

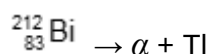
Name of the Student: _____

Max. Marks : 18 Marks

Time : 18 Minutes

Q1.

- (a) When an α particle is emitted from a nucleus of the isotope ${}^{212}_{83}\text{Bi}$, a nucleus of thallium, Tl, is formed. Complete the equation below.



(2)

- (b) The α particle in part (a) is emitted with 6.1 MeV of kinetic energy.

- (i) The mass of the α particle is 4.0 u. Show that the speed of the α particle immediately after it has been emitted is $1.7 \times 10^{-7} \text{ m s}^{-1}$. Ignore relativistic effects.

- (ii) Calculate the speed of recoil of the daughter nucleus immediately after the α particle has been emitted. Assume the parent nucleus is initially at rest.

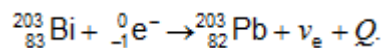
(6)

(Total 8 marks)

Q2.

- (a) The nuclide ${}^{203}_{83}\text{Bi}$ can decay by *electron capture* to become an isotope of lead as shown in

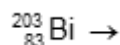
the following equation,



- (i) Explain what is meant by electron capture.

- (ii) Give **one** reason why electromagnetic radiation is emitted following this process.

- (iii) Give the equation for another process in which ${}^{203}_{83}\text{Bi}$ is converted into an isotope of lead.



(5)

- (b) The nuclide ${}^{203}_{83}\text{Bi}$ is also an α particle emitter. An initial measurement of the α particle activity of a sample of this isotope gives a corrected count rate of $1200 \text{ counts s}^{-1}$. After an interval of 24 hours the corrected rate falls to $290 \text{ counts s}^{-1}$. Assume that corrections have been made for the radiation both from daughter products and background radiation.

- (i) Show that the decay constant of ${}^{203}_{83}\text{Bi}$ is about $1.6 \times 10^{-5} \text{ s}^{-1}$.

- (ii) Calculate the half-life of this sample.

- (iii) Calculate the number of ${}^{203}_{83}\text{Bi}$ nuclei in the sample when the corrected count rate was $1200 \text{ counts s}^{-1}$.

(5)
(Total 10 marks)