OCR
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

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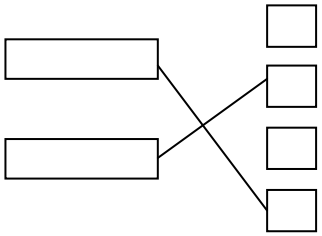
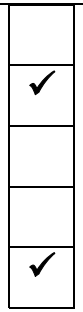
**Section A**

| 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)<br><br>total length = 30 + 10 = 40 (cm) | 1<br><br>1 | method in words / numbers **not** credit for bare 30 cm<br>**accept** 0.1 x 3 = 0.3 (m) for method<br><br>standalone method with evaluation<br>**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)<br>**accept** bare 40 cm for 2 marks |
| 3 | a | |  | 2 | **one** independent mark for each correct link<br><br>**not** multiple links from one box on left if one line is not clearly crossed out |
| | b | |  | 1<br><br>1 | **one** mark for each correct tick<br><br>3 ticks scores max 1<br><br>4 or more ticks scores 0 |
| 4 | a | | $n = c / v$ / = 3 x $10^8$ / 1.9 x $10^8$<br><br>= 1.6 | 1<br><br>1 | method in words / symbols / numbers<br>**not** just $v_1$ / $v_2$<br><br>evaluation **accept** 1.58 apply **SF** penalty to more than 3 S.F.<br>**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<br>**not** just wavefronts refract |
| | b | | e.g. lens thinner at edges<br><br>so waves slowed for less time / get ahead<br><br>**OR** refracts more at edges where surface is angled more for 2 marks | 1<br><br>1 | **accept** ora lens thicker at centre **not** just convex shape<br><br>so waves slowed for longer / get held back<br>**OR** wavefronts show distance of travel in equal time intervals<br>**allow reluctantly** waves are slowed down **more** near the centre of lens **BOD**<br>**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<br>**accept** permanent change of atomic positions **not** just movement of atoms<br>**not** has permanently changed **state** |
| | b | | **metals:** atomic planes / ion planes / crystalline structure / close packed ;<br><br>can slip / slide over each other<br><br>**OR**<br><br>**long-chain polymers:** coiled / random / cross-linked chains ;<br><br>chains slip / slide by each other / tangled molecules straighten / line up | 1<br><br>1 | **not** any mark for recording choice of material<br>marks require concept of slip ; in reasonable context **allow** AW<br><br>**accept** dislocation mechanism explained<br><br>**accept** bonds rotate / chains uncoil<br><br>**accept** clear **annotated** diagrams for either structure<br><br>**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 | 1 | method any clear attempt to find gradient **OR** σ / ε ratio<br>**ignore POT** errors for 1st mark |
| | | | ≈ $1.8 \times 10^{11}$ (Pa) / ≈ $1.8 \times 10^5$ M(Pa) | 1 | evaluation **accept** in range (1.77 to 1.83 ) x $10^{11}$<br>**not** any credit for inverse ratio 0/2 marks |
| | b | | plot line of max and or min slope through ± bars ; | 1 | AW also credit method from drawings on Fig. 7 **check Fig. 7**<br>e.g. one mark for a line of max/min slope through uncertainties |
| | | | find max and or min value / difference in gradient<br><br>**OR** using a point with error bars<br>use the max and or min value from ± bars ;<br>to calculate max and or min value of Y.M. | 1 | **accept** if their answer implies uncertainty range / spread |
| | | | **OR** using a point with error bars<br>estimate max % error (strain) from ± bar ;<br>recognise this % applies to original modulus | | **ignore** any reference to % error in stress<br><br>**accept** ± ≈ 5% estimate if no explanation for 1 mark<br>**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<br>$2^7 = 128$ / $\log_2 (128) = 7$ | 1<br>1 | **not** any other value<br>**must** have explanation for 2nd mark |
| | b | | pixels x bits pixel$^{-1}$ / = 700 x 520 x 7 / = 2.5(5) x $10^6$<br>= 2.55 x $10^6$ / 8 = 0.3(2) x $10^6$ bytes (< 1 Mbyte) | 1<br>1 | method **accept** ecf on wrong value from **a**<br>**not** any credit for number of pixels only **364000**<br>evaluation **accept** ecf from **a** only **not** pixels / 8<br>**accept** computer Mbyte = $1024^2$ gives 0.30(3) Mbyte |
| | c | | correct distances from image e.g. 2.6 cm and 0.7 cm<br>estimate ≈ 3.7 **OR** ratio in fractional form 2.6 / 0.7<br>further reasoning / explanation<br>image size ∝ object length / distance from lens /<br>image size ∝ (distance)$^{-1}$ /<br>image size = constant / distance /<br>( ratio ) = length Atlantis / length Endeavour | 1<br>1<br>1 | **1st mark** for measured values only to nearest ± 1 mm but if ratio for 2nd mark is in tolerance accept (not used markers)<br>**2nd mark** for calculated ratio / bald est. between 3.1 and 4.5<br>If inverse ratio i.e 0.22 to 0.32, max 1 for measured values<br>**3rd mark** for supporting argument<br>**accept** angle subtended argument<br>**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 /<br>≈ 145 pixels<br>length = 145 x 0.24 = 35 m | <br>1<br>1 | <br>**accept** estimated number of pixels in range 138 to 153<br>**accept** length in range 33 to 37 m<br>**allow** ecf on incorrect number of pixels |
| | d | ii | Using ratio from **c** 0.24 x 3.7 = 0.89 ( m pixel$^{-1}$)<br>**OR** Using length **di** / pixels for Endeavour<br>= 35 m / 39 pixels<br>= 0.90 ( m pixel$^{-1}$) | 1 | **accept** answers in range 0.7 to 1.1 (m pixel$^{-1}$)<br>**allow** ecf on 0.24 x incorrect ratio from **c**<br>**allow** ecf on length from **di** / (33 to 45) pixels for Endeavour<br>**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)<br>high f are missed | 1<br>1 | value<br>explanation **accept** aliases appear / spurious low f appear / require a minimum of two samples per cycle to detect that frequency<br>**accept** sample at 2 x **highest f** present<br>**not** just 2 x 3400<br>**not** signal becomes distorted |
| | b | ii | $b = \log_2 (V_t / V_n)$ / $\log_2 (250)$ **OR** $2^8 = 256$<br>= 7.9(7) **OR** > 250<br><br>e.g. with more bits signal resolution $\Delta V < V_{noise}$<br>so info is redundant / extra information is about details in noise not details in signal | 1<br>1<br><br>1 | method<br>$\log_2$ evaluation **OR** comparison **accept** $2^7 = 128$ (< 250)<br><br>AW but **must** be a high level convincing explanation<br>**not** any implication that more bits adds noise<br>**QWC** answers should be well justified for the final mark to be awarded<br>**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<br>= 5.4(4) x $10^4$ (bit s$^{-1}$) | 1<br>1 | method word equation / correct values **fractional bits** score 0<br>evaluation **accept** 54.4 kbit s$^{-1}$ ecf on **b(i)** sampling f<br>**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<br><br>**disadvantage**: e.g. greater bandwidth / higher rate of transmission / bit rate needed **so** not so cost effective<br><br>**OR** greater bandwidth **so** fewer calls per channel | 1<br><br>1 | **accept** less distortion<br>**not** just higher and lower f could be coded / picked up<br>**not** more detail / data / information / higher quality digital signal<br><br>**accept** higher sampling f needed **so** requires faster circuits / processing at higher rates<br>**accept** more memory to store / data compression needed<br>**not** more noise could be picked up<br>**not** just more expensive<br>**allow** answers assuming system is unchanged ORA<br>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 | $R < P / I^2$ / $= 2 \times 10^3 / (8 \times 10^3)^2$<br><br>$= 3.1(3) \times 10^{-5}$ (Ω) | 1<br><br>1 | **accept** $V = P / I = 0.25$ V then $R = V / I$ for full credit<br><br>**not** just $3 \times 10^{-5}$ (Ω) show that value<br><br>**ORA** show that $P = 1920$ W for 2 marks |
| | | ii | $V = I R$<br><br>$= 8\,000 \times 3.13 \times 10^{-5} = 0.25$ (V) | 1<br><br>1 | method **accept** $V = P / I$<br><br>evaluation **accept** ecf on $R$ value **ai**<br>**accept** 0.24 (V) using show that value |
| | b | i | $G = 1 / R$<br><br>$\Rightarrow A = G L / \sigma$ ( $= L / \sigma R$ ) | 1<br><br>1 | <br><br>**must** have algebraic rearrangement for $A$ expect credible flow |
| | | ii | $= 10 / (5.9 \times 10^7 \times 3.13 \times 10^{-5})$<br><br>$= 5.4 \times 10^{-3}$ ($m^2$) | 1<br><br>1 | **accept** ecf on $R$ from **a**<br><br>**accept** (5.6(5) **OR** 5.7) $\times 10^{-3}$ ($m^2$) using show that $R$<br>$5.5 \times 10^{-3}$ ($m^2$) 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 $T$ | 1 | **accept** $\varepsilon \propto T$ with temperature qualification<br>**not** just sensitivity remains constant |
| | | | then increases at a higher rate / gradient increases / sensitivity increases | 1 | **accept** then increases at faster rate<br>**not** then increases faster / more rapidly<br>**not** exponential after 40 ºC |
| | a | ii | gradient / $\Delta y / \Delta x$ / $0.23 \times 10^{-3} / 40$ | 1 | correct method attempt in words / symbols<br>**ignore POT** errors for 1st mark |
| | | | $= 5.8 \times 10^{-6}$ ($V$ ºC$^{-1}$) | 1 | evaluation **accept** values in range $(5.6 \text{ to } 5.9) \times 10^{-6}$<br>unit **accept** in mV ºC$^{-1}$ / μV ºC$^{-1}$<br>**POT** error max 1 |
| | b | i | 2 resistors (R, r) connected in series | 1 | **accept** 2 resistors (R, r) share the p.d. / ε<br>**not** just there are 2 resistors (R, r) |
| | b | ii | $V = \varepsilon - \varepsilon r / (R + r)$ | 1 | a correct first substitution / for application of $V = IR$ max 1 |
| | | | $= \varepsilon (R + r - r) / (R + r)$ | 1 | clear correct cancellation of $r$ terms |
| | | iii | $V = (\varepsilon \times 15) / 15.3$<br>$= \varepsilon \times 0.98$ (i.e. 2% low of ε) | 1<br>1 | method correct substitution into equation<br>evaluation **accept** $\varepsilon = 1.02\ V$<br>**accept** numerical solutions on any chosen ε value<br>**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 | 1 | AW **accept** max deflection < 1 mm / too small / unresolvable<br>**accept** too small (thinking generally mm /V)<br>**OR** too large (V/mm) |
| | | | not d.v.m: reaches full scale deflection at about 35 ºC | 1 | AW **accept** would not cover the higher temperatures / input p.d. to meter would exceed its max reading at 100 ºC<br>**accept** f.s.d. / max reading too low<br>**ignore** sensitivity comments |
| | | | **Total question 11** | **11** | |
| | | | **Total section B** | **39** | |

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