Oxford Cambridge and RSA

GCE

Physics A

H156/01: Breadth in physics

Advanced Subsidiary GCE

Mark Scheme for Autumn 2021

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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.

RM ASSESSOR

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 numerical answers only, 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, formulæ 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 numerical answers only, 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	D	1	
2	B	1	
3	D	1	
4	C	1	
5	B	1	
6	C	1	
7	C	1	
8	D	1	
9	A	1	
10	D	1	
11	A	1	
12	A	1	
13	B	1	
14	B	1	
15	D	1	
16	C	1	
17	D	1	
18	A	1	
19	D	1	
20	C	1	
	Total	20	

SECTION B

General rule: For substitution into an equation, allow any subject – unless stated otherwise in the guidance

Question			Answer	Marks	Guidance
21	(a)		Separation between droplets increases (further down)	B1	
	(b)		'No motion' explained either in terms of the first law or second law There is no / negligible resultant force	B1 B1	**Allow** $F = ma$, since $F = 0$, a is zero (hence at rest) **Allow** an object continues in a state of rest or uniform motion unless acted upon by a (resultant) force. **ALLOW** no frictional/extra/new force
	(c)	(i)	Tangent drawn at $t = 4.0$ s Attempt at calculating the gradient v calculated from gradient and between 9.50 - 10.50 ($m\ s^{-1}$) **OR** $s = 20$ (m) and $s = ½\ at^2$ $20 = ½\ a \times 4.0^2$ **or** $a = 2.5$ ($m\ s^{-2}$) $v = 2.5 \times 4.0$ **or** $v^2 = 2 \times 2.5 \times 20$ $v = 10$ ($m\ s^{-1}$)	C1 C1 A1 C1 C1 C1 A0	**Allow** other correct methods **Note** working required for this mark
	(c)	(ii)	change in momentum = 1200×10 or 12000 ($kg\ m\ s^{-1}$) rate of change of momentum = 3000 unit: $kg\ m\ s^{-2}$ or N **OR** $F = 1200 \times 2.5$ rate of change of momentum = 3000 unit: $kg\ m\ s^{-2}$ or N	C1 A1 B1 C1 A1 B1	**Allow** ECF from **(c)(i)** **Allow** 2850 - 3150 **Allow** newton **Allow** ECF from **(c)(i)** **Allow** newton
			Total	9	

Question			Answer	Marks	Guidance
22	(a)		Ruler (with mm scale)	B1	**Allow** any instruments with a mm scale e.g. tape measure **NOT** calipers and micrometre
	(b)		$\frac{0.002}{0.1000}(\times 100)$ or $\frac{0.1}{1.4}(\times 100)$ or $g = \frac{1.4^2}{2 \times 0.100}$	C1	**Allow** 1SF answers here for uncertainties **Not** g = 9.8 for this C1 mark; must see working
			$(2 \times 0.071\ldots + 0.02)$ or 0.1628 …. or 16.3 %	C1	**Allow** 0.16 or 16%
			absolute uncertainty = 1.6 (m s^{-2})	A1	**Note**: The answer must be given to 2 SF **Ignore** value of g given on the answer line, e.g. 9.8 ± 1.6
			OR		
			$g_{max} = \frac{1.5^2}{2 \times 0.098}$ (= 11.48) **or** $g_{min} = \frac{1.3^2}{2 \times 0.102}$ (= 8.28)	C1	
			range = 3.2 (m s^{-2})	C1	
			absolute uncertainty = 1.6 (m s^{-2})	A1	**Note**: The answer must be given to 2 SF
			Total	4	

Question			Answer	Marks	Guidance
23	(a)		Circuit diagram with LED, voltmeter and ammeter connected to a supply with correct polarity and some means of adjusting the p.d. Increase the p.d. until the LED is just lit / current is shown in the circuit ORA To observe the light from LED use a tube / turn lights off	B1 B1 B1	**Allow** variable (power) supply / variable resistor in circuit **Allow** this on a labelled diagram e.g. tube drawn around the diode
	(b)	(i)	$\frac{0.045}{1.6 \times 10^{-19}}$ number of electrons = 2.8×10^{17}	C1 A1	
		(ii)	$A = \pi \times (0.12 \times 10^{-3})^2$ **or** $4.5(2) \times 10^{-8}$ (m^2) $0.045 = \pi \times (0.12 \times 10^{-3})^2 \times 6.3 \times 10^{28} \times 1.6 \times 10^{-19} \times v$ $v = 9.9 \times 10^{-5}$ ($m\ s^{-1}$)	C1 C1 A1	**Allow** 2 marks for 2.5×10^{-5} ($m\ s^{-1}$); 0.24 mm and POT error
	(c)	(i)	(Current causes) increase in temperature of thermistor Resistance of thermistor decreases (and hence V decreases) **or** Current in the circuit increases, p.d. across resistor increases (and hence V decreases)	B1 B1	**Allow** warms up/heat ups **Ignore** increase temperature of the circuit
		(ii)	V = 2.4 (V) or V_R = 3.6 (V) I = 0.30 (A) resistance = 8.0 (Ω) **OR** V = 2.4 (V) and a potential divider equation / idea $2.4 = \frac{R}{R+12} \times 6.0$ or $\frac{R}{2.4} = \frac{12}{3.6}$ resistance = 8.0 (Ω)	C1 C1 A1 C1 C1 A1	**Not** V = 2.2 (V); misreading **Allow** ECF if V = 2.2 (V) is used **Allow** 8 (1 SF answer) **Not** V = 2.2 (V); misreading **Allow** ECF if V = 2.2 (V) is used **Allow** 8 (1 SF answer)
			Total	**13**	

Question			Answer	Marks	Guidance
24	(a)		Both travel at the same speed / speed of light/ 3.0×10^8 m s^{-1}	B1	**Ignore** travels at 'c'
	(b)		$3.0 \times 10^8 = f \times 2.5 \times 10^{-11}$ $f = 1.2 \times 10^{19}$ (Hz)	C1 A1	
	(c)		Use of E = hf or E = hc/λ **EITHER** (λ) number = $(500 \times 10^{-9})/(2.5 \times 10^{-11})$ number = 2.0×10^4 **OR** (E) number = $(7.96 \times 10^{-15})/ (3.98 \times 10^{-19})$ number = 2.0×10^4 **OR** (f) number = $(1.2 \times 10^{19}) / (6 \times 10^{14})$ number = 2.0×10^4	C1 C1 A1 C1 A1 C1 A1	**Allow** ECF from **(b)** **Allow** ECF from **(b)**
			Total	**6**	

Question			Answer	Marks	Guidance
25	(a)	(i)	It is longitudinal	B1	
		(ii)	Loudspeaker, microphone/ear and slit Sound spreads from the slit AW Size of slit comparable to the wavelength (of sound)	B1 B1 B1	**Allow** doorway for a slit/gap – receiver for microphone **Not** diffraction (since it is in the stem of the question)
	(b)	(i)	(refraction index) = speed of light in vacuum ÷ speed of light in material	B1	**Note** light must be mentioned at least once **Allow** n = c/v if all terms defined **Allow** ration of speed of light in vacuum to speed of light in material **NOT** speed of light in air for c
		(ii)1	Frequency (of light) is the same (in **A** and **B**) (Light travels) slower in **B or** $v_B = 0.77v_A$ ORA $v = f\lambda$ and $\lambda_B < \lambda_A$	B1 B1 B1	**Allow** *f* for frequency **Allow** v directly proportional to λ
		(ii)2	$\sin 60° = 1.3 \times \sin\theta$ $\theta = 42$ (°)	C1 A1	
		(ii)3	(No total internal reflection) Internal reflection / critical angle can only occur for light travelling from **B** to **A** AW	 B1	 **Allow** TIR can only occur for light entering an optically less dense material/lower refractive index ORA **Not** $\theta < \phi$
			Total	11	

Question			Answer	Marks	Guidance
26	(a)		weight × y = Fx	M1	**Allow** W or mg $Wy = Fx$ or $mgy = Fx$
			$(AL\rho g) \times y = Fx$	M1	
			$y = \left(\frac{F}{AL\rho g}\right)x$	A0	
	(b)	(i)	Straight line of best fit drawn through the data points	B1	
			Gradient = 1.5	B1	**Allow** gradient in the range 1.40 - 1.60
		(ii)	$\left(\frac{F}{AL\rho g}\right)$ = 1.5	C1	**Allow** ECF from **(b)(i)**
			$\frac{6.8}{6.4 \times 10^{-5} \times 0.90 \times \rho \times 9.81}$ = 1.5	C1	
			ρ = 8.0 × 10^3 (kg m^{-3})	A1	**Allow** 8 × 10^3 (1 SF answer) **Note** must be consistent with gradient value from **(b)(i)**
			Total	8	

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