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PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 60

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1 (a) (i) $(50 \text{ to } 200) \times 10^{-3}$ kg or $(0.05 \text{ to } 0.2)$ kg B1 [1]

(ii) $(50 \text{ to } 300)\,\text{cm}^3$ B1 [1]

(b) density = mass / volume or $\rho = M/V$ C1

$V = [\pi(0.38 \times 10^{-3})^2 \times 25.0 \times 10^{-2}]/4$ $(= 2.835 \times 10^{-8}\ \text{m}^3)$ C1

$\rho = (0.225 \times 10^{-3})/2.835 \times 10^{-8}$
$= 7940\,(\text{kg m}^{-3})$ A1

$\Delta\rho/\rho = 2(0.01/0.38) + (0.1/25.0) + (0.001/0.225)$ [= 0.061]
or
$\%\rho = 5.3\% + 0.40\% + 0.44\%$ (= 6.1%) C1

$\Delta\rho = 0.061 \times 7940 = 480\ (\text{kg m}^{-3})$

density $= (7.9 \pm 0.5) \times 10^3\,\text{kg m}^{-3}$ or $(7900 \pm 500)\,\text{kg m}^{-3}$ A1 [5]

2 (a) (i) horizontal component $(= 12\cos 50°) = 7.7\,\text{m s}^{-1}$ A1 [1]

(ii) vertical component $(= 12\sin 50°$ or $7.7\tan 50°) = 9.2\,\text{m s}^{-1}$ A1 [1]

(b) $v^2 = u^2 + 2as$ and $v = 0$ or $mgh = \frac{1}{2}mv^2$ or $s = v^2\sin^2\theta/2g$ C1

$9.2^2 = 2 \times 9.81 \times h$ hence $h = 4.3$ (4.31) m A1 [2]

alternative methods using time to maximum height of 0.94 s:

$s = ut + \frac{1}{2}at^2$ and $t = 0.94$ (s) (C1)
$s = 9.2 \times 0.94 - \frac{1}{2} \times 9.81 \times 0.94^2$ hence $s = 4.3$ m (A1)

or
$s = vt - \frac{1}{2}at^2$ and $t = 0.94$ (s) (C1)
$s = \frac{1}{2} \times 9.81 \times 0.94^2$ hence $s = 4.3$ m (A1)

or
$s = \frac{1}{2}(u + v)t$ and $t = 0.94$ (s) (C1)
$s = \frac{1}{2} \times 9.2 \times 0.94$ hence $s = 4.3$ m (A1)

(c) $t\ (= 9.2/9.81) = 0.94\ (0.938)$ s C1

horizontal distance $= 0.938 \times 7.7$ $(= 7.23\,\text{m})$ C1

displacement $= [4.3^2 + 7.23^2]^{1/2}$ C1

$= 8.4$ m A1 [4]

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3	(a)	(i)	force (= mg = 0.15 × 9.81) = 1.5 (1.47) N	A1	[1]
		(ii)	resultant force (on ball) is zero so normal contact force = weight *or* the forces are in opposite directions so normal contact force = weight *or* normal contact force up = weight down	A1	[1]
	(b)	(i)	(resultant) force proportional/equal to rate of change of momentum	B1	[1]
		(ii)	change in momentum = 0.15 × (6.2 + 2.5) (= 1.305 N s)	C1	
			magnitude of force = 1.305 / 0.12 = 11 (10.9) N	A1	
			or		
			(average) acceleration = (6.2 + 2.5) / 0.12 (= 72.5 m s^{-2})	(C1)	
			magnitude of force = 0.15 × 72.5 = 11 (10.9) N	(A1)	
			(direction of force is) upwards/up	B1	[3]
		(iii)	there is a change/gain in momentum of the floor	M1	
			this is equal (and opposite) to the change/loss in momentum of the ball so momentum is conserved	A1	[2]
			or		
			change of (total) momentum of <u>ball and floor</u> is zero so momentum is conserved	(M1) (A1)	
			or		
			(total) momentum of <u>ball and floor</u> before is equal to the (total) momentum of <u>ball and floor</u> after so momentum is conserved	(M1) (A1)	

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4 **(a)** the energy (stored) in a body due to its extension/compression/deformation/ change in shape/size B1 [1]

(b) **(i)** two values of F/x are calculated which are the same
e.g. 10.4 / 40 = 0.26 and 6.5 / 25 = 0.26 B1

or

ratio of two forces and the ratio of the corresponding two extensions are calculated which are the same
e.g. 5.2 / 10.4 = 0.5 and 20 / 40 = 0.5 (B1)

or

gradient of graph line calculated and coordinates of one point on the line used with straight line equation $y = mx + c$ to show $c = 0$ (B1)

(so) force is proportional to extension (and so Hooke's law obeyed) B1 [2]

(b) **(ii)** **1.** $k = F / x$ or k = gradient C1

gradient or values from a single point used e.g. $k = 10.4 / (40 \times 10^{-2})$

$k = 26\,\text{N m}^{-1}$ A1 [2]

2. work done = area under graph
or $\frac{1}{2}Fx$ or $\frac{1}{2}(F_2 + F_1)(x_2 - x_1)$
or $\frac{1}{2}kx^2$ or $\frac{1}{2}k(x_2^2 - x_1^2)$ C1

= $\frac{1}{2} \times 10.4 \times 0.4 - \frac{1}{2} \times 5.2 \times 0.2$
or $\frac{1}{2} \times (5.2 + 10.4) \times 20 \times 10^{-2}$
or $\frac{1}{2} \times 26 \times (0.4^2 - 0.2^2)$ C1

= 1.6 J A1 [3]

(c) remove the force and the spring goes back to its original length B1 [1]

5 **(a)** $T = 4$ (ms) or 4×10^{-3} (s) C1

$f = 1 / T = 1 / 0.004$

= 250 Hz A1 [2]

(b) intensity $\propto$ (amplitude)^2 and amplitude = 2.8 (2.83) (cm) B1

curve with same period and with amplitude 2.8 cm B1

curve shifted 1.0 ms to left or to right of wave X B1 [3]

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(c) (i) gradient = $(4.5 - 2.4) \times 10^{-3} / (3.25 - 1.75)$ [= 1.4×10^{-3}] B1

wavelength = $0.45 \times 10^{-3} \times 1.4 \times 10^{-3}$ C1

= 6.30×10^{-7} (m) C1

= 630 nm A1 [4]

(ii) (gradient is equal to λ / a therefore) gradient of line is reduced B1

value of x will be reduced for all values of D
or new line is completely below old line
or intercept is less B1 [2]

6 (a) (coulomb is) ampere second B1 [1]

(b) (total) charge or $Q = nAle$ M1

$I = Q/t$ and $l/t = v$ M1

$I = nAle/t = nAve$ therefore $v = I/nAe$ A1 [3]

(c) (i) ratio = $(I/nA_Ye)/(I/nA_Ze)$ C1

= A_Z/A_Y or $4A/A$ or $\pi d^2/(\pi d^2/4)$ C1

= 4 A1 [3]

(ii) $R = \rho l/A$ or $R = 4\rho l/\pi d^2$ B1

$R_Y = \rho l/A$ and $R_Z = \rho(2l)/4A$ so $R_Y/R_Z = 2$
or
$R_Y = 4\rho l/\pi d^2$ and $R_Z = 4\rho(2l)/\pi 4d^2$ or $2\rho l/\pi d^2$ so $R_Y/R_Z = 2$ A1 [2]

(iii) $V = 12R_Y/(R_Y + R_Z)$ or $I = 12/(R_Y + R_Z)$ and $V = IR_Y$ C1

$V = 12 \times 2/3$

= 8(.0) V A1 [2]

(iv) ratio = I^2R_Y/I^2R_Z or $(V_Y^2/R_Y)/(V_Z^2/R_Z)$ or $(V_YI)/(V_ZI)$

= 2 A1 [1]

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7 **(a)** hadron: neutron/proton
and
lepton: electron/(electron) neutrino B1 [1]

(allow other correct particles)

(b) **(i)** proton: up up down or uud B1 [1]

(ii) neutron: up down down or udd B1 [1]

(c) **(i)** neutron $\rightarrow$ proton + electron + (electron) antineutrino B1 [1]

(ii) up down down (quarks) change to up up down (quarks)
or
down (quark) changes to up (quark) B1 [1]

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