OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491:** Physics in Action

Mark Scheme for January 2011

Oxford Cambridge and RSA Examinations

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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.

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1. Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
not	=	answers which are not worthy of credit
reject	**=**	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

2. Annotations: the following annotations are available on SCORIS.

✓	=	correct response
✖	=	incorrect response
bod	=	benefit of the doubt
nbod	=	benefit of the doubt **not** given
ECF	=	error carried forward
^	=	information omitted
POT	=	power of 10 error
SF	=	significant figures
RE	=	repeated error
NAQ	=	not answered question
FT	=	follow through
CON	=	contradiction
?	=	unclear
AE	=	arithmetic error

Expected Answers			Marks	Additional Guidance
1	**a**	A ✓	1	**not** C s^{-1}
1	**b**	V ✓	1	**not** J C^{-1}
1	**c**	S ✓	1	**not** A V^{-1} **not** Ω^{-1}
2	**a**	95 Ω 105 Ω ✓	1	both correct for the **one** mark
	b	use of a correct potential divider formula e.g. $R_1 \times V / (R_1 + R_2)$ ✓ m	1	**accept** recognisable symbols / numbers method **allow** calculation of current, but must be clear e.g. either I = 0.05 OR 0.05 A (using 95 + 105) Ω not (100 + 100) Ω give BOD on 200 Ω total
		= 95 x 10 / 200 = 4.75 V ✓ e	1	evaluation **allow** ecf on incorrect values from (a)
3	**a**	**A** ✓	1	
	b	**C** ✓	1	
4		rotate the filter (and observe reflection) ✓ change angle *r* (and observe reflection) ✓ see if intensity of (reflected) light fluctuates ✓ from max to min / min to max for 90° rotation of filter ✓ at minimum intensity see if intensity of reflected light depends on angle *r* / position of reflection ✓ minimum intensity indicates degree of polarisation ✓	3	credit any three points **max 3** **accept** AW throughout **not** any credit for describing set up of Fig 4.1 **accept** glare for intensity and zero for minimum intensity **accept** minimum intensity when filter is crossed (with direction of vibration of reflected light) / vertical / at 90° to plane of polarisation ORA maximum when parallel **accept** max – min – max for a 180 º rotation / min – max - min i.e. don't penalise min if filter's polarisation is horizontal **QWC** award 3rd mark only if answer is well organised and clear

Expected Answers			Marks	Additional Guidance
5	**a**	(± 1.25 / 50) = ± 2.5% / ± 3% ✓	1	working not required **accept** answers in range ± 2% to ± 3% **not** answers expressed to more than 2 SF
5	**b**	the uncertainties (in either p.d. or wind speed) increase as the wind speed / p.d. increases / the % uncertainties (in either p.d. or wind speed) are constant / the % uncertainties in wind speed are larger than those in p.d ✓	1	**accept** AW **not** the uncertainties in wind speed are larger than those in p.d
5	**c**	output only starts to increase for wind speeds above 1.5 m s^{-1} / ✓ output starts linearly (to about 20 - 30 m s^{-1}) ✓ sensitivity decreases at higher wind speeds / the rate of increase of the p.d. decreases at higher wind speeds ✓	2	**accept** any 2/3 different correct features **accept** does not pass through the origin **not** proportional **accept** output initially increases at constant rate **not** reference to graph gradient alone **must** have region clear for any of the marks **accept** output p.d. starts to level off at higher wind speeds **accept** output increases at lower rate at higher windspeed **ignore** slower rate **not** any credit for answers involving uncertainties here
6	**a**	144 (bits) ✓	1	
	b	18 (bytes) ✓	1	**accept** ecf **(a)**/8 evaluated without method **not** any other value
	c	2^{144} = 2.2(3) x 10^{43} ✓	1	**accept** ecf 2 $^{\text{bits from (a)}}$ evaluated **not** any other value
7	**a**	mass = ρV and 2nd lens has less volume (but same density) ✓	1	**accept** less material of same density / lens is thinner and has same density
7	**b**	(higher index) means greater slowing / bending / refraction of light **so** thinner / less curved lens is needed (to achieve same power / curvature added to wavefronts**)** ✓	1	**accept** correct answers based on rays or bending of light including Snell's Law (now off spec) but **must link** explanation of index to lens shape **not** just it bends the light by the same amount
		Section A total	**20**	

Expected Answers			Marks	Additional Guidance
8	**ai**	straight line graph **B** half gradient of **A** ✓ and passing through origin	1	**expect** graph **B** to pass through points (0, 0) and (1.4, 5 ± 0.2) **not** any credit for freehand line outside marking tool **look at graph labels**
8	**ii**	straight line graph **C** four times gradient of **A** ✓ and passing through origin	1	**expect** graph **C** to pass through (0, 0) and (0.4, 11.4 ± 1.0) **not** any credit for freehand line outside marking tool
8	**bi**	proportionality / straight line through origin ✓	1	**accept** obeys Hooke's law **not** linear
8	**ii**	σ = 1.2(8) x 10^8 Pa / 1.3 x 10^8 Pa ✓ ε = 0.00070 ✓ $Y = \sigma / \varepsilon$ = 1.8(3) x 10^{11} Pa ✓	1 1 1	**accept** points from F(x) graph other than max values **accept** Y = FL / (eA) for 1 method marks / with correct substitution for 2nd mark **accept** final answers in range 1.8 to 1.9 x 10^{11} Pa final evaluation allow ecf on incorrect σ / ε values **POT** power of ten error max 2/3

Expected Answers			Marks	Additional Guidance
8	**c**	metal atoms lose <u>electrons</u> / form <u>+ve ions</u> ✓ <u>free</u> / <u>de-localised</u> / <u>gas</u> / <u>sea</u> –ve electrons ✓ <u>attractive forces</u> / <u>non-directional</u> bonding between +/- ions bonds them ✓ positive metal ions are <u>close-packed</u> / <u>regularly</u> <u>stacked</u> in <u>planes</u> / <u>lattice</u> / lines ✓ when +ve ions are given small <u>displacement</u> / atomic planes move relative to neighbours ✓ <u>restorative force</u> so ions return when force is removed **QWC** do **not** award full marks unless 3 or ✓ more appropriate technical terms used or if any **one** term is used incorrectly or if answer in terms of plastic behaviour do **not** accept incorrectly used technical terms	1 1 1 1	description of metallic bonding **accept** any **2** relevant points credit clear well labelled diagrams **QWC** <u>examples</u> of acceptable technical terms underlined **accept** other appropriate technical terms used correctly **explanation** of elastic **not** plastic behaviour **accept** AW **accept** move from equilibrium position and then return **accept** <u>electron glue</u> **not** any confusion with slip / sliding / plastic / ductile / malleable for this and also loses **QWC** mark i.e. max 2 if mentioned **QWC** <u>examples</u> of acceptable technical terms underlined **accept** shorthands for positive / negative charge + / - / +ve / -ve
		Total	**10**	

Expected Answers			Marks	Additional Guidance
9	**a**	22 (mV) ✓	1	**not** 21 mV
9	**b**	Time period = 0.90 ✓ ms ✓ f = 1/ T = 1 / (0.90 x 10^{-3}) = 1100 (Hz) ✓	2 1	reading 0.90 from graph ; recognition of ms / 10^{-3} s provided T $\leq$ 5 ms **accept** e.g. 5 waves / 4.5 ms for 2 marks evaluation **accept** 1111 (Hz) **allow** ecf on incorrect T up to 5 ms **accept** POT error 1.1 Hz scores 2/3
9	**c**	$\varepsilon = \sigma / Y = 2.0 / (72 \times 10^{9})$ ✓ $= 2.7(8) \times 10^{-11}$ ✓	1 1	method mark evaluation **accept** ora $\sigma = \varepsilon Y = 2.2$ Pa $\approx$ 2.0 Pa for full credit **accept** calculator value for full credit **accept** 2.7×10^{-11} (show that) / 2.8×10^{-11} **not** any credit for 2.8×10^{-2}
9	**d**	resolution = length / pixel = (10.5 / 4.0) x 0.20 x10^{-3} / 400 $\approx$ 1.3 μm ✓	1	evaluation **accept** estimates in the range 1.2 to 1.5 μm without apparent method
9	**ei**	ε at 900 V = $1.3 \times 10^{-9} \times 900 = 1.1(7) \times 10^{-6}$ ✓ $x = \varepsilon L = 1.17 \times 10^{-6} \times 8 \times 10^{-3}$ ✓ $= 9.3(6) \times 10^{-9}$ (m) / 9.4×10^{-9} (m) ✓	1 1 1	evaluation **accept** 1.2×10^{-6} method **allow** 2 marks if both parts calculated together evaluation **accept** 9.6×10^{-9} (m using rounded strain) **not** 9×10^{-9}
	ii	$9.36 \times 10^{-9} / 260 \times 10^{-12} \approx 36$ ✓	1	**accept** 35 / 37 from rounded strain **allow** ecf on incorrect extension from **i**
		Total	**11**	

Expected Answers			Marks	Additional Guidance
10	**a**	(a gas) in which some atoms / molecules / particles have lost <u>electrons</u> ✓	1	idea of atom's loss of <u>electrons</u> **ignore** gain of electrons **accept** e^- symbol / clearly labelled diagrams
		to become positive ions / charged ions ✓	1	idea of production of positive ions **ignore** production of –ve ions **not** any credit for just contains + and - charges
10	**b**	$\lambda = c / f = 1.0(3) \times 10^{-7}$ (m) ✓	1	evaluation mark **accept** 1×10^{-7} (m)
10	**c**	$E = VQ$ / = $240 \times 1.6 \times 10^{-19}$ ✓	1	method in symbols / numbers
		= $3.8(4) \times 10^{-17}$ (J) ✓	1	evaluation **accept** 4×10^{-17} (J)
10	**di**	240 V ✓ 120 V ✓	1 1	both p.d.s to ± 5 V
	ii	0.26(4) μA from graph ✓ power = $2.64 \times 10^{-7} \times 180 \times 6.2 \times 10^{6}$ ✓ = 295 (W) ✓	1 1 1	read from graph tolerance ± 0.005 μA method in words / numbers **accept** 4.7×10^{-5} (W) $pixel^{-1}$ **accept** answers in range 290 to 301 W evaluation **allow** ecf on incorrect current
		Total	**10**	

Expected Answers			Marks	Additional Guidance
11	**ai**	9.6 (Ω) ✓	1	**not** 10 (Ω)
	ii	graph curves <u>upwards</u> / gradient increases ✓	1	**not** just curves **not** resistance is gradient **accept** **Y**'s resistance rises as I or V rises
11	**bi**	resistance of **X** changes (as **S** is moved) and changes I / V of lamp ✓	1	**credit** change in R linked to I or V for 1st mark
		increasing resistance of **X** reduces current through **Y** / reduces p.d. across **Y** / reduces power of **Y** ✓	1	**credit** correct sense of change for 2nd mark **ORA** for reducing the resistance of **X** must have complete logical explanation for both marks **accept** good discussions of potential divider of **X** with **Y** and correct sense of change
	ii	2 A ✓ 24 / ecf current x 12 (W) ✓	2	one mark for each correct value no method needed
		given (p.d. ≈ 2.3 V) 2.1 (W) ✓	1	**accept** power estimates in range 2.0 to 2.2 W **not** 2.34 (W) misreading graph scale **accept** 3.1 / 3.7 (W) (using $V_{lamp} = 12 - V_X$)
11	**c**	greater range of current / p.d. / power control ✓	1	**accept** AW or any sensible high level answer
		from zero (to max 2A / 12 V / 24 W) ✓	1	**accept** is able to turn lamp off **not** more efficient / accurate / precise / reliable / sensitive / resolution / easy to control / cheaper / safer / better
		Total	**9**	
		Section B total:	**40**	
		Paper total:	**60**	

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