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.

$$^{212}_{83}\text{Bi} \rightarrow \alpha + \text{Tl}$$

(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 1.7×10^{-7} m s^{-1}. Ignore relativistic effects.

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(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.

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(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,

$$^{203}_{83}\text{Bi} + {}^{0}_{-1}\text{e}^{-} \rightarrow {}^{203}_{82}\text{Pb} + \nu_e + Q$$

(i) Explain what is meant by electron capture.

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

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

$^{203}_{83}\text{Bi} \rightarrow$

(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 counts s^{-1}. After an interval of 24 hours the corrected rate falls to 290 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 1.6×10^{-5} s^{-1}.

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

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

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(5)
(Total 10 marks)