

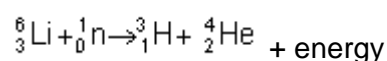
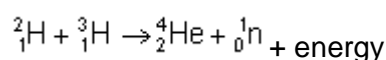
Name of the Student: _____

Max. Marks : 18 Marks

Time : 18 Minutes

Q1.

In the research into nuclear fusion one of the most promising reactions is between deuterons (${}^2_1\text{H}$) and tritium nuclei (${}^3_1\text{H}$) in a gaseous plasma. Although deuterons can be relatively easily extracted from sea water, tritium is difficult to produce. It can, however, be produced by bombarding lithium-6 (${}^6_3\text{Li}$) with neutrons. The two reactions are summarised as:



Masses of reactants:

$${}^1_0\text{n} = 1.008665\text{u}$$

$${}^2_1\text{H} = 2.013553\text{u}$$

$${}^3_1\text{H} = 3.016049\text{u}$$

$${}^4_2\text{He} = 4.002603\text{u}$$

$${}^6_3\text{Li} = 6.015122\text{u}$$

1u is equivalent to 1.66×10^{-27} kg or 931 MeV

- (a) (i) Explain why the atomic mass unit, u, may be quoted in kg or MeV.

(2)

- (ii) Calculate the maximum amount of energy, in MeV, released when 1.0 kg of lithium-6 is bombarded by neutrons.

energy released _____ MeV

(5)

- (iii) Suggest why the lithium-6 reaction could be thought to be self-sustaining once the deuteron-tritium reaction is underway.

(1)

- (b) (i) In order to fuse, a deuteron and a tritium nucleus must approach one another to within approximately 1.5×10^{-15} m.
Calculate the minimum total initial kinetic energy that these nuclei must have.

minimum total kinetic energy of nuclei _____ J

(3)

- (ii) Show that a temperature of approximately 4×10^9 K would be sufficient to enable this fusion to occur in a gaseous plasma.

(3)

- (iii) Explain in terms of the forces acting on nuclei why the deuterium-tritium mixture must be so hot in order to achieve the fusion reaction.

(4)
(Total 18 marks)