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 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]