OCR
Oxford Cambridge and RSA

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.

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
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 = ½ × 0.900 × 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	B1	**Allow** speed instead of velocity **Allow** 0.30 to 0.40
			Velocity decreases / deceleration from <u>0.3</u>(0 s) to <u>0.8</u>(0 s)	B1	**Allow** 0.30 to 0.40 and 0.76 to 0.80 **Allows** slows down
			Zero velocity / stationary after 0.8 (s) / towards the end	B1	Possible ECF
			gradient (of the graph) = velocity	B1	**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)				**Allow** other correct methods
			s = 0.5 (m) / t = 0.5 (s) $a = (-)\dfrac{2.0}{0.5}$ or $0 = 2.0^2 + 2 \times a \times 0.5$	C1	Possible ECF from **(b)**
			deceleration = (-) 4.0 (m s^{-2})	A1	**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)		Earth mentioned (as an integral part of the system) The Earth has (equal and) opposite momentum to the (falling) ball (so momentum is conserved) or The Earth moves upwards / towards the ball (with a tiny speed, so momentum is conserved)	M1 A1	**Not** 'ground' **Allow**: The Earth experiences an upward force (and moves upwards)
	(b)	(i)	($F = \frac{\Delta p}{\Delta t}$); $F = (-)\frac{10-6}{0.2}$ or $F = (-)\frac{4}{0.2}$ force = (-) 20 (N)	C1 A1	**Ignore** sign **Note** '$F = (-)\frac{10+6}{0.2}$ = 80 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) ($I = Anev$); $0.030 = 3.8 \times 10^{-6} \times 5.0 \times 10^{25} \times 1.6 \times 10^{-19} \times v$ $v = 9.9 \times 10^{-4}$ (m s^{-1})	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 = constant **Allow** 'more electrons / more charge carriers' **Allow** voltmeter reading stays 3.0 (V)
	(b)	(i)	$R = 2.0 + 8.0 = 10$ (Ω) ($I = 1.2/10$); $I = 0.12$ (A) ($1.5 = 1.2 + 0.12r$); $r = 2.5$ (Ω)	C1 C1 A1	**Allow** other correct methods **Allow** 2 marks for 4.5 (Ω); $R = 18$ Ω with $I = 0.067$ (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 $V = E$ – lost volts • Explanation of V increasing in terms of potential divider • Analysis showing $V \approx 0.7$ V when $d = 0$ or $V \approx 1.3$ V when $d = 1.0$ 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) amplitude decreases intensity ∝ 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: ($I = P/A$) power is constant and as area increases the intensity decreases **or** intensity ∝ 1/area and as area increases the intensity decreases
	(b)	(i)	The superposition of coherent waves	B1	**Not** 'combine / meet / interact' for 'superposition' **Allow** 'superposition of waves with a constant phase difference (at the sources)' **Allow** 'waves that superpose 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$^{(\circ)}$ or waves are in anti-phase **Not** λ/2 out of phase **Not** path difference is 1.5 cycles / periods / oscillations
			Total	**6**	

Question			Answer	Marks	Guidance
26	(a)		$\sqrt{\frac{T}{\mu}} \rightarrow \sqrt{\frac{\text{kg m s}^{-2}}{\text{kgm}^{-1}}}$ clearly leading to m s^{-1} Homogeneous because *v* and $(T/\mu)^{1/2}$ have same units	M1 A0	
	(b)		(μ = mass/length) Use (digital) balance / scales for mass Use ruler / measuring tape for the length Any one 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 length / mass (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 ½ 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 from **biii** – h from worst line) × 100 ÷ h from **biii** **or** Calculate the average h using f_0 and ϕ (values) % uncertainty = (½ range ÷ average h) × 100	B1 B1 B1 B1	**Allow** (line of) maximum / minimum gradient **Ignore** sign **Allow** gradient instead of h
			Total	7	

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