

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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Page 2	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2008	9702	04

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
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 varies
density of planet not constant
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
at its normal melting point / without any change in temperature M1
(reference to 1 kg or to ice → water scores max 1 mark) A1 [2]
- (b) (i) To make allowance 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 = $64.7 - \frac{1}{2} \times 16.6 = 56.4 \text{ g}$ C1
 $56.4 \times 10^{-3} \times L = 18$ C1
 $L = 320 \text{ kJ kg}^{-1}$ A1 [3]
(Use of $m = 64.7$, giving $L = 278 \text{ kJ kg}^{-1}$, scores max 1 mark
use of $m = 48.1$, giving $L = 374 \text{ kJ kg}^{-1}$, 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 rad s^{-1} (do not allow 1 s.f.) A1 [2]

Page 3	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2008	9702	04

- (c) (i) $v = \omega a$
 $= 28.3 \times 11 \times 10^{-3}$
 $= 0.31 \text{ m s}^{-1}$ (do not allow 1 s.f.) C1 A1 [2]
- (ii) $v = \omega \sqrt{a^2 - y^2}$
 $y = 3 \text{ mm}$
 $= 28.3 \times 10^{-3} \sqrt{11^2 - 3^2}$
 $= 0.30 \text{ m s}^{-1}$ (allow 1 s.f.) C1 C1 A1 [3]
- 4 (a) $\Delta U = q + w$ (allow correct word equation) B1 [1]
- (b) either kinetic energy constant because temperature constant
potential energy constant because no intermolecular forces
so no change in internal energy M1 M1 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
 $2 \times \frac{1}{2}mv^2 = q^2 / 4\pi\epsilon_0 r$ 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
 $v = 2.5 \times 10^6 \text{ m s}^{-1}$ 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
 $T = 5 \times 10^8 \text{ K}$ A1 [4]
- (c) e.g. this is very high temperature
temperature found in stars
(any sensible comment, 1 mark)
(if $T < 10^6 \text{ K}$, 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
rate of change of (magnetic) flux (linkage) M1 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)

Page 4	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2008	9702	04

	(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) <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 of electromagnetic energy / radiation	M1 A1	[2]
	(ii) discrete wavelengths mean photons have particular energies energy of photon determined by energy change of (orbital) electron so discrete energy levels	M1 M1 A0	[2]
	(c) (i) three energy changes shown correctly arrows 'pointing' in correct direction wavelengths correctly identified	B1 B1 B1	[3]
	(ii) chooses $\lambda = 486 \text{ nm}$ $\Delta E = hc / \lambda$ $= (6.63 \times 10^{-34} \times 3.0 \times 10^8) / (4.86 \times 10^{-9})$ $= 4.09 \times 10^{-19} \text{ J}$ (allow 2 s.f.)	C1 C1 A1	[3]
8	(a) region (of space) / area where a force is experienced by current-carrying conductor / moving charge / permanent magnet	B1 M1 A1	[3]
	(b) (i) electric	B1	[1]
	(ii) gravitational	B1	[1]
	(iii) magnetic	B1	[1]
	(iv) magnetic	B1	[1]

Page 5	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2008	9702	04

Section B

- 9 (a) IR has less attenuation (per unit length) B1
fewer (repeater) amplifiers / longer uninterrupted 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 / 0V B1
for amplifier not to saturate, P must be at about earth / 0V 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 k Ω C1
gain (= 33.3 / 5) = 6.66 C1
 V_{OUT} (= 6.66 \times 1.2) = 8.0 V (+ or – acceptable, allow 1 s.f.) A1 [3]
2. feedback resistance = 8.33 k Ω C1
 V_{OUT} (= {6.66 \times 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
Feedback / LDR 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 of slice 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]