Question Number	Answer	Mark
18(a)	$^{48}_{20}\text{Ca} + {}^{249}_{98}\text{Cf} \rightarrow {}^{294}_{118}\text{Og} + \mathbf{3} \times {}^{1}_{0}\text{n}$ (1)	**1**
18(b)(i)	Cyclotron **Or** Linac **Or** Particle accelerator (1)	**1**
18(b)(ii)	Conversion of energy to J (1) Conversion of mass to kg (1) Use of $E_k = \frac{1}{2}mv^2$ (1) $v = 3.1 \times 10^7$ m s^{-1} (1) Comparison of calculated value of v and c and valid conclusion (1) <u>Example of calculation</u> $E_k = 245 \times 10^6$ eV $\times 1.6 \times 10^{-19}$ J eV^{-1} $= 3.92 \times 10^{-11}$ J m = 47.95×1.66 x 10^{-27} kg $= 7.96 \times 10^{-27}$ kg $v = \sqrt{\frac{2 \times 3.92 \times 10^{-11}\text{J}}{7.96 \times 10^{-26}\text{ kg}}} = 3.14 \times 10^7$ m s^{-1}	**5**
18(c)	Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ (1) Use of $N = N_0 e^{-\lambda t}$ (1) $N_0 = 3.5 \times 10^3$ (1) <u>Example of calculation</u> $\lambda = \frac{0.693}{0.89 \times 10^{-3}\text{s}} = 779$ s^{-1} $500 = N_0 \text{e}^{-780\text{ s}^{-1} \times 2.5 \times 10^{-3}\text{ s}}$ $N_0 = \frac{500}{0.142} = 3.50 \times 10^3$	**3**

Question Number	Answer		Mark
18(d)	Handle the source with tongs	(1)	
	As alpha particles can only travel a few cm in air [Accept alpha particles have a very short range] **Or** The greater the distance, the lower the intensity of radiation received	(1)	
	OR		
	Handle the source for as short a time a possible	(1)	
	As the ionising effect is cumulative	(1)	**2**
	Total for question 18		**12**