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 = $\pi (14 \times 10^{-3})^2 \times 12 \times 10^{-3}$ (=7.389×10^{-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
        = 0.0502×9.81 = 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 $\dfrac{s^2 kg}{m^3}$) A1 [2]

(b) % uncertainty in K: 1% (for T) + 3% (for R) + 2% (for M) OR = 6% C1
K = [$(86400)^2 \times 6 \times 10^{24}$] / $(4.23 \times 10^7)^3$ = 5.918×10^{11} C1
6% of K = 0.355×10^{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 × 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 × 0.065 × 16^2 = 8.3(2) J A1 [2]

2. $v^2 = 2gh$ OR PE = mgh C1
    $h = 16^2$ / (2 × 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 = <u>distance</u> / time = <u>wavelength / time period</u>   M1
= λ / T = λf 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 × 4.8 × 10^{-2} = 12 × 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) 180º 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]

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]