RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491:** Physics in Action

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

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.

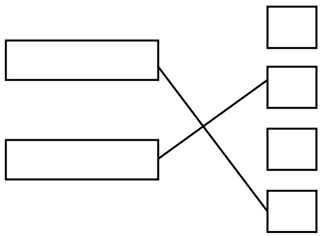
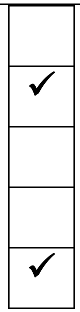
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

Section A

Question			Expected Answers	Marks	Additional Guidance
1			**(a)** Ω ; **(b)** W ; **(c)** C	3	**not** any ≡ units not listed e.g. A V^{-1} ; J s^{-1} ; As
2			extension = L x strain / = 10 x 3 = 30 (cm) total length = 30 + 10 = 40 (cm)	1 1	method in words / numbers **not** credit for bare 30 cm **accept** 0.1 x 3 = 0.3 (m) for method standalone method with evaluation **allow** ecf on extension value + 10 (cm) provided unit consistent and that the value added to 10 is clearly labelled extension (even if derived from a wrong formulation) **accept** bare 40 cm for 2 marks
3	a			2	**one** independent mark for each correct link **not** multiple links from one box on left if one line is not clearly crossed out
	b			1 1	**one** mark for each correct tick 3 ticks scores max 1 4 or more ticks scores 0
4	a		$n = c / v$ / $= 3 \times 10^8 / 1.9 \times 10^8$ = 1.6	1 1	method in words / symbols / numbers **not** just v_1 / v_2 evaluation **accept** 1.58 apply **SF** penalty to more than 3 S.F. **not** 1.57 **a.e.**

Section A

Question			Expected Answers	Marks	Additional Guidance
5	**a**		adds curvature to wavefronts / focusses wavefronts	**1**	AW **accept** waves converge / change curvature / curves waves **not** just wavefronts refract
	b		e.g. lens thinner at edges so waves slowed for less time / get ahead **OR** refracts more at edges where surface is angled more for 2 marks	**1** **1**	**accept** ora lens thicker at centre **not** just convex shape so waves slowed for longer / get held back **OR** wavefronts show distance of travel in equal time intervals **allow reluctantly** waves are slowed down **more** near the centre of lens **BOD** **but** penalise implication of different *n* values
6	**a**		(deforms under stress) and does not return to original size / shape (when stress is removed)	**1**	AW **accept** permanent deformation **accept** permanent change of atomic positions **not** just movement of atoms **not** has permanently changed **state**
	b		**metals:** atomic planes / ion planes / crystalline structure / close packed ; can slip / slide over each other **OR** **long-chain polymers:** coiled / random / cross-linked chains ; chains slip / slide by each other / tangled molecules straighten / line up	**1** **1**	**not** any mark for recording choice of material marks require concept of slip ; in reasonable context **allow** AW **accept** dislocation mechanism explained **accept** bonds rotate / chains uncoil **accept** clear **annotated** diagrams for either structure **max 1** if no mention of material / if incorrect material chosen

Section A

Question			Expected Answers	Marks	Additional Guidance
7	a		(gradient of graph) e.g. $108 \times 10^6 / 0.0006$ $\approx 1.8 \times 10^{11}$ (Pa) / $\approx 1.8 \times 10^5$ M(Pa)	1 1	method any clear attempt to find gradient **OR** σ / ε ratio **ignore POT** errors for 1st mark evaluation **accept** in range (1.77 to 1.83) x 10^{11} **not** any credit for inverse ratio 0/2 marks
	b		plot line of max and or min slope through ± bars ; find max and or min value / difference in gradient **OR** using a point with error bars use the max and or min value from ± bars ; to calculate max and or min value of Y.M. **OR** using a point with error bars estimate max % error (strain) from ± bar ; recognise this % applies to original modulus	1 1	AW also credit method from drawings on Fig. 7 **check Fig. 7** e.g. one mark for a line of max/min slope through uncertainties **accept** if their answer implies uncertainty range / spread **ignore** any reference to % error in stress **accept** ± ≈ 5% estimate if no explanation for 1 mark **accept** ≈10% if their estimate implies uncertainty range for 1
			Total section A	**21**	

Section B

Question			Expected Answers	Marks	Additional Guidance
8	a		7 $2^7 = 128$ / $\log_2(128) = 7$	1 1	**not** any other value **must** have explanation for 2nd mark
	b		pixels x bits $pixel^{-1}$ / = 700 x 520 x 7 / = $2.5(5) \times 10^6$ = $2.55 \times 10^6 / 8 = 0.3(2) \times 10^6$ bytes (< 1 Mbyte)	1 1	method **accept** ecf on wrong value from **a** **not** any credit for number of pixels only **364000** evaluation **accept** ecf from **a** only **not** pixels / 8 **accept** computer Mbyte = 1024^2 gives 0.30(3) Mbyte
	c		correct distances from image e.g. 2.6 cm and 0.7 cm estimate ≈ 3.7 **OR** ratio in fractional form 2.6 / 0.7 further reasoning / explanation image size ∝ object length / distance from lens / image size ∝ $(\text{distance})^{-1}$ / image size = constant / distance / (ratio) = length Atlantis / length Endeavour	1 1 1	**1st mark** for measured values only to nearest ± 1 mm but if ratio for 2nd mark is in tolerance accept (not used markers) **2nd mark** for calculated ratio / bald est. between 3.1 and 4.5 If inverse ratio i.e 0.22 to 0.32, max 1 for measured values **3rd mark** for supporting argument **accept** angle subtended argument **QWC** reasoning must be completely transparent for the award of 3/3 marks otherwise max 2/3
	d	i	pixels $shuttle^{-1}$ ≈ (2.6 cm / 9.3 cm) x 520 pixels / ≈ 145 pixels length = 145 x 0.24 = 35 m	 1 1	 **accept** estimated number of pixels in range 138 to 153 **accept** length in range 33 to 37 m **allow** ecf on incorrect number of pixels
	d	ii	Using ratio from **c** 0.24 x 3.7 = 0.89 (m $pixel^{-1}$) **OR** Using length **di** / pixels for Endeavour = 35 m / 39 pixels = 0.90 (m $pixel^{-1}$)	1	**accept** answers in range 0.7 to 1.1 (m $pixel^{-1}$) **allow** ecf on 0.24 x incorrect ratio from **c** **allow** ecf on length from **di** / (33 to 45) pixels for Endeavour **CLICK fit to height button to see earlier answers as well to check for ecf**
			Total question 8	**10**	

Section B

Question			Expected Answers	Marks	Additional Guidance
9	a		3100 (Hz)	1	
	b	i	6800 (Hz) <u>high</u> f are missed	1 1	value explanation **accept** aliases appear / spurious low f appear / require a minimum of two samples per cycle to detect that frequency **accept** sample at 2 x **highest f** present **not** just 2 x 3400 **not** signal becomes distorted
	b	ii	$b = \log_2 (V_t / V_n)$ / $\log_2 (250)$ **OR** $2^8 = 256$ $= 7.9(7)$ **OR** > 250 e.g. with more bits signal resolution $\Delta V < V_{noise}$ so info is redundant / extra information is about details in noise not details in signal	1 1 1	method $\log_2$ evaluation **OR** comparison **accept** $2^7 = 128$ (< 250) AW but **must** be a high level convincing explanation **not** any implication that more bits adds noise **QWC** answers should be well justified for the final mark to be awarded **accept** well annotated diagrams showing noise and total signal ranges and effect of more / fewer bits
	b	iii	rate = sampling f x bits sample^{-1} / 6800 x 8 = $5.4(4) \times 10^4$ (bit s^{-1})	1 1	method word equation / correct values **fractional bits** score 0 evaluation **accept** 54.4 kbit s^{-1} ecf on **b(i)** sampling f **accept** 53.1 kbits (taking computer k = 1024)
	c		**advantage** : e.g. better speech reproduction / higher quality speech / more natural / more life-like speech / Ss or Xs sound clearer **disadvantage**: e.g. greater bandwidth / higher rate of transmission / bit rate needed **so** not so cost effective **OR** greater bandwidth **so** fewer calls per channel	1 1	**accept** less distortion **not** just higher and lower f could be coded / picked up **not** more detail / data / information / higher quality digital signal **accept** higher sampling f needed **so** requires faster circuits / processing at higher rates **accept** more memory to store / data compression needed **not** more noise could be picked up **not** just more expensive **allow** answers assuming system is unchanged ORA e.g. more likely to produce aliases if sampling f is same
			Total question 9	**10**	

Section B

Question			Expected Answers	Marks	Additional Guidance
10	**a**	**i**	$R < P / I^2$ / = $2 \times 10^3 / (8 \times 10^3)^2$ = $3.1(3) \times 10^{-5}$ (Ω)	**1** **1**	**accept** $V = P / I$ = 0.25 V then $R = V / I$ for full credit **not** just 3×10^{-5} (Ω) show that value **ORA** show that P = 1920 W for 2 marks
		ii	$V = I R$ = $8\,000 \times 3.13 \times 10^{-5}$ = 0.25 (V)	**1** **1**	method **accept** $V = P / I$ evaluation **accept** ecf on R value **ai** **accept** 0.24 (V) using show that value
	b	**i**	$G = 1 / R$ $\Rightarrow A = G L / \sigma$ ($= L / \sigma R$)	**1** **1**	 **must** have algebraic rearrangement for A expect credible flow
		ii	= $10 / (5.9 \times 10^7 \times 3.13 \times 10^{-5})$ = 5.4×10^{-3} (m^2)	**1** **1**	**accept** ecf on R from **a** **accept** (5.6(5) **OR** 5.7) $\times 10^{-3}$ (m^2) using show that R 5.5×10^{-3} (m^2) using 2 SF value for R
			Total question 10	**8**	

Section B

Question			Expected Answers	Marks	Additional Guidance
11	a	i	proportional up to 40 ºC / initially / at lower T then increases at a higher rate / gradient increases / sensitivity increases	1 1	**accept** $\varepsilon \propto T$ with temperature qualification **not** just sensitivity remains constant **accept** then increases at faster rate **not** then increases faster / more rapidly **not** exponential after 40 ºC
	a	ii	gradient / $\Delta y / \Delta x$ / $0.23 \times 10^{-3} / 40$ $= 5.8 \times 10^{-6}$ (V ºC^{-1})	1 1	correct method attempt in words / symbols **ignore POT** errors for 1st mark evaluation **accept** values in range $(5.6 \text{ to } 5.9) \times 10^{-6}$ unit **accept** in mV ºC^{-1} / μV ºC^{-1} **POT** error max 1
	b	i	2 resistors (R, r) connected in series	1	**accept** 2 resistors (R, r) share the p.d. / ε **not** just there are 2 resistors (R, r)
	b	ii	$V = \varepsilon - \varepsilon r / (R + r)$ $= \varepsilon (R + r - r) / (R + r)$	1 1	a correct first substitution / for application of $V = IR$ max 1 clear correct cancellation of r terms
		iii	$V = (\varepsilon \times 15) / 15.3$ $= \varepsilon \times 0.98$ (i.e. 2% low of ε)	1 1	method correct substitution into equation evaluation **accept** $\varepsilon = 1.02\ V$ **accept** numerical solutions on any chosen ε value **max 1** if ε dropped or ignored but 0.98 OR 1.02 achieved
	c		not c.r.o: max deflection is about 0.6 mm / sensitivity is incorrect not d.v.m: reaches full scale deflection at about 35 ºC	1 1	AW **accept** max deflection < 1 mm / too small / unresolvable **accept** too small (thinking generally mm /V) **OR** too large (V/mm) AW **accept** would not cover the higher temperatures / input p.d. to meter would exceed its max reading at 100 ºC **accept** f.s.d. / max reading too low **ignore** sensitivity comments
			Total question 11	**11**	
			Total section B	**39**	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553