Question Number	Answer		Mark
20(a)	A massive nucleus splits into two (or more) smaller nuclei/fragments (of roughly equal mass and some neutrons)	**(1)**	**1**
20(b)(i)	Top line correct Bottom line correct $^{137}_{55}\mathrm{Cs} \rightarrow {}^{137}_{56}\mathrm{Ba} + {}^{0}_{-1}\beta^{-} + {}^{0}_{0}\bar{\nu}$	**(1)** **(1)**	**2**
20(b)(ii)	Momentum is conserved (so the Ba nucleus recoils) Energy released is shared (randomly) between the β^{-} and $\bar{\nu}$ **Or** the energy is shared between the 3 particles in the decay	**(1)** **(1)**	**2**

20(c)(i)	Use of $N = \frac{\text{mass of caesium}}{\text{mass of caesium atom}}$ Use of 1 u = 1.66×10^{-27} kg Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ Use of $A = \lambda N$ $A = 7.7 \times 10^{16}$ Bq Valid conclusion based on calculated value of activity <u>Example of calculation</u> $N = \frac{24\text{ kg}}{(136.9 \times 1.66 \times 10^{-27})\text{ kg}} = 1.06 \times 10^{26}$ $\lambda = \frac{\ln 2}{(30.2 \times 3.15 \times 10^{7})\text{s}} = 7.29 \times 10^{-10}\text{ s}^{-1}$ $A = -7.29 \times 10^{-10}\text{ s}^{-1} \times 1.06 \times 10^{26} = -7.73 \times 10^{16}\text{ Bq}$ 7.7×10^{16} Bq is not equal to 7.3×10^{16} Bq (so statement is incorrect) **Or** 7.7×10^{16} Bq is approximately equal to 7.3×10^{16} Bq (so statement is correct)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
20(c)(ii)	Use of 500 Bq per 100 g to calculate initial count rate Use of $A = A_0 e^{-\lambda t}$ $t = 5.37 \times 10^{9}$ s [171 year] [ecf from (i)] <u>Example of calculation</u> $A_0 = \frac{1}{4} \times 500\text{ Bq} = 125\text{ Bq}$ $A = \frac{150}{60\text{ s}} = 2.5\text{ Bq}$ $2.5\text{ Bq} = 125\text{ Bq}e^{-7.28\times10^{-10}\text{ s}^{-1}\times t}$ $\therefore \ln\frac{2.5\ Bq}{125\ Bq} = -7.28 \times 10^{-10}\ s^{-1} \times t$ $\therefore t = \frac{-3.91}{-7.28 \times 10^{-10}\text{ s}^{-1}} = 5.37 \times 10^{9}\text{ s}$	**(1)** **(1)** **(1)**	**3**
	Total for question 20		**14**