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

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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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Section A

1	**(a)**	**(i)**	$F = GMm / R^2$	B1	
		(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	
			$= 0.034$ 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 = $64.7 - ½ \times 16.6 = 56.4$ g	C1	
			$56.4 \times 10^{-3} \times L = 18$	C1	
			$L = 320$ 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.** $a = 11$ mm	A1	[1]
			2. $\omega = 2\pi f$	C1	
			$= 2\pi \times 4.5$		
			$= 28.3$ rad s^{-1} (*do not allow 1 s.f.*)	A1	[2]

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

(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*) B

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

7 **(a)** e.g. 'instantaneous' emission (of electrons)
threshold frequency below which no emission
(max) <u>electron</u> energy dependent on frequency
(max) <u>electron</u> 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]