RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491:** Physics in Action

Mark Scheme for June 2012

Oxford Cambridge and RSA Examinations

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.

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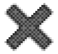
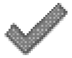
1. Annotations available in Scoris

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>	3	all 4 lines correct scores 3 2 / 3 lines correct scores 2 1 line correct scores 1
			Total	**3**	

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

Section A

Question			Answer	Marks	Guidance
3	(a)		$V_{out} = R_1 \times V_{in} / (R_1 + R_2)$ / = 20 x 6 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 (V)	1	evaluation must give answer to 2 SF for show that mark
	(b)		V^2 / R / $(1.2)^2 / 20$	1	method in correct algebra / numbers **accept** $I^2 R$ / $I V$ 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 (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)		$\Delta R / \Delta T$ / = (2500 – 1000) / (400 – 0)	1	method for clear attempt at gradient in algebra / words / numbers **accept** Δdependent / Δindependent OR Δy/Δx **not** any credit for R / T = 1750 / 200 = 8.8 (Ω ºC^{-1}) **not** just mention of gradient
			= 3.8 / 3.75 (Ω ºC^{-1})	1	evaluation **accept** in range 3.6 to 3.9 (Ω ºC^{-1}) for other triangles
	(b)		constant (sensitivity) up to T in range 400 to 500 ºC	1	**not** to 600 °C / above 500 ºC **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)		$m = v / u$ / $= 0.01 / 10$ $= 0.001$	1 1	method in algebra / words / numbers (formula not on data sheet) evaluation **ignore** - sign(s) **accept** fraction 1/1000
	(b)		$P = 1 / f$ / $= 1/v - 1/u$ $= 1 / 0.01 - 1 / (-10)$ $= 100.(1)$ (D) / 100 (D)	1 1 1	method recall of power of lens / manipulation of formula correct substitution (Cartesian – sign goes with value 10) evaluation **accept** $P = 1 / f \approx 1 / v = 100$ D for 3 marks **allow** 99.9 D (sign error) 2 marks max **not** 3rd mark for negative final answers **accept** $P = 1/v + 1/u = 100.(1)$ (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 pixel cm^{-1} method cont: pixels per arrow length of 1100 ± 100 pixels evaluation (distance = resolution x no. pixels) = 30 light years $pixel^{-1}$ x 1100 pixels = 33 000 light years	1 1 1	**Accept** 1st mark for evidence of estimate length arrow / length image / ≈ ¼ / length arrow / height image / ≈ ⅓ 4096 / 4 ≈ 1000 pixels / 3072 / 3 ≈ 1000 pixels **accept** Pythagorean solutions / components of arrow evaluation **accept** in range (33 ± 3) x 1000 light years **allow** only max 2 for correct methods with larger measuring errors in extended range (33 ± 10) x 1000 light years
			Total	**3**	

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

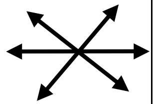
Section B

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** 1.7×10^8 Pa / N m^{-2}
		(ii)	$F = \sigma A$ / $= 14 \times 10^6 \times 1.9 \times 10^{-7}$ = 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 $\Delta\varepsilon$ 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 ε = 5.1 $x = \varepsilon L$ = 5.1 x 15 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 x 100% / 1.019) = 0.1 (%)	1	**accept** 0.098% but not more than 2 SF **not** 0.0981 (%)
	(c)	(i)	$t = Q / I$ / = 10 (μC) / 1.1 (μA) / 10 x 10^{-6} / 1.1 x 10^{-6} = 9.1 (s)	1 1	method in algebra / words / numbers / units evaluation **accept** 9 (s) **accept** ORA showing 1.1 μ(A) x 10 (s) = 11 μC (>10 μC) **not** 3.6 s (using 2.8 μA) but can score 1st mark if method clear
		(ii)	$R + r = \varepsilon / I$ / = 1.019 / (1.1 x 10^{-6}) $R + r$ = 926.4 kΩ R = 926.4 kΩ - 350 Ω ≈ 926 kΩ / $R >> r$ / r negligible compared to R	1 1 1	method **not** credit for $V = I R$ OR $V = \varepsilon - I R$ **allow** 1/3 for getting as far as V = 1.0186 V evaluation **accept** working to 2 SF 930 kΩ **max 2** if evaluating R_{meter} only as 930 kΩ and no discussion of r **OR** for using 2.8 μA and r leading to 364 kΩ
		(iii)	$V = I r$ / = 1.1 x 10^{-6} x 350 = 0.39 m(V) / 0.385 m(V)	1 1	method **not** any ecf here **not** just $V = I R$ evaluation **accept** 3.85 x 10^{-4} (V) **accept** 0.4 m(V) **accept** other methods eg potential divider allow 0.38 m(V)
	(d)		suggested problem — explanation I > 2.8 μA — $V < V_{standard}$ / $V < \varepsilon$ Q > 10 μC — $V < V_{standard}$ / $V < \varepsilon$ $V < V_{standard}$ / $V < \varepsilon$ — 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 ⇔ explanation so long as linked but needs quality somewhere **take** $\varepsilon = V_{standard}$ = 1.019 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 x 1080 x 12 x 3) = 74.6 M(bits)	1	needs 3 SF here for show that mark **accept** computer M giving 71.(2) M(bits)
		(iii)	= 74.6 x 10^6 x 120 / bandwidth ≈ bit rate / = bit rate / 2 = 9.(0) G(Hz) / 8.96 G(Hz) / 8.95 G(Hz)	1 1	method **accept** use of show that value / factors of ½ evaluation **accept** factors of ½ i.e. 4.4(8) G(Hz) **allow** ecf on incorrect bits from (ii) x 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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