Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **October/November 2021**

MARK SCHEME

Maximum Mark: 60

Published

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Question	Answer	Marks
1(a)	mass / volume	**B1**
1(b)(i)	(vernier/digital) calipers	**B1**
1(b)(ii)	percentage uncertainty $= (0.0004 / 0.0420) \times 100$ $= 1\%$	**A1**
1(c)(i)	$\text{kg m}^{-3} = \text{kg} \times \text{m}^n / \text{m}$ **or** $\text{kg m}^{-3} = \text{kg} \times \text{m}^n \times \text{m}^{-1}$	**M1**
	$-3 = n - 1$ and (so) $n = -2$	**A1**
1(c)(ii)	$(\Delta\rho / \rho) = (\Delta M / M) + 2(\Delta r / r) + (\Delta L / L)$	**C1**
	percentage uncertainty $= [(0.001 / 1.072) + 2 \times (0.0004 / 0.0420) + (0.0001 / 0.1242)]$ $(\times 100)$	**C1**
	$= 0.09\% + 2 \times 0.95\% + 0.08\%$ $= 2\%$	**A1**
1(c)(iii)	$\rho = (1.072 \times 0.0420^{-2}) / (2.094 \times 0.1242)$ $= 2337$ (kg m^{-3})	**C1**
	$\Delta\rho = 0.021 \times 2337$ $= 49$ (kg m^{-3})	**C1**
	$\rho = (2340 \pm 50)\ \text{kg m}^{-3}$	**A1**

Question	Answer	Marks
2(a)	mass × velocity	**B1**
2(b)(i)	kinetic energy = $\frac{1}{2}mv^2$	**C1**
	= $\frac{1}{2} \times 0.24 \times 2.3^2$	**C1**
	= 0.63 J	**A1**
2(b)(ii)	change in momentum = $\frac{1}{2} \times 240 \times 5.0 \times 10^{-3}$	**C1**
	= 0.60 N s	**A1**
2(b)(iii)	(change in velocity of Y) = 0.60 / 0.12 (= 5.0 m s^{-1})	**C1**
	final velocity of Y = 5.0 – 2.3 = 2.7 m s^{-1}	**A1**
	or	
	(final momentum of Y) = 0.60 – 0.12 × 2.3 (= 0.324 N s)	**(C1)**
	final velocity of Y = 0.324 / 0.12 = 2.7 m s^{-1}	**(A1)**
2(c)	sloping straight line from (0, 0) to t = 3.0 ms **and** another straight line continuous with the first from t = 3.0 ms to (5.0, 0)	**B1**
	lines showing maximum force of magnitude 240 N	**B1**
	lines wholly in the negative F region of the graph	**B1**

Question	Answer	Marks
3(a)(i)	$\sigma = F / xy$	**B1**
3(a)(ii)	$\varepsilon = (z - w) / w$	**B1**
3(a)(iii)	$E = \sigma / \varepsilon$	**C1**
	$= Fw / xy(z - w)$	**A1**
3(b)(i)	extension = 2.2 mm (*allow* 2.0–2.4 mm)	**A1**
3(b)(ii)	strain energy = area under graph/line **or** $\frac{1}{2}Fx$ **or** $\frac{1}{2}kx^2$	**C1**
	$= \frac{1}{2} \times 120 \times 1.4 \times 10^{-3}$ **or** $\frac{1}{2} \times 8.6 \times 10^{4} \times (1.4 \times 10^{-3})^2$	**C1**
	= 0.084 J	**A1**
3(b)(iii)	(some of the) deformation of the wire is plastic/permanent/not elastic **or** wire goes past the elastic limit/enters plastic region	**B1**
	energy (that cannot be recovered) is dissipated as thermal energy/becomes internal energy	**B1**

Question	Answer	Marks
4(a)	oscillations (of particles) are parallel to (the direction of) energy transfer	**B1**
4(b)(i)	(frequency varies as) vehicle moves relative to (stationary) observer	**C1**
	(vehicle) moving towards (observer) gives higher (observed) frequency (than 1.2 kHz) <u>and</u> (vehicle) moving away (from observer) gives lower (observed) frequency (than 1.2 kHz)	**A1**
4(b)(ii)	Doppler effect	**B1**
4(b)(iii)	position of vehicle labelled ‘X’ at top (12 o’clock) position on track	**B1**
4(b)(iv)	position of vehicle labelled ‘Y’ at right-hand edge (3 o’clock) position on track	**B1**
4(c)	maximum frequency = 1.40 (kHz) **or** 1.40×10^3 (Hz)	**C1**
	$1.40 = (1.2 \times 320) / (320 - v)$	**C1**
	$v = 46\ \text{m s}^{-1}$	**A1**
	or	
	minimum frequency = 1.05 (kHz) **or** 1.05×10^3 (Hz)	**(C1)**
	$1.05 = (1.2 \times 320) / (320 + v)$	**(C1)**
	$v = 46\ \text{m s}^{-1}$	**(A1)**

Question	Answer	Marks
5(a)	sum of current(s) in = sum of current(s) out **or** (algebraic) sum of current(s) is zero	**M1**
	at a junction (in a circuit)	**A1**
5(b)(i)	(current in R_4 or R_1 =) 0.30 + 0.30 (= 0.60 A)	**B1**
	(R =) 2.4 / 0.60 = 4.0 (Ω)	**A1**
	or	
	(p.d. across R_3 or R_2 =) 2.4 / 2 (= 1.2 V)	**(B1)**
	(R =) 1.2 / 0.30 = 4.0 (Ω)	**(A1)**
5(b)(ii)	E = 2.4 + 2.4 + 1.2	**C1**
	= 6.0 V	**A1**
	or	
	total resistance = 10 (Ω)	**(C1)**
	E = 10 $\times$ 0.60 = 6.0 V	**(A1)**
5(c)	total resistance increases	**B1**
	current decreases (in battery) so total power decreases	**B1**

Question	Answer	Marks
5(d)	resistivity = *RA* / *L*	**C1**
	$= 4.0 \times \pi \times (240 \times 10^{-6})^2 / 0.67$	**C1**
	$= 1.1 \times 10^{-6}\ \Omega\ \text{m}$	**A1**

Question	Answer	Marks
6(a)	α-particle mass given as 4u	**B1**
	α-particle charge given as (+)2*e*	**B1**
	both β-particles mass given as 0.0005 u	**B1**
	β^+ charge given as (+)*e* and β^- charge given as –*e* (Completed table: | | mass / u | charge / *e* | | α | 4 | (+)2 | | β^+ | 0.0005 | (+)1 | | β^- | 0.0005 | –1 |)	**B1**
6(b)(i)	neutron decays into proton and an electron / β^- particle	**B1**
6(b)(ii)	down to up	**B1**
6(b)(iii)	(electron) antineutrino(s) emitted	**B1**
	energy (released in decay)/momentum shared between antineutrino and β^- particle	**B1**