
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) $(50 \text{ to } 200) \times 10^{-3} \text{ kg}$ or $(0.05 \text{ to } 0.2) \text{ kg}$ 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
- $\rho = (0.225 \times 10^{-3}) / 2.835 \times 10^{-8}$
 $= 7940 \text{ (kg m}^{-3}\text{)}$ 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
- $\Delta\rho = 0.061 \times 7940 = 480 \text{ (kg m}^{-3}\text{)}$
- 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 $(= 12 \cos 50^\circ) = 7.7 \text{ m s}^{-1}$ A1 [1]
- (ii) vertical component $(= 12 \sin 50^\circ \text{ or } 7.7 \tan 50^\circ) = 9.2 \text{ m s}^{-1}$ 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 $h = 4.3 \text{ (4.31) m}$ A1 [2]
- alternative methods using time to maximum height of 0.94 s:
- $s = ut + \frac{1}{2}at^2$ and $t = 0.94 \text{ (s)}$ (C1)
 $s = 9.2 \times 0.94 - \frac{1}{2} \times 9.81 \times 0.94^2$ hence $s = 4.3 \text{ m}$ (A1)
- or
 $s = vt - \frac{1}{2}at^2$ and $t = 0.94 \text{ (s)}$ (C1)
 $s = \frac{1}{2} \times 9.81 \times 0.94^2$ hence $s = 4.3 \text{ m}$ (A1)
- or
 $s = \frac{1}{2}(u + v)t$ and $t = 0.94 \text{ (s)}$ (C1)
 $s = \frac{1}{2} \times 9.2 \times 0.94$ hence $s = 4.3 \text{ m}$ (A1)
- (c) $t (= 9.2/9.81) = 0.94 \text{ (0.938) s}$ C1
- horizontal distance = $0.938 \times 7.7 (= 7.23 \text{ m})$ C1
- displacement = $[4.3^2 + 7.23^2]^{1/2}$ C1
- $= 8.4 \text{ m}$ A1 [4]

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- 3 (a) (i) force ($= mg = 0.15 \times 9.81$) = 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 = $0.15 \times (6.2 + 2.5)$ (= 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 ms^{-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 ball and floor is zero (M1)
so momentum is conserved (A1)
- or*
- (total) momentum of ball and floor before is equal to the (total) momentum of ball and floor after (M1)
so momentum is conserved (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 $k = \text{gradient}$ 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) $T = 4 \text{ (ms)}$ or $4 \times 10^{-3} \text{ (s)}$ C1
- $f = 1/T = 1/0.004$
- = 250 Hz A1 [2]
- (b) intensity $\propto (\text{amplitude})^2$ 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 = $(4.5 - 2.4) \times 10^{-3} / (3.25 - 1.75) [= 1.4 \times 10^{-3}]$ B1
- wavelength = $0.45 \times 10^{-3} \times 1.4 \times 10^{-3}$ C1
- = $6.30 \times 10^{-7} \text{ (m)}$ 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 = $(I/nA_Y e) / (I/nA_Z e)$ 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
- $R_Y = \rho l/A$ 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 = $I^2 R_Y / I^2 R_Z$ or $(V_Y^2 / R_Y) / (V_Z^2 / R_Z)$ or $(V_Y I) / (V_Z I)$
- = 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]