Cambridge International AS & A Level

PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **May/June 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.

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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)	charge underlined (and no others)	**B1**
1(b)(i)	$I = P / A$	**C1**
	$= 750 / (1300 \times 10^{-3})^2$	**C1**
	$= 440\ \text{W m}^{-2}$	**A1**
1(b)(ii)	percentage uncertainty $= 3 + 2 \times (5 / 1300) \times 100$	**C1**
	$= 3 + 2 \times 0.38$ $= (\pm)\ 4\%$	**A1**
1(b)(iii)	efficiency = useful output power / total input power $= (160 / 750) \times 100$ $= 21\%$	**A1**
1(b)(iv)	area (of the new panel) is less	**B1**
	input power (of the new panel) is less (than the input power of the original panel) (as intensity is constant)	**B1**
	(useful power output is unchanged so) efficiency is greater (than the original panel)	**B1**

Question	Answer	Marks
2(a)(i)	39 $m\,s^{-1}$	**A1**
2(a)(ii)	tangent line to curve drawn on Fig. 2.1	**C1**
	a = gradient of tangent line = $\Delta v / \Delta t$ e.g. = (44 – 26) / (18 – 0) $0.9 \leqslant a \leqslant 1.1\ m\,s^{-2}$	**A1**
2(b)	$(\Sigma)F = 68 \times 9.81 - 1800$ (= –1133 N)	**C1**
	$a = (\Sigma)F / m = -1133 / 68$ = (–)17 $m\,s^{-2}$	**A1**
	upwards	**B1**
2c(i)	drag force decreases (as speed decreases)	**B1**
	(as speed decreases) resultant force decreases so (magnitude of) acceleration decreases (to zero)	**B1**
2(c)(ii)	$(\Delta)p = m\Delta v$ **or** $(\Delta)p = m(v - u)$	**C1**
	= 68 × (5.7 – 39) = (–)2300 N s	**A1**

Question	Answer	Marks
3(a)	$Q = It$	**C1**
	$= 3.3 \times 10^4 \times 2.6 \times 10^{-5}$ $= 0.86$ C	**A1**
3(b)	$P = IV$ **or** $P = VQ / t$ **or** $V = IR$ **and** $P = V^2/R$ **or** $P = I^2R$	**C1**
	$P = 3.3 \times 10^4 \times 3.0 \times 10^7$ **or** $P = (3.0 \times 10^7 \times 0.86) / (2.6 \times 10^{-5})$ **or** $P = (3.0 \times 10^7)^2 / 910$ **or** $P = (3.3 \times 10^4)^2 \times 910$ $P = 9.9 \times 10^{11}$ (W) $= 990$ GW	**A1**
3(c)(i)	$R = \rho L / A$	**C1**
	$9.6 = 1.7 \times 10^{-8} \times 95 / \pi r^2$	**C1**
	$r = 2.3 \times 10^{-4}$ m	**A1**
3(c)(ii)	(resistance) decreases by a factor of four	**A1**

Question	Answer	Marks
3(d)	$E = \sigma / \varepsilon$	**C1**
	$x = \sigma L / E$ $= 1.9 \times 10^6 \times 0.12 / (1.3 \times 10^{11})$	**C1**
	$= 1.8 \times 10^{-6}$ m	**A1**

Question	Answer	Marks
4(a)	$E = ½kx^2$ **or** $E = ½Fx$ **and** $F = kx$	**C1**
	$E = ½ \times 29 \times (8.0 \times 10^{-2})^2$ **or** $E = ½ \times 2.32 \times 8.0 \times 10^{-2}$ $E = 9.3 \times 10^{-2}$ J	**A1**
4(b)(i)	$(\Delta)E_{(P)} = mg(\Delta)h$	**C1**
	$= 4.5 \times 10^{-2} \times 9.81 \times 8.0 \times 10^{-2} \sin 15°$	**C1**
	$= 9.1 \times 10^{-3}$ J	**A1**
4(b)(ii)	$E_{(K)} = ½mv^2$	**C1**
	$(9.3 \times 10^{-2} - 9.1 \times 10^{-3}) = ½ \times 4.5 \times 10^{-2} \times v^2$	**C1**
	$v = (2 \times 8.4 \times 10^{-2} / 4.5 \times 10^{-2})^{0.5}$ $= 1.9\ \text{m s}^{-1}$	**A1**
4(c)(i)	$1.7 \times 2.0\ (\times 10^{-2})$ **or** $4.5 \times 10^{-2} \times 9.81 \times d$	**C1**
	$1.7 \times 2.0 \times 10^{-2} = 4.5 \times 10^{-2} \times 9.81 \times d$ $d = 7.7 \times 10^{-2}$ m	**A1**
4(c)(ii)	clockwise	**B1**

Question	Answer	Marks
5(a)	sum of electromotive force(s) = sum of potential difference(s) around a (closed) loop.	**B1**
5(b)(i)	$R = V / I$	**C1**
	$= (9.0 - 4.0) / 1.1 \times 10^{-2}$ $= 450\,\Omega$	**A1**
5(b)(ii)	resistance (of thermistor) = 25 (Ω) (from graph)	**C1**
	$V = E \times R_Y / (R_Y + R_X)$ $= 9 \times 25 / (25 + 450)$ **or** $I = E / R_{Total} = 9 / (25 + 450) = 1.89 \times 10^{-2}$ A $V = IR = 1.89 \times 10^{-2} \times 25$ **or** $V_{(X)} = 9 \times 450 / (25 + 450) = 8.53$ V $V = 9 - 8.53$	**C1**
	$V = 0.47$ V	**A1**
5(b)(iii)	(resistance of X increases so) the <u>total</u> resistance increases	**B1**
	current decreases	**B1**
	potential difference (across thermistor / Y) decreases	**B1**

Question	Answer	Marks
6(a)	$n\lambda = d\sin\theta$	C1
	$n = (3.8 \times 10^{-6} \times \sin 90°) / (520 \times 10^{-9})$ (= 7.3)	C1
	number of bright fringes formed = 15 (given as an integer)	A1
6(b)(i)	(frequency of red light is) less (than frequency of original light)	B1
6(b)(ii)	(red light has) longer wavelength	M1
	(so) number (of bright fringes formed) is less / fewer (bright fringes are formed)	A1

Question	Answer	Marks
7(a)	meson(s) **or** hadron(s)	B1
7(b)	Q: anti-up **or** anti-charm **or** anti-top	B1
	R: up **or** charm **or** top	B1