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MARK SCHEME

Maximum Mark: 60

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Question	Answer	Marks
1(a)	kelvin, mole, ampere, candela <i>any two</i>	B1
1(b)	use of resistivity = RA/l and $V = IR$ (to give $\rho = VA/Il$)	C1
	units of V : (work done / charge) $\text{kg m}^2 \text{s}^{-2} (\text{A s})^{-1}$	C1
	units of resistivity: $(\text{kg m}^2 \text{s}^{-3} \text{A}^{-1} \text{A}^{-1} \text{m})$ $= \text{kg m}^3 \text{s}^{-3} \text{A}^{-2}$	A1
	or	
	use of $R = \rho L/A$ and $P = I^2 R$ (gives $\rho = PA/I^2 L$)	(C1)
	units of P : $\text{kg m}^2 \text{s}^{-3}$	(C1)
1(c)(i)	units of resistivity: $(\text{kg m}^2 \text{s}^{-3} \times \text{m}^2) / (\text{A}^2 \times \text{m})$ $= \text{kg m}^3 \text{s}^{-3} \text{A}^{-2}$	(A1)
	$\rho = (RA/l)$	C1
	$= (0.03 \times 1.5 \times 10^{-6}) / 2.5$ ($= 1.8 \times 10^{-8}$)	C1
	$= 18 \text{ n}\Omega \text{ m}$	A1
1(c)(ii)	1. precision is determined by the range in the measurements/values/readings/data/results	B1
	2. metre rule measures to $\pm 1 \text{ mm}$ and micrometer to $\pm 0.01 \text{ mm}$ (so there is less (percentage) uncertainty/random error)	B1

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Question	Answer	Marks
2(a)	rate of change of displacement or change in displacement/time taken	B1
2(b)(i)	$s = ut + \frac{1}{2}at^2$	C1
	$t = [(2 \times 1.25) / 9.81]^{1/2} (= 0.5048 \text{ s})$	C1
	or	
	$v^2 = u^2 + 2as$	(C1)
	$v_{\text{vert}} = (2 \times 9.81 \times 1.25)^{1/2} (= 4.95)$	
	$t = [2s / (u + v)] = 2 \times 1.25 / 4.95 (= 0.5048 \text{ s})$	(C1)
	$v = d / t = 1.5 / 0.50(48)$	A1
	$= 3.0 (2.97) \text{ ms}^{-1}$	
2(b)(ii)	vertical velocity = at	C1
	$= 9.81 \times 0.5048 (= 4.95) \text{ [using } t = 0.50 \text{ gives } 4.9]$	
	velocity = $[(v_h)^2 + (v_v)^2]^{1/2}$	C1
	$= [(2.97)^2 + (4.95)^2]^{1/2}$	A1
	$= 5.8 (5.79) \text{ [using } t = 0.50 \text{ leads to } 5.7]$	
	direction (= $\tan^{-1} 4.95/2.97$) = 59°	A1
2(b)(iii)	kinetic energy = $\frac{1}{2}mv^2$	C1
	$= \frac{1}{2} \times 0.45 \times (5.8)^2$	A1
	$= 7.6 (7.57) \text{ J [using } t = 0.50 \text{ leads to } 7.3 \text{ J]}$	

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Question	Answer	Marks
2(b)(iv)	potential energy = mgh	C1
	= $(0.45 \times 9.81 \times 1.25)$	A1
	= 5.5 (5.52) J	
2(c)	there is KE of the ball at the start/leaving table or the ball has an initial/constant horizontal velocity or the ball has velocity at start/leaving table	B1

Question	Answer	Marks
3(a)	$E = \text{stress} / \text{strain}$ or $(F/A) / (e/l)$	C1
	= $[\text{gradient} \times 3.5] / [\pi \times (0.19 \times 10^{-3})^2]$	C1
	e.g. $E = [(40 - 5) / ([11.6 - 3.2] \times 10^{-3})] \times 3.5 / [\pi \times (0.19 \times 10^{-3})^2]$ or $[4170 \times 3.5] / [\pi \times (0.19 \times 10^{-3})^2]$	
	$E (= 1.3 \times 10^{11}) = 0.13 \text{ TPa}$ (<i>allow answers in range 0.120–0.136 TPa</i>)	A1
3(b)	a larger <u>range</u> of F required or <u>range</u> greater than 35 N	B1

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Question	Answer	Marks
4(a)	a body/mass/object continues (at rest or) at constant/uniform velocity unless acted on by a resultant force	B1
4(b)(i)	initial momentum = final momentum $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$	C1
	$0.60 \times 100 - 0.80 \times 200 = -0.40 \times 100 + v \times 200$ $v = (-) 0.3(0) \text{ m s}^{-1}$	A1
4(b)(ii)	<u>kinetic</u> energy is not conserved/is lost (but) <u>total</u> energy is conserved/constant or some of the (initial) <u>kinetic</u> energy is transformed into other forms of energy	B1

Question	Answer	Marks
5(a)	frequency is the number of vibrations/oscillations per unit time or the number of wavefronts passing a point per unit time	B1
5(b)	vibrations/oscillation of the air particles are parallel to the direction of it (the direction of travel of the sound wave)	B1
5(c)(i)	$T = 2(.0) \text{ (ms)}$	C1
	$f = 500 \text{ Hz}$	A1
5(c)(ii)	1. amplitude increases (time) period decreases 2. amplitude decreases (time) period increases <i>any 3 points</i>	B3

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Question	Answer	Marks
6(a)(i)	<u>waves</u> at (each) slit/aperture spread	B1
	(into the geometric shadow) <u>wave(s)</u> overlap/superpose/sum/meet/intersect	B1
6(a)(ii)	there is not a constant phase difference/coherence (for two separate light source(s)) or waves/light from the double slit are coherent/have a constant phase difference	B1
6(b)	$x = \lambda D / a$	C1
	$\lambda = (36 \times 10^{-3} \times 0.48 \times 10^{-3}) / (16 \times 2.4)$	C1
	$= 4.5 \times 10^{-7} \text{ m}$	A1
6(c)(i)	<u>no</u> movement of the water/water is flat/no ripples/disturbance	B1
	the path difference is 2.5λ or the phase difference is 900° or 5π rad	B1
6(c)(ii)	1. surface/water/P vibrates/ripples and as (waves from the two dippers) arrive in phase	B1
	2. surface/water/P vibrates/ripples and as amplitudes/displacements are no longer equal/do not cancel	B1

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Question	Answer	Marks
7(a)	energy transformed from <u>chemical to electrical</u> / unit charge (driven around a complete circuit)	B1
7(b)(i)	the current decreases (as resistance of Y increases)	M1
	lost volts go down (as resistance of Y increases)	M1
	p.d. AB increases (as resistance of Y increases)	A1
7(b)(ii)1.	$1.50 = 0.180 \times (6.00 + 0.200 + R_x)$	C1
	$R_x = 2.1(3) \Omega$	A1
7(b)(ii)2.	p.d. AB = $1.5 - (0.180 \times 0.200)$ or $0.18 \times (2.13 + 6.00)$	C1
	= $1.46(4) \text{ V}$	A1
7(b)(ii)3.	efficiency = (useful) power output / (total) power input or IV/IE	C1
	(= $1.46 / 1.5$) = 0.97 [0.98 if full figures used]	A1

Question	Answer	Marks
8(a)	β^- emission: neutron changes to proton (+ beta ⁻ /electron) and β^+ emission: proton changes to neutron (+ beta ⁺ /positron)	B1
	β^- emission: (electron) antineutrino also emitted and β^+ emission: (electron) neutrino also emitted	B1
8(b)	proton: up up down (and zero strange) neutron: up down down (and zero strange)	B1