19 Potassium chloride may be used to flavour food. Potassium chloride contains trace amounts of a radioactive isotope of potassium (K). This decays into an isotope of calcium (Ca) by beta decay.

(a) (i) Complete the nuclear equation for this decay:

$$\text{.....}{}^{40}\text{K} \rightarrow \text{.....}{}_{20}\text{Ca} + \text{.....}\beta^{-} + {}^{0}_{0}\bar{\nu}_{e}$$

(2)

(ii) Calculate the energy, in MeV, released when a nucleus of potassium-40 decays into a nucleus of calcium.

	Mass / u
Potassium nucleus	39.963998
Calcium nucleus	39.962591
Electron	0.00054858
Electron neutrino ($\bar{\nu}_e$)	negligible

(5)

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Energy released = ... MeV

(iii) Explain why there is a range of energies for the beta particles emitted in the decay of a sample of potassium-40.

(2)

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(b) A sample of potassium chloride initially contains 1.10×10^{22} atoms of potassium-40.

half-life of potassium-40 = 1.25×10^{9} years
1 year = 3.15×10^{7} s

(i) Show that the activity of this sample is about 1.9×10^{5} Bq.

(3)

(ii) It is claimed that after a period of 50 years, the activity of the sample would be less than the activity of a typical school source.

Assess the validity of this claim. Your answer should include a calculation.

activity of a school source = 1.85×10^{5} Bq

(2)

(Total for Question 19 = 14 marks)

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