UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9702 PHYSICS

9702/41 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.

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UNIVERSITY of CAMBRIDGE
International Examinations

Section A

1 (a) (i) force proportional to product of masses B1
force inversely proportional to square of separation B1 [2]

(ii) separation much greater than radius / diameter of Sun / planet B1 [1]

(b) (i) e.g. force or field strength $\propto 1 / r^2$
potential $\propto 1 / r$ B1 [1]

(ii) e.g. gravitational force (always) attractive B1
electric force attractive or repulsive B1 [2]

2 (a) number of atoms of carbon-12 M1
in 0.012 kg of carbon-12 A1 [2]

(b) $pV = NkT$ or $pV = nRT$ C1
substitutes temperature as 298 K C1
either $1.1 \times 10^5 \times 6.5 \times 10^{-2} = N \times 1.38 \times 10^{-23} \times 298$
or $1.1 \times 10^5 \times 6.5 \times 10^{-2} = n \times 8.31 \times 298$ and $n = N / 6.02 \times 10^{23}$ C1
$N = 1.7 \times 10^{24}$ A1 [4]

3 (a) acceleration / force proportional to displacement from a fixed point M1
acceleration / force (always) directed towards that fixed point / in opposite direction to displacement A1 [2]

(b) (i) $A\rho g / m$ is a constant and so acceleration proportional to x B1
negative sign shows acceleration towards a fixed point / in opposite direction to displacement B1 [2]

(ii) $\omega^2 = (A\rho g / m)$ C1
$\omega = 2\pi f$ C1
$(2 \times \pi \times 1.5)^2 = (\{4.5 \times 10^{-4} \times 1.0 \times 10^3 \times 9.81\} / m)$ C1
$m = 50$ g A1 [4]

4 (a) work done in bringing unit positive charge M1
from infinity (to that point) A1 [2]

(b) (i) field strength is potential gradient B1 [1]

(ii) field strength proportional to force (on particle Q) B1
potential gradient proportional to gradient of (potential energy) graph B1
so force is proportional to the gradient of the graph A0 [2]

(c) energy = $5.1 \times 1.6 \times 10^{-19}$ (J) C1
potential energy = $Q_1Q_2 / 4\pi\varepsilon_0 r$ C1
$5.1 \times 1.6 \times 10^{-19} = (1.6 \times 10^{-19})^2 / 4\pi \times 8.85 \times 10^{-12} \times r$ C1
$r = 2.8 \times 10^{-10}$ m A1 [4]

(d) (i) work is got out as x decreases M1
so opposite sign A1 [2]

(ii) energy would be doubled B1
gradient would be increased B1 [2]

5 (a) region (of space) where there is a force M1
either on / produced by magnetic pole
or on / produced by current carrying conductor / moving charge A1 [2]

(b) (i) force on particle is (always) normal to velocity / direction of travel B1
speed of particle is constant B1 [2]

(ii) magnetic force provides the centripetal force B1
$mv^2 / r = Bqv$ M1
$r = mv / Bq$ A0 [2]

(c) (i) direction from 'bottom to top' of diagram B1 [1]

(ii) radius proportional to momentum C1
ratio = 5.7 / 7.4
= 0.77 A1 [2]
*(answer must be consistent with direction given in **(c)(i)**)*

6 (a) (i) to concentrate the (magnetic) flux **/** reduce flux losses B1 [1]

(ii) changing flux (in core) induces current in core M1
currents in core give rise to a heating effect A1 [2]

(b) (i) e.m.f. induced proportional to M1
rate of change of (magnetic) flux (linkage) A1 [2]

(ii) magnetic flux in phase with / proportional to e.m.f. / current in primary coil M1
e.m.f. / p.d. across secondary proportional to rate of change of flux M1
so e.m.f. of supply not in phase with p.d. across secondary A0 [2]

(c) (i) for same power (transmission), high voltage with low current B1
with low current, less energy losses in transmission cables B1 [2]

(ii) voltage is easily / efficiently changed B1 [1]

7 **(a)** for a wave, electron can 'collect' energy continuously — B1
for a wave, electron will always be emitted / electron will be emitted at all frequencies….. — M1
after a sufficiently long delay — A1 [3]

(b) **(i)** *either* wavelength is longer than threshold wavelength
or frequency is below the threshold frequency
or photon energy is less than work function — B1 [1]

(ii) $hc / \lambda = \phi + E_{MAX}$ — C1
$(6.63 \times 10^{-34} \times 3.0 \times 10^{8}) / (240 \times 10^{-9}) = \phi + 4.44 \times 10^{-19}$ — C1
$\phi = 3.8 \times 10^{-19}$ J (*allow* 3.9×10^{-19} J) — A1 [3]

(c) **(i)** photon energy larger — M1
so (maximum) kinetic energy is larger — A1 [2]

(ii) fewer photons (per unit time) — M1
so (maximum) current is smaller — A1 [2]

8 **(a)** **(i)** Fe shown near peak — A1 [1]

(ii) Zr shown about half-way along plateau — A1 [1]

(iii) H shown at less than 0.4 of maximum height — A1 [1]

(b) **(i)** heavy / large nucleus breaks up / splits — M1
into two nuclei / fragments of approximately equal mass — A1 [2]

(ii) binding energy of nucleus = $B_E \times A$ — B1
binding energy of parent nucleus is less than sum of binding energies of fragments — B1 [2]

Section B

9 **(a)** to compare two potentials / voltages — M1
output depends upon which is greater — A1 [2]

(b) **(i)** resistance of thermistor = 2.5 kΩ — C1
resistance of X = 2.5 kΩ — A1 [2]

(ii) at 5 °C / at < 10 °C, $V^- > V^+$ — M1
so V_{OUT} is –9 V — A1
at 20 °C / at > 10 °C, $V^- < V^+$ and V_{OUT} is +9 V — B1
V_{OUT} switches between negative and positive at 10 °C — B1 [4]
(*allow similar scheme if 20 °C treated first*)

10 **(a)** product of density (of medium) and speed of sound (in the medium) — B1 [1]

(b) α would be nearly equal to 1 — M1
either reflected intensity would be nearly equal to incident intensity
or coefficient for transmitted intensity = $(1 - \alpha)$ — M1
transmitted intensity would be small — A1 [3]

(c) **(i)** $\alpha = (1.7 - 1.3)^2 / (1.7 + 1.3)^2$ — C1
$= 0.018$ — A1 [2]

(ii) attenuation in fat = $\exp(-48 \times 2x \times 10^{-2})$ — C1
$0.012 = 0.018 \exp(-48 \times 2x \times 10^{-2})$ — C1
$x = 0.42$ cm — A1 [3]

11 **(a)** frequency of carrier wave varies — M1
(in synchrony) with the displacement of the information signal — A1 [2]

(b) **(i)** 5.0 V — A1 [1]

(ii) 640 kHz — A1 [1]

(iii) 560 kHz — A1 [1]

(iv) 7000 (*condone unit*) — A1 [1]

12 **(a)** e.g. acts as 'return' for the signal
shields inner core from noise / interference / cross-talk
(*any two sensible* answers, 1 each, max 2) — B2 [2]

(b) e.g. greater bandwidth
less attenuation (per unit length)
less noise / interference
(*any two sensible* answers, 1 each, max 2) — B2 [2]

(c) attenuation is 2.4 dB — C1
attenuation = $10 \lg(P_1 / P_2)$ — C1
ratio = 1.7 — A1 [3]