CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the May/June 2015 series

9702 PHYSICS

9702/42 Paper 4 (A2 Structured Questions), maximum raw mark 100

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.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2015 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

CAMBRIDGE
International Examinations

1 (a) (i) 1. $F = Gm_1m_2/x^2$
$= (6.67 \times 10^{-11} \times 2.50 \times 5.98 \times 10^{24})/(6.37 \times 10^6)^2$ M1
$= 24.6\,\text{N}$ (*accept 2 s.f. or more*) A1 [2]

2. $F = mx\omega^2$ **or** $F = mv^2/x$ **and** $v = \omega x$ *(accept x or r for distance)* C1
$= 2.50 \times 6.37 \times 10^6 \times (2\pi/24 \times 3600)^2$
$= 0.0842\,\text{N}$ (*accept 2 s.f. or more*) A1 [2]

(ii) reading = 24.575 – 0.0842 B1
= 24.5 N (*accept only 3 s.f.*) A1 [2]

(b) gravitational force provides the centripetal force M1
gravitational force is 'equal' to the centripetal force
(*accept* $Gm_1m_2/x^2 = mx\omega^2$ **or** $F_C = F_G$) M1
'weight'/sensation of weight/contact force/reaction force is difference between F_G and F_C which is zero A1 [3]

2 (a) mean speed = $1.44 \times 10^3\,\text{m s}^{-1}$ A1 [1]

(b) evidence of summing of individual squared speeds C1
mean square speed = $2.09 \times 10^6\,\text{m}^2\,\text{s}^{-2}$ A1 [2]

(c) root-mean-square speed = $1.45 \times 10^3\,\text{m s}^{-1}$ A1 [1]
(allow ECF from ***(b)*** *but only if arithmetic error)*

3 (a) (numerically equal to) quantity of heat/(thermal) energy to change state/phase of unit mass M1
at constant temperature A1 [2]
(*allow 1/2 for definition restricted to fusion or vaporisation*)

(b) (i) constant gradient/straight line *(allow linear/constant slope)* B1 [1]

(ii) $Pt = mL$ *or* power = gradient $\times$ L C1

use of gradient of graph
(*or two points separated by at least 3.5 minutes*) M1

$110 \times 60 = L \times (372 - 325) \times 10^{-3}/7.0$
$L = 9.80 \times 10^5\,\text{J kg}^{-1}$ (*accept 2 s.f.*) (*allow 9.8 to 9.9 rounded to 2 s.f.*) A1 [3]

(iii) some energy/heat is lost to the surroundings *or* vapour condenses on sides M1
so value is an overestimate A1 [2]

4 (a) displacement (directly) proportional to acceleration/force M1
either displacement and acceleration in opposite directions
or acceleration (always) towards a (fixed) point A1 [2]

© Cambridge International Examinations 2015

(b) (i) ⅓π rad or 1.05 rad (*allow 60° if unit clear*) A1 [1]

(ii) $a_0 = -\omega^2 x_0$
$= (-)\ (2\pi / 1.2)^2 \times 0.030$ C1
$= (-)\ 0.82\ \text{m s}^{-2}$ A1 [2]
(*special case: using oscillator P gives $x_0 = 1.7$ cm and $a_0 = 0.47\ \text{m s}^{-1}$ for 1/2*)

(iii) max. energy $\propto x_0^2$
ratio $= 3.0^2 / 1.7^2$ C1
$= 3.1$ *(at least 2 s.f.)* A1 [2]
(*if has inverse ratio but has stated max. energy $\propto x_0^2$ then allow 1/2*)

(c) graph: straight line through (0,0) with negative gradient M1
correct end-points (–3.0, +0.82) and (+3.0, –0.82) A1 [2]

5 (a) work done bringing/moving per unit positive charge M1
from infinity (to the point) A1 [2]

(b) (i) slope/gradient (of the line/graph/tangent) B1 [1]
*(allow dV/dx, but **not** ΔV/Δx or V/x)*
(allow potential gradient)
(negative sign not required)

(ii) maximum at surface of sphere A or at $x = 0$ (cm) B1
zero at $x = 6$ (cm) B1
then increases but in opposite direction B1 [3]
(any mention of attraction max. 2/3)

(c) (i) M shown between $x = 5.5$ cm and $x = 6.5$ cm B1 [1]

(ii) **1.** $\Delta V = (570 - 230) = 340$ V *(allow 330 V to 340 V)* A1 [1]

2. $q(\Delta)V = \frac{1}{2}mv^2$ **or** change/loss in PE = change/gain in KE **or** $\Delta E_K = \Delta E_P$ B1

$4.8 \times 10^7 \times 340 = \frac{1}{2}v^2$ C1
$v^2 = 3.26 \times 10^{10}$
$v = 1.8 \times 10^5\ \text{m s}^{-1}$ *(not 1 s.f.)* A1 [3]

6 (a) packet/quantum/discrete amount of energy M1
of electromagnetic energy/radiation/waves A1 [2]

(b) (i) arrow below axis and pointing to right B1 [1]

© Cambridge International Examinations 2015

(ii) **1.** $E = hc/\lambda$
$= (6.63 \times 10^{-34} \times 3.0 \times 10^{8})/(6.80 \times 10^{-12})$ C1
$= 2.93 \times 10^{-14}$ J (*accept 2 s.f.*) A1 [2]

2. energy of electron $= (3.06 - 2.93) \times 10^{-14}$
$= 1.3 \times 10^{-15}$ J C1
speed $= \sqrt{(2E/m)}$ C1
$= 5.4 \times 10^{7}$ m s^{-1} A1 [3]

(c) momentum is a vector quantity B1
either must consider momentum in two directions
or direction changes so cannot just consider magnitude B1 [2]

7 **(a)** moving magnet gives rise to/causes/induces e.m.f./current in solenoid/coil B1
(induced current) creates field/flux in solenoid that opposes (motion of) magnet B1
work is done/energy is needed to move magnet (into solenoid) B1
(induced) current gives heating effect (in resistor) which comes from the work done B1 [4]

(b) current in primary coil give rise to (magnetic) flux/field B1
(magnetic) flux / field (in core) is in phase with current (in primary coil) B1
(magnetic) flux threads/links/cuts secondary coil inducing e.m.f. in secondary coil B1
*(there **must** be a mention of secondary coil)*
e.m.f. induced proportional to <u>rate</u> of change/cutting of flux/field so not in phase B1 [4]

8 **(a)** **(i)** energy $= 5.75 \times 1.6 \times 10^{-13}$
$= 9.2 \times 10^{-13}$ J A1 [1]

(ii) number $= 1900/(9.2 \times 10^{-13} \times 0.24)$ C1
$= 8.6 \times 10^{15}$ s^{-1} A1 [2]

(b) **(i)** decay constant $= 0.693/(2.8 \times 365 \times 24 \times 3600)$ C1
$= 7.85 \times 10^{-9}$ s^{-1} *(allow 7.8 or 7.9 to 2 s.f.)* A1 [2]

(ii) $A = \lambda N$
$8.6 \times 10^{15} = 7.85 \times 10^{-9} \times N$ C1
$N = 1.096 \times 10^{24}$ C1

mass $= (1.096 \times 10^{24} \times 236)/(6.02 \times 10^{23})$ M1
$= 430$ g A1 [4]

(c) $0.84 = 1.9 \exp(-7.85 \times 10^{-9} t)$ C1
$t = 1.04 \times 10^{8}$ s
$= 3.3$ years A1 [2]

© Cambridge International Examinations 2015

Section B

9 (a) $V_B = 1000\,\text{mV}$ C1
when strained, $V_A = 2000 \times 121.5/(121.5 + 120.0)$
$= 1006.2\,\text{mV}$ M1
change = 6.2 mV (*allow 6 mV)* A1 [3]

(b) (i) 1. resistor between V_{IN} and V^- **and** V^+ connected to earth B1
resistor between V^- and V_{OUT} B1 [2]

2. P / + sign shown on earth side of voltmeter B1 [1]

(ii) ratio of $R_F / R_{IN} = 40$ M1
R_{IN} between 100 Ω and 10 kΩ A1 [2]
(any values must link to the correct resistors on the diagram)

10 (a) product of density (of medium) and speed (of ultrasound) M1
in the medium A1 [2]

(b) (i) $7.0 \times 10^6 = 1.7 \times 10^3 \times$ speed C1
speed = $4.12 \times 10^3\,\text{m s}^{-1}$
wavelength $= (4.12 \times 10^3)/(9.0 \times 10^5)\,\text{m}$ C1
$= 4.6\,\text{mm}$ *(2 s.f. minimum)* A1 [3]

(ii) for air/tissue boundary, $I_R / I \approx 1$ M1
for air/tissue boundary, (almost) complete reflection/no transmission A1
for gel/tissue boundary, $I_R / I = 0.1^2 / 3.1^2$
$= 1.04 \times 10^{-3}$ *(accept 1 s.f.)* M1
gel enables (almost) complete transmission (into the tissue) A1 [4]

11 (a) (i) metal (*allow specific example of a metal*) B1 [1]

(ii) e.g. provides 'return' for the signal
shields inner core from interference/reduces cross-talk/reduces noise
increased security
(any two sensible suggestions, 1 each) B2 [2]

(b) (i) (gradual) loss of power/intensity/amplitude B1 [1]

(ii) dB is a log scale B1
either large (range of) numbers are easier to handle (on a log scale)
or compounding attenuations/amplifications is easier B1 [2]

(c) attenuation = $190 \times 11 \times 10^{-3} = 2.09\,\text{dB}$ C1
$-2.09 = 10\,\lg(P_{OUT} / P_{IN})$ C1
ratio = 0.62 A1 [3]

© Cambridge International Examinations 2015

12 handset transmits (identification) signal to number of base stations B1
base stations transfers (signal) to cellular exchange B1
(idea of station<u>s</u> needed at least once in first two marking points)

computer at cellular exchange selects base station with strongest signal B1
computer at cellular exchange selects a carrier frequency for mobile phone B1 [4]
(idea of computer needed at least once in these two marking points)

© Cambridge International Examinations 2015