CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/23**

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.

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

Cambridge International is publishing the mark schemes for the May/June 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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 method 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)	units of F: kg m s^{-2}	**C1**
	units of r: m and units of v: m s^{-1} units of η: kg m s^{-2} / (m × m s^{-1}) = kg m^{-1} s^{-1}	**A1**
1(b)	viscosity = 0.096 / (6 × π × 0.03 × 2.0)	**C1**
	= 0.085 kg m^{-1} s^{-1}	**A1**
1(c)	one arrow vertically downwards labelled weight / W	**B1**
	arrow(s) vertically upwards labelled U / upthrust **and** drag / F_D / viscous force	**B1**
1(d)(i)	$V = (4 / 3) \pi r^3$	**C1**
	upthrust = (4 / 3) × π × 0.03^3 × 920 × 9.81 = 1.0 N	**A1**
1(d)(ii)	weight = 1.0 + 0.096 (= 1.096 N)	**C1**
	m = 1.096 / 9.81 = 0.11 kg	**A1**

Question	Answer	Marks
2(a)	distance (from the point) in a straight line in a given direction	**B1**
2(b)(i)	distance = speed × time = 6.0 × 0.71 = 4.3 m	**A1**
2(b)(ii)	$s = ut + \frac{1}{2}at^2$ $= \frac{1}{2} \times 9.81 \times 0.71^2$	**C1**
	= 2.5 m	**A1**
2(b)(iii)	$\tan\theta = 2.5 / 4.3$ **or** hypotenuse $= \sqrt{(4.3^2 + 2.5^2)}$ (= 4.97 m) $\cos\theta = 4.3 / 4.97$ **or** $\sin\theta = 2.5 / 4.97$	**C1**
	$\theta = 30°$	**A1**

Question	Answer	Marks
2(b)(iv)	displacement = $\sqrt{(4.3^2 + 2.5^2)}$	**C1**
	= 4.9 m or 5.0 m	**A1**
	or	
	displacement = 2.5 / sin 30°	**(C1)**
	or	
	displacement = 4.3 / cos 30°	
	= 5.0 m	**(A1)**
2(b)(v)	KE = $\frac{1}{2}mv^2$ **or** GPE = mgh	**C1**
	initial KE + loss in GPE = final KE	**C1**
	$(\frac{1}{2} \times m \times 6.0^2) + (m \times 9.81 \times 2.5) = (\frac{1}{2} \times m \times v^2)$	
	v = 9.2 m s^{-1}	**A1**

Question	Answer	Marks
3(a)	extension is proportional to (applied) force	**B1**
3(b)(i)	P at (60, 5.4)	**A1**
3(b)(ii)	E at (80, 5.9)	**A1**
3(c)(i)	$k = F / x$ **or** k = gradient of (straight line section of) graph	**C1**
	e.g. gradient = 5.4 / 0.060 $k = 90\ \text{N m}^{-1}$	**A1**
3(c)(ii)	Young modulus or $E = \sigma / \varepsilon$ **or** FL / Ax **or** kL / A	**C1**
	$E = (5.4 \times 3.2) / (4.0 \times 10^{-7} \times 0.06)$ **or** $90 \times 3.2 / (4.0 \times 10^{-7})$	**C1**
	$E = 7.2 \times 10^{8}\ \text{Pa}$	**A1**
3(d)	work done = area under graph	**B1**
	$= (1.0 \pm 0.2)\ \text{J}$	**A1**
3(e)	the extension will be smaller (for the same force on the thicker sample) **or** a greater force is required (to extend the thicker sample by the same amount) **or** spring constant is proportional to area	**M1**
	the spring constant (of the second sample) will be greater	**A1**

Question	Answer	Marks
4(a)	270°	**A1**
4(b)	arrow pointing vertically downwards at T	**A1**
4(c)	$v = f\lambda$ **or** $v = \lambda / T$ **and** $f = 1 / T$	**C1**
	wavelength $= 0.62 \times 10^{-2} \times (4 / 3)$ $(= 0.83 \times 10^{-2}$ m)	**C1**
	$f = 0.27 / (0.83 \times 10^{-2})$ $= 33$ Hz	**A1**
4(d)	resultant displacement is the sum of the displacements of the waves (from S_1 and S_2) **or** waves (from S_1 and S_2) superpose (at P)	**B1**
	Any one point from: • (at P) the waves (from the two sources) (always) destructively interfere • (at P) the waves have a path difference that is (always) an odd number of half-wavelengths / their path difference is one and a half wavelengths • (at P) the waves have a phase difference that is (always) 180° / they are in antiphase / crest of one wave meets trough of other wave	**B1**
	amplitude (of the resultant wave) is zero (at all times)	**B1**

Question	Answer	Marks
5(a)(i)	sum of electromotive force(s) = sum of potential difference(s) around a (closed) loop **or** the (algebraic) sum of the p.d.(s) and e.m.f.(s) is zero around a (closed) loop	**B1**
5(a)(ii)	(law of conservation of) energy	**B1**
5(b)(i)	(by Kirchhoff's first law) $I = I_1 + I_2$	**B1**
	$V / R_T = V / R_1 + V / R_2$ therefore $1 / R_T = 1 / R_1 + 1 / R_2$	**B1**
5(b)(ii)	resistance of parallel combination $= (15 \times 10) / (15 + 10)$ $(= 6.0\,\Omega)$	**C1**
	$r = (E - V) / I$	**C1**
	$I = 1.38 / 6.0 = 0.23$ A $r = (1.50 - 1.38) / 0.23$ $= 0.52\,\Omega$	**A1**
	or	
	(by potential divider principle) $r / R_T = Ir / V$	**(C1)**
	$r / 6.0 = 0.12 / 1.38$ $r = 0.52\,\Omega$	**(A1)**
	or	
	(by potential divider equation) $V = E \times R_T / (R_T + r)$	**(C1)**
	$1.38 = 1.5 \times 6.0 / (6.0 + r)$ $r = 0.52\,\Omega$	**(A1)**

Question	Answer	Marks
5(c)(i)	as the (total) resistance has decreased (and e.m.f. is unchanged)	**M1**
	current will (in the cell) increase	**A1**
5(c)(ii)	(as greater current means a) bigger drop in p.d. across the internal resistance	**M1**
	p.d. (on voltmeter) will decrease	**A1**

Question	Answer	Marks
6(a)	$^{147}_{62}\text{Sm}$	**A1**
6(b)(i)	the (kinetic) energy of the particles is discrete / has only one value (so must be alpha)	**B1**
	and beta particles have a (continuous) range of (kinetic) energies (so can't be beta)	**B1**
6(b)(ii)	$^{147}_{62}\text{Sm} \rightarrow {}^{143}_{60}\text{Nd} + {}^{4}_{2}\alpha$ values for Sm and Nd correct with no other extra particles on either side of the equation	**A1**
	$^{4}_{2}\alpha$ correct	**A1**
6(c)(i)	up quark charge is +(2 / 3) (*e*) **or** bottom quark charge is –(1 / 3) (*e*)	**C1**
	0 = +(2 / 3) (*e*) – (1 / 3) (*e*) + *q* (so) charge (on third quark must be) –(1 / 3) (*e*)	**A1**
6(c)(ii)	down **or** strange	**A1**