Mark Scheme 2825/04
June 2005

Mark Scheme	Unit Code 2825 / 04	Session June	Year 2005	Version Fourth draft (pre-standardisation)
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			

Question	Expected Answers	Marks	
1 (a)(i)	$^4/_3 \pi r_0^3$ $^4/_3 \pi r^3$ alone gets 0	1	[1]
(ii)	$A\,^4/_3 \pi r_0^3$ allow ecf from (i)	1	[1]
(iii)	equates volumes: $^4/_3 \pi r^3 = A\,^4/_3 \pi r_0^3$ cancels ($^4/_3$) and π allow ecf giving $r^3 = A r_0^3$ providing expression includes π	1 1	[2]
(iv)	graph: straight line through origin, drawn with ruler (2) attempted straight line through origin, drawn freehand gets 1/2 gradient = r_0^3 allow even if line was a curve (1)	3	[3]
(b)(i)	density = m / V $= 197 \times 1.67 \times 10^{-27} / (197 \times {}^4/_3 \pi\, [1.4 \times 10^{-15}]^3)$ $= 1.5 \times 10^{17}$ kg m^{-3} accept 1.4×10^{17} to 1.5×10^{17} uses 1.6×10^{-27} to give 1.39×10^{17} gets 1,0,1 = 2/3	1 1 1	[3]
(ii)	correct method: *either* correct ratio of densities *or* correct ratio of volumes stated clearly or clear from working; $m = \rho V$ so $\rho_n V_n = \rho_a V_a$ $V_n / V_a = \rho_a / \rho_n = 1.9 \times 10^4 / (1.5 \times 10^{17}) = 1.3 \times 10^{-13}$ so 1.3×10^{-11} % ans	1 1	[2]
			12

2(a)(i)	*either* (mass / mass-energy / energy of separate nucleons) - (mass / mass-energy / energy of whole nucleus) or AW; *or* energy needed to separate / split / break apart neutrons and protons (completely); *or* energy released when separate nucleons / protons and neutrons combine to form nucleus;	1	[1]
	but NOT energy that binds / holds nucleus together NOT energy to break bonds between nucleons 'atoms' gets 0		
(ii)	*either* high binding energy (/ nucleon) means greater stability / less likely to fuse or fission *or* nuclides (tend to) move to / react towards the lowest potential energy/ highest binding energy (/nucleon) can be won in any of C, U, or Fe explanations or as separate statement;	1	
	${}^{12}_{6}C$ can undergo fusion; ${}^{235}_{92}U$ can undergo fission; ${}^{12}_{6}C$ and ${}^{235}_{92}U$ are both unstable gets 1/2	1 1	
	${}^{56}_{26}Fe$ is stable / does not experience fission or fusion;	1	[4]
(b)(i)	*either* neutron that is at (thermal) equilibrium with medium / substance / material through which it is passing *or* neutron whose (kinetic) energy is equal / comparable / similar / to energy of atoms / molecules through which it is passing *or* slow moving neutron *or* neutron having low (kinetic) energy / energy of 1 - 10 eV;	1	[1]
(ii)	${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U$ '+ neutrino' gets 0	1	[1]
(iii)	${}^{236}_{92}U \rightarrow {}^{135}_{53}I + {}^{95}_{39}Y + 6\,{}^{1}_{0}n$ accept ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{135}_{53}I + {}^{95}_{39}Y + 6\,{}^{1}_{0}n$ for 1/1	1	[1]
(iv)	${}^{235}_{92}U$: 7.6 ${}^{135}_{53}I$: 8.4 ${}^{95}_{39}Y$: 8.6 MeV read from graph, nuclides identified with readings	1	
	total BE: ${}^{235}_{92}U$: 7.6 x 235 (= 1786) ${}^{135}_{53}I$: 8.4 x 135 (= 1134) ${}^{95}_{39}Y$: 8.6 x 95 (= 817) three expressions	1	
	so energy released = 1134 + 817 - 1786 = 165 MeV	1 1	[4]
	8.4 + 8.6 - 7.6 = 9.4 MeV gets 1,0,1,0 = 2/4 uses 236 to get 157.4 MeV gets 3/4		12

3(a)	energy = VIt = V x (area under I-t graph) = $1.2 \times 4 \times 10^6 \times (20 + 5)$ = 1.2×10^8 J no V gets 0/4 *except* if stated 'area under graph = charge' which gets 1/4 *area calculation errors eg wrong triangle areas can get 3/4* omits 10^6 can get 3/4	1 1 1 1	 [4]
(b)	nuclei have (net) charge but atoms don't; nuclei would be deflected by *B* field / atoms are not;	1 1	 [2]
(c)	(momentum conservation: $m_H v_H = m_n v_n$ $m_H = 4 m_n$ so) $v_n = 4 v_H$ ke = $\frac{1}{2} m v^2$ ke of $^1_0$n = $\frac{1}{2} m (4 v_H)^2 = 8 m v_H^2$ } ke of $^4_2$He = $\frac{1}{2} \times 4 m v_H^2 = 2 m v_H^2$ } subs. so (ke of $^1_0$n) = 4 x (ke of He) (so $^1_0$n has 80%, $^4_2$He has 20% of total ke)	1 1 1 1	 [4] **10**
4(a)(i)	energy = 30 + 10 x 50 = 530 keV	1	[1]
(ii)	$\frac{1}{2} m v^2 = Ve$ $\frac{1}{2} \times 1.67 \times 10^{-27} v^2 = 530 \times 10^3 \times 1.6 \times 10^{-19}$ $v = 1.01 \times 10^7$ m s^{-1} allow 1.0 or 1×10^7 m s^{-1} omits 10^3 and gets 3.2×10^5 2/3 omits 1.6×10^{-19} and gets 2.5×10^{16} 1/3 omits 1.67×10^{-27} and gets 4.1×10^{-7} 1/3 ecf from (i): 500 keV to give 9.8×10^6 300 keV to give 7.6×10^6 40 keV to give 2.8×10^6 all can get 3/3	1 1 1	 [3]

(b)(i)	4.3×10^8 m s^{-1} is greater than speed of light; nothing can travel faster than light;	1 1	[2]
(ii)	protons accelerate so travel greater distance in same time (1) positrons (much) less massive than protons; (1) so same energy means greater speed (for positrons); (1) positron speeds approach speed of light; (1) cannot exceed it, so speed becomes (approx.) constant; (1) - aware positrons are affected by relativity can get 1/2 of these marks electrodes of equal length means (positron) speeds are constant; (1) any 3	3	[3]
(c)	rest energy + kinetic energy = $2hf$ omits rest energy or ke 1/2 $2 \times (9.11 \times 10^{-31})(3 \times 10^8)^2 + 650 \times 10^3 \times 1.6 \times 10^{-19} = 2 \times 6.63 \times 10^{-34} f$ (1.64×10^{-13} + 1.04×10^{-13} = $13.3 \times 10^{-34} f$) $f = 2.02 \times 10^{20}$ Hz omits rest energy and gets 7.82×10^{19} Hz 2/4 omits kinetic energy and gets 1.23×10^{20} Hz 2/4 any further error (-1) each, to zero	2 1 1	 [4] **13**
5(a)	sketch showing: 2 dees + alternating source connected; (uniform) magnetic field, in region of dees and normal to diagram; path - continuous circular loops of increasing radius entering both dees at every revolution with direction of travel shown eg by arrow;	1 1 1	[3]

(b)	*either* magnetic field exerts a force (on particle) *or* force from Fleming's left hand rule ; *either* force (always) at right angles to (direction of) motion *or* force has no component along direction of motion / changes only *direction* of motion / doesn't change speed; NOT direction of travel perpendicular to magnetic field (so) acts as a centripetal force / experiences force towards centre of circle;	1 1 1	 [3]
(c)	magnetic force = mass x acceleration $BQv = mv^2/R$ or $F = BQv$ (1) and $F = mv^2/R$ (1) $v = BQR/m$ time for one orbit $T = 2\pi R/v$ $= 2\pi m/(BQ)$ frequency $f = 1/T$ *or* $T = 1/f$ $= BQ/(2\pi m)$ $T = \pi R/v$ to give $f = BQ/(\pi m)$ can get 2,0,1,1 = 4/5	2 1 1 1	 [5] **11**
6(a)	**baryon**: two examples proton; (1) *neutron*; (1) 3 particles quoted, including one wrong gets 1/2 only quark composition: proton uud; (1) neutron udd; (1) (aware consists of 3 quarks, unspecified, gets 1/2) stability: proton stable inside (stable) nucleus; (1) *proton possible decay / half life* = 10^{32} years when free; (1) allow any half life > 10^{30} years neutron stable inside (stable) nucleus; (1) neutron half life = 10/15 minutes when free; (1) any 6	6	

(b)	**lepton**: two examples: electron; (1) positron; (1) neutrino; (1) any 2 (2) (allow muon, tauon) 3 particles including one wrong gets 1 only composition: fundamental (- no quark components); (1) forces: weak force / interaction; (1) electron / positron - (also) electromagnetic / electrostatic force; (1) where found: electron - in atom, outside nucleus *or* in β^- decay ; (1) positron (rarely) emerging from (high mass) radioisotopes / in β^+ decay / accelerating-colliding machines; (1) neutrino - travelling in space eg from Sun *or* emitted (with electron / positron) in beta decay ; (1) allow ONCE 'resulting from high energy particle collisions' any 6	6	[12] **12**