

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
GCE Advanced Subsidiary Level and GCE Advanced Level

**MARK SCHEME for the October/November 2011 question paper  
for the guidance of teachers**

**9702 PHYSICS**

**9702/21**

Paper 2 (AS Structured Questions), maximum raw mark 60

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.

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- 1 (a) density = mass / volume B1 [1]
- (b) density of liquids and solids same order as spacing similar / to about 2×  
density of gases much less as spacing much more  
or density of gases much lower hence spacing much more B1 [2]
- (c) (i) density =  $68 / [50 \times 600 \times 900 \times 10^{-9}]$   
= 2520 (allow 2500) kg m<sup>-3</sup> C1  
A1 [2]
- (ii)  $P = F / A$  C1  
=  $68 \times 9.81 / [50 \times 600 \times 10^{-6}]$  C1  
=  $2.2 \times 10^4$  Pa A1 [3]
- 2 (a) torque is the product of one of the forces and the distance between forces  
the perpendicular distance between the forces M1  
A1 [2]
- (b) (i) torque =  $8 \times 1.5 = 12$  Nm A1 [1]
- (ii) there is a resultant torque / sum of the moments is not zero  
(the rod rotates) and is not in equilibrium M1  
A1 [2]
- (c) (i)  $B \times 1.2 = 2.4 \times 0.45$  C1  
 $B = 0.9(0)$  N A1 [2]
- (ii)  $A = 2.4 - 0.9 = 1.5$  N / moments calculation A1 [1]
- 3 (a) (i) horizontal velocity =  $15 \cos 60^\circ = 7.5$  m s<sup>-1</sup> A1 [1]
- (ii) vertical velocity =  $15 \sin 60^\circ = 13$  m s<sup>-1</sup> A1 [1]
- (b) (i)  $v^2 = u^2 + 2as$   
 $s = (13)^2 / (2 \times 9.81) = 8.6(1)$  m A1 [1]  
using  $g = 10$  then max. 1
- (ii)  $t = 13 / 9.81 = 1.326$  s or  $t = 9.95 / 7.5 = 1.327$  s A1 [1]
- (iii) velocity =  $6.15 / 1.33$  M1  
=  $4.6$  m s<sup>-1</sup> A0 [1]
- (c) (i) change in momentum =  $60 \times 10^{-3} [-4.6 - 7.5]$  C1  
=  $(-0.73)$  N s A1 [2]
- (ii) final velocity / kinetic energy is less after the collision or  
relative speed of separation < relative speed of approach  
hence inelastic M1  
A0 [1]

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- 4 (a) electrical potential energy (stored) when charge moved and gravitational potential energy (stored) when mass moved  
due to work done in electric field and work done in gravitational field B1 B1 [2]
- (b) work done = force  $\times$  distance moved (in direction of force)  
and force =  $mg$   
 $mg \times h$  or  $mg \times \Delta h$  M1 A1 [2]
- (c) (i)  $0.1 \times mgh = \frac{1}{2} mv^2$   
 $0.1 \times m \times 9.81 \times 120 = 0.5 \times m \times v^2$   
 $v = 15.3 \text{ ms}^{-1}$  B1 B1 A0 [2]
- (ii)  $P = 0.5 m v^2 / t$   
 $m / t = 110 \times 10^3 / [0.25 \times 0.5 \times (15.3)^2]$   
 $= 3740 \text{ kg s}^{-1}$  C1 C1 A1 [3]
- 5 (a) ohm = volt / ampere B1 [1]
- (b)  $\rho = RA / l$  or unit is  $\Omega \text{ m}$   
units:  $\text{VA}^{-1} \text{ m}^2 \text{ m}^{-1} = \text{NmC}^{-1} \text{ A}^{-1} \text{ m}^2 \text{ m}^{-1}$   
 $= \text{kg m}^2 \text{ s}^{-2} \text{ A}^{-1} \text{ s}^{-1} \text{ A}^{-1} \text{ m}^2 \text{ m}^{-1}$   
 $= \text{kg m}^3 \text{ s}^{-3} \text{ A}^{-2}$  C1 C1 A1 [3]
- (c) (i)  $\rho = [3.4 \times 1.3 \times 10^{-7}] / 0.9$   
 $= 4.9 \times 10^{-7} (\Omega \text{ m})$  C1 A1 [2]
- (ii) max = 2.(0) V  
min =  $2 \times (3.4 / 1503.4) = 4.5 \times 10^{-3} \text{ V}$  A1 A1 [2]
- (iii)  $P = V^2 / R$  or  $P = VI$  and  $V = IR$   
 $= (2)^2 / 3.4$   
 $= 1.18$  (allow 1.2) W C1 A1 [2]
- (d) (i) power in Q is zero when  $R = 0$  B1 [1]
- (ii) power in Q = 0 / tends to zero as  $R = \text{infinity}$  B1 [1]

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- 6 (a) extension is proportional to force (for small extensions) B1 [1]
- (b) (i) point beyond which (the spring) does not return to its original length when the load is removed B1 [1]
- (ii) gradient of graph =  $80 \text{ N m}^{-1}$  A1 [1]
- (iii) work done is area under graph /  $\frac{1}{2} Fx$  /  $\frac{1}{2} kx^2$   
 $= 0.5 \times 6.4 \times 0.08 = 0.256$  (allow 0.26) J C1  
A1 [2]
- (c) (i) extension =  $0.08 + 0.04 = 0.12 \text{ m}$  A1 [1]
- (ii) spring constant =  $6.4 / 0.12 = 53.3 \text{ N m}^{-1}$  A1 [1]
- 7 (a) nuclei with the same number of protons and a different number of neutrons B1  
B1 [2]
- (b) (i) (mass + energy) (taken together) is conserved (B1)  
momentum is conserved (B1)  
one point required max. 1 B1 [1]
- (ii)  $a = 1$  and  $b = 0$  B1  
 $x = 56$  B1  
 $y = 92$  B1 [3]
- (c) proton number = 90 B1  
nucleon number = 235 B1 [2]