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.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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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 ✓	1	both p.d.s to ± 5 V
		120 V ✓	1	
	ii	0.26(4) μA from graph ✓	1	read from graph tolerance ± 0.005 μA
		power = $2.64 \times 10^{-7} \times 180 \times 6.2 \times 10^{6}$ ✓	1	method in words / numbers **accept** 4.7×10^{-5} (W) $pixel^{-1}$
		= 295 (W) ✓	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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