CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9702 PHYSICS

9702/23 Paper 2 (AS Structured Questions), maximum raw mark 60

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1 volume = $\pi (14 \times 10^{-3})^2 \times 12 \times 10^{-3}$ ($=7.389 \times 10^{-6}$ m^3) C1
density = mass / volume [any subject] C1
mass = $6.8 \times 10^3 \times 7.389 \times 10^{-6} = 0.0502$
weight = mg C1
$= 0.0502 \times 9.81 = 0.49$ N (mark not awarded if not to **two** s.f.) A1 [4]

2 **(a)** SI units for T: s, R: m and M: kg (or seen clearly in formula) C1
$K = T^2 M / R^3$ units: s^2 kg m^{-3} (allow s^2 kg / m^3 or $\frac{\text{s}^2\text{kg}}{\text{m}^3}$) A1 [2]

(b) % uncertainty in K: 1% (for T) + 3% (for R) + 2% (for M) OR = 6% C1
$K = [(86400)^2 \times 6 \times 10^{24}] / (4.23 \times 10^7)^3 = 5.918 \times 10^{11}$ C1
6% of $K = 0.355 \times 10^{11}$ C1
$K = (5.9 \pm 0.4) \times 10^{11}$ (SI units) correct power of ten required for both A1 [4]
[incorrect % value then max. 1]

3 **(a)** **(i)** velocity = rate of <u>change</u> of displacement
OR displacement <u>change</u> / time (taken) A1 [1]

(ii) acceleration = rate of <u>change</u> of velocity
OR <u>change</u> in velocity / time (taken) A1 [1]

(b) **(i)** initial constant velocity as straight line / gradient constant B1
middle section deceleration/ speed / velocity decreases / slowing down as gradient decreases B1
last section lower velocity (than at start) as gradient (constant and) smaller B1 [3]
[special case: all three stages correct descriptions but no reasons 1/3]

(ii) velocity = 45 / 1.5 = 30 m s^{-1} A1 [1]

(iii) velocity at 4.0 s is (122 – 98) / 2.0 = 12 (m s^{-1}) (allow 12 to 13) B1
acceleration = (12 – 30) / 2.5 = –7.2 m s^{-2} (if answer not this value then comment needed to explain why, e.g. difficulty in drawing tangent) A1 [2]

(iv) $F = ma$ C1
$= (-)1500 \times 7.2 = (-)11000$ (10800) N A1 [2]

4 **(a)** gravitational PE is energy of a <u>mass</u> due to its position in a <u>gravitational field</u> B1
elastic PE energy <u>stored</u> (in an object) <u>due to</u> (a force) changing its shape / deformation / being compressed / stretched / strained B1 [2]

(b) **(i)** **1.** kinetic energy = ½ mv^2 C1
$= ½ \times 0.065 \times 16^2 = 8.3(2)$ J A1 [2]

2. $v^2 = 2gh$ OR PE = mgh C1
$h = 16^2 / (2 \times 9.81) = 13(.05)$ m A1 [2]

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(ii) speed at t = ½ total time = 8 ($m\,s^{-1}$) or total t = 1.63 or $t_{1/2}$ = 0.815 s C1
KE is ¼ or h at $t_{1/2}$ = 9.78 (m) C1
and PE is ¾ of max ratio = 3 or ratio = 9.78 / 3.26 = 3 A1 [3]

(iii) time is less because (average) acceleration is greater OR average force is greater B1 [1]

5 (a) (i) 1. wavelength: minimum distance between two points moving in phase
OR distance between neighbouring or consecutive peaks or troughs
OR wavelength is the distance moved by a wavefront in time T or one oscillation/cycle or period (of source) B1 [1]

2. frequency: number of wavefronts / (unit) time
OR number of oscillations per unit time or oscillations/time B1 [1]

(ii) speed = <u>distance</u> / time = <u>wavelength / time period</u> M1
= $\lambda / T = \lambda f$ A0 [1]

(b) (i) amplitude = 4.0 mm (allow 1 s.f.) A1 [1]

(ii) wavelength = 18 / 3.75 (= 4.8) C1
speed = $2.5 \times 4.8 \times 10^{-2} = 12 \times 10^{-2}\,m\,s^{-1}$ unit consistent with numerical answer, e.g. in $cm\,s^{-1}$ if cm used for λ and unit changed on answer line A1 [2]
[if 18 cm = 3.5λ used giving speed 13 (12.9) $cm\,s^{-1}$ allow max. 1].

(iii) 180° or π rad A1 [1]

(c) light and screen and correct positions above and below ripple tank B1
strobe or video camera B1 [2]

6 (a) e.m.f. = total energy available (per unit charge) B1
some (of the available energy) is used/lost/wasted/given out in the internal resistance of the battery (hence p.d. available less than e.m.f.) B1 [2]

(b) (i) $V = IR$ C1
I = 6.9 / 5.0 = 1.4 (1.38) A A1 [2]

(ii) r = lost volts / current C1
= (9– 6.9) / 1.38 = 1.5(2) Ω A1 [2]

(c) (i) $P = EI$ (**not** $P = VI$ if only this line given or 9 V not used in second line) C1
= 9 × 1.38 = 12 (12.4) W A1 [2]

(ii) efficiency = output power / total power C1
= VI / EI = 6.9 / 9 or (9.52) / (12.4) = 0.767 / 76.7% A1 [2]

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7 (a) (i) six vertical lines from plate to plate equally spaced across plates B1
[only allow if greatest to least spacing is < 1.3, condone slight curving on the two edges. There must be no area between the plates where an additional line(s) could be added.]
arrow downwards on at least one line B1 [2]

(ii) $E = V / d$ C1
$= 1200 / 40 \times 10^{-3} = 3.0 \times 10^{4}$ V m^{-1} (allow 1 s.f.) A1 [2]

(b) (i) $F = Ee$ C1
$= 3 \times 10^{4} \times 1.6 \times 10^{-19} = 4.8 \times 10^{-15}$ N A1 [2]

(ii) couple = $F \times$ separation of charges C1
$= 4.8 \times 10^{-15} \times 15 \times 10^{-3} = 7.2 \times 10^{-17}$ A1
unit: N m or unit consistent with unit used for the separation B1 [3]

(iii) A at top/next to +ve plate B at bottom/next to –ve plate vertically aligned M1
[could be shown on the diagram]
forces are equal and opposite in same line / no resultant force and no resultant torque A1 [2]

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