UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the November 2004 question paper

9702 PHYSICS

9702/04 **Paper 4 (Core), maximum raw mark 60**

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. This shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

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.

Mark schemes must be read in conjunction with the question papers and the *Report on the Examination*.

- CIE will not enter into discussion or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the November 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.

Grade thresholds taken for Syllabus 9702 (Physics) in the November 2004 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 4	60	39	34	18

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.

November 2004

GCE A LEVEL

MARK SCHEME
MAXIMUM MARK: 60
SYLLABUS/COMPONENT: 9702/04 PHYSICS Paper 4 (Core)

1	**(a)**		θ (rad) $= 2\pi\ x\ (10.3/360)$	1	
			$= 0.180$ rad (n.b. 3 sig. fig.)	1	**[2]**
	(b)	**(i)**	$\tan\theta = 0.182$ (n.b. 3 sig. fig.)	1	
		(ii)	percentage error = (0.002/0.180) x 100	1	
			= 1.1 (%)	1	**[3]**
			(allow 0.002/0.182 and allow 1→ 4 sig. fig.)		
2	**(a)**	**(i)**	grav. pot. energy = GM_1M_2/R	1	
			energy $= \{6.67 \times 10^{-11} \times 197 \times 4 \times (1.66 \times 10^{-27})^2\}/9.6 \times 10^{-15}$	1	
			$= 1.51 \times 10^{-47}$ J	1	**[3]**
		(ii)	elec. pot. energy = $Q_1Q_2/4\pi\varepsilon_0R$	1	
			energy $= \{79 \times 2 \times (1.6 \times 10^{-19})^2\}/4\pi \times 8.85 \times 10^{-12} \times 9.6 \times 10^{-15}$	1	
			$= 3.79 \times 10^{-12}$ J	1	**[3]**
			*(For the substitution, -1 each error or omission to max 2 in **(i)** and in **(ii)**)*		
	(b)		electric potential energy >> gravitational potential energy	1	**[1]**
	(c)		*either 6* MeV = 9.6 *x* 10^{-13} J or 3.79 *x* 10^{-12} J = 24 MeV	1	
			not enough energy to get close to the nucleus	1	**[2]**
3	**(a)**	**(i)**	reasonable shape as 'inverse' of k.e. line	1	
		(ii)	straight line, parallel to x-axis at 15 mJ	1	**[2]**
	(b)		*either* (max) kinetic energy (= ½ mv^2) = ½ m$\omega^2 a_0^2$	1	
			$15 \times 10^{-3} = ½ \times 0.15 \times \omega^2 \times (5.0 \times 10^{-2})^2$	1	
			$\omega = 8.9(4)$ rad s^{-1}	1	
			or (k.e. = ½ mv^2), v = 0.44(7) m s^{-1}	1	
			$\omega = v/a = (0.447)/(5.0 \times 10^{-2})$	1	
			$\omega = 8.9(4)$ rad s^{-1}	1	**[3]**
	(c)	**(i)**	*either* loss of energy (from the system) *or* amplitude decreases *or* additional force acting (on the mass)	1	
			either continuous/gradual loss *or* force always opposing motion	1	**[2]**
		(ii)	*either* (now has 80% of its) p.e./k.e. = 12 mJ *or* loss in k.e. = 3 mJ	1	
			new amplitude = 4.5 cm (allow ± 0.1 cm)	1	**[2]**

4	**(a)**	**(i)**	50 mT	1	
		(ii)	flux linkage = *BAN*	1	
			$= 50 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150 = 3.0 \times 10^{-4}$ Wb	1	**[3]**
			(allow 49 mT→ 2.94×10^{-4} Wb or 51 mT→ 3.06×10^{-4} Wb)		
	(b)		e.m.f./induced voltage *(do not allow current)*		
			proportional/equal to	1	
			rate of change/cutting of flux (linkage)	1	**[2]**
	(c)	**(i)**	new flux linkage $= 8.0 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$		
			$= 4.8 \times 10^{-5}$ Wb	1	
			change $= 2.52 \times 10^{-4}$ Wb	1	**[2]**
		(ii)	e.m.f. $= (2.52 \times 10^{-4})/0.30$	1	
			$= 8.4 \times 10^{-4}$ V	1	**[2]**
	(d)	*either*	for *a* small change in distance *x*	1	
			(change in) flux linkage decreases as distance increases	1	
			so speed must increase to keep rate of change constant	1	**[3]**
		or	(change in) flux linkage decreases as distance increases	(1)	
			at constant speed, e.m.f/flux linkage decreases as x increases	(1)	
			so increase speed to keep rate constant	(1)	
5	**(a)**		into (plane of) paper/downwards	1	**[1]**
	(b)	**(i)**	the <u>centripetal force</u> = mv^2/r	1	
			$mv^2/r = Bqv$ <u>hence</u> $q/m = v/rB$ *(some algebra essential)*	1	**[2]**
		(ii)	$q/m = (8.2 \times 10^{6})/(23 \times 10^{-2} \times 0.74)$	1	
			$= 4.82 \times 10^{7}$ C kg^{-1}	1	**[2]**
	(c)	**(i)**	mass $= (1.6 \times 10^{-19})/(4.82 \times 10^{7} \times 1.66 \times 10^{-27})$	1	
			= 2u	1	**[2]**
		(ii)	proton + neutron	1	**[1]**
6	**(a)**	**(i)**	*either* probability of decay *or* d*N*/dt = $(-)\lambda N$ OR A = $(-)\lambda N$	1	
			per unit time — with symbols explained	1	**[2]**
		(ii)	greater energy of α particle means	0	
			(parent) nucleus less stable	1	
			nucleus more likely to decay	1	
			hence Radium-224	1	**[3]**
	(b)	**(i)**	*either* λ = ln2/3.6 = 0.193 or λ = ln2/3.6 x 24 x 3 600 $= 2.23 \times 10^{-6}$	1	
			unit day^{-1} s^{-1}	1	**[2]**
			(one sig.fig., *-1, allow λ in hr^{-1})*		

		(ii) $N = \{(2.24 \times 10^{-3})/224\} \times 6.02 \times 10^{23}$	1	
		$= 6.02 \times 10^{18}$	1	
		activity $= \lambda N$		
		$= 2.23 \times 10^{-6} \times 6.02 \times 10^{18}$	1	
		$= 1.3 \times 10^{13}$ Bq	1	**[4]**
	(c)	$A = A_0 \, e^{-\ln 2 . t/T}$		
		$0.1 = \exp(-\ln 2 \, . \, n)$	1	
		$n = 3.32$	1	**[2]**
		(n = 3 without working scores 1 mark)		
7	**(a)**	variation is non-linear	1	
		two possible temperatures	1	**[2]**
	(b)	e.g. 1. small thermal capacity/measure $\Delta\theta$ of small object /short response time		
		2 readings taken at a point/physically small		
		3 can be used to measure temperature difference		
		4 no power supply required		
		etc. (any two, 1 mark each)	2	**[2]**