

GCE

Physics A

Unit **H156/01**: Breadth in physics

Advanced Subsidiary GCE

Mark Scheme for June 2017

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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
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

MARKING INSTRUCTIONS

Generic version as supplied by OCR Sciences

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.

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

SECTION B

Question			Answer	Marks	Guidance
21	(a)		(KE = $\frac{1}{2} \times 0.900 \times 2.0^2$) kinetic energy = 1.8 (J)	B1	
	(b)		Constant velocity from 0 to 0.3(0 s) / up to 0.3(0 s) / up to the crash / at the start Velocity decreases / deceleration from <u>0.3</u> (0 s) to <u>0.8</u> (0 s) Zero velocity / stationary after 0.8 (s) / towards the end gradient (of the graph) = velocity	B1 B1 B1 B1	Allow speed instead of velocity Allow 0.30 to 0.40 Allow 0.30 to 0.40 and 0.76 to 0.80 Allows slows down Possible ECF Allow slope instead of gradient Allow <u>gradient</u> is 2.0 (m s ⁻¹) / <u>gradient</u> is constant (up to 0.30 s) / straight line (up to 0.30 s), so velocity / speed is constant Allow <u>gradient</u> decreases (between 0.30 s and 0.80 s), so velocity / speed decreases Allow <u>gradient</u> is zero (after 0.80 s), so velocity / speed is zero
	(c)		$s = 0.5 \text{ (m)}$ / $t = 0.5 \text{ (s)}$ $a = (-) \frac{2.0}{0.5}$ or $0 = 2.0^2 + 2 \times a \times 0.5$ deceleration = (-) 4.0 (m s ⁻²)	C1 A1	Allow other correct methods Possible ECF from (b) Allow 1 sf answer Ignore sign
			Total	7	

Question			Answer	Marks	Guidance
22	(a)		(clockwise moment = anticlockwise moment) $2.5 \times 9100 = 3.5 \times F$ (Any subject) $F = 6500$ (N)	C1 A1	
	(b)		$1.4 \times 10^{10} = \frac{1.1 \times 10^5}{\text{strain}}$ (Any subject) / strain = 7.86×10^{-6} $x = \frac{1.1 \times 10^5}{1.4 \times 10^{10}} \times 2.3$ $x = 1.8 \times 10^{-5}$ (m) or $1.1 \times 10^5 = \frac{6500}{A}$ / $A = 0.059$ (m ²) $(F = \frac{EAx}{L}); 6500 = \frac{1.4 \times 10^{10} \times 0.059 \times x}{2.3}$ (Any subject) $x = 1.8 \times 10^{-5}$ (m)	C1 C1 A1 C1 C1 A1	Possible ECF from (a)
			Total	5	

Question			Answer	Marks	Guidance
23	(a)		<u>Earth</u> mentioned (as an integral part of the system) The Earth has (equal and) <u>opposite</u> momentum to the (falling) ball (so momentum is conserved) or The Earth moves <u>upwards</u> / <u>towards the ball</u> (with a tiny speed, so momentum is conserved)	M1 A1	Not 'ground' Allow: The Earth experiences an <u>upward</u> force (and moves upwards)
	(b)	(i)	$(F = \frac{\Delta p}{\Delta t}); \quad F = (-) \frac{10 - 6}{0.2} \quad \text{or} \quad F = (-) \frac{4}{0.2}$ force = (-) 20 (N)	C1 A1	Ignore sign Note '$F = (-) \frac{10 + 6}{0.2} = 80 \text{ N}$' scores zero
		(ii)	momentum = 8 (kg m s⁻¹) between $t = 0$ and 0.40 s momentum = 12 (kg m s⁻¹) after $t = 0.60$ s momentum increases linearly between 0.40 s and 0.60 s	B1 B1 B1	Ignore omission of label Y
			Total	7	

Question			Answer	Marks	Guidance
24	(a)	(i)	current = 0.030 (A) $(I = Anev)$; $0.030 = 3.8 \times 10^{-6} \times 5.0 \times 10^{25} \times 1.6 \times 10^{-19} \times v$ $v = 9.9 \times 10^{-4} \text{ (m s}^{-1}\text{)}$	C1 A1	
		(ii)	The resistance (of the thermistor or circuit) decreases Current / I / ammeter reading increases because $I \propto 1/R$ or number density (of charge carriers) increases Voltmeter reading does not change (because there is no internal resistance)	B1 B1 B1	 Allow $V = IR$ (any subject) <u>and</u> $V = \text{constant}$ Allow 'more electrons / more charge carriers' Allow voltmeter reading stays 3.0 (V)
	(b)	(i)	$R = 2.0 + 8.0 = 10 \text{ (}\Omega\text{)}$ $(I = 1.2/10)$; $I = 0.12 \text{ (A)}$ $(1.5 = 1.2 + 0.12r)$; $r = 2.5 \text{ (}\Omega\text{)}$	C1 C1 A1	Allow other correct methods Allow 2 marks for 4.5 (Ω); $R = 18 \Omega$ with $I = 0.067 \text{ (A)}$
		(ii)	As d increases the (total) resistance (of the circuit) increases (ORA) and therefore the current / I decreases (ORA) Any <u>one</u> from: - Explanation of V increasing in terms of $V + Ir = E$ or $V + V_r = 1.5$ or $V = E - \text{lost volts}$ - Explanation of V increasing in terms of potential divider - Analysis showing $V \approx 0.7 \text{ V}$ when $d = 0$ or $V \approx 1.3 \text{ V}$ when $d = 1.0 \text{ m}$ or any other value of V for a given d	M1 A1 B1	Allow 'As length (of wire) increases resistance increases' (ORA) Allow 'lost volts / p.d across r / Ir decreases, so V increases'
			Total	11	

Question			Answer	Marks	Guidance
25	(a)	(i)	4 (cm)	B1	
		(ii)	(As the wave spreads out the) <u>amplitude decreases</u> intensity $\propto$ amplitude ² and therefore intensity decreases	M1 A1	Not 'displacement' Not 'A decreases' Ignore 'energy is lost' Allow $I \propto A^2$ Note Do not allow this mark if we also have $I \propto 1/x^2$ but allow this mark if we also have $I \propto 1/x$ Allow 1 mark for: ($I = P/A$) <u>power</u> is constant and as area increases the intensity decreases or intensity $\propto 1/\text{area}$ and as area increases the intensity decreases
	(b)	(i)	The <u>superposition</u> of coherent waves	B1	Not 'combine / meet / interact' for 'superposition' Allow ' <u>superposition</u> of waves with a constant phase difference (at the sources)' Allow 'waves that <u>superpose</u> constructively / destructively'
		(ii)	path difference (is 4.5 cm, which) is 1.5λ Destructive interference occurs	M1 A1	Allow lengths are 5λ & 3.5λ and phase difference = 180° or waves are in anti-phase Not $\lambda/2$ out of phase Not path difference is 1.5 cycles / periods / oscillations
			Total	6	

Question			Answer	Marks	Guidance
26	(a)		$\sqrt{\frac{T}{\mu}} \rightarrow \sqrt{\frac{\text{kg m s}^{-2}}{\text{kg m}^{-1}}}$ clearly leading to m s^{-1} Homogeneous because v and $(T/\mu)^{1/2}$ have same units	M1 A0	
	(b)		$(\mu = \text{mass/length})$ Use (digital) balance / scales for mass Use ruler / measuring tape for the length Any <u>one</u> from: 1. Measure mass to the nearest gram / 0.1 g / 0.01 g / 0.001 g / 'high resolution' 2. Measure length to (the nearest) mm 3. Repeat for different <u>length</u> / <u>mass</u> (and determine average value for the mass per unit length) 4. Use a longer length of wire (reduce the percentage uncertainty) 5. Ensure there is no zero-error for the balance / scales or use calibrated balance / scales (AW)	B1 B1 B1	Not 'weight', but allow 'weigh using scales to get mass' Allow for $\mu = T/v^2$ route: T is measured using a newtonmeter or determine T using mg by measuring (hanging) mass m using a balance / scales Allow for $\mu = T/v^2$ route: Determine v by measuring length using a ruler / tape measure (and also either stopwatch or stroboscope) Allow any other sensible suggestion Ignore incorrect use of the terms accuracy and precision Not 'repeat measurements' for 3 Allow 'determine gradient of mass against length graph' or 'determine gradient of $T-v^2$ graph' for 3
	(c)		Speed / v (of the progressive wave) is the same Wavelength / λ decreases as frequency / f increases length = $\lambda/2$ (for the first harmonic), length = λ (for the second harmonic) and length = $3\lambda/2$ (for the third harmonic)	B1 B1 B1	Allow $f \propto 1/\lambda$ or λ is halved when f is doubled (AW) Allow L for length Allow $\lambda = 2L/n$ (n is 1, 2 and 3) Not just $\lambda/2$, λ and $3\lambda/2$ next to the patterns
			Total	7	

Question			Answer	Marks	Guidance
27	(a)		The <u>minimum</u> frequency of the EM waves / light / uv / photon for the removal of (surface) electron(s)	B1	Allow 'minimum / smallest frequency of EM wave to cause photoelectron emission' Not wave
	(b)	(i)	$hf = \phi + KE_{(\max)}$ <u>and</u> kinetic energy = 0 (at f_0) (therefore $\phi = hf_0$)	B1	
		(ii)	Data point (to with $\frac{1}{2}$ small square) and a reasonable straight (best-fit) line drawn with a straight edge / ruler	B1	Not freehand / wobbly line
		(iii)	Correct conversion from eV to J using 1.6×10^{-19} (gradient = h) gradient determined and $h = (6.4 \text{ to } 7.4) \times 10^{-34}$ (J s)	B1 B1	Note this can be a single value of ϕ or $\Delta\phi$ Allow value of h must be given to 2 or 3 SF
		(iv)	Draw a worst-fit line (and determine gradient / h) (AW) % uncertainty = $(h \text{ from } \mathbf{biii} - h \text{ from worst line}) \times 100 \div h \text{ from } \mathbf{biii}$ or Calculate the average h using f_0 and ϕ (values) % uncertainty = $(\frac{1}{2} \text{ range} \div \text{average } h) \times 100$	B1 B1 B1 B1	Allow (line of) maximum / minimum gradient Ignore sign Allow gradient instead of h
			Total	7	

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