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	[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 (*reference to 1 kg or to ice → water scores max 1 mark*)	A1	[2]
	(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 × 16.6 = 56.4 g	C1	
			$56.4 \times 10^{-3} \times L = 18$	C1	
			$L = 320\ \text{kJ kg}^{-1}$ (*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*)	A1	[3]
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	
			$= 2\pi \times 4.5$ $= 28.3\ \text{rad s}^{-1}$ (*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 <u>very</u> 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) <u>reduces</u> eddy current (losses)	B1	
<u>reduces</u> 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]