Mark Scheme	Unit Code	Session	Year	Final
	2824	June	2005	Version

Abbreviations, annotations and conventions used in the Mark Scheme

/ = alternative and acceptable answers for the same marking point
; = separates marking points
() = words which are not essential to gain credit
ecf = error carried forward
AW = alternative wording

Question			Expected Answers	Marks	
1	a	i	48 (N) 0.25 (s)	1	
		ii	estimating area under graph or mean F; 6.5 ± 1	2	3
	b	i	a = F/m or = 48/0.5 ; = 96 (m s^{-2}) *ecf a(i)*	2	
		ii	Ft = mv; v = *a(ii)*/0.5 = 2*a(ii)* (m s^{-1}) *ecf a(ii)*	2	
		iii	k.e. = ½ mv^2 or = ½ x 0.5 x *b(ii)*^{2} ; = *a(ii)*^{2} (J) *ecf b(ii)*	2	6
	c		Ft = mv ± mu or = 0.5 (8 ± 14) ;	1	
			F = 11/0.18 ; = 61(.1) (N) *aliter mean a = 12(2) m* s^{-2} *F = ma*	2	3
			Total		12
2	a		force (of attraction) on unit mass (at that point in space/at the surface of a planet)	1	1
	b	i	(mgh =) 1500 x 40 x 1.5 x 10^5 ; = 9.0 x 10^9 (J)	2	
		ii	(larger as) g decreases with height	1	
		iii	v = 2πR/T ; = 2π x 2.0 x 10^7/(4.5 x 10^3) = 2.8 x 10^4 m s^{-1}	2	
			½ mv^2; = 0.5 x 1500 x (2.8 x 10^4)^2 = 5.9 x 10^{11} (J)	2	7
			aliter: F = mv^2/R ; = mg ; so ½ mv^2 = ½ mgR ;= 6.0 x 10^{11} (J)		
	c	i	4.5 (N kg^{-1})	1	
		ii	g = (-)GM/r^2	1	
		iii	g ∝ 1/r^2 ;so value is 40/9 = 4.4(4) (N kg^{-1}) *ecf c(i)*	2	4
			Total		12
3	a		when pressure or volume or (internal) energy of an ideal gas tends to zero, the temperature must tend to zero; the temperature scale with this	1	
			zero of temperature is the kelvin scale/AW	1	2
	b		applying pV/T = constant; V/290 = 0.01 x 10^6/230 ; V = 1.26 x 10^4 (m^3)	3	3
	c	i	n = pV/RT = 1.0 x 10^5 x 1.26 x 10^4/(8.31 x 290) ; = 5.2 x 10^5 *allow 5.4*	2	
		ii	4.0 x 10^{-3} x 5.2 x 10^5 = 2.1 x 10^3 (kg) *ecf c(i)*	1	3
	d		internal energy ∝ T /AW; E = 1.9 x 230/290 = 1500 (MJ)	2	2
	e	i	two vertical arrows with line of action passing through the centre of mass of the balloon (the upward one longer than the downward one); labelled	1	
			1.3 x 10^5 N/upward force/upthrust/lift and Mg/weight	1	2
		ii	Ma = U – Mg ; 27 M = 1.3 x 10^5 – Mg	2	
			giving M = 3.5 x 10^3 kg *give 1 mark out of 3 for M = 4.8 x* 10^3 *kg*	1	3
			Total		15

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4	a		the splitting of a nucleus into two (or more) smaller nuclei/particles/fragments (spontaneously/after absorption of a neutron)	1	
	b		$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^{1}_{0}n$ *-1 mark per error*	2	
	c		$\Delta E = c^2\Delta m$; $\Delta m = 0.186$ u (= 3.09×10^{-28} kg) ;	2	
			$\Delta E = 9 \times 10^{16} \times 0.186 \times 1.66 \times 10^{-27} = 2.78 \times 10^{-11}$ (J)	1	
	d		$F = kQ_1Q_2/r^2$; $Q_1 = 56e$, $Q_2 = 36e$;	2	
			$F = 9 \times 10^9 \times 56 \times 36 \times (1.6 \times 10^{-19})^2/(1.3 \times 10^{-14})^2$; = 2.7(4) x 10^3 (N)	2	
			Total		10
5	a		B = F/Il with symbols explained or appropriate statement in words;	1	
			explicit reference to I and B at right angles/define from F = BQv etc	1	2
	b	i	arrow towards centre of circle	1	
		ii	field out of paper; Fleming's L.H.rule/moving protons act as conventional current	1 1	
		iii	F = Bev *allow BQv*	1	
		iv	$F = mv^2/r$; $Bev = mv^2/r$;	2	
			$B = mv/er = 1.67 \times 10^{-27} \times 1.5 \times 10^7/(1.6 \times 10^{-19} \times 60)$; = 0.0026 ; T *allow Wb m^{-2}*	3	
		v	the field must be doubled ; B ∝ v (as m, e and r are fixed)/an increased force is required to maintain the same radius	1 1	11
			Total		13
6	a	i	cosine curve;	1	
			sensible (exponential) decay of amplitude with time;	1	
			correct period	1	
		ii	amplitude will decay more rapidly; greater damping/air resistance on wings **or** greater damping; air resistance on wings **or** oscillation will effectively cease in shorter time; greater energy/amplitude loss per cycle **or** AW	2	
			frequency will decrease/period increase; greater mass/inertia of system	2	7
	b	•	resonance occurs at /close to the natural frequency of an oscillating object/system	1	
			caused by driving force (at this frequency)	1	
			when maximum energy transfer between driver and driven/maximum amplitude achieved *max 2 marks*	1	
		•	small amplitude (≈ that of driver) at low frequencies/less than 1.0 Hz; *driver and driven in phase*	1	
			amplitude rises to maximum; at 1.0 Hz *driver and driven 90° out of phase*	2	
			(very) small amplitude at high frequencies/greater than 1.0 Hz	1	
			driver and driven (180°) out of phase (up to 2 marks can be credited for accurate reference to phase shifts as shown in italics) but max 3 marks	2	5
			Total		12

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7	a	α helium nucleus β electron γ photon/e-m radiation/energy	1	
		α charge +(2e) mass $4m_p$/4u β charge –(e) mass m_e γ charge 0 mass 0	2	
		α emission energy 3 – 7 MeV β emission energy 1 – 2 MeV γ emission energy about 1 – 2 MeV **or** all of the same order of magnitude/AW	1	
		α monoenergetic from given nuclide β range of emission energies from given nuclide from zero to a maximum γ monoenergetic from given nuclide **or** comparison in terms of velocities	1	
		α range 3 – 7 cm of air β range 1 – 2 m of air γ range inverse square law in air/ order of kms	1	
		α absorbed by paper β absorbed by thin/ 1 mm Al sheet γ up to cm of Pb sheet	1	
		α strongly ionising β weakly ionising γ hardly ionising at all	1	
		any other sensible comparison *max 6 marks*	1	6
	b	range/penetration/absorption/deflection experiment suggested *but no further progress made to answer question otherwise:*	1	
		suitable arrangement and choice of apparatus *all can be shown on a diagram*	2	
	•	range/penetration/absorption experiment:		
		α place detector very close/ 2cm from source; measure count rate, use paper screen or move back to 10 cm or more, measure count rate, interpret result; contrast to background count level/ other emissions from same source	3	
		β place detector e.g. 10 cm from source measure count rate, add thin sheets of Al until count drops to very low or almost constant value; interpret result	2	
		γ place detector e.g. 10 cm from source measure count rate, add thin sheets of Pb until count drops to very low/background level; interpret result *max 6 marks*	2	
	•	*aliter* deflection experiment:		
		needs vacuum for α experiment;	1	
		source for radiation passes through region of E- or B- field;	1	
		deflection or not of particles detected by detector to distinguish emissions;	1	
		detail of directions; *all 3 correct – 2 marks can only score max of 1 mark unless vacuum mentioned*	2	
		amount of curvature determines energy of emission; and nature of particle *max 6 marks*	1 1	6
		Quality of written communication		4
		Total		16