CAMBRIDGE
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PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **February/March 2024**

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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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)	current and mass only ticked	**A1**
1(b)	(power =) work (done) / time	**C1**
	units of power $= J\,s^{-1}$ $= kg\,m^2\,s^{-2} / s$ $= kg\,m^2\,s^{-3}$	**A1**
1(c)	power = intensity × area	**C1**
	$= 950 \times 2.2 \times 10^{-4}$	**C1**
	$= 0.21\,W$	**A1**

Question	Answer	Marks
2(a)	rate of change of velocity	**B1**
2(b)	$\frac{1}{2} m(\Delta)v^2 = mg(\Delta)h$	**C1**
	$v^2 = 5.9^2 + 2 \times 9.81 \times 7.8$ $v^2 = 188$	**C1**
	$v = 14\ \text{m s}^{-1}$	**A1**
	or by resolving components Vertically: $v^2 = u^2 + 2as$ $v^2 = (5.9\sin 60)^2 + 2 \times -9.81 \times (1.2 - 9.0)$ $v_v = 13.4$	**(C1)**
	horizontally: $v_h = 5.9\cos 60$ $v_h = 2.95$	**(C1)**
	resultant velocity $= \sqrt{(13.4^2 + 2.95^2)}$ $= 14\ \text{m s}^{-1}$	**(A1)**
2(c)(i)	(As the diver moves down their) speed decreases	**B1**
	(So) viscous force / drag (force) decreases	**B1**
2(c)(ii)	$(F =) \rho g V$ $= 1000 \times 9.81 \times 7.5 \times 10^{-2} = 740$ (N)	**A1**

Question	Answer	Marks
2c(iii)	resultant force = 740 + 950 – (78 × 9.81) = 925	**C1**
	acceleration = F / m	**C1**
	= 925 / 78 = 12 m s^{-2}	**A1**
	(vertically) upwards	**B1**

Question	Answer	Marks
3(a)(i)	$\sigma = 0.72 \times 10^9$	**C1**
	force = $\sigma \times A$ = $0.72 \times 10^9 \times \pi \times (1.2 \times 10^{-3} / 2)^2$	**C1**
	= 810 N	**A1**
	or Young modulus = gradient of graph e.g. = $0.80 \times 10^9 / 6.0 \times 10^{-3}$ = 1.33×10^{11}	**(C1)**
	force = Young modulus × strain × A = $1.33 \times 10^{11} \times 5.4 \times 10^{-3} \times \pi \times (1.2 \times 10^{-3} / 2)^2$	**(C1)**
	= 810 N	**(A1)**

Question	Answer	Marks
3(a)(ii)	$E_{(P)} = ½ Fx$ or $E_{(P)} = ½ kx^2$ **and** $F = kx$	**C1**
	$x = 2E_P / F$ $x = 2 \times 0.31 / 810$ $x = 7.7 \times 10^{-4}$	**C1**
	$L = x / \varepsilon$ $L = 7.7 \times 10^{-4} / 5.4 \times 10^{-3}$ $L = 0.14$ m	**A1**
	or $E_{(P)} = ½ Fx+$ or $E_{(P)} = ½ kx^2$ **and** $k = EA/L$	**(C1)**
	$x = 2E_P / EA\ \varepsilon$ $x = 2 \times 0.31 / (1.33 \times 10^{11} \times \pi \times (1.2 \times 10^{-3} / 2)^2 \times 5.4 \times 10^{-3})$ $x = 7.6 \times 10^{-4}$	**(C1)**
	$L = x / \varepsilon$ $L = 7.6 \times 10^{-4} / 5.4 \times 10^{-3}$ $L = 0.14$ m	**(A1)**
3(b)	A straight line, passing through the origin with a larger gradient than wire X.	**M1**
	Gradient of the line is twice the gradient of wire X.	**A1**

Question	Answer	Marks
4(a)	$^{4}_{2}\alpha$	**B1**
	$^{211}_{82}Q$	**B1**
4(b)(i)	**sum / total** momentum (of a system of bodies) is constant **or** **sum / total** momentum before = **sum / total** momentum after	**M1**
	for an isolated system / no (resultant) **external** force	**A1**
4(b)(ii)	$p_\alpha = p_P - p_Q$ $4(u)v = 215(u) \times 3.2 \times 10^5 (- 0)$ $v = 215(u) \times 3.2 \times 10^5 / 4(u)$	**C1**
	$v = 1.7 \times 10^7$ m s^{-1}	**A1**

Question	Answer	Marks
5(a)	vibrations / oscillations (of the particles / wave) are perpendicular to the direction (of the propagation of energy)	**B1**
5(b)	infrared	**B1**
5(c)	$T = 6 \times 5.0 \times 10^{-15}$ $T = 3.0 \times 10^{-14}$	**C1**
	$\lambda = c\,T$ **or** $\lambda = c / f$ **and** $f = 1 / T$	**C1**
	$\lambda = 3.0 \times 10^8 \times 3.0 \times 10^{-14}$ **or** $\lambda = 3.0 \times 10^8 / 3.33 \times 10^{13}$ $= 9.0 \times 10^{-6}$ m	**A1**

Question	Answer	Marks
6(a)(i)	Any three from: • Light diffracts at the (two) slits. • Light (from each slit) meets / superposes (at the screen). • When the phase difference is 0 (degrees) a bright fringe / (intensity) maximum is formed. • When the phase difference is 180 (degrees) a dark fringe / (intensity) minimum is formed.	**B3**
6(a)(ii)	$\lambda = ax / D$	**C1**
	$\lambda = 1.2 \times 10^{-3} \times (10.2 \times 10^{-3} / 6) / 3.1$	**C1**
	$\lambda = 6.6 \times 10^{-7}$ m	**A1**
6(a)(iii)	(new fringe separation will be) smaller	**B1**
6(b)(i)	A cross at the intersection of the string and the mean position line.	**B1**
6(b)(ii)	0	**A1**
6(b)(iii)	180°	**A1**

Question	Answer	Marks
7(a)	energy (transferred) per (unit) charge	**B1**
7(b)	V = 0.25 × 6 =1.5	**C1**
	$Ir = E - IR$ Ir = 1.8 – 1.5 = 0.3	**C1**
	r = 0.3 / 0.25 = 1.2 Ω	**A1**
	or (Total) R = 1.8 / 0.25 = 7.2 $E / I = (R + r)$	**(C1)**
	1.8/0.25 = 6 + r	**(C1)**
	r = 7.2 – 6 = 1.2 Ω	**(A1)**
7(c)(i)	The same	**B1**
7(c)(ii)	Any 3 from: • before t_1 / when current constant, the (total) resistance is constant • at t_1 / when current increases, the (total) resistance decreases (due to decrease of external resistance) • (after t_1) temperature (of lamp) increases (so the resistance of the lamp increases) • (after t_1) resistance **of lamp** increases (so total resistance increases so the current in the ammeter decreases)	**B3**

Question	Answer	Marks
8(a)	lepton(s)	**B1**
8(b)(i)	up or top or charm	**B1**
8(b)(ii)	meson(s)	**B1**
8(c)(i)	β^- (particle) **or** electron	**B1**
8(c)(ii)	equal	**B1**
8(c)(iii)	(the charge of) R is greater (than Q)	**B1**