

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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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
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]

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- (c) (i) $v = \omega a$
 $= 28.3 \times 11 \times 10^{-3}$
 $= 0.31 \text{ m s}^{-1}$ (do not allow 1 s.f.)
- (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.)
- 4 (a) $\Delta U = q + w$ (allow correct word equation)
- (b) either kinetic energy constant because temperature constant
potential energy constant because no intermolecular forces
so no change in internal energy
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
 $2 \times \frac{1}{2}mv^2 = q^2 / 4\pi\epsilon_0 r$
 $2 \times \frac{1}{2} \times 2 \times 1.67 \times 10^{-27} \times v^2$
 $= (1.6 \times 10^{-19})^2 / (4\pi \times 8.85 \times 10^{-12} \times 1.1 \times 10^{-14})$
 $v = 2.5 \times 10^6 \text{ m s}^{-1}$
- (b) $pV = \frac{1}{2}Nm\langle c^2 \rangle$ and $pV = NkT$
 $\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT$ (award 1 mark of first two if $\langle c^2 \rangle$ not used)
 $\frac{1}{2} \times 2 \times 1.67 \times 10^{-27} \times (2.5 \times 10^6)^2 = \frac{3}{2} \times 1.38 \times 10^{-23} \times T$
 $T = 5 \times 10^8 \text{ K}$
- (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)
- 6 (a) (i) either prevent loss of magnetic flux
or improves flux linkage with secondary
- (ii) reduces eddy current (losses)
reduces losses of energy (in core)
- (b) (i) (induced) e.m.f. proportional to / equal to
rate of change of (magnetic) flux (linkage)
- (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)

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	(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]

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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]