

Question Number	Answer	Mark
17a	It is a lepton (1)	2
	It is a fundamental particle Or second generation (1)	
17b	negative pion (1)	2
	muon anti-neutrino (1)	
17c	Use of $\Delta E = c^2 \Delta m$ (1)	3
	Divide mass of muon by mass of electron Or multiplies the mass of an electron by 200 (1)	
	Mass of muon is 207 times that of an electron so true statement Or 200 times electron mass is 1.82×10^{-28} kg which is just under 1.88×10^{-28} kg so it is correct (1)	
	<u>Example of calculation</u> $\text{mass} = \frac{106 \text{ MeV}/c^2 \times 10^6 \times 1.6 \times 10^{-19} \text{ J eV}^{-1}}{(3 \times 10^8)^2 (\text{m s}^{-1})^2} = 1.88 \times 10^{-28} \text{ kg}$ $\text{mass} = \frac{1.88 \times 10^{-28} \text{ kg}}{9.11 \times 10^{-31} \text{ kg}}$ mass = 207 times that of an electron	
17di	A unit of energy is GeV Or a unit of mass is GeV/c^2 (1)	2
	The unit of momentum is the same as the unit of energy/velocity so GeV divided by $c = \text{GeV}/c$ Or The unit of momentum is the same as the unit of mass \times velocity so $\text{GeV}/c^2 \times c = \text{GeV}/c$ (1)	
17dii	Use of Circumference = $2\pi r$ (1)	3
	Use of $r = p / BQ$ (1)	
	Show that a momentum of $1.65 \times 10^{-18} \text{ N s}$ is consistent with the correct radius (7.11 m) by determination of p , r , B or Q and statement that it is correct (1)	
	<u>Example of calculation</u> $r = 44.7 \text{ m} / 2\pi = 7.11 \text{ m}$ $r = \frac{1.65 \times 10^{-18} \text{ N s}}{1.45 \text{ T} \times 1.6 \times 10^{-19} \text{ C}} = 7.11 \text{ m}$	
17diii	muons travelling close to speed of light (1)	2
	relativistic effect on particle lifetime (1)	
Total for question 17		14