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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

= kg m s^{-2} × m s^{-1} = kg m^2 s^{-3} A1 [2]

(b) power = VI [or V^2/R **and** $V = IR$ or I^2R **and** $V = IR$] B1

(units of V:) kg m^2 s^{-3} 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)** constant 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]

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(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 (M1)
to show no intercept hence obeys Hooke's law (A1)

(ii) gradient or one point on line used e.g. $4.5/1.8 \times 10^{-2}$ C1

(k =) 250 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) 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) 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]

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(ii) lost volts = $0.5 \times 2.8 = 1.4\,(\text{V})$ or $E = 12 = 2.8 \times (R + r)$ C1

$R = V/I = (12 - 1.4)/2.8$ or $(R + r) = 4.29\,\Omega$ C1

$= 3.8\,(3.79)\,\Omega$ or $R = 3.8\,\Omega$ 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 $\theta = 90°$
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

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

(iii) $W = Eqd$ or Vq C1

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

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

$= 1.4(4) \times 10^{-16}\,\text{J}$ 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]

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