

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491**: Physics in Action

Mark Scheme for January 2012

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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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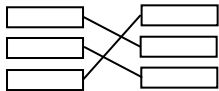
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Annotations available in SCORIS

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 $\equiv$ units not listed e.g. N m^{-2} ; A V^{-1} accept PA
	(b)	W ; V	2	do not accept any $\equiv$ units not listed e.g. J s^{-1} ; J C^{-1}
2	(a)	3800 (Hz)	1	
	(b)	8000 (Hz)	1	not 7600 (Hz)
	(c)	$2^7 = 128$ ($\approx V_{\text{total}} / V_{\text{noise}}$)	1	accept $\log_2(128) = 7$
	(d)	$8000 \times 7 = 56 \times 10^3$ (bit s^{-1})	1	allow ecf on (b) $\times 7$ e.g. $7600 \times 7 = 53.2 \times 10^3$ (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)	$V = \varepsilon - Ir$; $I = 3.0 - 0.45 \times 0.38$; $= 2.83$ (V)	2	method ; evaluation requires 3 rd 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			$v = c / n \quad / \quad = 3 \times 10^8 / 2.4$ $= 1.25 \times 10^8 \text{ (m s}^{-1}\text{)}$	1	method accept algebraic / numerical
				1	evaluation accept $1.3 \times 10^8 \text{ (m s}^{-1}\text{)}$ not $1.2 \times 10^8 \text{ (m s}^{-1}\text{)}$
7	(a)		diameter	1	accept $0.25 (\pm 0.01) \text{ mm} \quad / \quad D$
	(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 $\pm 4\%$ estimate in diameter if calculated or $\pm 8\%$ estimate in area if calculated or $\pm \%$ 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 $x\text{-area} = F / \sigma$ / $= 5.4 \times 10^4 / 1.1 \times 10^8$ evaluation = $4.9 \times 10^{-4} \text{ (m}^2\text{)}$	1 1	method accept algebra / numbers not just $\sigma = F / A$ evaluation accept $5 \times 10^{-4} \text{ m}^2$ / 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 $x = \varepsilon \times L$ / $= 0.00052 \times 650$ 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 $0.32(5) \text{ m}$ using show that strain 0.05% accept ecf on strain from (ci) $\times 650$ max 1 for calculating with $\varepsilon\%$ (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 $R_{\text{fixed}} / R_{\text{thermistor}}$ 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	penalise any error of physics max 1/3 e.g. p.d. through / current across / current remains constant when $R_{\text{thermistor}}$ changes $V_{\text{thermistor}}$ 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 3 rd QoWC mark
	(b)	(i)	(sensitivity) decreases (as temperature rises)	1	
		(ii)	gradient / $\Delta V / \Delta T$ / $\Delta y / \Delta x$ / $\Delta \text{output} / \Delta \text{input}$ / change dependent / change independent variables values e.g. 0.5 / 20 evaluation = 0.025 ($\text{V } ^\circ\text{C}^{-1}$)	1 1 1	method look at graph below answers accept e.g. $(3.7 - 1.1) / 70 = (0.037) (\text{V } ^\circ\text{C}^{-1})$ for max 1 accept values from graph / linear extrapolation of tangent at 70°C / sensible small triangles drawn on graph around 70°C not any further credit for V / T calculations 0.053 ($\text{V } ^\circ\text{C}^{-1}$) evaluation accept within range 0.021 to 0.029 ($\text{V } ^\circ\text{C}^{-1}$)
		(iii)	from graph $V_{\text{fixed at } 70^\circ\text{C}} = 3.7 \text{ V}$ method mark: any correctly substituted divider equation e.g. $R / 800 = 3.7 / 2.3$ OR $I = 2.3 / 800 = 2.9 \text{ mA}$ $R = 1300 / 1290 / 1287 (\Omega)$	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 $R = 500 \pm 10 (\Omega)$
			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 $1/f = 1/v - 1/u$ / $= 1/0.055 - 1/(-10)$ $= 18.3$ (D)	1 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 1 st mark evaluation accept 18.2 (D) must have 3 S.F. for show that not 18.1 (D) (from sign error)
		(iii)	magnification $\times D$ / using similar triangles 67 mm $\times$ 0.0055 $= 0.00037$ m (≈ 0.4 mm)	1 1	method allow ecf mag (ai) $\times D$ correctly evaluated for 2 marks accept 67 mm / 182 (NB $1/M = 182$) evaluation 0.37 / 0.3685 mm must have at least 2 S.F. for show that
	(b)	(i)	$= 70 \times 0.37 \approx 26$ / 25.9 (integer not necessary) ($= 70 \times 0.4 = 28$) using show that value	1	accept $70 \times 0.3685 = 25.8$ accept ecf for image size from (aiii) in mm $\times$ 70 not 4690
		(ii)	$= 67 \text{ mm} / 25.8 = 2.6 \times 10^{-3}$ (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 $1/70 \text{ mm} / 0.0055$ OR $1/70 \text{ mm} \times 182$ / similar triangles methods
	(c)		$= 0.085(2)$ m (based on ± 1 pixel on each image) must have unit 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 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 $(0.08 + \text{bii})$ OR $(0.08 + 2 \times \text{bii})$ up to max value of 0.090 m 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 3 rd 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 2 nd 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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