7 VJC students are designing a space probe to explore the outer reaches of the Solar System. Because the space probe will travel very far away from the Sun, it cannot be powered using solar panels. Instead, a 'nuclear battery' called a radioisotope thermoelectric generator (RTG) that converts the heat produced from the nuclear fuel directly into electric energy.

The nuclear fuel to be used is strontium-90 (${}^{90}_{38}Sr$), with a half-life of 29 years. It decays by beta emission to form yttrium-90 (symbol: Y).

(a) Write an equation to represent the decay of strontium-90 to yttrium-90. [1]

(b) The masses of a strontium-90 nucleus and a yttrium-90 nucleus are shown below:

Strontium-90: 89.907738*u*
Yttrium-90: 89.907151*u*

Show that the energy released in one reaction is 5.71×10^{-15} J. [2]

(c) The RTG is required to supply a power of 155 W at the beginning of the space mission. The efficiency of the conversion process from nuclear power to electrical power is 7.0%.

(i) Show that the activity needed from the strontium-90 fuel at the beginning of the mission is 3.88×10^{17} Bq. [2]

(ii) Calculate the number of nuclei of strontium-90 needed at the start of the mission. [2]

Number of nuclei = ……

(iii) Hence calculate the mass of pure strontium-90 needed at the start of the mission. [2]

Mass = ……