21 A hundred years ago, a method to determine the age of certain rocks was developed. An unstable isotope of rubidium is present in some rocks when they form. Over time the rubidium decays to a stable isotope of strontium.

(a) Rubidium decays to strontium via β^- decay. Complete the nuclear equation representing the decay.

$$^{\cdots\cdots}_{37}\mathrm{Rb} \rightarrow {}^{87}_{\cdots\cdots}\mathrm{Sr} + {}^{\cdots\cdots}_{\cdots\cdots}\beta^- + \overline{\nu}_e$$

(2)

(b) A sample of Moon rock from the Apollo 11 mission was analysed to determine the age of the rock. When the sample was analysed the number of rubidium atoms was N_R and the number of strontium atoms was N_S.

As strontium atoms have all been produced from the decay of rubidium, the original number of rubidium atoms in the sample was $(N_R + N_S)$.

From the analysis of the sample, it was determined that $\frac{N_S}{N_R} = 0.0532$

Deduce whether this ratio is consistent with the Earth and the Moon forming at the same time.

age of Earth = 4.5×10^9 years
half-life of rubidium isotope = 4.88×10^{10} years

(5)

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(c) Give a reason why the half-life of the rubidium isotope is hard to determine.

(1)

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(d) Recent investigations suggest that the half-life of the rubidium isotope may be larger than the traditionally accepted value.

Explain how this would affect the ages obtained by this dating method.

(2)

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(Total for Question 21 = 10 marks)