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 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	
		$V = [\pi(0.38 \times 10^{-3})^2 \times 25.0 \times 10^{-2}]/4$ (= 2.835×10^{-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 $(7900 \pm 500)\,kg\,m^{-3}$	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 — (M1)
so momentum is conserved — (A1)

or

(total) momentum of <u>ball and floor</u> before is equal to the (total) momentum of <u>ball and floor</u> after — (M1)
so momentum is conserved — (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. $k = 10.4 / (40 \times 10^{-2})$

$k = 26\,\text{N m}^{-1}$ — 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

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

= 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 <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 = $(I / nA_Y e) / (I / nA_Z e)$	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 $(V_Y I) / (V_Z I)$		
	= 2	A1	[1]

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]