

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491**: Physics in Action

Mark Scheme for June 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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1. 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

Annotations on 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

Subject Specific Marking Instructions.

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text: 8(c), 10(b)(i)&(ii).
QWC ticks or crosses on pen symbol please.

Do not penalise RE rounding errors more than once on the paper. SF penalty only on 9 (b) max 2 SF on uncertainty calculation.
Expect 'show that' calculations to be worked out to 1 figure beyond the value given.

Section A

Question			Answer	Marks	Guidance															
1			<table><tr><th>units</th><th></th><th>equivalents</th></tr><tr><td>A</td><td></td><td>J s⁻¹</td></tr><tr><td>V</td><td></td><td>V A⁻¹</td></tr><tr><td>W</td><td></td><td>C s⁻¹</td></tr><tr><td>Ω</td><td></td><td>J C⁻¹</td></tr></table>	units		equivalents	A		J s ⁻¹	V		V A ⁻¹	W		C s ⁻¹	Ω		J C ⁻¹	3	all 4 lines correct scores 3 2 / 3 lines correct scores 2 1 line correct scores 1
units		equivalents																		
A		J s ⁻¹																		
V		V A ⁻¹																		
W		C s ⁻¹																		
Ω		J C ⁻¹																		
			Total	3																

Question			Answer		Marks	Guidance
2					3	all 4 lines correct scores 3 2 / 3 lines correct scores 2 1 line correct scores 1
			properties	definitions		
			stiff	the force per unit cross-sectional area		
			stress	difficult to indent or scratch		
			hard	a small strain for a large stress on a material		
			tough	needs a large energy to break and create a new fracture surface		
			Total		3	

Section A

Question			Answer	Marks	Guidance
3	(a)		$V_{\text{out}} = R_1 \times V_{\text{in}} / (R_1 + R_2) \quad / \quad = 20 \times 6 \text{ V} / (20 + 80)$	1	method in correct algebra / numbers accept resistance ratio = voltage ratio arguments allow 1 mark for current = 0.060 A / 60 mA must clearly be a current
			$= 1.2 \text{ (V)}$	1	evaluation must give answer to 2 SF for show that mark
	(b)		$V^2 / R \quad / \quad (1.2)^2 / 20$	1	method in correct algebra / numbers accept $I^2 R \quad / \quad I V$ only with correct substitution (formulae on data sheet) allow ecf on I OR V from (a) accept $(1.0)^2 / 20$ from show that
			$= 0.072 \text{ (W)}$	1	evaluation accept 0.050 (W) from show that not ecf on incorrect current within (b)
			Total	4	

Question			Answer	Marks	Guidance
4	(a)		$\Delta R / \Delta T \quad / \quad = \quad (2500 - 1000) / (400 - 0)$	1	method for clear attempt at gradient in algebra / words / numbers accept Δ dependent / Δ independent OR $\Delta y / \Delta x$ not any credit for $R / T = 1750 / 200 = 8.8 \text{ (}\Omega \text{ }^{\circ}\text{C}^{-1}\text{)}$ not just mention of gradient
			$= 3.8 \quad / \quad 3.75 \quad (\Omega \text{ }^{\circ}\text{C}^{-1})$	1	evaluation accept in range 3.6 to 3.9 $(\Omega \text{ }^{\circ}\text{C}^{-1})$ for other triangles
	(b)		constant (sensitivity) up to T in range 400 to 500 $^{\circ}\text{C}$	1	not to 600 $^{\circ}\text{C}$ / above 500 $^{\circ}\text{C}$ not R grows linearly with T
			(then) decreases (as T rises)	1	accept curves down / levels off / approaches zero / gradient decreases not just line starts to curve
			Total	4	

Section A

Question			Answer	Marks	Guidance
5	(a)		$m = v / u \quad / \quad = 0.01 / 10$ $= 0.001$	1 1	method in algebra / words / numbers (formula not on data sheet) evaluation ignore - sign(s) accept fraction 1/1000
	(b)		$P = 1 / f \quad / \quad = 1/v - 1/u$ $= 1 / 0.01 - 1 / (-10)$ $= 100.(1) \text{ (D)} \quad / \quad 100 \text{ (D)}$	1 1 1	method recall of power of lens / manipulation of formula correct substitution (Cartesian – sign goes with value 10) evaluation accept $P = 1 / f \approx 1 / v = 100 \text{ D}$ for 3 marks allow 99.9 D (sign error) 2 marks max not 3 rd mark for negative final answers accept $P = 1/v + 1/u = 100.(1) \text{ (D)}$ for 3 marks if fully consistent with real is positive sign convention but no part marks Look out for v and u values interchanged giving 100.1 (D), scores max 1 mark for formula rearranged or $P = 1 / f$
			Total	5	

Question			Answer	Marks	Guidance
6			method started: 3.5 cm / 13.2 cm OR (3.5 cm x 3072 pixels) / (9.8 cm) OR $\approx 310 \text{ pixel cm}^{-1}$	1	Accept 1 st mark for evidence of estimate length arrow / length image / $\approx \frac{1}{4}$ / length arrow / height image / $\approx \frac{1}{3}$
			method cont: pixels per arrow length of 1100 ± 100 pixels	1	$4096 / 4 \approx 1000 \text{ pixels}$ / $3072 / 3 \approx 1000 \text{ pixels}$ accept Pythagorean solutions / components of arrow
			evaluation (distance = resolution x no. pixels) = 30 light years pixel^{-1} x 1100 pixels = 33 000 light years	1	evaluation accept in range $(33 \pm 3) \times 1000 \text{ light years}$ allow only max 2 for correct methods with larger measuring errors in extended range $(33 \pm 10) \times 1000 \text{ light years}$
			Total	3	

Question			Answer	Marks	Guidance
7			1 5.0	1	
			2 0.5 (kW)	1	
			Total	2	
			Total section A	24	

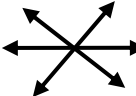
Section B

Question			Answer	Marks	Guidance
8	(a)	(i)	stress / strain / 14 MPa / 0.082 = 170 = 170 MPa / 170 MNm ⁻²	1 1 1	method evaluation accept 171 ignore POT errors here answer must have consistent POT with unit accept 1.7 x 10 ⁸ Pa / N m ⁻²
		(ii)	$F = \sigma A$ / = 14 x 10 ⁶ x 1.9 x 10 ⁻⁷ = 2.66 (N) / 2.7 (N)	1 1	method in algebra / words / numbers evaluation not 2.6 (N) RE (penalise RE only once on paper)
	(b)	(i)	any 2 from 4 points about the sample: plastic behaviour / very large increase in strain for small increase in stress / gets stiffer OR larger $\Delta\sigma$ for small $\Delta\epsilon$ OR larger ΔF for small Δx / up to x 6 original length for breaking OR x 5 at strain 4	2	accept will not return to original size / shape not inelastic accept strain increases at a high rate not rapidly / quickly accept starts to neck / tear not any credit for Y.M. decreases not easier / harder to stretch not any credit for molecular explanations here not any credit for just descriptions of what the graph does not any credit for then breaks
		(ii)	breaking strain $\epsilon = 5.1$ $x = \epsilon L = 5.1 \times 15 \text{ cm}$ = 76.5 (cm)	1 1 1	read from graph accept in range 5.05 to 5.15 method in algebra / words / numbers accept use of extension = 0.082 x 15 for method mark only evaluation expect in range 75.8 to 77.3 (cm) allow ecf on strains in range 5 to 5.5 for max 2 allow 2/3 for bare 75 (cm)
	(c)		originally long chains are <u>amorphous</u> / crumpled / folded / <u>random</u> / spaghetti-like ; <u>monomers rotate</u> / <u>bonds rotate</u> / chains slip past each other / chains line up / disentangle / unfold / becomes more <u>crystalline</u> ; (<u>inter</u> / <u>intra molecular</u> / <u>cross links</u> / <u>hydrogen bonds</u>) bonds break OR once molecules aligned bonds themselves are being stretched ; QWC for <u>any underlined</u> term used correctly	1 1 1 1	accept suggestions for pre-elastic limit accept suggestions about <u>cross links</u> restricting movement or preventing return once broken not any credit here for macroscopic plastic behaviour accept good diagram evidence even if not labelled accept aligned molecules increase stiffness QWC mark only if one technical term has been appropriately used and spelled correctly
			Total	14	

Section B

Question			Answer	Marks	Guidance
9	(a)		4	1	
	(b)		$(0.001 \times 100\% / 1.019) = 0.1\%$	1	accept 0.098% but not more than 2 SF not 0.0981 (%)
	(c)	(i)	$t = Q / I \quad / \quad = 10 \text{ } (\mu\text{C}) / 1.1 \text{ } (\mu\text{A}) \quad / \quad 10 \times 10^{-6} / 1.1 \times 10^{-6}$ $= 9.1 \text{ (s)}$	1 1	method in algebra / words / numbers / units evaluation accept 9 (s) accept ORA showing $1.1 \text{ } (\mu\text{A}) \times 10 \text{ (s)} = 11 \text{ } (\mu\text{C})$ not 3.6 s (using $2.8 \text{ } (\mu\text{A})$) but can score 1 st mark if method clear
		(ii)	$R + r = \varepsilon / I \quad / \quad = 1.019 / (1.1 \times 10^{-6})$ $R + r = 926.4 \text{ k}\Omega$ $R = 926.4 \text{ k}\Omega - 350 \text{ }\Omega \approx 926 \text{ k}\Omega \quad /$ $R \gg r \quad / \quad r$ negligible compared to R	1 1 1	method not credit for $V = IR$ OR $V = \varepsilon - IR$ allow 1/3 for getting as far as $V = 1.0186 \text{ V}$ evaluation accept working to 2 SF 930 k Ω max 2 if evaluating R_{meter} only as 930 k Ω and no discussion of r OR for using $2.8 \text{ } (\mu\text{A})$ and r leading to 364 k Ω
		(iii)	$V = Ir \quad / \quad = 1.1 \times 10^{-6} \times 350$ $= 0.39 \text{ m(V)} \quad / \quad 0.385 \text{ m(V)}$	1 1	method not any ecf here not just $V = IR$ evaluation accept $3.85 \times 10^{-4} \text{ (V)}$ accept 0.4 m(V) accept other methods eg potential divider allow 0.38 m(V)
	(d)		suggested problem explanation $I > 2.8 \text{ } (\mu\text{A})$ $V < V_{\text{standard}} \quad / \quad V < \varepsilon$ $Q > 10 \text{ } (\mu\text{C})$ $V < V_{\text{standard}} \quad / \quad V < \varepsilon$ $V < V_{\text{standard}} \quad / \quad V < \varepsilon$ V_{lost} across r greater V_{lost} across r greater systematic error V_{lost} across r meter over-reads not all V_{standard} across meter	2	be flexible about exchanging problem $\Leftrightarrow$ explanation so long as linked but needs quality somewhere take $\varepsilon = V_{\text{standard}} = 1.019 \text{ V}$ problem accept too much current or charge (drawn) / too little time to make measurement not just more current so inaccurate not inaccurate calibration / less precise / higher % error accept cell polarises / internal resistance increases
			Total	11	

Section B

Question			Answer	Marks	Guidance
10	(a)	(i)	4096	1	not just 2^{12}
		(ii)	$(1920 \times 1080 \times 12 \times 3) = 74.6 \text{ M(bits)}$	1	needs 3 SF here for show that mark accept computer M giving 71.(2) M(bits)
		(iii)	$= 74.6 \times 10^6 \times 120 / \text{bandwidth} \approx \text{bit rate} / = \text{bit rate} / 2$ $= 9.(0) \text{ G(Hz)} / 8.96 \text{ G(Hz)} / 8.95 \text{ G(Hz)}$	1 1	method accept use of show that value / factors of $\frac{1}{2}$ evaluation accept factors of $\frac{1}{2}$ i.e. 4.4(8) G(Hz) allow ecf on incorrect bits from (ii) $\times 120$
	(b)	(i)	waves are transverse / oscillations perp. to direction of travel unpolarised: all possible directions of oscillation /  polarised: one direction of oscillation /  For diagrams: directions need double headed arrows to score and labelled un/polarised	1 1 1	accept evidence from diagram / clear representation of transverse wave needs labels for oscillation + travel not just sine wave accept diagrams at least 3 directions of oscillation ignore wave travels in all directions accept diagram with one direction of oscillation / partially polarised light ignore wave travels in one direction if no diagrams only award 3 marks for very clear well expressed written answers
		(ii)	Up to 3 of following polarisation points: a polarising filter transmits plane polarised light ; fixed filter must be at 90° to L-crystal (polarisation direction) / forms crossed polar filters ; which do not transmit light / block light ; Up to 2 of following switching points (to a max 4 total): when switched by signal from TV to control glasses ; L-crystal filter switched on by voltage ; voltage switched from one eye / lens to other alternately ; TV signal synchronised with frame rate	4	AW accept polarising filter only allows one direction of vibration not filters in opposite directions allow other workable switching solutions / sensible details QWC final mark only awarded if four points clearly explained
			Total	11	
			Total Section B	36	
			Total for paper	60	

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