UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9702 PHYSICS

9702/41 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, which would have considered the acceptability of alternative answers.

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UNIVERSITY *of* CAMBRIDGE
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Section A

1	**(a)**	**(i)**	force proportional to product of masses	B1	
			force inversely proportional to square of separation	B1	[2]
		(ii)	separation <u>much</u> greater than radius / diameter of Sun / planet	B1	[1]
	(b)	**(i)**	e.g. force or field strength $\propto 1 / r^2$		
			potential $\propto 1 / r$	B1	[1]
		(ii)	e.g. gravitational force (always) attractive	B1	
			electric force attractive or repulsive	B1	[2]
2	**(a)**		number of atoms of carbon-12	M1	
			in 0.012 kg of carbon-12	A1	[2]
	(b)		$pV = NkT$ or $pV = nRT$	C1	
			substitutes temperature as 298 K	C1	
			either $1.1 \times 10^5 \times 6.5 \times 10^{\ 2} = N \times 1.38 \times 10^{\ 23} \times 298$		
			or $1.1 \times 10^5 \times 6.5 \times 10^{\ 2} = n \times 8.31 \times 298$ and $n = N / 6.02 \times 10^{23}$	C1	
			$N = 1.7 \times 10^{24}$	A1	[4]
3	**(a)**		acceleration / force proportional to displacement from a fixed point	M1	
			acceleration / force (always) directed towards that fixed point / in opposite direction to displacement	A1	[2]
	(b)	**(i)**	$A\rho g / m$ is a constant and so acceleration proportional to x	B1	
			negative sign shows acceleration towards a fixed point / in opposite direction to displacement	B1	[2]
		(ii)	$\omega^2 = (A\rho g / m)$	C1	
			$\omega = 2\pi f$	C1	
			$(2 \times \pi \times 1.5)^2 = (\{4.5 \times 10^{\ 4} \times 1.0 \times 10^3 \times 9.81\} / m)$	C1	
			$m = 50$ g	A1	[4]
4	**(a)**		work done in bringing unit positive charge	M1	
			from infinity (to that point)	A1	[2]
	(b)	**(i)**	field strength is potential gradient	B1	[1]
		(ii)	field strength proportional to force (on particle Q)	B1	
			potential gradient proportional to gradient of (potential energy) graph	B1	
			so force is proportional to the gradient of the graph	A0	[2]

	(c)		energy = $5.1 \times 1.6 \times 10^{19}$ (J)	C1	
			potential energy = $Q_1Q_2 / 4\pi\varepsilon_0 r$	C1	
			$5.1 \times 1.6 \times 10^{19} = (1.6 \times 10^{19})^2 / 4\pi \times 8.85 \times 10^{12} \times r$	C1	
			$r = 2.8 \times 10^{10}$ m	A1	[4]
	(d)	**(i)**	work is got out as *x* decreases	M1	
			so opposite sign	A1	[2]
		(ii)	energy would be doubled	B1	
			gradient would be increased	B1	[2]
5	**(a)**		region (of space) where there is a force	M1	
			either on / produced by magnetic pole		
			or on / produced by current carrying conductor / moving charge	A1	[2]
	(b)	**(i)**	force on particle is (always) normal to velocity / direction of travel	B1	
			speed of particle is constant	B1	[2]
		(ii)	magnetic force provides the centripetal force	B1	
			$mv^2 / r = Bqv$	M1	
			$r = mv / Bq$	A0	[2]
	(c)	**(i)**	direction from 'bottom to top' of diagram	B1	[1]
		(ii)	radius proportional to momentum	C1	
			ratio = 5.7 / 7.4		
			= 0.77	A1	[2]
			(answer must be consistent with direction given in ***(c)(i)****)*		
6	**(a)**	**(i)**	to concentrate the (magnetic) flux **/** reduce flux losses	B1	[1]
		(ii)	changing flux (in core) induces current in core	M1	
			currents in core give rise to a heating effect	A1	[2]
	(b)	**(i)**	e.m.f. induced proportional to	M1	
			rate of change of (magnetic) flux (linkage)	A1	[2]
		(ii)	magnetic flux in phase with / proportional to e.m.f. / current in primary coil	M1	
			e.m.f. / p.d. across secondary proportional to rate of change of flux	M1	
			so e.m.f. of supply not in phase with p.d. across secondary	A0	[2]
	(c)	**(i)**	for same power (transmission), high voltage with low current	B1	
			with low current, less energy losses in transmission cables	B1	[2]
		(ii)	voltage is easily / efficiently changed	B1	[1]

7 **(a)**	for a wave, electron can 'collect' energy continuously	B1	
	for a wave, electron will always be emitted / electron will be emitted at all frequencies…..	M1	
	after a sufficiently long delay	A1	[3]
(b) **(i)**	*either* wavelength is longer than threshold wavelength *or* frequency is below the threshold frequency *or* photon energy is less than work function	B1	[1]
(ii)	$hc / \lambda = \phi + E_{MAX}$	C1	
	$(6.63 \times 10^{34} \times 3.0 \times 10^{8}) / (240 \times 10^{9}) = \phi + 4.44 \times 10^{19}$	C1	
	$\phi = 3.8 \times 10^{19}$ J (*allow* 3.9×10^{19} J)	A1	[3]
(c) **(i)**	photon energy larger	M1	
	so (maximum) kinetic energy is larger	A1	[2]
(ii)	fewer photons (per unit time)	M1	
	so (maximum) current is smaller	A1	[2]
8 **(a)** **(i)**	Fe shown near peak	A1	[1]
(ii)	Zr shown about half-way along plateau	A1	[1]
(iii)	H shown at less than 0.4 of maximum height	A1	[1]
(b) **(i)**	heavy / large nucleus breaks up / splits	M1	
	into two nuclei / fragments of approximately equal mass	A1	[2]
(ii)	binding energy of nucleus = $B_E \times A$	B1	
	binding energy of parent nucleus is less than sum of binding energies of fragments	B1	[2]

Section B

9 **(a)** to compare two potentials / voltages — M1
output depends upon which is greater — A1 [2]

(b) **(i)** resistance of thermistor = 2.5 kΩ — C1
resistance of X = 2.5 kΩ — A1 [2]

(ii) at 5 °C / at < 10 °C, V > V^{+} — M1
so V_{OUT} is –9 V — A1
at 20 °C / at > 10 °C, V < V^{+} and V_{OUT} is +9 V — B1
V_{OUT} switches between negative and positive at 10 °C — B1 [4]
(*allow similar scheme if 20 °C treated first*)

10 **(a)** product of density (of medium) and speed of sound (in the medium) — B1 [1]

(b) α would be nearly equal to 1 — M1
either reflected intensity would be nearly equal to incident intensity
or coefficient for transmitted intensity = (1 – α) — M1
transmitted intensity would be small — A1 [3]

(c) **(i)** $\alpha = (1.7 - 1.3)^2 / (1.7 + 1.3)^2$ — C1
= 0.018 — A1 [2]

(ii) attenuation in fat = exp(–48 × 2x × 10^{2}) — C1
0.012 = 0.018 exp(–48 × 2x × 10^{2}) — C1
x = 0.42 cm — A1 [3]

11 **(a)** frequency of carrier wave varies — M1
(in synchrony) with the displacement of the information signal — A1 [2]

(b) **(i)** 5.0 V — A1 [1]

(ii) 640 kHz — A1 [1]

(iii) 560 kHz — A1 [1]

(iv) 7000 (*condone unit*) — A1 [1]

12 **(a)** e.g. acts as 'return' for the signal
shields inner core from noise / interference / cross-talk
(*any two sensible* answers, 1 each, max 2) — B2 [2]

(b) e.g. greater bandwidth
less attenuation (per unit length)
less noise / interference
(*any two sensible* answers, 1 each, max 2) — B2 [2]

(c) attenuation is 2.4 dB — C1
attenuation = 10 lg(P_1 / P_2) — C1
ratio = 1.7 — A1 [3]