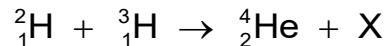


- 8 (a)** The world's largest nuclear fusion reactor experiment ITER is currently under construction in southern France. An electrically charged hydrogen gas will be heated to extremely high temperature, when fusion begins to take place. The binding energy per nucleon changes after the reaction. The fusion reaction involves isotopes of hydrogen, deuterium ( ${}_1^2H$ ) and tritium ( ${}_1^3H$ ) and the release of energy.



- (i) Explain what is meant by *binding energy* of a nucleus.

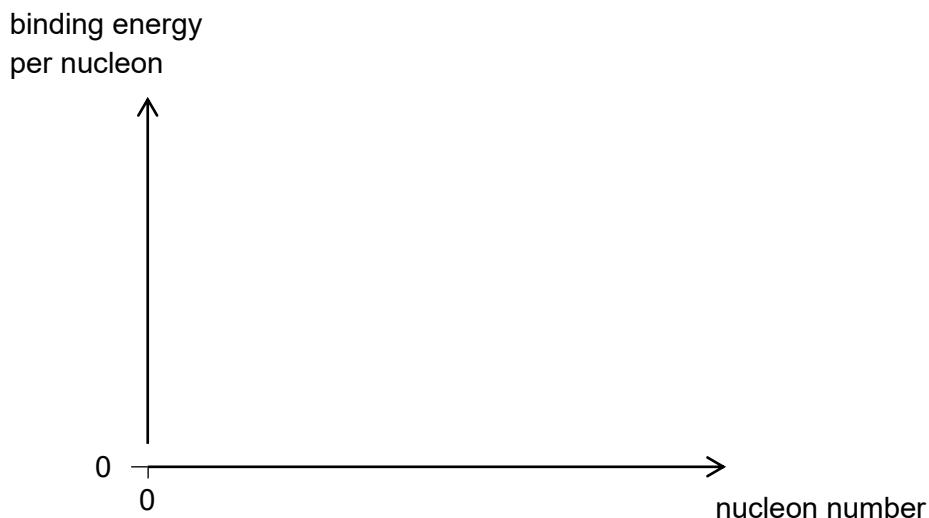
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[2]

- (ii) On Fig. 8.1, sketch a graph to show the variation with nucleon number of the binding energy per nucleon.



[1]

**Fig. 8.1**

- (iii) Explain why fusion of nuclei having high nucleon numbers is not associated with a release of energy.

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[2]

- (iv) State what is particle X.

[1]

.....

- (v) Suggest an advantage of nuclear fusion as a source of energy production.

[1]

.....

.....

- (vi) Calculate the amount of energy produced by 15 kg of appropriate mixture of the isotopes of hydrogen. The following data are provided:

	Mass
$^2_1H$	2.0141 u
$^3_1H$	3.0160 u
$^4_2He$	4.0026 u
$^1_1H$	1.0073 u
$^1_0n$	1.0087 u
$^{-1}_0e$	0.0005 u

energy = ..... J [4]

- (b) (i) "Uranium-238 is an *alpha-emitter* of *half life*  $4.5 \times 10^9$  years."

Explain what is meant by the terms in italics in the above statement.

.....

.....

.....

.....

[2]

- (ii) An alpha-emitting Uranium-238 radioactive source is placed inside an ionization chamber. It produces an ionization current of  $2.4 \times 10^{-6}$  A. If each alpha particle produces on average  $2.0 \times 10^5$  ion pairs, determine the activity of the source.  
(Assume that the ions are singly-charged and that all ions are collected.)

activity = ..... Bq [3]

- (iii) The abundance of Uranium-238 in naturally-occurring uranium minerals on Earth is 99.28%. This means that there are 99.28 atoms of Uranium-238 for every 100 atoms of all uranium isotopes. The abundance of Uranium-235 is 0.72%. The decay constant of Uranium-238 is  $15.5 \times 10^{-11}$  year<sup>-1</sup> and the decay constant of Uranium-235 is  $98.5 \times 10^{-11}$  year<sup>-1</sup>.

In the early twentieth century, Rutherford assumed that at the time of the formation of the Earth's crust, an equal amount of each isotope was present. Making this assumption, determine the age of the Earth.

age = ..... years [4]

[Total: 20]

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