

GCE

Physics B (Advancing Physics)

H157/01: Foundations of physics

Advanced Subsidiary GCE

Mark Scheme for June 2019

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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.

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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

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
(1)m	a method mark, awarded if a correct method is used
(1)e	an evaluation mark, awarded for correct substitution and evaluation

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text: 21c, 22b, 23d.

Section A: MCQs

Question			Answer	Marks	Guidance
1			B	1	
2			A	1	
3			D	1	
4			B	1	
5			D	1	
6			C	1	
7			C	1	
8			D	1	
9			C	1	
10			B	1	
11			A	1	
12			D	1	
13			B	1	
14			C	1	
15			A	1	
16			B	1	
17			B	1	
18			C	1	
19			A	1	
20			C	1	
			Total	20	

SECTION B

Question			Expected Answer	Mark	Rationale/Additional Guidance
21	a		coulomb	1	Accept minor spelling errors Accept C
	b		Volume = AL Charge (per unit volume) = ne and leading to Charge (per unit volume) x volume = nA/e	1 1	Expect to see a clear statement of calculation of volume Allow $V = AL$ either separately or in a more complete equation Expect to see a statement of where ne comes from e.g. charge on electron is e so total charge (per unit volume) is ne. Allow correct evaluation through current = $nAve$ of clearly expressed.
	c		$3.2 = 8.0 \times 10^{28} \times A \times 0.50 \times 10^{-3} \times 1.6 \times 10^{-19}$ $A = 5.0 \times 10^{-7}$ $5.0 \times 10^{-7} = \pi d^2 / 4$ gives $d = 8.0 \times 10^{-4}$ (m)	1 1 1	Substitution. Penalise POT on v here. Area calculation Evaluation. Allow correct method leading to an appropriate evaluation of d from an arithmetic error on A if A is clear.
			Total	6	

Question			Expected Answer	Mark	Rationale/Additional Guidance
22	a		$2L$	1	
	b		$340 = f \times (2 \times 0.61)$ ecf $f = 278.6$ $f = 280$ (Hz)	1 1 1	Substitution. Allow ecf for incorrect value of multiple of L from (a). Evaluation Answer to 2sf. The sf mark can be awarded for any 2sf answer where a valid attempt to determine f has been made.
	c		λ is now $4L / 4 \times 0.61$ $f = 140$ (Hz)	1 1	Allow doubles wavelength OR frequency will halve. Allow 139 from none rounded value in 22b Do not penalise sf. Bare answer scores both marks. Ecf on 22b / 2
			Total	6	

Question		Expected Answer	Mark	Rationale/Additional Guidance
23	a	Time is available for review, so the accuracy is increased OR Data is recorded, so can be reviewed/checked later OR Can be slowed down/freeze-framed on playback, so readings/measurements can be taken easier OR Allows more data to be taken in shorter time, so more data points for graph.	1	Expect an explanation along with a statement. Allow suitable valid alternatives. Allow alternatives which relate to distance/time measurements being used.
	b	Acceleration determined from gradient Gradient calculation shown which comes out to be ~ 10	1 1	Allow $a = \Delta y / \Delta x$ or $a = \Delta v / \Delta t$ or $a = \text{rise/run}$ Allow gradient triangle drawn on graph. First mark is for explanation. Allow substitution of values from graph into suitable equation of motion e.g. $(4-0)/(0.4-0) = 10$. Allow $4/0.4 = 10$. Second mark is for calculation. Allow calculation from equation of motion.
	c	$v = 4.0 \text{ (m s}^{-1}\text{)}$ from graph $E = \frac{1}{2} \times 0.05 \times 4^2$ $E = 0.40 \text{ (J)}$	1 1 1	Value correctly read from graph. Incorrect reading will lose all marks. Substitution. Penalise POT on m for this mark. Evaluation. Accept 0.4 (J).
	d	Calculation of KE at rebound = $(\frac{1}{2} \times 0.05 \times 2.8^2) = 0.196 \text{ (J)}$ Evaluation of difference in KE (e.g. $0.40 - 0.196 = 0.204 \text{ (J)}$)	1 1	No mark for simply determining rebound speed. Allow 0.20 J Ecf on c and/or misread / arithmetic error for rebound KE

			Percentage change (= KE change / initial KE) = 51%	1	OR evaluation of 49% e.g. $0.204 / 0.4 = 51\%$ Accept 50% if KE at rebound to 2sf.
			Total	9	
			Total Section B	21	

SECTION C

Question		Expected Answer	Mark	Rationale/Additional Guidance
24	a	Angle between incident ray and (marked) normal	1	Expect marks as curved lines within angle, or arrow pointing to angle. Allow 1 mark if both angles measured from ray to surface instead of normal Allow any pair that would work e.g. incident entering and incident exiting. No marks If more than two angles marked.
		Angle between refracted ray and (marked) normal	1	
	b	Mark in pairs (suggestion + suitable reason): - Mark rays with pins - So you can draw more accurately once block is removed - Use a narrower beam - To reduce uncertainty in angle measurement - Adjust lamp / filament or use laser - So the rays are narrower - Dim room / brighten bulb or use laser - So you can see the rays more clearly / better contrast	2	Accept other suitable correct suggestions. Do not allow e.g sharper pencil, smaller scale and other methods which do not improve accuracy of measurement.
	c	$n = \sin 28 / \sin 17$ $= 1.6(1)$	1	Bare answer score both marks.
			1	Allow 1.60 only if correct calculation shown.
	d	The larger the refractive index, the slower the speed The higher the refractive index, the greater the decrease in wavelength OR Refractive index has no effect on frequency.	1	ORA
			1	ORA
				Expect answers which refer to the correct sense of change of speed and / or wavelength.
Total			8	

Question		Expected Answer	Mark	Rationale/Additional Guidance
25	a	Light waves maintain a constant phase relationship	1	Allow a constant phase difference. Do not allow zero phase difference.
	b	Clear statement of small angle approximation $\tan \theta \sim \theta$ $\theta = 14/200 = 0.07$ QED	1 1	Allow $\sin \theta \sim \theta$ Allow answer drawn on fig 25.1 Substitution leading to evaluation. No mark if not used small angle approximation.
	c	(Path difference of $\lambda/2$ means) waves are in anti-phase Or $180^\circ / \pi$ (rad) out of phase To cause destructive interference	1 1	Not just out of phase / not in phase Allow diagram showing two waves in antiphase / diagram with two phasor arrows shown with zero resultant Allow destructive superposition / cancellation NOT superimposed / superimposition
	d	$\frac{1}{2} \times (0.01 \times 10^{-3}) \times 0.07 = \lambda/2$ $\lambda = 700$ (nm)	1 1	Use of $\sin \theta \sim \theta$ by implication Allow 0.07 rad is $4(.01)^\circ$ leading to $\frac{1}{2} \times (0.01 \times 10^{-3}) \times \sin 4^\circ = \lambda/2$ No ecf from incorrect angle calculated in b. Allow 1 st mark for calculation of 350nm (missing factor of 2). Allow $\lambda = 698$ (nm) from use of $\sin 4^\circ$.
	e	Advantage: Distance to A / separation of max/min (or 14cm) would increase, so smaller % uncertainty (in distance measurement) Disadvantage: Pattern is dimmer, so less contrast between bright and dark.	1 1	Do not allow responses relating to reduced % uncertainty in D . Allow : so more difficult to see (pattern). Do not allow statements regarding clarity.
Total			9	

Question			Expected Answer	Mark	Rationale/Additional Guidance
26	a		So that negligible current passes through it	1	Allow so that (total/combined/parallel) resistance of the wire/voltmeter doesn't change
			In order that it does not affect the value it's trying to measure	1	Do not allow responses such as "so the reading is accurate". Do not allow responses such as "so that more current flows through the wire" for second mark. Allow appropriate effect on ammeter e.g otherwise the current on ammeter is through voltmeter and wire (which is larger).
	b		Current = $1 / (47+3) = 20$ (mA) p.d. = $\frac{1}{2} \times 0.02 \times 3 = 0.03$ (V) or 30mV	1 1	Allow equivalent other working e.g. by proportion or use of potential divider e.g. $1 \times 1.5/50 = 0.03$ V. Allow first mark for evaluations of pd as 0.06V.
	c	i	Straight line <u>through the origin</u>	1	Allow a linear extrapolation on the graph to origin, if linear/straight line is used in written response.
	c	ii	Calculates R/l at $l=20$ cm; (expect $3.5 \Omega\text{m}^{-1}$)	1	e.g. $R/l = 0.7/0.2 = 3.5 \Omega\text{m}^{-1}$. Allow 0.68 or 0.69 for R leading to 3.4 or $3.45 \Omega\text{m}^{-1}$. Do not allow gradient calculation at 20cm.
			Calculates R/l in linear section (expect $3.0 \Omega\text{m}^{-1}$)	1	e.g. $R/l = 1.8/0.6 = 3.0 \Omega\text{m}^{-1}$. Allow some tolerance from graph. Allow gradient calculation for this part, as long as it is calculated wholly in the linear region.
			Increase is $0.5 / 3.0 = 17\%$	1	Allow ecf for third mark for reasonable attempts for R/l
			Temperature rise = $17\% / 0.4\% = 43$ ($^{\circ}\text{C}$)	1	Allow ecf for fourth mark for reasonable attempt at % increase.

	c	iii	<u>Cross-sectional</u> area/diameter of wire	1	Allow emf / pd of cell / thickness of wire. Ignore irrelevant statements Not material of wire.
	d		(Reduce uncertainty/more accurate/more precise because...) the key is narrower than a crocodile clip the ruler makes sure the reading is taken in line with the key It will reduce parallax error.	2	This statement needs to be made before marks can be awarded. Any two separate marking points. ALLOW suitable example values e.g ± 0.5 mm instead of ± 2 mm
			Total Total Section C Total Sections B & C	12 29 50	

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