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

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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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]

(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 = distance / time = wavelength / time period 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
$= 9 \times 1.38$ = 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]

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]