

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2014 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 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Page 2	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9702	42

Section A

- 1 (a) gravitational force provides/is the centripetal force
 $GMm/r^2 = mv^2/r$
 $v = \sqrt{GM/r}$
 allow gravitational field strength provides/is the centripetal acceleration
 $GM/r^2 = v^2/r$
- (b) (i) kinetic energy increase/change = loss/change in (gravitational) potential energy
 $\frac{1}{2}mV_0^2 = GMm/x$
 $V_0^2 = 2GM/x$
 $V_0 = \sqrt{2GM/x}$
 (max. 2 for use of r not x)
- (ii) V_0 is (always) greater than v (for $x = r$)
 so stone could not enter into orbit
- (expressions in (a) and (b)(i) must be dimensionally correct)
- 2 (a) use of kelvin temperatures
 both values of (V/T) correct (11.87), V/T is constant so pressure is constant
 (allow use of $n = 1$. Do not allow other values of n .)
- (b) (i) work done = $p\Delta V$
 $= 4.2 \times 10^5 \times (3.87 - 3.49) \times 10^3 \times 10^{-6}$
 $= 160 \text{ J}$
- (do not allow use of V instead of ΔV)
- (ii) increase/change in internal energy = heating of system
 + work done on system
 $= 565 - 160$
 $= 405 \text{ J}$
- (c) internal energy = sum of kinetic energy and potential energy / $E_K + E_P$
 no intermolecular forces
 no potential energy (so $\Delta U = \Delta E_K$)
- 3 (a) resonance
- (b) $Pt = mc \Delta\theta$
 $750 \times 2 \times 60 = 0.28 \times c \times (98 - 25)$
 $c = 4400 \text{ J kg}^{-1} \text{ K}^{-1}$
- (use of $\Delta\theta = 73 + 273$ max. 1/3)
 (use of $t = 2 \text{ s}$ not 120 s max. 2/3)

Page 3	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9702	42

- (c) e.g. some microwave leakage from the cooker
e.g. container for the water is also heated
(any sensible suggestion) B1 [1]
- 4 (a) (i) $F_E = Q_1Q_2/4\pi\epsilon_0r^2$
 $= 8.99 \times 10^9 \times (1.6 \times 10^{-19})^2 / (2.0 \times 10^{-15})^2$
 $= 58 \text{ N}$ C1
A1 [2]
- (ii) $F_G = Gm_1m_2/r^2$
 $= 6.67 \times 10^{-11} \times (1.67 \times 10^{-27})^2 / (2.0 \times 10^{-15})^2$
 $= 4.7 \times 10^{-35} \text{ N}$ C1
A1 [2]
- (b) (i) force of repulsion (much) greater than force of attraction
must be some other force of attraction
to hold nucleus together B1
M1
A1 [3]
- (Do not allow if $F_G > F_E$ in (a) or one of the forces not calculated in (a))
- (ii) outside nucleus there is repulsion between protons B1
either attractive force must act only in nucleus
or if not short range, all nuclei would stick together B1 [2]
- 5 (a) only curve with decreasing gradient M1
acceptable value near $x = 0$ and does not reach zero A1 [2]
- (if graph line less than 4.0 cm do not allow A1 mark)
(no credit if graph line has positive and negative values of V_H)
- (b) graph: from 0 to 2T, two cycles of a sinusoidal wave M1
all peaks above 3.5 mV C1
peaks at 4.95/5.0 mV (allow 4.8 mV to 5.2 mV) A1 [3]
- (c) e.m.f. induced in coil when magnetic field/flux is changing/cutting B1
- either at each position, magnetic field does not vary
so no e.m.f. is induced in the coil/no reading on the millivoltmeter
or at each position, switch off current and take millivoltmeter reading
or at each position, rapidly remove coil from field and take meter reading B1 [2]
- 6 (a) electric and magnetic fields normal to each other B1
- either charged particle enters region normal to both fields
or correct B direction w.r.t. E for zero deflection B1
for no deflection, $v = E/B$ B1 [3]
- (no credit if magnetic field region clearly not overlapping with electric field region)

Page 4	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9702	42

- (b) (i) $m = Bqr/v$ C1
 $= (640 \times 10^{-3} \times 1.6 \times 10^{-19} \times 6.2 \times 10^{-2}) / (9.6 \times 10^4)$ C1
 $= 6.61 \times 10^{-26} \text{ kg}$ C1
 $= (6.61 \times 10^{-26}) / (1.66 \times 10^{-27}) \text{ u}$
 $= 40 \text{ u}$ A1 [4]
- (ii) $q/m \propto 1/r$ or m constant and $q \propto 1/r$ B1
 q/m for A is twice that for B B1
ions in path A have (same mass but) twice the charge (of ions in path B) B1 [3]
- 7 (a) angle subtended at the centre of a circle B1
by an arc equal in length to the radius B1 [2]
- (b) (i) arc = distance \times angle C1
diameter = $3.8 \times 10^5 \times 9.7 \times 10^{-6}$
= 3.7 km A1 [2]
- (ii) Mars is (much) further from Earth/away (*answer must be comparative*) B1
angle (at telescope is much) smaller B1 [2]
- 8 (a) photon energy = hc/λ
 $= (6.63 \times 10^{-34} \times 3.0 \times 10^8) / (590 \times 10^{-9})$ C1
 $= 3.37 \times 10^{-19} \text{ J}$ C1
- number = $(3.2 \times 10^{-3}) / (3.37 \times 10^{-19})$
= 9.5×10^{15} (allow 9.4×10^{15}) A1 [3]
- (b) (i) $p = h/\lambda$ C1
 $= (6.63 \times 10^{-34}) / (590 \times 10^{-9})$
 $= 1.12 \times 10^{-27} \text{ kg m s}^{-1}$ C1
- total momentum = $9.5 \times 10^{15} \times 1.12 \times 10^{-27}$
= $1.06 \times 10^{-11} \text{ kg m s}^{-1}$ A1 [3]
- (ii) force = $1.06 \times 10^{-11} \text{ N}$ A1 [1]
- 9 (a) time for number of atoms/nuclei/activity (of the isotope) M1
to be reduced to one half (of its initial value) A1 [2]
- (b) (i) $A = \lambda N$ C1
 $460 = N \times \ln 2 / (8.1 \times 24 \times 60 \times 60)$ C1
 $N = 4.6 \times 10^8$ A1 [3]
- (ii) number of water molecules in 1.0 kg = $(6.02 \times 10^{23}) / (18 \times 10^{-3})$ C1
= 3.3×10^{25}
- ratio = $(3.3 \times 10^{25}) / (4.6 \times 10^8)$
= 7.2 (7.3) $\times 10^{16}$ A1 [2]

Page 5	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9702	42

- (c) $A = A_0 e^{-\lambda t}$ and $\lambda t_{1/2} = \ln 2$ C1
 $170 = 460 \exp(-\{\ln 2 t\}/8.1)$ C1
 $t = 11.6$ days (allow 2 s.f.) A1 [3]

Section B

- 10 (a) compares the potentials/voltages at the (inverting and non-inverting) inputs B1
either output (potential) dependent on which input is the larger
or $V^+ > V^-$, then V_{OUT} is positive B1
states the other condition B1 [3]
- (b) (i) ring drawn around both the LEDs (and series resistors) B1 [1]
- (ii) $V^- = (1.5 \times 2.4)/(1.2 + 2.4) = 1.0\text{V}$ B1 [1]
(allow $1.5 \times 2.4/3.6 = 1.0\text{V}$)
- (iii) 1. V_{OUT} switches at $+1.0\text{V}$ B1
maximum V_{OUT} is 5.0V B1
when curve is above $+1.0\text{V}$, V_{OUT} is negative (or v.v.) B1 [3]
2. at time t_1 , diode R is emitting light, diode G is not emitting B1
at time t_2 , diode R is not emitting, diode G is emitting B1 [2]
(must be consistent with graph line. If no graph line then 0/2)
- 11 (a) X-ray: flat/shadow/2D image B1
regardless of depth of object/depth not indicated B1
- CT scan: built up from (many) images at different angles B1
image is three-dimensional B1
image can be rotated/viewed at different angles B1 [5]
- (b) (i) $I = I_0 e^{-\mu x}$ C1
 $0.25 = e^{-0.69x}$
 $x = 2.0\text{ mm}$ (allow 1 s.f.) A1 [2]
- (ii) for aluminium, $I/I_0 = e^{-0.46 \times 2.4}$
 $= 0.33$ C1
fraction $= 0.33 \times 0.25$
 $= 0.083$ A1 [2]
- (iii) gain/dB $= 10 \lg(I/I_0)$ C1
 $= 10 \lg(0.083)$
 $= (-) 10.8\text{ dB}$ (allow 2 s.f.) A1
with negative sign B1 [3]
- 12 (a) (i) satellite is in equatorial orbit B1
travelling from west to east B1
period of 24 hours/1 day B1 [3]

Page 6	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9702	42

- (ii) *either* uplink signal is highly attenuated
or signal is highly amplified (before transmission) as downlink signal
prevents downlink signal swamping the uplink signal B1 B1 [2]
- (b) speed of signal is same order of magnitude in both systems B1
optic fibre link (much) shorter than via satellite M1
time delay using optic fibre is less A1 [3]