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
BOD	Benefit of doubt given
CON	Contradiction
✖	Incorrect response
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
TE	Transcription error
NBOD	Benefit of doubt not given
POT	Power of 10 error
∧	Omission mark
SF	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 <u>independent</u> 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 <u>method</u> 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 <u>compensatory</u> 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 <u>answer</u> 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 <u>more</u> significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the <u>entire</u> 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)	$(4 \times 0.38 \times 10^{-9}) = 1.5(2) \times 10^{-9}$ (m)	1 L	**accept** 1.5(2) n(m)
(b)	$= 3.3 \times 10^{5} \times 1.52 \times 10^{-9} \times 0.38 \times 10^{-9} /(20 \times 0.38 \times 10^{-9})$;	1 S	substitution **allow** ecf on width from (a) for 2 marks **allow** 1 mark for correct $L = 7.6$ nm **OR** correct $A = 5.8 \times 10^{-19}$ m^2 as part method
	$= 25.1 \ \mu S$	1 S	evaluation **accept** 25.08 μS expect 3rd 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 (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	1 H	method **accept** $M = 2.3 \times 10^{-4}$ for first mark giving 8.7 m **not** 4286
	$= 2$ mm x 15 m / 3.5 mm ; $= 8.6$ m / 8.57 m	1 H	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)	$(1.2 - 0.4) / 70$;	1 H	method **accept** for 2 marks $(1.2 - 0.4) / (70 - T_{ROOM})$ where $15\,°C < T_{ROOM} < 25\,°C$ **not** $1.2 / 70$;
	$= 11.(4)\ m(V\ °C^{-1})$ / $0.011(4)\ (V\ °C^{-1})$	1 H	evaluation **accept** T_{ROOM} estimates giving sensitivity in range 15 to $18\ m(V\ °C^{-1})$ **not** any credit for dividing by time
	Total	4	

Question	Answer	Marks	Guidance
7(a)	$2^{10} = 1024\ (>1000)$ / $\log_2 (1000) = 9.97$;	1 S	calculation **accept** 9.96
	so use 10 bits	1 L	evaluation **allow** 1 mark for 10 bits only without justification
(b)	with over 1000 levels resolution or $\Delta V < V_{noise}$;	1 H	
	so more bits contain only details of noise not more about signal	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	
	Total	2	
	Total section A	25	

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 ;	1 S	**must** describe a feature of graph **accept** is straight line through origin **not** just obeys Hooke's Law
		(initially) much steeper than epoxy (stiffer)	1 H	**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 MPa / 0.005 ;	1 L	method **accept** other points on $\propto$ region of graph
		2.8 x 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</u> oriented <u>monomers</u> / can <u>unravel</u> / <u>uncoil</u> / unfold / <u>extend</u> a little ;	1 S	QoWC 3 plausible suggestions well expressed with at least two <u>technical terms</u> used correctly and
		by <u>bond rotation</u> / breaking of <u>cross-links</u>	1 S	plastic behaviour AND restriction covered **ignore** chains are amorphous / molecules stretch out
		restriction: <u>cross links</u> <u>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 ;	1 H	**must** name problem property and state the problem for the canoe for each mark **ignore** too heavy and will sink
		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 S	**ignore** soft and easy to scratch **ignore** tough here / malleable
(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 $\dfrac{£265\,M}{2 \times 10^6}$ / $\dfrac{£265\,G}{2 \times 10^9}$ $= £130$ user^{-1} yr^{-1} **OR** annual costs: per tablet / iphone / blackberry purchase over 5 yr £400 / 5 = £80 ISP costs £20 × 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) 180×10^3 kW × 8800 h × 0.12 £ 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 $^{-1}$ year $^{-1}$ = 5×10^{-3} kW × 6 h × 365 d × 0.12 = £1.31 (accept seems almost free)
	Total	12	

8

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)	$R_{total} = (4.7/2 + 0.9) = 3.25\ \Omega$; $I = \varepsilon / R_t$ / $= 3.1/3.25$; $= 0.95$ (A)	1 H 1 H 1 H	**accept** evidence of total resistance $= 3.25\ \Omega$ 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** $= I R_t$ / $= 0.95 \times 2.35$; $= 2.2(3)$ (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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