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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) (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 $s = ut + \frac{1}{2}at^2$ **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) $s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2} \times 9.81 \times (1.25)^2$ [= 7.66] C1
$s = \frac{1}{2} \times 9.81 \times (1.75)^2$ [= 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
$s = \frac{1}{2} \times 9.81 \times (1.25)^2$ [= 7.66] (C1)
$s = 12.26 \times 0.50 + \frac{1}{2} \times 9.81 \times (3.00 - 2.50)^2$ [= 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
$R_{tot} = 12/0.53 \times 10^{-3}$ (= $22.5 \times 10^3\ \Omega$) (C1)
$R_X = (22.5 - 15.0 - 3.0) \times 10^3$ (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 (M1)
therefore p.d. across Z decreases (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 <u>greater</u> than (total) mass on right-hand side/products M1

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

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