ / $P \approx 1/0.055$ **accept** calculation of f = 0.0547 m for 1st mark
			= 18.3 (D)	1	evaluation accept 18.2 (D) **must** have 3 S.F. for show that **not** 18.1 (D) (from sign error)
		(iii)	magnification x D / using similar triangles 67 mm x 0.0055	1	method **allow** ecf mag (ai) x D correctly evaluated for 2 marks **accept** 67 mm / 182 (NB $1/M$ = 182)
			= 0.00037 m (≈ 0.4 mm)	1	evaluation 0.37 / 0.3685 mm must have at least 2 S.F. for show that
	(b)	(i)	= 70 x 0.37 ≈ 26 / 25.9 (integer not necessary) (= 70 x 0.4 = 28) using show that value	1	**accept** 70 x 0.3685 = 25.8 **accept** ecf for image size from (aiii) in mm x 70 **not** 4690
		(ii)	= 67 mm / 25.8 = 2.6 x 10^{-3} (m) (= 67 / 28 = 2.39 mm) using show that value	1	**accept** 2.6 mm / 1 S.F. answers so 3 mm OR 2 mm **accept** other methods 1/70 mm / 0.0055 OR 1/70 mm x 182 / similar triangles methods
	(c)		= 0.085(2) m (based on ± 1 pixel on each image) must have unit	1	**accept** 0.0826 m OR 0.083 m (based on ± 1 pixel) **accept** any answers in range 0.082 m to 0.086 m **allow** ecf on (0.08 + bii) OR (0.08 + 2 x bii) up to max value of 0.090 m
			bii is the resolution of ball's position (at 10 m from camera) / recognition that on CCD resolution is to nearest integer of pixels **standalone explanation**	1	**accept** AW and other sensible comments: **accept** reasoning about whole numbers of pixels / about use of 1 or 2 pixels uncertainty in 2 images **not** any credit for answers that imply a "perfect" measurement
			Total	**9**	

Question			Answer	Marks	Guidance
11	(a)	(i)	(25 / 12) = 2.08 (A)	1	2.1 (A) to 2 S.F. **not** 2 (A) to 1 S.F.
		(ii)	(2.08 / 12) = 0.17(3) (S)	1	0.17 (S) to 2 S.F. **not** 0.2 (S) **accept** 0.174 ***/*** 0.175 / 0.18 (S) from rounding **accept** ecf on ai / 12 correctly evaluated
	(b)		many / high density of ; free / delocalised / unbound / gas / sea of / soup ; electrons which act as ; movement of <u>charge</u> carriers / transfer (negative) <u>charge</u> / carry charge	1 1 1	any 3 / 4 marking points in a well organised sentence for 3rd QWC mark **ignore** lattice of positive ions **accept** idea of flow of <u>charge</u> / idea of drift velocity of charge **must** mention charge in motion **not** just are charged
	(c)	(i)	there are no free charge carriers / electrons	1	**accept** electrons are localised in ionic/covalent bonds **accept** not many / few / low density free electrons
		(ii)	lamp runs hot / heating identified as a problem ceramics don't melt in the lamp ORA for plastics ceramics have a high(er) melting point (scores 2 heating implicit)	1 1	**accept** plausible thermal properties explained e.g. ceramics have a small(er) thermal expansion so pins do not loosen / ceramics better / good thermal conductors so do not overheat for **2 marks** (running hot is implicit) **not** heat resistance / temperature resistance for 2nd mark
		(iii)	plastics are tough(er) / not brittle / less brittle (than ceramics)	1	**accept** AW less likely to break under impacts **ignore** safer because plastic is electrical insulator / cheaper / easier to manufacture / easy to mould / durable
			Total	**9**	

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