

GCE

Physics B (Advancing Physics)

Unit **G491**: Physics in Action

Advanced Subsidiary GCE

Mark Scheme for June 2016

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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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Annotations available in RM Assessor

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Level 1
	Level 2
	Level 3
	Transcription error
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Error in number of significant figures
	Correct response
	Wrong physics or equation

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

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

Subject-specific Marking Instructions**CATEGORISATION OF MARKS**

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

Section A

Question	Answer	Marks	Guidance
1	W ; S ; A	3 LLL	not any equivalent units not on list e.g. J s^{-1} ; A V^{-1} ; C s^{-1}
	Total	3	

Question	Answer	Marks	Guidance
2(a)		2 LS	3 correct scores 2 1 OR 2 correct scores 1
	Total	2	

Question	Answer	Marks	Guidance
3(a)	D ; D	2 SL	
(b)	0.2 M(Hz) / 200 k(Hz)	1 S	200 000 (Hz)
	Total	3	

Section A

Question	Answer	Marks	Guidance
4(a)	$(4 \times 0.38 \times 10^{-9}) = 1.5(2) \times 10^{-9} \text{ (m)}$	1 L	accept 1.5(2) n(m)
(b)	$= 3.3 \times 10^5 \times 1.52 \times 10^{-9} \times 0.38 \times 10^{-9} / (20 \times 0.38 \times 10^{-9})$; $= 25.1 \text{ } \mu\text{S}$	1 S 1 S	substitution allow ecf on width from (a) for 2 marks allow 1 mark for correct $L = 7.6 \text{ nm}$ OR correct $A = 5.8 \times 10^{-19} \text{ m}^2$ as part method evaluation accept 25.08 μS expect 3 rd SF for show that
	Total	3	

Question	Answer	Marks	Guidance
5 (a)	$1/u$ is negligibly small / $1/u \approx 0$ / $1/u$ tends to 0 / u tends to ∞	1 S	must refer to a term in equation or numeric answer ignore rays are parallel OR wavefronts plane
(b)(i)	$(P \approx 1/v = 1/\{3.5 \times 10^{-3}\}) = 290 / 286 \text{ (D)}$	1 S	accept estimate 300 (D) / correct full lens equation solutions giving 285.8 (D) not 285.6 (D) sign error in equation
(b)(ii)	using magnification / similar triangles $= 2 \text{ mm} \times 15 \text{ m} / 3.5 \text{ mm} ; = 8.6 \text{ m} / 8.57 \text{ m}$	1 H 1 H	method accept $M = 2.3 \times 10^{-4}$ for first mark giving 8.7 m not 4286 evaluation accept 8.7 m
	Total	4	

Section A

Question	Answer	Marks	Guidance
6(a)	sensor is larger / is plastic-coated / has larger heat capacity / has lower <u>thermal conductivity</u> / is more sphere than disk shaped / has a smaller area : volume ratio	1 L	not takes longer to heat up / just smaller surface area / just more insulation / conductance / resistance
(b)	A	1 S	
(c)	$(1.2 - 0.4) / 70$; $= 11.(4) \text{ m(V } ^\circ\text{C}^{-1})$ / $0.011(4) \text{ (V } ^\circ\text{C}^{-1})$	1 H 1 H	method accept for 2 marks $(1.2 - 0.4) / (70 - T_{\text{ROOM}})$ where $15^\circ\text{C} < T_{\text{ROOM}} < 25^\circ\text{C}$ not $1.2 / 70$; evaluation accept T_{ROOM} estimates giving sensitivity in range 15 to 18 $\text{m(V } ^\circ\text{C}^{-1})$ not any credit for dividing by time
	Total	4	

Question	Answer	Marks	Guidance
7(a)	$2^{10} = 1024 (> 1000)$ / $\log_2(1000) = 9.97$; so use 10 bits	1 S 1 L	calculation accept 9.96 evaluation allow 1 mark for 10 bits only without justification
(b)	with over 1000 levels resolution or $\Delta V < V_{\text{noise}}$; so more bits contain only details of noise not more about signal	1 H 1 H	ignore increased storage required not more bits begins to sample noise / fewer bits ignores or filters out noise i.e. not recognising that V_{total} or total signal with noise is sampled
	Total	4	

Question	Answer	Marks	Guidance
8(a)	4	1 L	
(b)	2	1 L 2	
	Total	25	
	Total section A		

Section B

Question	Answer	Marks	Guidance
9 (a)(i)	large increase of strain for no increase of stress (above 0.008 strain) / shows clear yield at 0.008 strain / when graph flattens	1 L	not just has a large plastic deformation must relate to a graph feature
	(ii) only has a proportional region (of elasticity) / breaks within proportional limit / does not have <u>flat</u> plastic region ; (initially) much steeper than epoxy (stiffer)	1 S 1 H	must describe a feature of graph accept is straight line through origin not just obeys Hooke's Law assume elastic first description otherwise max 1 if order is not clear
(b)	$100 / 22 = 4.55$ / 4.5(4)	1 L	not 4.6 RE SF penalise 5 1SF
(c) (i)	Y.M. e.g. = $14 \text{ MPa} / 0.005$;	1 L	method accept other points on ∞ region of graph
	2.8×10^9 (Pa)	1 S	evaluation accept in range 2.7 GPa to 2.9 GPa POT error max 1
(c) (ii)	plastic: long chains of <u>randomly oriented monomers</u> / can <u>unravel</u> / <u>uncoil</u> / unfold / <u>extend</u> a little ; by <u>bond rotation</u> / breaking of <u>cross-links</u>	1 S 1 S	QoWC 3 plausible suggestions well expressed with at least two <u>technical terms</u> used correctly and plastic behaviour AND restriction covered ignore chains are amorphous / molecules stretch out
	restriction: <u>cross links tie</u> / <u>bond</u> chains together ; preventing large scale <u>uncoiling</u> / <u>unravelling</u> / unfolding / <u>extension</u> of chains	1 H	not just cross links prevent slip not credit for sliding of layers
	(d) (i)	1 glass is (too) brittle / not tough (enough) and would crack / shatter / break / fail ; 2 epoxy not very stiff and would bend / deform / extend (too) much OR weak / not very strong and might break OR is very plastic and might extend a lot or change shape permanently	1 H 1 S
(d) (ii)	epoxy binds to glass transferring stress to stiffer glass fibres ; flexible epoxy protects brittle fibres from scratching / cracking / cracks propagating	1 L 1 H	must explain the useful property and state the benefit for each material not answers relating to canoe rather than materials
(d) (iii)	gives higher strength / stiffness in every direction OR prevents cracks propagating in any direction	1 L	accept gives higher strength / stiffness isotropic within the mat
Total		14	

Section B

Question	Answer	Marks	Guidance
10 (a) (i)	from graph 2.15×10^9 ; $\times 100\% / 7 \times 10^9 = 31$ (%)	2 L L	reading from graph to $\pm 0.05 \times 10^9$ giving 30% to 31% ; calculation allow FT on a misreading of graph in range 27% to 33% / POT max 1
(a) (ii)	$1\% \times 2.15 \times 10^9 \times 5$ (W) ; $= 1.075 \times 10^8$ (W)	1 S 1 S	method allow ecf on population reading in (ai) evaluation not any credit based on world population accept 1.1×10^8 (W) and in range $(1.05 \text{ to } 1.1) \times 10^8$ (W) with ecf from ai range is 0.95×10^8 to 1.15×10^8 (W)
(b) (i)	logarithmic / exponential growth / linear growth <u>on a log scale</u>	1 L	accept $\times 100$ every 12 yrs not $\times 100$ every 10 years
(ii)	1.8×10^8 (comps J^{-1}) from graph ; comps $J^{-1} \times J s^{-1} / 1.8 \times 10^8 \times 5$; $= 0.9 \times 10^9$ (computations s^{-1})	1 S 1 H 1 H	accept within $\pm 0.2 \times 10^8$ (comps J^{-1}) independent mark method allow incorrect reading $\times 5$ for 1 max evaluation accept in range $(0.8 \text{ to } 1) \times 10^9$ (computations s^{-1})
(c)	annual costs: per farm / per 10^3 farms build & maintain £75 M / £75 G energy to run £190 M / £190 G total per user $\frac{£265 \text{ M}}{2 \times 10^6} / \frac{£265 \text{ G}}{2 \times 10^9}$ $= £130 \text{ user}^{-1} \text{ yr}^{-1}$ OR annual costs: per tablet / iphone / blackberry purchase over 5 yr £400 / 5 = £80 ISP costs £20 \times 12 = £240 energy costs £1.3 (negligible) total per user £321	1 S 1 L 1 H 1 H	credit any sensible calculation / estimate / idea either pro / con the quote for 1 mark each (allow ± 1 order of magnitude on other candidate estimates) $180 \times 10^3 \text{ kW} \times 8800 \text{ h} \times 0.12 \text{ £ kWh}^{-1}$; but could sell heat accept calculations based on previous data attempts to cost snail mail / payments for advertising offset ISP subscriptions QoWC up to 4 marks max provided clear and coherent and no glaring errors and must contain some quantitative estimate e.g. energy cost tablet user $^{-1} \text{ year}^{-1} = 5 \times 10^{-3} \text{ kW} \times 6 \text{ h} \times 365 \text{ d} \times 0.12 = £1.31$ (accept seems almost free)
	Total	12	

Section B

Question	Answer	Marks	Guidance
11 (a)	$\varepsilon = V + Ir$ / $= 2.6 + 0.55 \times 0.9$ / $= I(R + r)$ / $= 0.55(4.7 + 0.9)$ $= 3.1$ (V)	1 S 1 S	method in algebra / numbers evaluation accept 3.095 (V) / 3.08 (V)
(b) (i)	$R_{\text{total}} = (4.7/2 + 0.9) = 3.25 \Omega$; $I = \varepsilon / R_{\text{t}}$ / $= 3.1 / 3.25$; $= 0.95$ (A)	1 H 1 H 1 H	accept evidence of total resistance = 3.25Ω otherwise score 0 calculation allow ecf on ε from (a) evaluation must show evidence of 2 SF calculation ORA $V = 1/2 \times 4.7 + 1 \times 0.9 = 3.25$ V (≈ 3.1 V) for full credit
(b) (ii)	$V = \varepsilon - Ir$ / $= 3.1 - (0.95 \times 0.9)$; $= 2.2(4)$ (V) OR $= IR_{\text{t}}$ / $= 0.95 \times 2.35$; $= 2.2(3)$ (V)	2 HH	method accept ecf on (a) and (bi) values ; evaluation allow 1 mark max for using show that current i.e. $V = 1/2 \times 4.7 = 2.35$ V
(b) (iii)	$P_{(a)} = 0.55 \times 2.6 = 1.4(3)$ W OR $P_{(b)} = 0.95 \times 2.2 = 2.1(2)$ W ; $P_{(b)} / P_{(a)} = 1.48$ (≈ 1.5)	1 L 1 S	evidence of either power correctly evaluated accept I^2R OR V^2/R methods ecf on incorrect V value from (bii) needs 3 SF for show that allow ecf from (bi & bii) on calculated ratios > 1 without further AE
	Total	9	
	Total Section B	35	
	Total for paper	60	

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