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MARK SCHEME for the May/June 2015 series

9702 PHYSICS

9702/22 Paper 2 (AS Structured Questions), maximum raw mark 60

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1	(a)	(work =) force × distance or force × displacement or (W =) $F \times d$	M1	
		units of work: $\text{kg m s}^{-2} \times \text{m} = \text{kg m}^2 \text{s}^{-2}$	A1	[2]
	(b)	$(\text{p.d.} =) \dfrac{\text{work (done) or energy (transformed) (from electrical to other forms)}}{\text{charge}}$	B1	[1]
	(c)	$R = V / I$	B1	
		units of V: $\text{kg m}^2 \text{s}^{-2} / \text{A s}$ **and** units of I: A	C1	
		or		
		$R = P / I^2$ [or $P = VI$ **and** $V = IR$]	(B1)	
		units of P: $\text{kg m}^2 \text{s}^{-3}$ **and** units of I: A	(C1)	
		or		
		$R = V^2 / P$	(B1)	
		units of V: $\text{kg m}^2 \text{s}^{-2} / \text{A s}$ **and** units of P: $\text{kg m}^2 \text{s}^{-3}$	(C1)	
		units of R: $(\text{kg m}^2 \text{s}^{-2} / \text{A}^2 \text{s} =) \text{kg m}^2 \text{s}^{-3} \text{A}^{-2}$	A1	[3]
2	(a)	speed decreases/stone decelerates <u>to rest/zero</u> at 1.25 s	B1	
		speed then increases/stone accelerates (in opposite direction)	B1	[2]
	(b) (i)	$v = u + at$ (or $s = ut + ½at^2$ **and** $v^2 = u^2 + 2as$)	C1	
		$= 0 + (3.00 - 1.25) \times 9.81$	C1	
		$= 17.2\ (17.17)\ \text{m s}^{-1}$	A1	[3]
	(ii)	$s = ut + ½at^2$		
		$s = ½ \times 9.81 \times (1.25)^2$ [= 7.66]	C1	
		$s = ½ \times 9.81 \times (1.75)^2$ [= 15.02]	C1	
		(distance = 7.66 + 15.02)		
		[$v = u + at = 0 + 9.81 \times (2.50 - 1.25) = 12.26\ \text{m s}^{-1}$]		
		or		
		$s = ½ \times 9.81 \times (1.25)^2$ [= 7.66]	(C1)	
		$s = 12.26 \times 0.50 + ½ \times 9.81 \times (3.00 - 2.50)^2$ [= 7.36]	(C1)	
		(distance = 2 × 7.66 + 7.36)		
		Example alternative method:		
		$s = (v^2 - u^2) / 2a = (12.26^2 - 0) / 2 \times 9.81$ [= 7.66]	(C1)	
		$s = (v^2 - u^2) / 2a = (17.17^2 - 12.26^2) / 2 \times 9.81$ [= 7.36]	(C1)	
		(distance = 2 × 7.66 + 7.36)		

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			22.7 (22.69 or 23) m	A1	[3]
		(iii)	(s = 15.02 – 7.66 =) 7.4 (7.36) m *(ignore sign in answer)*	A1	
			down	A1	[2]
	(c)		straight line from positive value of v to t axis	M1	
			same straight line <u>crosses</u> t axis at t = 1.25 s	A1	
			same straight line continues with same gradient to t = 3.0 s	A1	[3]
3	**(a)**	**(i)**	(vertical component = 44 sin 30° =) 22 N	A1	[1]
		(ii)	(horizontal component = 44 cos 30° =) 38(.1) N	A1	[1]
	(b)		$W \times 0.64 = 22 \times 1.60$	C1	
			(W =) 55 N	A1	[2]
	(c)		F has a horizontal component (not balanced by W) or F has 38 N acting horizontally or 38 N acts on wall or vertical component of F does not balance W or F and W do not make a closed triangle of forces	B1	[1]
	(d)		line from P in direction towards point on wire vertically above W and direction up	B1	[1]
4	**(a)**		(p =) mv	C1	
			Δp (= – 6.64 × 10^{-27} × 1250 – 6.64 × 10^{-27} × 1250) = 1.66 × 10^{-23} N s	A1	[2]
	(b)	**(i)**	molecule collides with wall/container **and** there is a change in momentum	B1	
			change in momentum / time is force or $\Delta p = Ft$	B1	
			<u>many/all/sum of</u> molecular collisions over surface/area of container produces pressure	B1	[3]
		(ii)	more collisions per unit time so greater pressure	B1	[1]
5	**(a)**		curved line showing decreasing gradient with temperature rise	M1	
			smooth line not touching temperature axis, not horizontal or vertical anywhere	A1	[2]
	(b)	**(i)**	(no energy lost in battery because) no/negligible internal resistance	B1	[1]

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	(ii)	$I = V/R$		
		$= 8/15 \times 10^3$ or $1.6/3.0 \times 10^3$ or $2.4/4.5 \times 10^3$ or $12/22.5 \times 10^3$	C1	
		$= 0.53 \times 10^{-3}$ A	A1	[2]
	(iii)	p.d. across X = $12 - 8.0 - 3.0 \times 10^3 \times 0.53 \times 10^{-3}$ (= 2.4 V)	C1	
		$R_X = 2.4/(0.53 \times 10^{-3})$	C1	
		or $R_{tot} = 12/0.53 \times 10^{-3}$ (= $22.5 \times 10^3\ \Omega$) $R_X = (22.5 - 15.0 - 3.0) \times 10^3$	 (C1) (C1)	
		$4.5(2) \times 10^3\ \Omega$	A1	[3]
	(iv)	resistance decreases hence current (in circuit) is greater	M1	
		p.d. across X and Y is greater hence p.d across Z decreases	A1	
		or explanation in terms of potential divider: R_Z decreases so $R_Z/(R_X + R_Y + R_Z)$ is less therefore p.d. across Z decreases	 (M1) (A1)	[2]
6	**(a)**	progressive waves transfer/propagate energy **and** stationary waves do not	B1	
		<u>amplitude</u> constant for progressive wave **and** varies (from max/antinode to min/zero/node) for stationary wave	B1	
		adjacent particles in phase for stationary wave **and** out of phase for progressive wave	(B1)	[2]
	(b) (i)	wave / microwave <u>from source/S</u> reflects <u>at reflector/R</u>	B1	
		reflected and (further) incident waves overlap/meet/superpose	B1	
		waves have same <u>frequency/wavelength/period</u> **and** <u>speed</u> (so stationary waves formed)	B1	[3]
	(ii)	detector/D is moved between reflector/R and source/S (or v.v.)	B1	
		maximum, minimum/zero, (maximum… etc.) observed on meter/deflections/readings/measurements/recordings	B1	[2]
	(iii)	<u>determine/measure</u> the distance between adjacent minima/nodes or maxima/antinodes **or** across <u>specific number</u> of nodes/antinodes	B1	
		wavelength is twice distance between <u>adjacent</u> nodes/minima or maxima/ antinodes (or other correct method of calculation of wavelength from measurement)	B1	[2]

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(c) $v = f\lambda$ C1

$f = 3.0 \times 10^{8} / (2.8 \times 10^{-2})$ [$= 1.07 \times 10^{10}$ Hz] C1

11 (10.7) GHz A1 [3]

7 **(a)** 92 protons and 143 neutrons B1 [1]

(b)

	value
a	1
b	0
c	141
d	55

(a and b both required) B1
B1
B1 [3]

(c) kinetic energy (of products) or gamma/γ (radiation or photon) B1 [1]

(d) (total) mass on left-hand side/reactants is greater than (total) mass on right-hand side/products M1

difference in mass is (converted to) energy A1 [2]

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