Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS | **9702/23**
Paper 2 AS Level Structured Questions | **October/November 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.

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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.

Question	Answer	Marks
1(a)	(SI base unit of α =) $m^3 s^{-1} \times m / m^4 = s^{-1}$	A1
1(b)	(percentage uncertainty =) 3 + 4 + 2 × 4 = 15 (%)	A1
1(c)	$\alpha = QL / r^4$ $= 2.72 \times 10^{-8} \times 2.5 \times 10^{-2} / (7.1 \times 10^{-5})^4$ $= 2.7 \times 10^7$	C1
	absolute uncertainty $= 0.15 \times [2.7 \times 10^7]$ $= 0.4 \times 10^7$	C1
	$\alpha = (2.7 \pm 0.4) \times 10^7 \ s^{-1}$	A1

Question	Answer	Marks
2(a)(i)	(e.g. a =) [16.5 – 0] / [0.30 – 0] = 55 (m s^{-2})	**A1**
2(a)(ii)	(F =) $T - W$	**A1**
2(a)(iii)	$ma = T - mg$ $m = 16 / (55 + 9.81)$	**C1**
	m = 0.25 kg	**A1**
2(b)(i)	$s = ut + ½at^2$ **or** $v^2 = u^2 + 2as$ **or** $s = vt - ½at^2$ **or** $s = ½(u + v)t$ **or** s = area under graph $s = ½ \times 55 \times 0.30^2$ **or** $s = 16.5^2 / (2 \times 55)$ **or** $s = 16.5 \times 0.30 - ½ \times 55 \times 0.30^2$ **or** $s = ½ \times 16.5 \times 0.30$	**C1**
	s = 2.5 m	**A1**
2(b)(ii)	u = 16.5 (m s^{-1})	**C1**
	$v^2 = u^2 + 2as$ $v^2 = 16.5^2 + 2 \times 9.81 \times 2.5$	**C1**
	v = 18 m s^{-1}	**A1**

Question	Answer	Marks
3(a)	sum of CW moments = sum of ACW moments	**M1**
	about the same point for (an object in rotational) equilibrium	**A1**
3(b)	moment = 0.3(0) × 0.29 cos 40° **or** 0.3(0) × 0.222	**C1**
	= 0.067 N m	**A1**
3(c)(i)	$k = F / x$ **or** k = gradient	**C1**
	e.g. $k = 21 / 10 \times 10^{-3}$ $k = 2100\ \text{N m}^{-1}$	**A1**
3(c)(ii)	$V_{(\text{sphere})} = \frac{4}{3} \times \pi \times (0.0480)^3$	**C1**
	$F = \rho g V$ (upthrust =) $1000 \times 9.81 \times (\frac{4}{3} \times \pi \times (0.048)^3) \times 0.26(0) = 1.18$ (N)	**A1**
3(c)(iii)	1.18 × 0.29 **or** 0.30 × 0.29 **or** $F \times 0.017$	**C1**
	$(1.18 \times 0.29) = (0.30 \times 0.29) + (F \times 0.017)$ $F = 15$ N	**A1**

Question	Answer	Marks
3(c)(iv)	$E_{(P)} = ½kx^2$ **or** $E_{(P)} = ½Fx$	C1
	$x = F / k = 15 / 2100$ **or** x determined from graph for F = 15.0 N $E_P = ½ \times 2100 \times (15 / 2100)^2$ **or** $E_P = ½ \times 15 \times (15 / 2100)$ E_P = 0.054 J	A1
3(d)	the <u>sphere</u> has gained gravitational potential energy	B1

Question	Answer	Marks
4(a)(i)	circles drawn around any two particles with seven (uncircled) particles in between	**A1**
4(a)(ii)	curve has an initial negative displacement and initial amplitude same as original curve	**B1**
	curve has same amplitude as original curve throughout	**B1**
	curve has same wavelength as original curve throughout, with constant (non-zero) phase difference	**B1**
4(a)(iii)	(to the) right / rightwards	**A1**
4(b)	$\lambda = 2 \times 0.19$ $= 0.38$ m	**C1**
	$v = f\lambda$	**C1**
	$v = (16 \times 10^3) \times 0.38$ $v = 6100$ m s^{-1}	**A1**
4(c)	$I \propto A^2$	**C1**
	$I = (1 / 2)^2 I_0$ intensity = $0.25\ I_0$	**A1**
4(d)(i)	same frequency / wavelength / period	**B1**
4(d)(ii)	• a stationary wave has nodes/antinodes (and a progressive wave does not) • a stationary wave does not transfer/propagate energy (and a progressive wave does transfer/propagate energy) • different points on a stationary wave have different amplitudes (and all points on a progressive wave have the same/constant amplitude) • stationary wave has adjacent particles that are in phase (and adjacent particles on progressive wave are out of phase) *Any two points, 1 mark each. Allow the reverse statement for each marking point.*	**B2**

Question	Answer	Marks
5(a)	sum of e.m.f.(s) = sum of p.d.(s) **or** (algebraic) sum of e.m.f.(s) and p.d.(s) is zero	**M1**
	around a loop / around a closed circuit	**A1**
5(b)(i)	$1 / r_{(T)} = 1 / 0.59 + 1 / 0.59 + 1 / 0.59$	**B1**
	$(r_{(T)} =)$ 0.197 (Ω) $(R =)$ 2.2 – 0.197 = 2.0 Ω	**A1**
	or	
	I = 1.5 / 2.2 (= 0.68 A) **and** i = 0.68 / 3 (where I is the circuit current and i is the current from each cell)	**(B1)**
	$(E = IR + ir =)$ 1.5 = 0.68R + (0.68 / 3) × 0.59 **and** R = 2.0 Ω	**(A1)**

Question	Answer	Marks
5(b)(ii)	current = 1.5 / 2.2	**C1**
	= 0.68 A	**A1**
	or	
	p.d. across cell = p.d. across conductor $1.5 - 0.59I = 3I \times 2.0$ so $I = 0.228$ A (where I is current in cell) current = 3×0.228	**(C1)**
	= 0.68 A	**(A1)**
	or	
	current in conductor = 3 × current in cell $V / 2.0 = 3 \times (1.5 - V) / 0.59$ (where V is p.d. across conductor) $V = 1.37$ V current = 1.37 / 2.0	**(C1)**
	= 0.68 A	**(A1)**
5(c)(i)	$R = \rho L / A$	**C1**
	$R = 4\rho L / \pi d^2$ (ρ and L are the same so) $R_A / R_B = 7.6^2 / 4.3^2$	**C1**
	= 3.1	**A1**

Question	Answer	Marks
5(c)(ii)	$I = Anvq$ and I, n, q are same / equal / constant	**B1**
	$\dfrac{v_A}{v_B} = \dfrac{A_B}{A_A} = \dfrac{d_B^{\;2}}{d_A^{\;2}}$ ratio = $7.6^2 / 4.3^2$ = 3.1	**A1**
5(d)	combined internal resistance (of the cells) will be greater **or** total / circuit resistance (of circuit) greater (because a parallel resistance removed)	**B1**
	more ‘lost volts’ (inside each cell) **or** internal resistances take a greater share of total p.d. **or** conductor gets a smaller share of the total p.d. **or** current in <u>conductor</u>/total current decreases	**M1**
	(so) potential difference (across conductor) decreases	**A1**

Question	Answer	Marks
6(a)	${}^{14}_{7}X$	**B1**
	${}^{0}_{-1}e^{-}$	**B1**
6(b)(i)	$d \rightarrow u + e^{-} + \overline{\nu}$ **or** $udd \rightarrow uud + e^{-} + \overline{\nu}$	**B1**
6(b)(ii)	–1 / 3 (e) = + 2 / 3 (e) – 1(e) (+ 0) **or** 2 / 3 (e) – 1 / 3 (e) – 1 / 3 (e) = 2 / 3 (e) + 2 / 3 (e) – 1 / 3 (e) – 1 (e) (+ 0)	**B1**
6(c)(i)	electrons / β-particles (emitted from the nucleus) have a (continuous) range of / different (kinetic) energies	**B1**
6(c)(ii)	the (emitted) neutrinos take varying amounts of the (same total) energy (released in the decay)	**B1**