

Question Number	Answer	Mark
19(a)(i)	<p>Top line correct (1)</p> <p>Bottom line correct (1)</p> <p>(2)</p> <p><u>Example of calculation</u></p> ${}_{19}^{40}\text{K} \rightarrow {}_{20}^{40}\text{Ca} + {}_{-1}^0\beta^{-} + {}_0^0\bar{\nu}_e$	
19(a)(ii)	<p>Calculation of mass difference (1)</p> <p>Conversion from u to kg (1)</p> <p>Use of $\Delta E = c^2\Delta m$ (1)</p> <p>Use of 1.6×10^{-19} to convert energy to eV (1)</p> <p>$\Delta E = 0.80$ (MeV) (1)</p> <p>(5)</p> <p><u>Example of calculation:</u></p> <p>Mass difference = $39.963998 \text{ u} - 39.962591 \text{ u} - 0.00054858 \text{ u} = 8.584 \times 10^{-4} \text{ u}$</p> <p>Mass difference = $8.584 \times 10^{-4} \text{ u} \times 1.66 \times 10^{-27} \text{ kg u}^{-1} = 1.425 \times 10^{-30} \text{ kg}$</p> <p>$\Delta E = c^2\Delta m = (3.00 \times 10^8 \text{ m s}^{-1})^2 \times 1.425 \times 10^{-30} \text{ kg} = 1.282 \times 10^{-13} \text{ J}$</p> <p>$\Delta E = \frac{1.282 \times 10^{-13} \text{ J}}{1.60 \times 10^{-13} \text{ J MeV}^{-1}} = 0.802 \text{ MeV}$</p>	
19(a)(iii)	<p>Momentum/KE is given to 3 particles in the decay</p> <p>Or (KE of Ca is negligible so) KE for the beta-neutrino pair was constant (1)</p> <p>The energy split between the beta particle and the neutrino is random</p> <p>Or the momentum of the emitted beta particle varies</p> <p>Or The (anti) neutrino energy varies (1)</p> <p>(2)</p>	

19(b)(i)	<p>Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ (1)</p> <p>Use of $\frac{\Delta N}{\Delta t} = (-)\lambda N$ (1)</p> <p>$A = 1.94 \times 10^5$ (Bq) (1)</p> <p><u>Example of calculation:</u></p> $\lambda = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{1.25 \times 10^9 \times 3.15 \times 10^7 \text{ s}} = 1.76 \times 10^{-17} \text{ s}^{-1}$ $\frac{\Delta N}{\Delta t} = \lambda N = 1.76 \times 10^{-17} \text{ s}^{-1} \times 1.10 \times 10^{22} = 1.94 \times 10^5 \text{ Bq}$	(3)
19(b)(ii)	<p>Use of $A = A_0 e^{-\lambda t}$ (1)</p> <p>$t = 8.6 \times 10^7$ years, so claim is false.</p> <p>Or Activity after 50 years = 1.94×10^5 Bq so claim is false (valid calculation needed) (1)</p> <p>(ecf activity from (i))</p> <p><u>Example of calculation</u></p> $1.85 \times 10^5 = 1.94 \times 10^5 e^{-1.76 \times 10^{-17} t}$ $-1.76 \times 10^{-17} \text{ s}^{-1} \times t = \ln \left(\frac{1.85 \times 10^5 \text{ Bq}}{1.94 \times 10^5 \text{ Bq}} \right)$ $t = \frac{-0.0475}{-1.76 \times 10^{-17}} = 2.70 \times 10^{15} \text{ s} = 8.57 \times 10^7 \text{ years}$	(2)
Total for question 19		14