Cambridge International AS & A Level

PHYSICS	**9702/22**
Paper 2 AS Level Structured Questions	**May/June 2022**
MARK SCHEME	
Maximum Mark: 60	

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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This document consists of **14** printed pages.

Abbreviations

/	Alternative and acceptable answers for the same marking point.
( )	Bracketed content indicates words which do not need to be explicitly seen to gain credit but which indicate the **context** for an answer. The context does not need to be seen but if a context is given that is incorrect then the mark should not be awarded.
___	Underlined content must be present in answer to award the mark. This means either the exact word or another word that has the same technical meaning.

Mark categories

B marks	These are <u>independent</u> marks, which do not depend on other marks. For a **B** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer.
M marks	These are <u>method</u> marks upon which **A** marks later depend. For an **M** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer. If a candidate is not awarded an **M** mark, then the later **A** mark cannot be awarded either.
C marks	These are <u>compensatory</u> marks which can be awarded 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 them. 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 awarded. If a correct answer is given to a numerical question, all of the preceding **C** marks are awarded automatically. It is only necessary to consider each of the **C** marks in turn when the numerical answer is not correct.
A marks	These are <u>answer</u> marks. They may depend on an **M** mark or allow a **C** mark to be awarded by implication.

Annotations

✓	Indicates the point at which a mark has been awarded.
X	Indicates an incorrect answer or a point at which a decision is made not to award a mark.
XP	Indicates a physically incorrect equation ('incorrect physics'). No credit is given for substitution, or subsequent arithmetic, in a physically incorrect equation.

ECF	Indicates 'error carried forward'. Answers to later numerical questions can always be awarded up to full credit provided they are consistent with earlier incorrect answers. <u>Within</u> a section of a numerical question, ECF can be given after AE, TE and POT errors, but **not** after XP.
AE	Indicates an 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.
POT	Indicates a power of ten 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.
TE	Indicates incorrect transcription of the correct data from the question, a graph, data sheet or a previous answer. For example, the value of 1.6×10^{-19} has been written down as 6.1×10^{-19} or 1.6×10^{19}. 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.
SF	Indicates that the correct answer is seen in the working but the final answer is incorrect as it is expressed to too few significant figures.
BOD	Indicates that a mark is awarded where the candidate provides an answer that is not totally satisfactory, but the examiner feels that sufficient work has been done ('benefit of doubt').
CON	Indicates that a response is contradictory.
I	Indicates parts of a response that have been seen but disregarded as irrelevant.
M0	Indicates where an A category mark has not been awarded due to the M category mark upon which it depends not having previously been awarded.
^	Indicates where more is needed for a mark to be awarded (what is written is not wrong, but not enough). May also be used to annotate a response space that has been left completely blank.
SEEN	Indicates that a page has been seen.

Question	Answer	Marks
1(a)	only ampere and kilogram underlined	**B1**
1(b)(i)	percentage uncertainty $= 2.1 + 0.6 + (1.5 \times 2)$	**C1**
	$= 5.7\%$	**A1**
1(b)(ii)	absolute uncertainty $= (5.7 / 100) \times 8.245 \times 10^9$	**C1**
	$(= 4.7 \times 10^8$ Pa or 0.47×10^9 Pa$)$	
	$E = (8.2 \pm 0.5) \times 10^9$ Pa	**A1**

Question	Answer	Marks
2(a)	$T \sin 68° + 32 = 280$	**C1**
	$T = 270$ N	**A1**
2(b)(i)	$F = \rho g V$	**A1**
	$V = 280 / (1.0 \times 10^3 \times 9.81)$	
	$= 0.029$ m^3	
2(b)(ii)	$\rho = (32 / 9.81) / 0.029$	**C1**
	$= 110$ kg m^{-3}	**A1**

Question	Answer	Marks
2(c)	$(\Delta)E = mg(\Delta)h$ **or** $(\Delta)E = W(\Delta)h$	**C1**
	$(\Delta)h = (-)\ 77 / 32$	**C1**
	$(\Delta)h = (-)\ 2.4$ final height $= 6.2 - 2.4$ $= 3.8\ \text{m}$	**A1**
2(d)(i)	$T = kx$ where k is a constant **or** $T = (EA / L)x$ where A is (cross-sectional) area, E is Young modulus, L is (original/unstretched) length	**B1**
2(d)(ii)	$E = \dfrac{1}{2}kx^2$ **or** $E = \dfrac{1}{2}Fx$ **and** $F = kx$	**C1**
	$E = 0.65 \times 2^2$ $= 2.6\ \text{J}$	**A1**
	or	
	$E = \dfrac{1}{2}Fx$ $0.65 = \dfrac{1}{2} \times 270 \times x$ and so $x = 4.8 \times 10^{-3}\ \text{m}$ $k = F/x = 270 / 4.8 \times 10^{-3}$ $= 5.6 \times 10^4$	**(C1)**

Question	Answer	Marks
2(d)(ii)	final $E = \dfrac{1}{2} \times 540 \times 9.6 \times 10^{-3}$ **or** $E = \dfrac{1}{2} \times (270 \times 2) \times (4.8 \times 10^{-3} \times 2)$ **or** $E = \dfrac{1}{2} \times 5.6 \times 10^{4} \times (9.6 \times 10^{-3})^{2}$ $= 2.6\ \text{J}$	**(A1)**

Question	Answer	Marks
3(a)	$v^2 = u^2 + 2as$	**C1**
	$s = 5.6^2 / (2 \times 9.81)$	
	(max height =) $3.1 + 5.6^2 / (2 \times 9.81) = 4.7$ (m)	**A1**
3(b)	$s = ut + \dfrac{1}{2}at^2$	**C1**
	$4.7 = \dfrac{1}{2} \times 9.81 \times t^2$	
	$t = 0.98$ s	**A1**
3(c)	line drawn from a non-zero speed at $t = 0$ to a greater speed at $t = T$	**B1**
	a single sloping straight line drawn from $t = 0$ to $t = T$	**B1**
	line starts with a positive non-zero value of v and ends with a negative non-zero value of v	**B1**
3(d)	acceleration (of the ball)	**B1**
3(e)(i)	(magnitudes of accelerations are) equal / same	**B1**
3(e)(ii)	(speeds are) equal / same	**B1**

Question	Answer	Marks
4(a)	<u>sum</u>/<u>total</u> momentum before = <u>sum</u>/<u>total</u> momentum after **or** <u>sum</u>/<u>total</u> momentum (of a system of objects) is constant	**M1**
	<u>if no (resultant) external force/for a closed system</u>	**A1**
4(b)(i)	$(3.0 \times 4.0 \times \cos\theta)$ **or** $(2.5 \times 4.8 \times \cos\theta)$ **or** (5.5×3.7)	**C1**
	$(3.0 \times 4.0 \times \cos\theta) + (2.5 \times 4.8 \times \cos\theta) = (5.5 \times 3.7)$	**C1**
	$\theta = 32°$	**A1**
4(b)(ii)	$\left(\text{initial } E_K = \dfrac{1}{2} \times 3.0 \times 4.0^2 + \dfrac{1}{2} \times 2.5 \times 4.8^2 =\right) 53 \text{ (J)}$ **or** $\left(\text{final } E_K = \dfrac{1}{2} \times 5.5 \times 3.7^2 =\right) 38 \text{ (J)}$	**C1**
	values of initial E_K and final E_K both correct **and** inelastic stated	**A1**

Question	Answer	Marks
5(a)	constant phase difference (between the waves)	**B1**
5(b)(i)	path difference = 1.5 × 660 = 990 nm	**A1**
5(b)(ii)	phase difference = 360° × 1.5 = 540°	**A1**
5(c)	$\lambda = ax / D$	**C1**
	$x = (660 \times 10^{-9} \times 1.8) / 0.44 \times 10^{-3}$	**C1**
	= 2.7×10^{-3} m	**A1**
5(d)	bright fringes are brighter	**B1**
	no change to dark fringes	**B1**
	no change to (fringe) separation / (fringe) spacing	**B1**
5(e)	(blue light has) shorter wavelength	**M1**
	(so) decrease (slit) separation	**A1**

Question	Answer	Marks
6(a)	$V = V_1 + V_2 + V_3$	**B1**
	$IR = IR_1 + IR_2 + IR_3$ **or** $(V/I) = (V_1/I) + (V_2/I) + (V_3/I)$ **and** $R = R_1 + R_2 + R_3$	**B1**
6(b)(i)	$V/8.0 = 6.0 \times 10^3 / (4.0 \times 10^3 + 6.0 \times 10^3)$ **or** $I = 8.0 / (4.0 \times 10^3 + 6.0 \times 10^3) = 8.0 \times 10^{-4}$ $V = 8.0 \times 10^{-4} \times 6.0 \times 10^3$	**C1**
	$V = 4.8\,V$	**A1**
6(b)(ii)	total resistance in parallel = $3.0 \times 10^3\,(\Omega)$ **or** $3.0\,(k\Omega)$	**C1**
	current = $8.0 / (3.0 \times 10^3 + 6.0 \times 10^3)$ = $8.9 \times 10^{-4}\,A$	**A1**
6(c)	<u>thermistor</u> resistance increases	**B1**
	(thermistor resistance increases so total resistance increases so) current decreases (in battery)	**M1**
	($P = EI$ and E constant so) power decreases	**A1**

Question	Answer	Marks
7(a)(i)	P = 0 **and** Q = 137	**A1**
A1	R = –1 **and** S = 56	**A1**
7(a)(ii)	lepton(s)	**B1**
7(b)(i)	(charge of ddd / Y =) $-\frac{1}{3}(e) \ -\frac{1}{3}(e) \ -\frac{1}{3}(e) = -1(e)$	**B1**
	(charge of $\overline{u}$d / Z =) $-\frac{1}{3}(e) \ -\frac{2}{3}(e) = -1(e)$	**B1**
7(b)(ii)	meson: Z / $\overline{u}$ d because consists of a quark and an antiquark	**B1**
	baryon: Y / ddd because consists of three quarks	**B1**