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MARK SCHEME

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This document consists of **8** printed pages.

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

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

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

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

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

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

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

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

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