UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2008 question paper

9702 PHYSICS

9702/04 Paper 4 (A2 Structured Questions), maximum raw mark 100

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UNIVERSITY of CAMBRIDGE International Examinations

Section A

1 (a) (i) $F = GMm / R^2$ B1 [1]

(ii) $F = mR\omega^2$ B1 [1]

(iii) reaction force = $GMm / R^2 - mR\omega^2$ (*allow e.c.f.*) B1 [1]

(b) (i) *either* value of R in expression $R\omega^2$ varies
or $mR\omega^2$ no longer parallel to GMm / R^2 / normal to surface B1
becomes smaller as object approaches a pole / is zero at pole B1 [2]

(ii) 1. acceleration = $6.4 \times 10^6 \times (2\pi / \{8.6 \times 10^4\})^2$ C1
$= 0.034\ \text{m s}^{-2}$ A1 [2]
2. acceleration = 0 A1 [1]

(c) e.g. 'radius' of planet <u>varies</u>
density of planet <u>not constant</u>
planet spinning
nearby planets / stars
(*any sensible comments, 1 mark each, maximum 2)* B2 [2]

2 (a) (Thermal) energy / heat required to convert unit mass of solid to liquid M1
at its normal melting point / without any change in temperature A1 [2]
(*reference to 1 kg or to ice → water scores max 1 mark*)

(b) (i) To <u>make allowance</u> for heat gains from the atmosphere B1 [1]

(ii) e.g. constant rate of production of droplets from funnel
constant mass of water collected per minute in beaker
(*any sensible suggestion, 1 mark)* B1 [1]

(iii) mass melted by heater in 5 minutes = $64.7 - ½ \times 16.6 = 56.4\,\text{g}$ C1
$56.4 \times 10^{-3} \times L = 18$ C1
$L = 320\ \text{kJ kg}^{-1}$ A1 [3]
(*Use of m = 64.7, giving L = 278 kJ kg^{-1}, scores max 1 mark*
use of m = 48.1, giving L = 374 kJ kg^{-1}, scores max 2 marks)

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

(b) (i) maximum / minimum height / 8 mm above cloth / 14 mm below cloth B1 [1]

(ii) 1. $a = 11\,\text{mm}$ A1 [1]
2. $\omega = 2\pi f$ C1
$= 2\pi \times 4.5$
$= 28.3\ \text{rad s}^{-1}$ (*do not allow 1 s.f.*) A1 [2]

(c) **(i)** $v = \omega a$ C1
$= 28.3 \times 11 \times 10^{-3}$
$= 0.31$ m s^{-1} (*do not allow 1 s.f.*) A1 [2]

(ii) $v = \omega \sqrt{(a^2 - y^2)}$
$y = 3$ mm C1
$= 28.3 \times 10^{-3} \sqrt{(11^2 - 3^2)}$ C1
$= 0.30$ m s^{-1} (*allow 1 s.f.*) A1 [3]

4 **(a)** $\Delta U = q + w$ (*allow correct word equation*) B1 [1]

(b) *either* kinetic energy constant because temperature constant M1
potential energy constant because no intermolecular forces M1
so no change in internal energy A1 [3]
or kinetic energy and potential energy both constant (M1)
so no change in internal energy (A1)
reason for *either* constant k.e. *or* constant p.e. given (A1)

5 **(a)** change/loss in kinetic energy = change/gain in electric potential energy B1
$2 \times \frac{1}{2}mv^2 = q^2 / 4\pi\varepsilon_0 r$ C1
$2 \times \frac{1}{2} \times 2 \times 1.67 \times 10^{-27} \times v^2$
$= (1.6 \times 10^{-19})^2 / (4\pi \times 8.85 \times 10^{-12} \times 1.1 \times 10^{-14})$ M1
$v = 2.5 \times 10^6$ m s^{-1} A0 [3]

(b) $pV = \frac{1}{2}Nm\langle c^2 \rangle$ and $pV = NkT$ C1
$\frac{1}{2} m\langle c^2 \rangle = \frac{3}{2} kT$ (*award 1 mark of first two if* $\langle c^2 \rangle$ *not used*) C1
$\frac{1}{2} \times 2 \times 1.67 \times 10^{-27} \times (2.5 \times 10^6)^2 = \frac{3}{2} \times 1.38 \times 10^{-23} \times T$ C1
$T = 5 \times 10^8$ K A1 [4]

(c) e.g. this is very high temperature
temperature found in stars
(*any sensible comment, 1 mark)*
(*if* $T < 10^6$ *K, should comment that too low for fusion to occur*) B1 [1]

6 **(a)** **(i)** *either* prevent loss of magnetic flux
or improves flux linkage with secondary B1 [1]

(ii) reduces eddy current (losses) B1
reduces losses of energy (in core) B1 [2]

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

(ii) changing current in primary gives rise to (1)
changing flux in core (1)
flux links with the secondary coil (1)
changing flux in secondary coil, inducing e.m.f. (1)

(*any three, 1 each to max 3*) B3 [3]

(c) e.g. can change voltage easily / efficiently
high voltage transmission reduces power losses
(*any two sensible suggestions, 1 each*) B2 [2]

7 **(a)** e.g. 'instantaneous' emission (of electrons)
threshold frequency below which no emission
(max) electron energy dependent on frequency
(max) electron energy not dependent on intensity
rate of emission (of electrons) depends on intensity
(*any three sensible suggestions, 1 each*) B3 [3]

(b) **(i)** 'packet' / quantum of energy M1
of electromagnetic energy / radiation A1 [2]

(ii) discrete wavelengths mean photons have particular energies M1
energy of photon determined by energy change of (orbital) electron M1
so discrete energy levels A0 [2]

(c) **(i)** three energy changes shown correctly B1
arrows 'pointing' in correct direction B1
wavelengths correctly identified B1 [3]

(ii) chooses λ = 486 nm C1
$\Delta E = hc / \lambda$ C1
$= (6.63 \times 10^{-34} \times 3.0 \times 10^{8}) / (4.86 \times 10^{-9})$
$= 4.09 \times 10^{-19}$ J (*allow 2 s.f.*) A1 [3]

8 **(a)** region (of space) / area where B1
a force is experienced by M1
current-carrying conductor / moving charge / permanent magnet A1 [3]

(b) **(i)** electric B1 [1]

(ii) gravitational B1 [1]

(iii) magnetic B1 [1]

(iv) magnetic B1 [1]

Section B

9 **(a)** IR has less attenuation (per unit length) B1
fewer (repeater) amplifiers / longer <u>uninterrupted</u> length B1 [2]

(b) *either* limited range B1
(so) cells do not overlap (appreciably) B1 [2]
or short wavelength (B1)
so convenient length aerial (on mobile phone) (B1)

(c) large bandwidth / large information carrying capacity B1
different so that uplink signal not swamped by downlink B1 [2]

10 **(a)** **(i)** **1.** inverting (amplifier) B1 [1]
2. gain of op-amp is very large / infinite B1
non-inverting input is at earth / 0 V B1
for amplifier not to saturate, P must be at about earth / 0 V B1 [3]

(ii) input resistance is very large B1
(so) current in R_1 = current in R_2 B1
$I = V_{IN} / R_1$ B1
$I = -V_{OUT} / R_2$ (*minus sign can be in either of the equations*) B1
hence *gain* = $V_{OUT} / V_{IN} = -R_2 / R_1$ A0 [4]

(b) **(i)** **1.** feedback resistance = 33.3 kΩ C1
gain (= 33.3 / 5) = 6.66 C1
V_{OUT} (= 6.66 × 1.2) = 8.0 V (+ *or* – *acceptable, allow 1 s.f.*) A1 [3]
2. feedback resistance = 8.33 kΩ C1
V_{OUT} (= {6.66 × 1.2} / 5) = 2.0 V (+ *or* – *acceptable, allow 1 s.f.*) A1 [2]

(ii) (Increase in lamp-LDR distance gives) decrease in intensity M1
<u>Feedback</u> / <u>LDR</u> resistance increases M1
voltmeter reading increases / becomes more negative A1 [3]

11 **(a)** CT image: (thin) slice (through structure) B1
any further detail e.g. built up from many 'slices' / 3-D image B1
X-ray image: 'shadow' image (of whole structure) / 2-D image B1 [3]

(b) X-ray image <u>of slice</u> taken from many different angles (1)
these images are combined (and processed) (1)
repeated for many different slices (1)
to build up a 3-D image (1)
3-D image can be rotated (1)
computer required to store and process huge quantity of data (1)
(*any five, 1 each to max 5*) B5 [5]