

6(a) Isotope X undergoes radioactive decay to form isotope Y. The half-life of isotope X is 2.0×10^5 years. The activity of a pure sample of isotope X extracted from an ore is measured to be 1.1×10^7 Bq.

(i) Explain why the measured activity of the sample X is relatively constant. [2]

(iii) It is discovered that isotope Y undergoes radioactive decay to form isotope Z. The half-life of isotope Y is 1.5 hours.

1. Calculate the decay constant of Y. [1]

2. The number of isotope Y in the sample is found to be constant. Explain how this is possible. [1]

3. Hence, calculate this constant number of nuclei of Y. [2]

b(i) Th-232 decays by alpha-emission with a decay constant of $4.95 \times 10^{-11} \text{ yr}^{-1}$. This is the beginning of a decay chain which eventually ends in Pb-208. A sample of rock is found to contain both Th-232 and Pb-208 such that the ratio of the number of nuclei of Th-232 to Pb-208 is 5:1.

When the rock was formed, there was no Pb-208 present in the sample. Estimate the age of the rock in years. [2]

- (ii) State the assumption made in **(b)(i)** regarding the intermediate product nuclei. [1]
- (iii) State with a reason, whether your answer in **(b)(i)** is an overestimate or an underestimate of the age of the rock if the assumption in **(b)(ii)** is not valid. [1]