Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/21**

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

MARK SCHEME

Maximum Mark: 60

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

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	
	$V = [\pi(0.38 \times 10^{-3})^2 \times 25.0 \times 10^{-2}]/4$ $(= 2.835 \times 10^{-8}\ \text{m}^3)$	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) $v^2 = u^2 + 2as$ <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. $k = 10.4 / (40 \times 10^{-2})$		
$k = 26\,\text{N m}^{-1}$	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	
= $½ \times 10.4 \times 0.4 - ½ \times 5.2 \times 0.2$ or $½ \times (5.2 + 10.4) \times 20 \times 10^{-2}$ or $½ \times 26 \times (0.4^2 - 0.2^2)$	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]

(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]