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

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Section A

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

(ii) separation <u>much</u> 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]

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(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]

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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]

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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]

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