

GCE

Physics A

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

Advanced Subsidiary GCE

Mark Scheme for June 2018

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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 RM Assessor

Annotation		Meaning
	Correct response	Used to indicate the point at which a mark has been awarded (one tick per mark awarded).
	Incorrect response	Used to indicate an incorrect answer or a point where a mark is lost.
AE	Arithmetic error	Do not allow the mark where the error occurs. Then follow through the working/calculation giving full subsequent ECF if there are no further errors.
BOD	Benefit of doubt given	Used to indicate a mark awarded where the candidate provides an answer that is not totally satisfactory, but the examiner feels that sufficient work has been done.
BP	Blank page	Use BP on additional page(s) to show that there is no additional work provided by the candidates.
CON	Contradiction	No mark can be awarded if the candidate contradicts himself or herself in the same response.
ECF	Error carried forward	Used in <u>numerical answers only</u> , unless specified otherwise in the mark scheme. Answers to later sections of numerical questions may be awarded up to full credit provided they are consistent with earlier incorrect answers. Within a question, ECF can be given for AE, TE and POT errors but not for XP.
L1	Level 1	L1 is used to show 2 marks awarded and L1^ is used to show 1 mark awarded.
L2	Level 2	L2 is used to show 4 marks awarded and L2^ is used to show 3 marks awarded.
L3	Level 3	L3 is used to show 6 marks awarded and L3^ is used to show 5 marks awarded.
POT	Power of 10 error	This is usually linked to conversion of SI prefixes. Do not allow the mark where the error occurs. Then follow through the working/calculation giving ECF for subsequent marks if there are no further errors.
SEEN	Seen	To indicate working/text has been seen by the examiner.
SF	Error in number of significant figures	Where more SFs are given than is justified by the question, do not penalise. Fewer significant figures than necessary will be considered within the mark scheme. Penalised only once in the paper.
TE	Transcription error	This error is when there is incorrect transcription of the correct data from the question, graphical read-off, formulae booklet or a previous answer. Do not allow the relevant mark and then follow through the working giving ECF for subsequent marks.
XP	Wrong physics or equation	Used in <u>numerical answers only</u> , unless otherwise specified in the mark scheme. Use of an incorrect equation is wrong physics even if it happens to lead to the correct answer.
^	Omission	Used to indicate where more is needed for a mark to be awarded (what is written is not wrong but not enough).

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

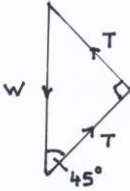
Annotation	Meaning
/	alternative and acceptable answers for the same marking point
Reject	Answers which are not worthy of credit
Not	Answers which are not worthy of credit
Ignore	Statements which are irrelevant
Allow	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

SECTION A

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

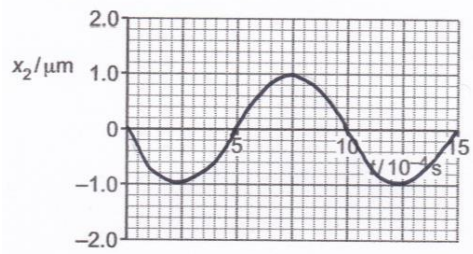
SECTION B

Question			Answer	Marks	Guidance
21	(a)		Distance / displacement / length measured using the (metre) rule and time measured using the stopwatch $(s = \frac{1}{2} [v + u]t \text{ and } u = 0)$ $v = 2 \times \text{average velocity}$	B1 B1	Allow this mark even if the measurements are taken after trolley has left the ramp Note v must be the subject Allow $v = 2 \times \text{average speed}$ Allow $v = 2x/t$ without the terms defined (x can be d , D or s) Not $s = \frac{1}{2} vt$ Allow $v = x/t$, where x = distance travelled along horizontal surface assuming it is smooth / negligible friction Allow 1 mark for the following where there is no mention of timing / stopwatch: Measure height / vertical distance with a (metre) rule and use $v = \sqrt{2gh}$ (no need to define the terms)
	(b)	(i)	$(v^2 = u^2 + 2as)$ $2.5^2 = 1.3^2 + 2 \times 1.10 \times a$ (Any subject) $a = 2.1 \text{ (m s}^{-2}\text{)}$	C1 A1	Allow other methods Allow this mark for $t = 0.58 \text{ (s)}$ Note answer to 3 SF is $2.07 \text{ (m s}^{-2}\text{)}$
	(b)	(ii)	$ma = mg \sin \theta$ or $a = g \sin \theta$ or $2.07 = 9.81 \times \sin \theta$ $\theta = 12^\circ$	C1 A1	Allow $2.1 \text{ (m s}^{-1}\text{)}$ Allow $g = 9.8$ Note using $\tan^{-1}(2.07/9.81)$ is wrong physics . Possible ECF from (b)(i) Allow $g = 10$ here; it gives the same answer to 2 SF Allow 1 mark for 78°
			Total	6	

Question			Answer	Marks	Guidance
22	(a)		(The resultant of the tensions in the springs is) $W / 4.8$ (N) Direction: up(wards) / opposite to weight / opposite to W (because the total force in the vertical direction is zero)	B1 B1	
	(b)		Triangle with at least two forces shown, one angle marked and the W side being longest The (force) arrows are consistently clockwise or anticlockwise 	B1 B1	Allow  for right angle Ignore 'orientation' of the triangle Ignore any other figures Note all three arrows are required
	(c)		$2 \times T^2 = 4.8^2$ or $2T \sin 45^\circ = 4.8$ or $T = 4.8 \sin 45^\circ$ $T = 3.39(4)$ (N)	B1 B1	Note: $\sin 45^\circ = \cos 45^\circ$ Note: T must be given to at least 3 SF
	(d)		$3.4 = 24x$ or $(x =) \frac{3.4}{24}$ or $(x =) 0.14(17)$ (m) $(E = \frac{1}{2} \times 24 \times 0.1417^2$ or $E = \frac{1}{2} \times 3.4 \times 0.1417)$ energy = 0.24 (J)	C1 A1	Allow the C1 mark for $E = 3.4^2 / (2 \times 24)$ Allow 3.39(4) N No ECF from (c)
			Total	8	

Question			Answer	Marks	Guidance
23	(a)		Weight (of tube), <u>upthrust</u> (and tension / F are the forces acting on the tube) (For $t < 60$ s) the <u>upthrust</u> (on the tube) increases One detail point from: • <u>Upthrust</u> increases because <u>weight</u> of water displaced increases (up to 60s) or <u>upthrust</u> is constant (after 60s) because <u>weight</u> of water displaced is constant • Constant gradient (before 60 s) because upthrust or volume (of water displaced) or mass (of water displaced) or weight (of water displaced) increases at a constant <u>rate</u> • (After $t = 60$ s / eventually / finally the) upthrust is constant because tube is (fully) submerged / container is full (of water) • $F = \text{upthrust} - \text{weight}$ / $F = U - W$ (Any subject)	B1 B1 B1	Allow 'buoyancy <u>force</u>' for upthrust throughout, but not just 'buoyancy' Not 'mass' or 'volume' of water displaced Not upthrust = weight of fluid / water displaced Allow 'no more water is displaced after 60 (s) because tube is (fully) submerged' AW
	(b)		(resultant force $\Rightarrow$) $4.2 - 0.8$ or 3.4 (N) ($m \Rightarrow$) $0.8/9.81$ or $0.0815 \dots$ (kg) ($a = \frac{3.4}{(0.8/9.81)}$) $a = 42$ (m s^{-2})	C1 C1 A1	Allow 0.082 (kg) Not 0.08 (kg) Allow 2 marks for $F = 3.4$ (N), $m = 0.08$ (kg) and hence $a = 42.5$ or 43 (m s^{-2})
	(c)		There is (an increasing) friction / drag (acting on the tube)	B1	Allow (water) resistance / resistive force Allow upthrust decreases as tube comes out of water AW Not 'drag and upthrust', unless the upthrust is qualified as above
			Total	7	

Question			Answer	Marks	Guidance
24	(a)	(i)	$(P = VI = 10.0 \times 0.030)$ power = 0.30 (W)	B1	Allow 0.3 (W) without any SF penalty Allow 300 <u>m</u> (W)
		(ii)	The component is (an NTC) thermistor. (As V or I increases the) resistance of the component decreases Any <u>one</u> from: Component cannot be a diode / LED because of current in one direction only (AW) (As V or I increases the) component gets warmer / increase in number density (of free charge carriers)	B1 B1 B1	Allow calculations at 5 V and 10 V to support this, ignore POT errors
	(b)		$R = \frac{\rho L}{A} = \frac{1.5 \times 10^{-2} \times 8.0 \times 10^{-3}}{1.2 \times 10^{-6}}$ or 100 (Ω) (total resistance =) 168 (Ω) (current = 3.0/168) $I = 0.018$ A	C1 C1 A1	Possible POT error here Note using $A = (1.2 \times 10^{-6})^2$ is wrong physics, hence this C1 mark is lost Possible ECF from incorrect value of R for this C1 mark and the next A1 mark Allow 2 marks 0.044 (A); A taken as 1.2×10^{-3} , which gives $R = 0.1$ and $I = 3.0/68.1 = 0.044$ (A) Not $I = 3.0/68 = 0.044$ (A) because this is wrong physics
			Total	7	

Question			Answer	Marks	Guidance
25	(a)		The <u>period</u> is determined by counting squares / from time-base	B1	Note: Any reference to <u>wavelength</u> will lose this mark Not 'determine T '
			The frequency f is period ⁻¹	B1	Allow $f = 1/T$
	(b)	(i)	Correct curve with amplitude of $1.0 \mu\text{m}$ and a phase difference of 180° 	B1	Allow a curve shown for a minimum of one period Allow $\pm 0.2 \mu\text{m}$ for amplitude at any two points Not 'triangular' profile for the curve
		(ii)	The amplitude (at P) is smaller / $< 3.0 (\mu\text{m})$ / $= 2.0 (\mu\text{m})$ intensity $\propto$ amplitude ² (therefore the intensity is not the same)	B1 B1	Not displacement Allow $I \propto A^2$, where I = intensity and A = amplitude Allow 2 marks for 'intensity is $\left(\frac{2}{3}\right)^2 \times 100 = 44\%$ '
		(iii)	(The path difference is) $17 (\text{cm})$ or half wavelength or $\lambda/2$. Hence destructive (interference)	M1 A1	Not $(n + \frac{1}{2})\lambda$ Not <u>phase</u> difference is $17 (\text{cm})$ or half wavelength or $\lambda/2$
Total				7	

Question			Answer	Marks	Guidance
26	(a)	(i)	$\left(\lambda = \frac{3.00 \times 10^8}{11 \times 10^9}\right)$ $\lambda = 0.027 \text{ (m)}$	B1	Note answer to 3 SF is 0.0273 (m) Possible SF penalty for 0.03 (m)
		(ii)	Diffraction / spreading of the waves (occur at the narrow slit.) This is because the wavelength is similar / comparable to the width / size / length of the slit (ORA)	M1 A1	Allow 'wavelength is same as the gap (size)' AW
	(b)		Speed of light is less in water (ORA) Frequency is the same (in both) Wavelength is smaller in water (ORA)	B1 B1 B1	Allow calculated values for air and water Allow speed decreases (from air to water) Not v or c Allow f is the same Allow wavelength / λ decreases (from air to water)
	(c)		Laser / ray box or protractor mentioned Ray diagram showing (incident) ray within the block, (refracted) ray along the straight edge of block and critical angle marked between the incident ray and the normal (Refractive index determined using) $n = 1/\sin C$	B1 B1 B1	Not 'ray of light' for laser / ray box Allow C , critical angle, θ or i for the angle marked between the incident ray and normal Note : No labelling of rays or normal is required Ignore direction of rays Ignore any internally reflected ray Note this mark is for the ray diagram . Ignore description, unless there are <u>multiple</u> refracted rays shown Allow any subject and terms do not need to be defined Not bald ' $n_1 \sin \theta_1 = n_2 \sin \theta_2$ '
			Total	9	

Question			Answer	Marks	Guidance
27	(a)		(They have different) wavelength / frequency	B1	Allow: (They have different) <u>photon</u> energy / ionisation (effects) Not wrong physics, e.g. <i>X-rays have longer wavelength</i> Ignore uses of these wave(s)
	(b)	(i)	(surface area =) $4\pi \times (1.4 \times 10^9)^2$ or $2.46 \times 10^{19} \text{ (m}^2\text{)}$ (intensity = $\frac{P}{4\pi r^2}$) intensity = $\frac{2.7 \times 10^{27}}{4\pi \times (1.4 \times 10^9)^2}$ intensity = $1.1 \times 10^8 \text{ (W m}^{-2}\text{)}$	C1 C1 A0	Allow $2.5 \times 10^{19} \text{ (m}^2\text{)}$ Note: Using $\pi \times (1.4 \times 10^9)^2$ is wrong physics; hence no marks in this show question
		(ii)	$E = \frac{3.00 \times 10^8 \times 6.63 \times 10^{-34}}{5.0 \times 10^{-7}}$ $E = 4.0 \times 10^{-19} \text{ (J)}$	C1 A1	Note: Answer to 3 SF is $3.98 \times 10^{-19} \text{ (J)}$ Allow $4 \times 10^{-19} \text{ (J)}$ without any SF penalty
		(iii)	(number per second = $\frac{2.7 \times 10^{27}}{4.0 \times 10^{-19}}$) number per second = $6.8 \times 10^{45} \text{ (s}^{-1}\text{)}$	B1	Possible ECF from (b)(ii)
			Total	6	

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