

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G491**: Physics in Action

Mark Scheme for June 2013

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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.

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1. Annotations available in scoris

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation

2. Subject-specific Marking Instructions

Annotations used in detailed mark scheme

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	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

Please annotate all marking as fully as possible, the annotations are helpful for TLs monitoring marking, but also helps centres. Always annotate on the long written answers where ticks should show where marks are awarded. Q9c & Q10aii also place **X** on pen symbol if QoWC mark not awarded.

Otherwise:

- i) Where full marks are given no annotation necessary.
- ii) Where part marks given use a tick at point of award for each mark awarded so that ticks = marks total for that part.
- iii) Where no marks are given and there is working a **X/^** to show the error/omission and nothing awarded.

Apply S.F. penalty only to Q9bii Penalise 1 mark for 4 or more S.F. 8.333×10^8 (Hz)/treat recurring sign as S.F. error.

Rounding Error RE should only be applied once per candidate if appropriate. See e.g. Q9bii RE for 8.4×10^8 (Hz) scores max 1.

Press Fit to Height button to inspect additional pages/additional objects easily, apply a **^** annotation to show a blank page has been seen.

Section A

Question			Answer	Marks	Guidance
1			D R L	2	3 correct scores 2 1 correct scores 1
			Total	2	

Question			Answer	Marks	Guidance
2	(a)		$P = 1/f$ / $1/0.2$; 5.(0) (D)	2	method ; evaluation
	(b)		curvature = $-0.4 + 5.0$ / curvature out = curvature in + curvature added by lens ; = 4.6 (D)	1 1	method accept words curvature added by lens / state equation $1/v = 1/u + 1/f$ in this format / numbers evaluation allow ecf on (a)
			Total	4	

Question			Answer	Marks	Guidance
3	(a)		5 waves in $100\ \mu\text{s}$; 20×10^{-6} (s) / $20\ \mu\text{(s)}$ OR main f at $50 \pm 2\ \text{kHz}$; $1/50 \times 10^3 = 2 \times 10^{-5}$ (s)	2	method allow 6 waves in $100\ \mu\text{s}$ / 5 in $110\ \mu\text{s}$ for max 1 ; evaluation accept 2×10^{-5} (s) accept $20 \pm 1\ \mu\text{s}$ allow 20 (s) / 0.02 (s) POT 1 mark not $100\ \mu\text{s}$ for time of pulse / $1/f$ with incorrect value
	(b)		140 (kHz)	1	
	(c)		1000 / 10^3	1	accept any correct ratio: 1000/1 / $10^3/1$ / $10^9/10^6$ not 1/1000 / $1:10^3$
			Total	4	

Question			Answer	Marks	Guidance
4	(a)		difficult to scratch / dent	1	not difficult to crack / not soft / no deformation not how easy to scratch or dent / it cannot be scratched
	(b)		helps the axe head stay sharp / keep its edge	1	not stops cracks forming / prevents damage / durable / long-lasting / can chop harder materials must clearly relate to the edge e.g. not "it" wont be damaged

Question		Answer	Marks	Guidance
	(c)	e.g. stiff / high YM ; so does not distort under impact OR strong ; so does not break / tough ; so does not crack / shatter (during impact) / needs high energy to break	2	expect appropriate property ; justification to match accept not brittle (tough) ignore malleable / corrosion free / economic reasons / reference to microstructure
		Total	4	

Question		Answer	Marks	Guidance
5	(a)	$E = QV$ / 2900×3.7 ; $= 10730 \text{ (J)}$ / $10.7(3) \text{ k(J)}$ / $11 \times 10^3 \text{ (J)}$ / 11 k(J)	1 1	method: words / equation / numbers any correct evaluation (no method) scores max 2 marks
	(b)	$P = E/t$ / $= 10730 / 540$ / $I = 2900 / 540 = 5.37 \text{ A}$; $= 19.9 \text{ (W)}$ / 20 (W)	1 1	method : words / equation / numbers allow (a) / 540 ecf accept $20.(4) \text{ (W)}$ / 19.8 (W) from rounded calculations
		Total	4	

Question		Answer	Marks	Guidance
6	(a)	$I = VG$ / $3 \times 45 \times 10^{-3}$ / $R = (1/G) = 22.(2) \Omega$; $= 0.14 \text{ (A)}$	1 1	method evaluation accept 135 m(A) / 0.135 (A)
	(b)	15 mS	1	accept underlined / other obvious indications if unambiguous
		Total	3	

Question		Answer	Marks	Guidance
7	(a)	table values: 0 ; 252	1 1	
	(b)	contrast improved / better	1	accept contrast / range of greyscale increased not just change brightness / intensity level ignore sharper / edge detection / clearer
		Total	3	

Section A Total: 24

Section B

Question			Answer	Marks	Guidance
8	(a)	(i)	(directly) proportional / $\propto$	1	accept linear through origin not as P increases p.d. increases / strong + correlation / Ohmic / just increase at constant rate / just linear
		(ii)	$\Delta V / \Delta P$ / $\Delta \text{output} / \Delta \text{input}$ / e.g. 300 / 200 ; = 1.5 (mV/mmHg)	1 1	method accept other graph values to $\pm \frac{1}{2}$ graph squares evaluation accept in range 1.45 to 1.54 (mV/mmHg)
	(b)	(i)	1 e.g. 12 beats in 10 s / 18 beats in 15 s 72 (beats min ⁻¹) 2 e.g. (120 + 108)/2 114 (mmHg) Make sure to mark both parts 8(b)(i)1 & 2	1 1 1 1	method allow max 1 for correct method with miscounted beats e.g. 13 beats in 10 s gives 78 (beats min ⁻¹) evaluation accept in range 70 to 74 (beats min ⁻¹) method evidence of at least 2 data in average process / on graph / within correct range evaluation accept in range 112 to 116 (mmHg) not any credit for 120 (mmHg)
		(ii)	fluctuation of: max / min pressure ; fluctuation of heart rate ; max pressure range is 13 ± 1 / min p range 6 ± 1 mmHg ; with period of $\approx 8 \pm 1$ s ; p rises rapidly falls more slowly during each beat ; minor amplitude oscillation of p during each drop ; each heartbeat has 3 / 4 separate pressure peaks	2	accept any 2 correct qualitative / quantitative points accept lower / higher frequency oscillation present accept amplitude modulated not trivial features e.g. p varies / pressure differences / small pressure jumps / there is a max and a min of blood pressure / one data point identified e.g. lowest pressure is 80 mmHg at 4.5 s allow 2 marks to be awarded in either section
	(c)		$\log_2 400$ (= 8.6) ; so 9 bits	1 1	method: must show calculation using 400 levels / alternatives accept $2^9 = 512 > 400$ / $2^8 = 256 < 400$ accept 401 levels evaluation just correct answer score max 2
			Total	11	

Question			Answer	Marks	Guidance
9	(a)	(i)	$3 \times 10^9 / 3500 = 8.6 \times 10^5$ (bytes) / ORA $3 \times 10^9 / 10^6 = 3000$ books if 1 Mbyte book ⁻¹ (so less than 1 Mbyte book ⁻¹)	1	accept 8.57×10^5 (bytes) / 9.2×10^5 (bytes) / 0.878 Mbytes (based on 1k = 1024)
		(ii)	pages AND words 100 - 1000 5 – 20 ; e.g. <u>400</u> x 30 x <u>9</u> x 6 = 6.5×10^5 (bytes)	1 1	both estimates in ranges for first mark expect in range 9×10^4 to 3.6×10^6 not any a.e. check value = p x w x 180 accept ecf on estimates outside range if arithmetic correct allow sensible adjustment for spaces if applied
	(b)	(i)	$8.6 \times 10^5 \times 8/60$ / rate = info / time ; = 1.1×10^5 (bit s ⁻¹)	1 1	method accept ecf (ai) x 8/60 allow ecf on (a ii) x 8/60 / 1 Mbyte x 8/60 [for quick check x 8/60 = 0.133] allow max 1 for incorrect / omitted bit conversion accept 1.14×10^5 / 1.15×10^5 / 1.3×10^5 (bit s ⁻¹) allow 14300 max 1 mark (no conversion to bits)
		(ii)	$f = v / \lambda$ / $3 \times 10^8 / 0.36$; 8.3×10^8 (Hz) / 830 M(Hz) / 830×10^6 (Hz)	1 1	method: words / equation / numbers evaluation SF penalty on 1 or 4 or more e.g. 8.333×10^8 (Hz) max 1 / RE 8.34×10^8 (Hz) max 1 per candidate
		(iii)	yes because frequency >> / > bit rate ; bandwidth needs to be $\approx$ bit rate - allow factors of x2 / x ½ here bandwidth or bit rate $\approx$ 1/ 7500 of carrier frequency	1 1	1 st mark minimum acceptable statement must compare and confirm accept could download in shorter time as confirmation 2 nd mark for: correct use of bandwidth / ratio calculated: $f_{\text{carrier}} / \text{bandwidth}$ or $f_{\text{carrier}} / \text{bit rate}$ allow ecf on (bi) & (bii) expect units of calcs to be clear not anything about sampling for second mark
	(c)		advantage: e-book does not require paper and many trees can be saved / benefits the environment / books never out of print / more people may read more books making society more cultivated/knowledgeable ; disadvantage: information in digital format is easily transferred and this may encourage piracy / law breaking / copyright infringement / can't transfer info to a friend's e-book / bookshops and employment may disappear	2	1 st mark for identifying an advantage and disadvantage can be to society or individual allow plausible cost suggestions / energy arguments (to produce / to run) accept interpretations of e-book as digital content or h/ware 2 nd mark awarded if either adv or disadvantage to society developed and correct QoWC for all text (penalise > 1 error of spelling, punctuation, grammar) expect sentences, bullet points are acceptable for lists
			Total	11	

Question			Answer	Marks	Guidance
10	(a)	(i)	it is made from two (or more) materials ; aggregate / stone / sand with cement / mortar ; matrix with inclusions / bonded together	2	not any reference to mixture means max 1 accept 2 (or more) named components scores 2 ignore particles of different size
		(ii)	under tension it suffers brittle fracture because: <u>amorphous</u> / <u>random</u> structure / no <u>dislocations</u> so no <u>slip</u> ; strong / <u>directional</u> / bonds break if near (micro-) <u>crack</u> ; (micro-) <u>cracks</u> open under tension ; <u>stress concentrates</u> at <u>crack tip</u> ; due to less <u>cross-sectional area</u> to bear <u>load</u> ; leading to <u>crack propagation</u> ; under compression: (micro-) <u>cracks</u> close ; aggregate takes the load / strong <u>non-directional</u> / <u>ionic</u> / <u>covalent</u> bonds give compressive strength	4	any 4 points: (max 2/4 if listed points not related to tension or compression) ignore grains / concrete is not plastic so breaks under tension candidates can gain credit for directional / non-directional bonds because: covalent directional bonds within $(\text{SiO}_4)^{4-}$ and the group is ionically charged so also non-directional bonding QoWC correct use of two technical <u>terms</u> and correct explanation of tension and compression otherwise max 3
	(b)	(i)	$E \text{ ratio} = \sigma \text{ ratio (at same strain)}$ $= 300 \text{ (MPa)} / 60 \text{ (MPa)}$ $= 5$	3	accept any valid ratio leading to answer 5 if no units OR correct moduli score 1 mark each so $2.0 \times 10^{11} / 4 \times 10^{10} = 5$ for 3 marks allow max 2 for 1 graph reading error accept correct bare answer for max 3
		(ii)	60 (MPa) / 20 (MPa) $= 3$	1 1	breaking stresses read from graph accept breaking strains read from graph 0.15(%) / 0.05(%) (due to proportionality) and correct bare answer for max 2 evaluation of ratio
	(c)	(i)	forces on anchor plates are equal in size (and opposite in direction) $\sigma = F / A$ linked with argument to $\sigma \propto 1/A$	1 1	accept forces balanced / in equilibrium allow same force not same tension accept arguments worked through numerically to show inverse proportionality and equality of force for full marks
		(ii)	$30 \text{ MPa} \times 5 = 1.5 \times 10^8 \text{ (Pa)} / 150 \text{ M(Pa)}$	1	allow tolerance 130 to 170 M(Pa) from graph reading accept reading direct from steel graph at same strain $\approx 160 \text{ M(Pa)}$ accept negative signs
			Total	14	

Section B Total: 36

Paper Total: 60

Additional Guidance for visually modified papers only

1. The Young modulus of concrete in Q10bi - accept for full marks values which lead to any ratio of stiffness in the range 4 to 6. Credit a modulus in the range 3.3×10^{10} Pa to 5×10^{10} Pa.
2. The compressive and tensile breaking stresses required to calculate the ratio in Q10bii - if estimating from stress credit fully answers in the range 2.5 to 3.5 instead of 3.0.

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