CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 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 **(a)** spacing = 380 or 3.8×10^2 pm B1 [1]

(b) time = 24 × 3600
time = 0.086 (0.0864) Ms B1 [1]

(c) time = distance / speed = $\frac{1.5 \times 10^{11}}{3 \times 10^8}$ C1
= 500 (s) = 8.3 min A1 [2]

(d) momentum and weight B1 [1]

(e) **(i)** arrow to the right of plane direction (about 4° to 24°) B1 [1]

(ii) scale diagram drawn
or use of cosine formula $v^2 = 250^2 + 36^2 - 2 \times 250 \times 36 \times \cos 45°$
or resolving $v = [(36 \cos 45°)^2 + (250 - 36 \sin 45°)^2]^{1/2}$ C1

resultant velocity = 226 (220 – 240 for scale diagram) m s^{-1}
allow one mark for values 210 to 219 or 241 to 250 m s^{-1}
or use of formula (v^2 = 51068) v = 230 (226) m s^{-1} A1 [2]

2 **(a)** **(i)** accelerations (A to B and B to C) are same magnitude B1
accelerations (A to B and B to C) are opposite directions
or both accelerations are toward B B1
(A to B and B to C) the component of the weight down the slope provides the acceleration B1 [3]

(ii) acceleration = $g \sin 15°$ C1
$s = 0 + \frac{1}{2} at^2$ $s = 0.26 / \sin 15° = 1.0$ C1

$t^2 = \frac{1.0 \times 2}{9.8 \times \sin 15°}$ t = 0.89 s A1 [3]

(iii) $v = 0 + g \sin 15 t$ or $v^2 = 0 + 2g \sin 15 \times 1.0$ C1
v = 2.26 m s^{-1} A1 [2]
(using loss of GPE = gain KE can score full marks)

(b) loss of GPE at A = gain in GPE at C or loss of KE at B = gain in GPE at C B1
$h_1 = h_2$ = 0.26 m or $\frac{1}{2} mv^2 = mgh$ $h_2 = 0.5 \times (2.26)^2 / 9.81 = 0.26$ m
$x = 0.26 / \sin 30° = 0.52$ m A1 [2]

3 **(a)** power is the rate of doing work or power = work done / time (taken) or
power = energy transferred / time (taken) B1 [1]

(b) **(i)** as the speed increases drag / air resistance increases B1
resultant force reduces hence acceleration is less B1
constant speed when resultant force is zero B1 [3]
(allow one mark for speed increases and acceleration decreases)

(ii) force from cyclist = drag force / resistive force B1
$P = 12 \times 48$ M1
$P = 576\,\text{W}$ A0 [2]

(iii) tangent drawn at speed = $8.0\,\text{m s}^{-1}$ M1
gradient values that show acceleration between 0.44 to $0.48\,\text{m s}^{-2}$ A1 [2]

(iv) $F - R = ma$ C1
$600 / 8 - R = 80 \times 0.5$ [using $P = 576$] $576 / 8 - R = 80 \times 0.5$ C1
$R = 75 - 40 = 35\,\text{N}$ $R = 72 - 40 = 32\,\text{N}$ A1 [3]

(v) at $12\,\text{m s}^{-1}$ drag is 48 N, at $8\,\text{m s}^{-1}$ drag is 35 or 32 N
R / v calculated as 4 and 4 or 4.4
and consistent response for whether R is proportional to v or not B1 [1]

4 (a) e.m.f. = chemical energy to electrical energy M1
p.d. = electrical energy to thermal energy M1
idea of per unit charge A1 [3]

(b) $E = I(R + r)$ or $I = E / (R + r)$ (any subject) B1 [1]

(c) (i) $E = 5.8\,\text{V}$ B1 [1]

(ii) evidence of gradient calculation or calculation with values from graph
e.g. $5.8 = 4 + 1.0 \times r$ C1
$r = 1.8\,\Omega$ A1 [2]

(d) (i) $P = VI$ C1
$P = 2.9 \times 1.6 = 4.6\,(4.64)\,\text{W}$ A1 [2]

(ii) power from battery = $1.6 \times 5.8 = 9.28$ or efficiency = VI / EI C1
efficiency = $(4.64 / 9.28) \times 100 = 50\,\%$ or $(2.9 / 5.8) \times 100 = 50\%$ A1 [2]

5 (a) travel through a vacuum / free space B1 [1]

(b) (i) B : name: **microwaves** wavelength: 10^{-4} to $10^{-1}\,\text{m}$ B1
C : name: **ultra-violet / UV** wavelength: 10^{-7} to $10^{-9}\,\text{m}$ B1
F : name: **X –rays** wavelength: 10^{-9} to $10^{-12}\,\text{m}$ B1 [3]

(ii) $f = \dfrac{3 \times 10^8}{500 \times 10^{-9}}$ C1

$f = 6(.0) \times 10^{14}\,\text{Hz}$ A1 [2]

(c) vibrations are in one direction M1
perpendicular to direction of propagation / energy transfer
or good sketch showing this A1 [2]

6 (a) (i) electron B1 [1]

(ii) any **two:**
can be deflected by electric and magnetic fields or negatively charged /
absorbed by few (1 – 4) mm of aluminum / 0.5 to 2 m or metres for range in air /
speed up to 0.99c / range of speeds / energies
B2 [2]

(iii) decay occurs and cannot be affected by external / environmental factors
or two stated factors such as chemical / pressure / temperature / humidity B1 [1]

(b) 3 and 0 for superscript numbers B1
2 and –1 for subscript numbers B1 [2]

(c) energy = $5.7 \times 10^{3} \times 1.6 \times 10^{-19}$ ($= 9.12 \times 10^{-16}$ J) C1

$$v^2 = \frac{2 \times 9.12 \times 10^{-16}}{9.11 \times 10^{-31}}$$ C1

$v = 4.5 \times 10^{7}\ \text{m s}^{-1}$ A1 [3]

(d) both have 1 proton and 1 electron B1
1 neutron in hydrogen-2 and 2 neutrons in hydrogen-3 B1 [2]
(special case: for one mark 'same number of protons / atomic number
different number of neutrons')