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

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UNIVERSITY *of* CAMBRIDGE
International Examinations

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	
			$m = 50\,\text{g}$	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 = $(1 - \alpha)$	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 = $\exp(-48 \times 2x \times 10^{-2})$	C1	
			$0.012 = 0.018 \exp(-48 \times 2x \times 10^{-2})$	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]