**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

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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 B1
or density of gases much lower hence spacing much more B1 [2]

**(c)** **(i)** density = 68 / [50 × 600 × 900 × $10^{-9}$] C1
= 2520 (allow 2500) kg m$^{-3}$ A1 [2]

**(ii)** $P = F / A$ C1
= 68 × 9.81 / [50 × 600 × $10^{-6}$] C1
= 2.2 × $10^{4}$ Pa A1 [3]

**2** **(a)** torque is the product of one of the forces and the distance between forces M1
the perpendicular distance between the forces A1 [2]

**(b)** **(i)** torque = 8 × 1.5 = 12 N m A1 [1]

**(ii)** there is a resultant torque / sum of the moments is not zero M1
(the rod rotates) and is not in equilibrium A1 [2]

**(c)** **(i)** B × 1.2 = 2.4 × 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° = 7.5 m s$^{-1}$ A1 [1]

**(ii)** vertical velocity = 15 sin 60° = 13 m s$^{-1}$ 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$^{-1}$ A0 [1]

**(c)** **(i)** change in momentum = 60 × $10^{-3}$ [–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 M1
hence inelastic A0 [1]

**4** **(a)** electrical potential energy (stored) when charge moved and gravitational potential energy (stored) when mass moved B1
due to work done in electric field and work done in gravitational field B1 [2]

**(b)** work done = force × distance moved (in direction of force)
and force = $mg$ M1
$mg \times h$ or $mg \times \Delta h$ A1 [2]

**(c)** **(i)** $0.1 \times mgh = \frac{1}{2} mv^2$ B1
$0.1 \times m \times 9.81 \times 120 = 0.5 \times m \times v^2$ B1
$v = 15.3\,\text{m s}^{-1}$ A0 [2]

**(ii)** $P = 0.5\, m\, v^2 / t$ C1
$m / t = 110 \times 10^3 / [0.25 \times 0.5 \times (15.3)^2]$ C1
$= 3740\,\text{kg s}^{-1}$ A1 [3]

**5** **(a)** ohm = volt / ampere B1 [1]

**(b)** $\rho = RA / l$ or unit is $\Omega\,\text{m}$ C1
units: $\text{V A}^{-1}\,\text{m}^2\,\text{m}^{-1}$ $= \text{N m C}^{-1}\,\text{A}^{-1}\,\text{m}^2\,\text{m}^{-1}$ C1
$= \text{kg m}^2\,\text{s}^{-2}\,\text{A}^{-1}\,\text{s}^{-1}\,\text{A}^{-1}\,\text{m}^2\,\text{m}^{-1}$
$= \text{kg m}^3\,\text{s}^{-3}\,\text{A}^{-2}$ A1 [3]

**(c)** **(i)** $\rho = [3.4 \times 1.3 \times 10^{-7}] / 0.9$ C1
$= 4.9 \times 10^{-7}\ (\Omega\,\text{m})$ A1 [2]

**(ii)** max = 2.(0) V A1
min = $2 \times (3.4 / 1503.4) = 4.5 \times 10^{-3}$ V A1 [2]

**(iii)** $P = V^2 / R$ or $P = VI$ and $V = IR$ C1
$= (2)^2 / 3.4$
= 1.18 (allow 1.2) W A1 [2]

**(d)** **(i)** power in Q is zero when $R = 0$ B1 [1]

**(ii)** power in Q = 0 / tends to zero as $R$ = infinity B1 [1]

**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 N m$^{-1}$ A1 [1]

**(iii)** work done is area under graph / ½ $Fx$ / ½ $kx^2$ C1
= 0.5 × 6.4 × 0.08 = 0.256 (allow 0.26) J A1 [2]

**(c)** **(i)** extension = 0.08 + 0.04 = 0.12 m A1 [1]

**(ii)** spring constant = 6.4 / 0.12 = 53.3 N m$^{-1}$ A1 [1]

**7** **(a)** nuclei with the same number of protons B1
and a different number of neutrons 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]