Cambridge International AS & A Level

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PHYSICS | **9702/21**

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

MARK SCHEME

Maximum Mark: 60

Published

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1 (a) (i)	$(50 \text{ to } 200) \times 10^{-3}$ kg or (0.05 to 0.2) kg	B1	[1]
(ii)	(50 to 300) cm^3	B1	[1]
(b)	density = mass / volume or $\rho = M/V$	C1	
	$V = [\pi(0.38 \times 10^{-3})^2 \times 25.0 \times 10^{-2}]/4$ ($= 2.835 \times 10^{-8}$ m^3)	C1	
	$\rho = (0.225 \times 10^{-3})/2.835 \times 10^{-8}$ $= 7940$ (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	
	$\Delta\rho = 0.061 \times 7940 = 480$ (kg m^{-3})		
	density = $(7.9 \pm 0.5) \times 10^3$ kg m^{-3} or (7900 ± 500) kg m^{-3}	A1	[5]
2 (a) (i)	horizontal component ($= 12\cos 50°$) = 7.7 m s^{-1}	A1	[1]
(ii)	vertical component ($= 12\sin 50°$ or $7.7\tan 50°$) = 9.2 m s^{-1}	A1	[1]
(b)	$v^2 = u^2 + 2as$ <u>and</u> $v = 0$ or $mgh = ½mv^2$ 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:		
	$s = ut + ½at^2$ and $t = 0.94$ (s) $s = 9.2 \times 0.94 - ½ \times 9.81 \times 0.94^2$ hence $s = 4.3$ m	(C1) (A1)	
	or $s = vt - ½at^2$ and $t = 0.94$ (s) $s = ½ \times 9.81 \times 0.94^2$ hence $s = 4.3$ m	 (C1) (A1)	
	or $s = ½(u + v)t$ and $t = 0.94$ (s) $s = ½ \times 9.2 \times 0.94$ hence $s = 4.3$ m	 (C1) (A1)	
(c)	t (= 9.2 / 9.81) = 0.94 (0.938) s	C1	
	horizontal distance = 0.938×7.7 (= 7.23 m)	C1	
	displacement = $[4.3^2 + 7.23^2]^{1/2}$	C1	
	= 8.4 m	A1	[4]

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)	

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. $k = 10.4/(40 \times 10^{-2})$

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

2. work done = area under graph
or $½Fx$ or $½(F_2 + F_1)(x_2 - x_1)$
or $½kx^2$ or $½k(x_2^2 - x_1^2)$ C1

= $½ \times 10.4 \times 0.4 - ½ \times 5.2 \times 0.2$ C1
or $½ \times (5.2 + 10.4) \times 20 \times 10^{-2}$
or $½ \times 26 \times (0.4^2 - 0.2^2)$

= 1.6 J A1 [3]

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

5 **(a)** $T = 4\,(\text{ms})$ or $4 \times 10^{-3}\,(\text{s})$ C1

$f = 1/T = 1/0.004$

$= 250\,\text{Hz}$ A1 [2]

(b) intensity ∝ (amplitude)^2 <u>and</u> 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]

(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

$I = Q / t$ <u>and</u> $l / t = v$ 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

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

(iii) $V = 12R_Y / (R_Y + R_Z)$ or $I = 12 / (R_Y + R_Z)$ <u>and</u> $V = IR_Y$ 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]

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