OCR
RECOGNISING ACHIEVEMENT

GCE

# Physics B (Advancing Physics)

Advanced GCE **H559**

Advanced Subsidiary GCE **H159**

## Mark Scheme for the Units

## January 2010

HX59/MS/R/10J

Oxford Cambridge and RSA Examinations

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**Advanced Subsidiary GCE Physics (H159)**

**MARK SCHEMES FOR THE UNITS**

# G491 – Physics in Action

**Section A**

| Question | | | Expected Answers | Marks | Additional Guidance |
|---|---|---|---|---|---|
| 1 | (a) | | $\Omega$ m / V $A^{-1}$ m / etc. | 1 | **accept** any correct equivalent base units e.g. $S^{-1}$ m / $\Omega$ $m^2$ $m^{-1}$<br>**accept** in words e.g. Ohm metres / capital M for m |
| | (b) | | S $m^{-1}$ / $(\Omega$ m$)^{-1}$ / etc. | 1 | **accept** any correct equivalent base units e.g. A $V^{-1}$ $m^{-1}$<br>**accept** in words e.g. Siemens per metre / capital M for m |
| 2 | | | increase ; brightness /<br>increase / stretch / improve ; contrast /<br>**OR** Any two from:<br>(pixel value) subtract (smallest pixel value) / multiply / by greater than 1 | 2 | AW sense of change for first mark ; named modification **accept** brighter for 2 marks<br>**accept** increase pixel values for 1 mark<br>**accept** stretch **/** increase range of pixel values for 2 marks<br>e.g. times pixel value by 4 gets 2 mark<br>**ignore** edge detection, noise reduction etc |
| 3 | (a) | | crystal features / sharp or straight edges / flat planes or straight lines / regular angles / cleavage | 1 | **accept** AW for idea of regularity in any form<br>**accept** straight breaks / sharp cracks<br>**Ignore** references to crack propagation<br>**accept** ORA: states feature of plastic flow and notes they are missing<br>**NOT** edges are rough / jagged / harsh |
| | (b) | | structure might fail / fracture / is not tough<br>in low temperatures (of space) | 1 | AW ora but need to make link to low temperatures<br>**allow** weaker / not as strong in cold |
| 4 | (a) | | peak to peak signal in the range 4.1 to 4.5 mV | 1 | n.b. analogue signal without noise variation – judge by value |
| | (b) | | peak to peak noise in the range 0.2 to 0.5 mV | 1 | |
| | (c) | | $(2^8)$ = 256 (levels) | 1 | **NOT** 255 |
| | (d) | | **First** easy **mark,** any **one** relevant point:<br>4 bits / $2^4$ gives 16 levels /<br>coding for noise detail is pointless / (4) bits are redundant /<br>resolution for (8 bits) is too good / small / smaller than noise (level)<br>**Second mark** (must be quantitative)<br>$(V_{total} / V_{noise}) \approx 16$ / own value correctly calculated /<br>resolution $\approx$ 5 mV / 255 = 0.02 mV | 2 | AW throughout<br>**accept** $\log_2 (V_{total} / V_{noise}) \approx 4$ for 1 mark / with own value correctly calculated 2 marks<br>**NOT** Any credit for sampling eliminating noise / converting noise to signal, but do not penalise with **con**.<br>**accept** for first mark resolution of 4 bits $\approx$ noise level<br><br>**allow** ecf on their values from **a** and **b**<br>e.g. 2.3/0.2 =11.5 |

| Question | | | Expected Answers | Marks | Additional Guidance |
|---|---|---|---|---|---|
| 5 | | | $R = V^2 / P$ / $= 240^2 / 2200$<br>26.(2) (Ω ) | 1<br>1 | method / **allow** 1st mark for ( $I = P / V$ ) = 9.1(7) A<br>evaluation no s.f. penalty |
| 6 | (a) | | components e.g. glass & plastic / steel & concrete / stone/aggregate & cement / steel & glass / lignin & cellulose<br><br>make composite e.g. GRP / reinforced concrete / concrete / safety glass / natural wood | 1<br><br><br>1 | must mention two sensible components of a known / feasible composite for first mark<br>**accept** natural composite materials e.g. wood / bone<br>name the composite material for second mark (must be plausible)<br>**NOT** e.g. steel reinforced carbon / carbon fibre reinforced steel / alloys (0 marks for alloy answers in part (**a**) )<br>1 mark only if the materials do not correspond to composite |
| | (b) | | any one benefit of **each** component made clear e.g. strength / stiffness of glass ; toughness of plastic<br><br>OR toughness / tensile strength of steel ; cheapness / aesthetics / moldability of concrete | 2 | **accept** aesthetic / economic / other non-physical properties for **one** component only<br>**only** credit same property repeated once only<br>**accept** tensile and compressive strength as different properties<br>**allow** correct properties even if no credit for composite in (a)<br>credit alloys answers from **(a)** e.g. steel – iron confers strength to alloy / carbon confers toughness<br>**accept** properties developed in composite or properties of individual component materials to all answers (even if not the most significant property conferred) |
| 7 | | | wavefronts concave focusing where ray meets CCD<br>wavelengths consistent with plane waves (judged by eye) | 1<br>1 | **NOT** any credit for only **rays** focussing<br>Expect 3 or 4 wavefronts drawn to fill gap, **but** 2 correctly placed waves can score also 2 marks |
| | | | **Total section A** | **19** | |

**Section B**

| Question | | | Expected Answers | Marks | Additional Guidance |
|---|---|---|---|---|---|
| 8 | (a) | (i) | (stress / strain graph) is proportional / constant stiffness / obeys Hooke's Law / shows elastic behaviour / is linear and through origin | 1 | AW **accept** any one answer<br>**accept** Young Modulus is constant<br>**not** just linear (need both points if this answer ) |
| | | (ii) | *E* is initial gradient / numerical attempt up to strain 0.11%<br>e.g. gradient = 200 MPa / 0.0009<br>= 2.2(2) x $10^{11}$ ( $\pm$ 0.1 x $10^{11}$ ) (Pa) | 1<br>1<br>1 | method **accept** triangle drawn on graph for this mark<br>**accept** other correct values from graph including linear extrapolations<br>**evaluation**: penalise incorrect use of % as -1 mark<br>i.e. max 2/3 for 2.2 x $10^{7}$ Pa / 2.2 x $10^{9}$ Pa<br>also penalise missing M prefix -1 mark<br>i.e. 2200 Pa scores 1 out of 3<br>**NOT** any credit for graph points outside elastic region<br>e.g. 300 MPa / 0.005 (scores 0) |
| | (b) | (i) | ($L_0 \varepsilon$ = 0.2 x 0.005) = 0.001 (m) / 1.0 mm | 1 | evaluation only, method not expected |
| | | (ii) | ($A = \pi D^2 / 4$) = 5.0(3) x $10^{-5}$ ($m^2$)<br>$F = \sigma A$ / = 300 x $10^{6}$ x 5.0(3) x $10^{-5}$<br>= 1.5(1) x $10^{4}$ (N) | 1<br>1<br>1 | part evaluation<br>method<br>**accept** full credit for correct answer<br>**accept** ecf on incorrect areas for last two marks<br>**accept** max stress of 220 MPa gives 1.1(1) x $10^{4}$ (N) for max 2/3 |
| | (c) | | 3 points from:<br>not all of the planes slip at once ;<br>dislocation described / annotated diagrams ;<br>produce stress / strain concentration ;<br>which moves (through grain) by a few planes / rows slipping at a time ;<br>if all of planes slip the resulting strain >> 0.1%<br>plausible diagrams illustrating the above points (without mention of dislocations) can gain full credit | 3 | 3rd mark is for **QWC** clarity that slip / stress / strain is localised to a few planes / rows of atoms at a time not all at once<br><br>AW throughout<br><br>**QWC** answer must clearly explain that slip is localised to a few planes / rows of atoms at a time, otherwise max 2 |
| | | | **Total question 8** | **11** | |

| Question | | | Expected Answers | Marks | Additional Guidance |
|---|---|---|---|---|---|
| 9 | (a) | | for functioning circuit diagram including:<br>battery / cell, (m)A and sample in series<br>voltmeter in parallel with sample | <br>1<br>1 | <br>**accept** Ωmeter and sample in one loop for full credit<br>**NOT** voltmeter in series (scores 0 for part (**a**))<br>**accept** voltmeter in parallel with sample **and** ammeter<br>**ignore** series / safety resistors (unless voltmeter across them) |
| | (b) | | Any 3 points from<br>measure *R* directly / measure *V* and *I* ;<br>*G* = 1 / *R* / *G* = *I* / *V* ;<br>measure length *L* (of semiconductor ) ;<br>measure width and height (of semiconductor ) | 3 | <br><br>**NOT** any credit for lengths only mentioned in an equation |
| | (c) | | <br>(cross-sectional) area = width x height<br>(use of) $\sigma = G L / A$ in symbols /<br>$\sigma$ = 0.01 x 0.01 / (0.01 x 0.001) | <br>1<br>1 | **Look at (b) / (c) together, credit here if seen in (b)**<br>**must** be clear area is width x height in (b) / (c) for this mark<br>**must** have transposed equation from formulae sheet for this mark |
| | (d) | | **identify** source of uncertainty (any measurement) / systematic error (zero error / calibration of any instrument)<br><br>**changes** e.g. use micrometer to measure thickness / Vernier calliper to measure width & height / more sensitive meters<br>repeat readings / swap / calibrate meters **and** average to find mean / spread / monitor temperature / reduce p.d.<br><br>**improvements / explanation** measurements more precise to ± 0.01 mm / plot *I* vs *V* graph & line of best fit, use gradient for *G* to reduce absolute / % uncertainty<br>swap / calibrate meters to eliminate systematic error | 1<br><br>1<br><br>1<br><br>1 | 1st mark quite easy e.g. uncertainty in thickness measurement / systematic error in resistance measurement / temperature effects / meter resistance / meter resolution<br>**NOT** human error / internal resistance of supply<br><br><br>**NOT just** repeat readings / take more accurate measurements<br><br><br>**QWC** max 2 if ideas are not clearly described and explained |
| | | | **Total question 9** | **10** | |

| Question | | | Expected Answers | Marks | Additional Guidance |
|---|---|---|---|---|---|
| 10 | (a) | (i) | 720 x 1280 x 24 x 50 = 1.1(1) x $10^9$ (bits $s^{-1}$) | 1 | **accept** bare answer to 2 or more s.f. |
| | | (ii) | 1.1 x $10^9$ x 3600 (s/hr) / 8 (bits/byte)<br><br>= 498 Gbytes | 1<br>1 | method / **allow** 1st mark for getting as far as 3.98 x $10^{12}$ bits or for recognising 8 bits per byte<br>evaluation **accept** 450 Gbytes using $10^9$ bits $s^{-1}$ / 495 Gbytes using rounded bit rate |
| | | (iii) | 200 (Gbyte) / 80 (hr) = 2.5 (Gbyte / hr) | 1 | **accept** bare answer to 2 s.f.<br>**accept** ORA 3Gbytes x 80 = 240 > 200 |
| | (b) | (i) | max information per hour > memory capacity per hour / 498 Gbyte > 2.5 Gbyte (so data must be compressed) | 1 | **accept** ecf on (a)(ii) > (a)(iii)<br>**accept** total information for 80hrs (312 Tb > 1.6 Tb)<br>**ignore** factors of 2 or 0.5<br>expect compression ratio 200:1 if worked out |
| | | (ii) | one point from: 10 MHz < 1.1 Gbit $s^{-1}$ / (a)(i)<br>signal bandwidth is too small to support the max bit rate / bandwidth needs to be ≈ bit rate /<br>cannot transmit several bits per carrier cycle<br>(so data must be compressed) | 1 | **accept** ecf on 10 MHz < (a)(i)<br>AW |
| | (c) | | transverse wave by word / diagram<br>oscillations (of E / B field) only in vertical direction / plane | 1<br>1 | **accept** any transverse wave diagram<br>AW but must be described / diagram labelled clearly<br>**NOT** travels / moves in one plane / direction |
| | | | **Total question 10** | **8** | |

| Question | | | Expected Answers | Marks | Additional Guidance |
|---|---|---|---|---|---|
| 11 | (a) | (i) | ($I = V / R$ = 6.0 / 240 ) = 0.025 (A) | 1 | **accept** 0.03 (A) |
| | | (ii) | **Constant current, any 2 from**<br>**B** increases resistance /<br>**F** decreases in resistance /<br>changes of resistance are equal (and opposite ) /<br>total resistance remains constant<br><br>**p.d. across B increases**<br>Constant current and larger R hence larger V<br>OR<br>ratio $R_B / R_F > 1$ / correct discussion of potential divider $R_B / R_{total} > ½$ | 2<br><br><br><br><br><br>1 | AW<br><br><br><br><br><br>**allow** $V = I R$ argument |
| | (b) | (i) | $\Delta y / \Delta x$ / e.g. = (3.010 – 2.998) / (0.6 – 0)<br>= 0.020 (V $MPa^{-1}$ ) | 1<br>1 | method **must** clearly be attempt at a gradient for 1st mark<br>evaluation two marks if value is correct |
| | | (ii) | from graph when $\Delta y$ = 1 mV /<br>pressure resolution = voltage resolution / sensitivity<br>$\Delta x$ = 0.05 M(Pa) / 5.0 x $10^4$ (Pa) | 1<br><br>1 | method must be clear for 1st mark<br><br>evaluation **allow** 0.05 (Pa) for 1 mark (prefix omission) |
| | | (iii) | change of temperature will change resistance /<br><br>(if a resistor changes temp. ) p.d. will shift off 3.0 V /<br>produces a constant difference / error offset / zero error | 1<br><br>1 | **accept** wrong sense for metals<br><br>**accept** shift up / down in p.d / sense of shift **not** expected |
| | (c) | (i) | both potential dividers produce 3.0 V so p.d. is zero /<br>the voltage at both **M** and **N** is the same so p.d. is zero | 1 | AW |
| | | (ii) | (pressure resolution) = 500 (Pa ) | 1 | **accept** ecf on (b)(ii) / 100 |
| | | | **Total question 11** | **12** | |
| | | | **Total section B** | **41** | |
| | | | **Paper total** | **60** | |