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Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the May/June 2015 series

9702 PHYSICS

9702/21 Paper 2 (AS Structured Questions), maximum raw mark 60

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1	**(a)**	power = work / time or energy / time or (force × distance) / time	B1	
		= $\text{kg m s}^{-2} \times \text{m s}^{-1} = \text{kg m}^2 \text{s}^{-3}$	A1	[2]
	(b)	power = VI [or V^2/R **and** $V = IR$ or I^2R **and** $V = IR$]	B1	
		(units of V:) $\text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$	B1	[2]
2	**(a)**	speed = distance / time and velocity = displacement / time	B1	
		speed is a scalar as distance has no direction **and** velocity is a vector as displacement has direction	B1	[2]
	(b) (i)	<u>constant</u> acceleration or linear/uniform increase in velocity until 1.1 s	B1	
		rebounds or bounces or changes direction	B1	
		decelerates to zero velocity at the same acceleration as initial value	B1	[3]
	(ii)	$a = (v - u)/t$ or use of gradient implied	C1	
		= (8.8 + 8.8) / 1.8 or appropriate values from line or = (8.6 + 8.6) / 1.8	B1	
		= 9.8 (9.78) m s^{-2} or = 9.6 m s^{-2}	A1	[3]
	(iii)	**1.** distance = first area above graph + second area below graph	C1	
		= (1.1 × 10.8) / 2 + (0.9 × 8.8) / 2 (= 5.94 + 3.96)	C1	
		= 9.9 m	A1	[3]
		2. displacement = first area above graph – second area below graph	C1	
		= (1.1 × 10.8) / 2 – (0.9 × 8.8) / 2		
		= 2.0 (1.98) m	A1	[2]
	(iv)	correct shape with straight lines and all lines above the time axis or all below	M1	
		correct times for zero speeds (0.0, 1.15 s, 2.1 s) and peak speeds (10.8 m s^{-1} at 1.1 s and 8.8 m s^{-1} at 1.2 s and 3.0 s)	A1	[2]
3	**(a)**	4.5 × 50 – 2.8 × M (= ...)	C1	
		(...) = –1.8 × 50 + 1.4 × M	C1	
		(M =) 75 g	A1	[3]

	(b)		total initial kinetic energy/KE not equal to the total final kinetic energy/KE or relative speed of approach is not equal to relative speed of separation so not elastic or is inelastic	B1	[1]
	(c)		force on X is equal and opposite to force on Y (Newton III)	M1	
			force equals/is proportional to rate of change of momentum (Newton II)	M1	
			time of collision same for both balls hence change in momentum is the same	A1	[3]
4	**(a)**	**(i)**	two sets of co-ordinates taken to determine a constant value (F/x)	M1	
			F/x constant hence obeys Hooke's law	A1	[2]
			or gradient calculated and one point on line used to show no intercept hence obeys Hooke's law	 (M1) (A1)	
		(ii)	gradient or one point on line used e.g. $4.5/1.8 \times 10^{-2}$	C1	
			(k =) $250\,\text{N m}^{-1}$	A1	[2]
		(iii)	work done or E_P = area under graph or $\frac{1}{2}Fx$ or $\frac{1}{2}kx^2$	C1	
			$= 0.5 \times 4.5 \times 1.8 \times 10^{-2}$ or $0.5 \times 250 \times (1.8 \times 10^{-2})^2$	C1	
			$= 0.041\ (0.0405)\,\text{J}$	A1	[3]
	(b)		KE = $\frac{1}{2}mv^2$		
			$\frac{1}{2}mv^2 = 0.0405$ or KE = 0.0405 (J)	C1	
			($v = [2 \times 0.0405/1.7]^{1/2}$ =) $0.22\ (0.218)\,\text{m s}^{-1}$	A1	[2]
5	**(a)**		very high/infinite resistance for negative voltages up to about 0.4 V	B1	
			resistance decreases from 0.4 V	B1	[2]
	(b)		initial straight line from (0,0) into curve with decreasing gradient but not to horizontal	M1	
			repeated in negative quadrant	A1	[2]
	(c)	**(i)**	$R = 12^2/36 = 4.0\,\Omega$	A1	
			or $I = P/V = 36/12 = 3.0$ A and $R = 12/3.0 = 4.0\,\Omega$	 (A1)	[1]

(ii) lost volts = 0.5 × 2.8 = 1.4 (V)	or E = 12 = 2.8 × (R + r)	C1	
R = V/I = (12 – 1.4) / 2.8	or (R + r) = 4.29 Ω	C1	
= 3.8 (3.79) Ω	or R = 3.8 Ω	A1	[3]

(d) resistance of the lamp increases with increase of V or I B1 [1]

6 (a) diffraction is the spreading of a wave as it passes through a slit or past an edge B1

when two (or more) waves superpose/meet/overlap M1
resultant displacement is the sum of the displacement of each wave A1 [3]

(b) $n\lambda = d \sin\theta$ and $v = f\lambda$ C1

max order number for θ = 90°
hence n (= f/vN) = $7.06 \times 10^{14} / (3 \times 10^{8} \times 650 \times 10^{3})$ M1

n = 3.6
hence number of orders = 3 A1 [3]

(c) greater wavelength so fewer orders seen A1 [1]

7 (a) a region/space/area where a (stationary) charge experiences an (electric) force B1 [1]

(b) (i) at least four parallel equally spaced straight lines perpendicular to plates B1

consistent direction of an arrow on line(s) from left to right B1 [2]

(ii) electric field strength $E = V/d$ C1

$E = (450 / 16 \times 10^{-3})$
$= 28 \times 10^{3}$ (28 125) V m^{-1} A1 [2]

(iii) $W = Eqd$ or Vq C1

$q = 3.2 \times 10^{-19}$ (C) C1

$W = 28\,125 \times 3.2 \times 10^{-19} \times 16 \times 10^{-3}$ or $450 \times 3.2 \times 10^{-19}$

$= 1.4(4) \times 10^{-16}$ J A1 [3]

(iv) $\text{ratio} = \dfrac{450 \times 3.2 \times 10^{-19}}{450 \times -1.6 \times 10^{-19}}$ *(evidence of working required)*

= (–) 2 A1 [1]