

GCE

Physics A

Unit H156/02: Depth 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
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
FT	Follow through
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
	Omission mark
RE	Rounding error or repeated error
SF	Error in number of significant figures
	Correct response
AE	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

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	(a)	Sum of <u>thinking distance</u> and the <u>braking distance</u>	B1	Allow the (total) <u>distance</u> travelled from when the driver sees a hazard to the vehicle stopping wtte
	(b)	i $\frac{61000}{3600} = 16.944$ 17 ms^{-1}	M1 A0	Note v must be the subject
	ii 1	$\frac{1}{2} \times 1.9 \times 10^5 \times 17^2$ $2.7(5) \times 10^7(\text{J})$	C1 A1	Allow use of 16.9 gives $2.7 \times 10^7(\text{J})$
	ii 2	$0 = 17^2 + 2a \times 310$ OR $t = \frac{310}{8.5} = 36.5$ $a = (-) \frac{17^2}{2 \times 310} = (-) \frac{289}{620}$ OR $a = \frac{17}{36.5}$ $0.47 (\text{ms}^{-2})$	C1 C1 A1	Allow $v^2 = u^2 + 2as$ with values stated correctly Ignore negative sign Allow use of 16.9 gives 0.46 Not 0.5
	ii 3	$1.9 \times 10^5 \times 0.47$ 89000(N)	C1 A1	Allow ECF from (b) (ii) 1 and (b) (ii) 2 Allow $\frac{2.7 \times 10^7}{310}$ Allow $1.9 \times 10^5 \times 0.46$ Allow $\frac{1.9 \times 10^5 \times 17}{36.5}$ Allow alternatives 87100, 87400, 88000
	(iii)	Component of train's <u>weight</u> acts against the motion/down the incline/same direction as braking force OR some KE transferred to GPE <u>Smaller distance because larger opposing forces/net force or greater deceleration or less work done by braking force</u>	B1 B1	Not gravity will slow it down Not down, parallel
		Total	11	

Question		Answer		Marks	Guidance														
2	(a)	<table border="1"> <thead> <tr> <th>F/N</th><th>e/cm</th></tr> </thead> <tbody> <tr><td>0</td><td>0.0</td></tr> <tr><td>0.49</td><td>1.0</td></tr> <tr><td>0.98</td><td>1.8</td></tr> <tr><td>1.47</td><td>2.8</td></tr> <tr><td>1.96</td><td>3.6</td></tr> <tr><td>2.45</td><td>4.6</td></tr> </tbody> </table>	F/N	e/cm	0	0.0	0.49	1.0	0.98	1.8	1.47	2.8	1.96	3.6	2.45	4.6		B1	<p>Note Column heading required and values in table. Allow 0 for 0.0 Not 1 for 1.0</p>
F/N	e/cm																		
0	0.0																		
0.49	1.0																		
0.98	1.8																		
1.47	2.8																		
1.96	3.6																		
2.45	4.6																		
	(b)	<p>y-axis labelled correctly e/cm</p> <p>y-axis scale is simple and uses at least half the graph paper</p> <p>Data points plotted correctly.</p>		B1	Allow extension / cm or $e(cm)$ for e/cm														
				B1	Note axis tick labels must be at least every two large squares (4 cm)														
				B1	Check two data points (0.98, 1.8) <u>and</u> (2.45, 4.6) Thickness of each point must be less than half a small square														
				B1	Not freehand / wobbly line														
	(c)	<p>Gradient in the range 1.80 to 1.94 OR 0.0180 to 0.0194</p>		B1	Allow 1.8 or 1.9 OR 0.018 or 0.019 Not 2 OR 0.02 Ignore POT errors Ignore significant figures														
	(d)	$k_2 = \frac{1}{\text{gradient}} = \frac{1}{(c)}$ <p>Correct value for k_2 <u>and</u> correct unit $N\text{cm}^{-1}$ or $N\text{m}^{-1}$ <u>and</u> given to 2 or 3 significant figures</p>		C1	Note expect about $0.55\text{ (N cm}^{-1}\text{)}$ or $55\text{ (N m}^{-1}\text{)}$														
				A1	Note unit must be with correct power of ten														

Question		Answer	Marks	Guidance
	(e)	<p>Hooke's law: Extension is (directly) proportional to the load (provided elastic limit not exceeded)</p> <p>Graph is not a <u>straight line passing through the origin</u> so Hooke's law is not obeyed OR</p> <p>Graph is a <u>straight line passing through the origin</u> so Hooke's law is obeyed</p>	B1 B1	
	(f)	$k_1 = 2 \times (d)$ or springs in series = k/n $\frac{2}{3}$	C1 A1	<p>Allow $F = k_1e = k_22e = k_33e$ Note 2:3 scores one mark</p> <p>Allow 0.66, 0.67</p>
		Total	12	

Question			Answer	Marks	Guidance
3	a	i	Micrometer/(Vernier) calliper Repeat readings (in different directions) <u>and</u> average	B1 B1	Not ruler
		ii	$\frac{4}{3}\pi(0.014)^3$ OR 1.15×10^{-5} $m = 650 \times 1.15 \times 10^{-5} = 7.47 \times 10^{-3}$ 0.0075 (kg)	M1 M1 A0	Allow $\frac{4}{3}\pi(1.4)^3$ Note must see correct POT
		iii	$1000 \times 1.15 \times 10^{-5} \times 9.81 = 0.11$ N OR $0.0075 \times 9.81 = 0.074$ N $F = 0.11 - 0.074 = 0.037$ (N) OR $9.81(1000 - 650)$ or $1.15 \times 10^{-5} \times (1000 - 650)$ $F = 1.15 \times 10^{-5} \times 9.81(1000 - 650) = 0.039$ (N)	C1 A1 C1 A1	Allow use of 7.47×10^{-3} kg from a ii Allow ecf from a ii

Question		Answer	Marks	Guidance
b		<p>Level 3 (5–6 marks) Clear procedure, measurements and analysis <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Some procedure, some measurements and some analysis. <i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i></p> <p>Level 1 (1–2 marks) Limited procedure and limited measurements or limited analysis <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i></p> <p>0 marks No response or no response worthy of credit.</p>	B1 x6	<p>Indicative scientific points may include:</p> <p>Procedure</p> <ul style="list-style-type: none"> labelled diagram long tube method to determine <u>terminal</u> velocity check for terminal velocity safety precaution (tray to avoid spills/gloves/clamp tube) method to remove sphere <p>Measurements</p> <ul style="list-style-type: none"> measurement of diameter use micrometer/calliper to measure diameter averages diameter measurements to determine v, e.g. stopwatch, ruler, light gate connected to timer, detailed use of video camera repeats experiment for same r <p>Analysis</p> <ul style="list-style-type: none"> $r = d / 2$ determination of terminal velocity plot a graph of v against r^2 $K = \text{gradient}$.
		Total	12	

Question			Answer	Marks	Guidance
4	a	i	$R = \frac{230^2}{3500} = 15.11$ 15 (Ω)	M1 A0	Allow calculation of current (15.2) and $R = V/I$ Not $3500 / 230 = 15.2$
		ii	$A = \pi \times 0.00055^2 (= 9.5 \times 10^{-7} \text{ m}^2)$ $L = \frac{15 \times 9.5 \times 10^{-7}}{1.6 \times 10^{-6}}$ 8.9 (m)	C1 C1 A1	Note 8.9×10^{-7} scores two marks Allow 15.1 gives 9.0 m
		iii	(Ohm's law states that) V proportional to I (provided the physical conditions/temperature remain constant) Since the <u>temperature is not constant</u> , Ohm's law will not apply	B1 B1	Allow one mark for Ohm's law will not apply because as temperature changes the resistance changes
	b		3.5 x 7 or 3.5 x 7 x 7 or 10.5 x 7 or 10.5 x 7 x 7 or 514.5 $514.5 \times 7.6p = \text{£}39.10 \text{ or } \text{£}39.11$	C1 A1	Note for use of 17 hours £94.96 scores one mark Allow 3910p or 3911p or £39.1 or £39.102
	c	i	$V = \frac{1.1}{6.8 + 1.4 + 1.1} \times 6$ 0.71 (V)	C1 A1	Allow $I = \frac{6}{(6.8+1.4+1.1) \times 10^3} = 0.00065$ Allow 0.7
	c	ii	As temperature of thermistor increases, resistance of thermistor decreases Total resistance of circuit decreases or current increases Greater proportion of p.d. across <u>fixed resistor</u> or p.d. across <u>fixed resistor</u> increase Reading on the voltmeter will increase	B1 B1 M1 A1	
			Total	14	

Question		Answer	Marks	Guidance
5	a	<p><i>phase difference:</i> difference in degrees/radians/angle between points on the same wave or (similar) points on two waves</p> <p><i>coherence:</i> constant/fixed phase difference</p>	B1 B1	<p>Note must be a comparison between points/waves</p> <p>Allow how far out of step/sync or leads/lags for difference</p> <p>Allow constant / fixed phase relationship</p> <p>Ignore 'the frequency / wavelength is the same'</p> <p>Not the same phase difference</p> <p>Not zero phase difference</p>
	b	<p>i At point P: path difference between slits and screen is a whole/integer number of <u>wavelengths</u> (for constructive interference)</p> <p>At point Q: path difference between slits and screen is an <u>odd number of half wavelengths</u> (for destructive interference)</p>	B1 B1	<p>Allow $n\lambda$ or λ</p> <p>Not phase difference</p> <p>Allow $(n + \frac{1}{2})\lambda$</p> <p>Not $\lambda/2$</p>
	ii 1	$x = 4.22 \text{ mm}$ $\lambda = \frac{4.22 \times 10^{-3} \times 0.56 \times 10^{-3}}{4.50}$ $5.25 \times 10^{-7} \text{ m}$	C1 C1 A1	<p>Note $x = 42.2 \text{ mm}$ or $4.2 \times 10^{-2} \text{ m}$ scores zero</p> <p>Note $x = 3.84, 4.77 \times 10^{-7} \text{ m}$ may score max 2</p>

Question		Answer	Marks	Guidance
	ii 2	$\frac{0.02}{4.5} \text{ or } \frac{0.02}{0.56} \text{ or } \frac{0.2}{42.2}$ $\left(\frac{0.02}{4.5} + \frac{0.02}{0.56} + \frac{0.2}{42.2} \right) \times 100 = 4.48 \%$ <p>Alternative max/min method:</p> $\lambda_{max} = \frac{4.24 \times 10^{-3} \times 0.58 \times 10^{-3}}{4.48} = 5.49 \times 10^{-7}$ <p>and/or</p> $\lambda_{min} = \frac{4.20 \times 10^{-3} \times 0.54 \times 10^{-3}}{4.52} = 5.02 \times 10^{-7}$ $\frac{\Delta\lambda}{\lambda} \times 100 = 4.4\% \text{ or } 4.6\%$	C1 A1 B1 B1	Allow 4% or 5% with evidence of working Ignore significant figures
	c i	$\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{5.25 \times 10^{-7}} = \frac{1.989 \times 10^{-25}}{5 \text{ b ii 1}} = 3.79 \times 10^{-19} \text{ J}$ $n = \frac{50 \times 10^{-3}}{3.79 \times 10^{-19}} = 2.5 \times 10^{23} \times 5 \text{ b ii 1} = 1.3 \times 10^{17}$	C1 A1	Allow ecf from bii
	ii	$2.6 \text{ eV} = 2.6 \times 1.6 \times 10^{-19} = 4.16 \times 10^{-19} \text{ J ORA}$ <p>Energy of photon is less than work function so photoelectrons will not be emitted</p>	M1 A1	Allow photon has 2.37 eV of energy Allow conclusion based 5 c i
		Total	13	

Question		Answer	Marks	Guidance
6	a	<p>A progressive wave transfers energy/information (in the direction of the wave)/all points have (the same) amplitude</p> <p>In a stationary wave there is no net energy transfer/energy is stored/has points which are always zero amplitude/or points have different amplitudes</p>	B1 B1	<p>Note for two marks there must be a comparison</p> <p>Allow stationary wave has nodes (and antinodes) for one mark</p>
	b	<p>Level 3 (5–6 marks) Clear explanation of observations and correct method to determine the speed of sound</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Clear explanation of observations or correct method to determine the speed of sound or has limited explanation of observations and limited method for the determination of the speed of sound</p> <p><i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i></p> <p>Level 1 (1–2 marks) Has limited explanation of observations or limited evidence of method to determine the speed of sound</p> <p><i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i></p> <p>0 marks No response or no response worthy of credit.</p>	B1 x6	<p>Indicative scientific points may include:</p> <p>Explanation of Observations</p> <ul style="list-style-type: none"> Understanding of how the standing wave is formed from the interference between the incident and reflected wave Idea of nodes and antinodes Node at closed end and antinode at open end Understanding of the direction of oscillation of particles Fundamental frequency/1st harmonic indicated for closed tube. Fundamental frequency/1st harmonic indicated for open tube Harmonics indicated for closed tube Harmonics indicated for open tube <p>Determination of speed of sound</p> <ul style="list-style-type: none"> λ correctly linked to length $v = f\lambda$ v calculated for different harmonics/tube or appropriate graphical method 338 m s^{-1}
		Total	8	

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