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PHYSICS **9702/23**

Paper 2 AS Level Structured Questions **October/November 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 independent 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 mandatory 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 compensatory 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 answer marks. They may depend on an **M** mark or allow a **C** mark to be awarded by implication.

Question	Answer	Marks
1(a)	rate of change of velocity	**B1**
1(b)(i)	curved path from aircraft to ground, starting horizontal at aircraft and then with increasing negative gradient as it moves towards the ground	**B1**
1(b)(ii)	$s = ut + ½at^2$ $63 = ½ \times 9.81 \times t^2$	**C1**
	time = 3.6 s	**A1**
1(b)(iii)	$v^2 = 2 \times 9.81 \times 63$ **or** $v = 0 + (9.81 \times 3.6)$ **or** $63 = (v \times 3.6) - (½ \times 9.81 \times 3.6^2)$ **or** $63 = ½ \times (0 + v) \times 3.6$ $v = 35\ \text{m s}^{-1}$	**A1**
1(b)(iv)	$\text{speed}^2 = 35^2 + 42^2$	**C1**
	speed = $55\ \text{m s}^{-1}$	**A1**

Question	Answer	Marks
2(a)	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**
2(b)(i)	$240 \times 16 = 480v$ and so $v = 8.0\ \text{m s}^{-1}$ **or** (initial momentum =) 240×16 (= $3840\ \text{g m s}^{-1}$) **and** $v = 3840 / 480 = 8.0\ \text{m s}^{-1}$	**A1**
2(b)(ii)	(E_K =) $\frac{1}{2} mv^2$	**C1**
	$\Delta E_K = \frac{1}{2}[(0.24 \times 16^2) - (0.48 \times 8.0^2)]$	**C1**
	= 15 J	**A1**
2(c)(i)	$F = (0.24 \times 16) / (2.0 \times 10^{-3})$ **or** $F = (0.48 \times 8) / (2.0 \times 10^{-3})$	**C1**
	= 1900 N	**A1**
	direction: to the left	**B1**
2(c)(ii)	equal (magnitude)	**B1**
	opposite (direction)	**B1**

Question	Answer	Marks
3(a)	(for a system in equilibrium,) sum of clockwise moments (about a point) equals sum of anticlockwise moments (about the same point)	**B1**
3(b)(i)	2.6×0.40 **or** $F \times 0.40$ (any one moment)	**C1**
	$U = 4.0 - F$ $= 4.0 - (2.6 \times 0.40 / 0.40) = 1.4$ N	**A1**
	or	
	2.6×0.4 **or** $(4.0 - U) \times 0.4$	**(C1)**
	$2.6 \times 0.4 = (4.0 - U) \times 0.4$ hence $U = (4.0 - 2.6) = 1.4$ N	**(A1)**
3(b)(ii)	$U = \rho g V$ **and** $A = V / h$ **or** $p = h\rho g$ **and** $A = U / p$ **or** $A = U / h\rho g$	**C1**
	$A = 1.4 / (0.10 \times 1.0 \times 10^3 \times 9.81)$	**C1**
	$= 1.4 \times 10^{-3}$ m^2	**A1**
3(c)	line starting at (0.10, 0.40)	**B1**
	straight line with negative gradient	**B1**
	line ending at (0.29, 0)	**B1**

Question	Answer	Marks
4(a)(i)	(normal) force per unit cross-sectional area	**B1**
4(a)(ii)	extension per unit unstretched length	**B1**
4(b)(i)	$E = FL / Ax$	**C1**
	$A = (9.0 \times 0.84) / (1.9 \times 10^9 \times 0.47 \times 10^{-3})$	**C1**
	$= 8.5 \times 10^{-6}\ \text{m}^2$	**A1**
4(b)(ii)	*F*, *L* and *x* are all the same (for both wires / as in X) **or** *F* and strain are the same	**B1**
	A is greater (for Y), so the Young modulus (for Y) is less than 1.9×10^9 Pa **or** less than that of wire X	**B1**

Question	Answer	Marks
5(a)(i)	cross labelled N marked at the intersection of the solid and dashed lines or at X or Y **and** cross labelled A marked at a peak or a trough	**B1**
5(a)(ii)	(XY is 1.5 wavelengths, so) wavelength = 0.48 × (2 / 3) = 0.32 m **or** (wavelength is twice node–node distance so) $\lambda / 2 = 0.48 / 3 = 0.16$ m and wavelength = 0.16 × 2 = 0.32 m	**B1**
5(a)(iii)	$v = f\lambda$	**C1**
	frequency = 1400 / 0.32 = 4400 Hz	**A1**
5(b)(i)	$f_o = f_s v / (v - v_s)$ $f_o = (780 \times 320) / (320 - 39)$	**C1**
	maximum frequency = 890 Hz	**A1**
5(b)(ii)	line showing *f* varying both above and below a mean frequency and returning to the original start value of *f*	**B1**
	a single cycle of a smoothly oscillating curve of correct phase (starting at mean position, falling to a trough, then rising to a peak, ending at mean position)	**B1**

Question	Answer	Marks
6(a)	potential difference per unit current	**B1**
6(b)(i)	$\rho = RA / L$	**C1**
	$= (0.33 \times 8.0 \times 10^{-6}) / 2.4$ $= 1.1 \times 10^{-6}\ \Omega\,\text{m}$	**A1**
6(b)(ii)	$Q = It$	**C1**
	$= 4.7 \times 5.0 \times 60$ $= 1400\ \text{C}$	**A1**
6(b)(iii)	$I = nAvq$ $n = 4.7 / (8.0 \times 10^{-6} \times 0.16 \times 10^{-3} \times 1.60 \times 10^{-19})$	**C1**
	$= 2.3 \times 10^{28}\ \text{m}^{-3}$	**A1**
6(c)(i)	correct symbols for resistor and thermistor, shown correctly connected in series with the battery	**B1**
6(c)(ii)	(as temperature increases) resistance of thermistor decreases	**M1**
	(total resistance decreases so) greater current (in circuit/wire) so power (dissipated in the wire) increases **or** (total resistance decreases so) greater (share of) p.d. across wire so power (dissipated in the wire) increases	**A1**

Question	Answer	Marks
7(a)	up quark charge = (+) 2 / 3 **and** down quark charge = –1 / 3	**B1**
	strange quark charge = –1 / 3	**B1**
	up antiquark charge = –2 / 3 **and** down antiquark charge = (+) 1 / 3 **and** strange antiquark charge = (+) 1 / 3	**B1**
7(b)(i)	hadron(s)	**B1**
7(b)(ii)	baryons composed of three quarks **or** baryons composed of three antiquarks	**B1**
	mesons composed of one quark and one antiquark	**B1**
7(c)	up quark changes to a down quark	**B1**
	positron and (electron) neutrino (emitted)	**B1**

