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**PHYSICS**

**9702/22**

Paper 2 AS Level Structured Questions

**October/November 2017**

MARK SCHEME

Maximum Mark: 60

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**Published**

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Question	Answer	Marks
1(a)(i)	micrometer (screw gauge)/digital calipers	<b>B1</b>
1(a)(ii)	take several readings (and average)	<b>M1</b>
	along the wire <b>or</b> around the circumference	<b>A1</b>
1(b)(i)	$\sigma = 4 \times 25 / [\pi \times (0.40 \times 10^{-3})^2] = 1.99 \times 10^8 \text{ N m}^{-2}$ <b>or</b> $\sigma = 25 / [\pi \times (0.20 \times 10^{-3})^2] = 1.99 \times 10^8 \text{ N m}^{-2}$	<b>A1</b>
1(b)(ii)	$\%F = 2\%$ <b>and</b> $\%d = 5\%$  <b>or</b> $\Delta F / F = \frac{0.5}{25}$ <b>and</b> $\Delta d / d = \frac{0.02}{0.4}$	<b>C1</b>
	$\%\sigma = 2\% + (2 \times 5\%)$ <b>or</b> $\%\sigma = [0.02 + (2 \times 0.05)] \times 100$  $\%\sigma = 12\%$	<b>A1</b>
1(b)(iii)	absolute uncertainty = $(12/100) \times 1.99 \times 10^8$  = $2.4 \times 10^7$	<b>C1</b>
	$\sigma = 2.0 \times 10^8 \pm 0.2 \times 10^8 \text{ N m}^{-2}$ <b>or</b> $2.0 \pm 0.2 \times 10^8 \text{ N m}^{-2}$	<b>A1</b>

Question	Answer	Marks
2(a)	force $\times$ <u>perpendicular</u> distance (of line of action of force) to/from a point	<b>B1</b>
2(b)(i)	$2.4r$ <b>or</b> $(1.2 \times 2r)$ <b>or</b> $(1.2r + 1.2r)$	<b>A1</b>
2(b)(ii)	(anticlockwise moment =) $6.0 \times r/2 \times \sin \theta$	<b>C1</b>
	$6.0 \times r/2 \times \sin \theta = 2.4r$ $\theta = 53^\circ$	<b>A1</b>
2(b)(iii)	6.0 N	<b>A1</b>

Question	Answer	Marks
3(a)	$p = 1000 \times 9.81 \times 7.0 \times 10^{-2}$ <b>or</b> $1000 \times 9.81 \times 1.9 \times 10^{-2}$	<b>C1</b>
	$\Delta p = 1000 \times 9.81 \times (7.0 \times 10^{-2} - 1.9 \times 10^{-2})$ <b>or</b> $686 - 186$ $= 500 \text{ Pa}$	<b>A1</b>
3(b)	$F = pA$ <b>or</b> $(\Delta)F = \Delta p \times A$	<b>C1</b>
	upthrust = $500 \times (5.1 \times 10^{-2})^2 = 1.3 \text{ N}$ <b>or</b> upthrust = $(686 - 186) \times (5.1 \times 10^{-2})^2 = 1.3 \text{ N}$ <b>or</b> upthrust = $1000 \times 9.81 \times 5.1 \times 10^{-2} \times (5.1 \times 10^{-2})^2 = 1.3 \text{ N}$	<b>A1</b>
3(c)	force = $4.0 - 1.3$ $= 2.7 \text{ N}$	<b>A1</b>

Question	Answer	Marks
3(d)	extension/x/e = 2.7/30	<b>C1</b>
	= 0.09 (m) <b>or</b> 9 (cm)	<b>C1</b>
	height above surface = 9 – 7 = 2 cm	<b>A1</b>
3(e)(i)	mass = 4.0/9.81	<b>C1</b>
	acceleration = 2.7/(4.0/9.81) = 6.6 ms <sup>-2</sup>	<b>A1</b>
3(e)(ii)	viscous force <u>increases</u> (and then becomes constant)	<b>M1</b>
	(weight and upthrust constant so) acceleration decreases (to zero)	<b>A1</b>

Question	Answer	Marks
4(a)	(two) waves travelling (at same speed) in opposite directions overlap	<b>B1</b>
	waves (are same type and) have same frequency/wavelength	<b>B1</b>
4(b)(i)	5	<b>A1</b>
4(b)(ii)	$T = 1/40 (= 2.5 \times 10^{-2})$	<b>C1</b>
	time taken = $2.5 \times 10^{-2} / 2$ $= 1.3 \times 10^{-2} \text{ s } (1.25 \times 10^{-2} \text{ s})$	<b>A1</b>
4(b)(iii)	$180^\circ$	<b>A1</b>
4(b)(iv)	$v = f\lambda$	<b>C1</b>
	$\lambda = 2.0/2.5 (= 0.80 \text{ m})$ $v = 0.80 \times 40$ $= 32 \text{ m s}^{-1}$	<b>A1</b>

Question	Answer	Marks
5(a)	(coulomb is) ampere second	<b>B1</b>
5(b)(i)	$E = V/d$ <b>or</b> $E = F/Q$	<b>C1</b>
	$F = VQ/d$	<b>A1</b>
	$F = (2.0 \times 10^2 \times 8.0 \times 10^{-19})/4.0 \times 10^{-2} = 4.0 \times 10^{-15} \text{ N}$	
5(b)(ii)	arrow pointing to the left labelled 'electric force' <b>and</b> arrow pointing downwards labelled 'weight'	<b>B1</b>
5(b)(iii)	1. resultant force = $\sqrt{[(3.9 \times 10^{-15})^2 + (4.0 \times 10^{-15})^2]}$	<b>C1</b>
	$= 5.6 \times 10^{-15} \text{ N}$	<b>A1</b>
	2. angle = $\tan^{-1} (3.9 \times 10^{-15}/4.0 \times 10^{-15})$ $= 44^\circ$	<b>A1</b>
5(c)	downward sloping line from (0, 2.0)	<b>M1</b>
	magnitude of gradient of line increases with time and line ends at (T, 0)	<b>A1</b>

Question	Answer	Marks
6(a)	flow of charge carriers	<b>B1</b>
6(b)(i)	$nALe$	<b>B1</b>
6(b)(ii)	( $t$ is time taken for electrons to move length $L$ ) $I = Q/t$	<b>B1</b>
	$I = nALe/t$ or $I = nALe/(L/v)$ or $I = nAvte/t$ and $I = nAve$	<b>B1</b>
6(c)(i)	ratio = area at X/area at Y $= [\pi d^2/4]/[\pi(0.69d)^2/4]$ or $d^2/(0.69d)^2$ or $1/0.69^2$	<b>C1</b>
	$= 2.1$	<b>A1</b>
6(c)(ii)	1. $R = \rho L/A$ or $R/L \propto 1/A$	<b>C1</b>
	resistance per unit length = $1.7 \times 10^{-2} \times (\text{area at X/area at Y})$ $= 1.7 \times 10^{-2} \times 2.1$ $= 3.6 \times 10^{-2} \Omega \text{ m}^{-1}$	<b>A1</b>
	2. $P = I^2R$ or $P = V^2/R$	<b>C1</b>
	$R = 3.6 \times 10^{-2} \times 3.0 \times 10^{-3} (= 1.08 \times 10^{-4} \Omega)$ $P = 0.50^2 \times 1.08 \times 10^{-4}$ or $P = (5.4 \times 10^{-5})^2/1.08 \times 10^{-4}$ $= 2.7 \times 10^{-5} \text{ W}$	<b>A1</b>

Question	Answer	Marks
6(c)(iii)	(cross-sectional area decreases so) resistance increases	<b>M1</b>
	( $P = I^2R$ , so) power increases	<b>A1</b>

Question	Answer	Marks
7(a)	lepton(s)	<b>B1</b>
7(b)	protons: 7 <b>and</b> neutrons: 6	<b>A1</b>
7(c)	$E = \frac{1}{2}mv^2$	<b>C1</b>
	$= 0.80 \times 10^6 \times 1.60 \times 10^{-19}$	<b>C1</b>
	$= 1.28 \times 10^{-13} \text{ (J)}$	<b>A1</b>
	$v^2 = 2 \times 1.28 \times 10^{-13} / 2.2 \times 10^{-26}$ $v = 3.4 \times 10^6 \text{ m s}^{-1}$	
7(d)	an (electron) neutrino/ $\nu_{(e)}$ is also produced (and this has energy)	<b>B1</b>