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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

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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° **or** displacement = 4.3 / cos 30°	**(C1)**
	= 5.0 m	**(A1)**
2(b)(v)	KE = $\frac{1}{2}mv^2$ **or** GPE = mgh	**C1**
	initial KE + loss in GPE = final KE $(\frac{1}{2} \times m \times 6.0^2) + (m \times 9.81 \times 2.5) = (\frac{1}{2} \times m \times v^2)$	**C1**
	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**