A2 Physics – Fusion questions

1. The fusion of two deuterium nuclei produces a nuclide of helium plus a neutron and liberates 3.27 MeV of energy. How does the mass of the two deuterium nuclei compare with the combined mass of the helium nucleus and neutron?

A It is 5.8×10^{-30} kg greater before fusion.

B It is 5.8×10^{-30} kg greater after fusion.

C It is 5.8×10^{-36} kg greater before fusion.

D It is 5.8×10^{-36} kg greater after fusion.

(Total 2 marks)

2. In the reaction shown, a proton and a deuterium nucleus, ${}^{2}_{1}\mathrm{H}$, fuse together to form a helium nucleus, ${}^{3}_{2}\mathrm{He}$

$$ {}^{1}_{1}\mathrm{p} + {}^{1}_{1}\mathrm{H} \longrightarrow {}^{3}_{2}\mathrm{He} + \mathrm{Q} $$

What is the value of Q, the energy released in this reaction?

mass of a proton = 1.00728 u

mass of a ${}^{2}_{1}\mathrm{H}$ nucleus = 2.01355 u

mass of a ${}^{3}_{2}\mathrm{He}$ nucleus = 3.01493 u

A 5.0 MeV

B 5.5 MeV

C 6.0 MeV

D 6.5 MeV

(Total 2 marks)

3. The reaction shown below occurs when a proton and a deuterium nucleus, ${}^{2}_{1}\mathrm{H}$, fuse to form a helium nucleus, ${}^{3}_{2}\mathrm{He}$.

$$ {}^{1}_{1}\mathrm{p} + {}^{2}_{1}\mathrm{H} \longrightarrow {}^{3}_{2}\mathrm{He} + Q $$

If the energy released, *Q*, is 5.49 MeV, what is the mass of the helium nucleus?

mass of ${}^{2}_{1}\mathrm{H}$ nucleus = 2.01355 u

mass of proton = 1.00728 u

1u is equivalent to 931.3 Me V

A 0.00589 u

B 3.01494 u

C 3.02083 u

D 3.02323 u

(Total 2 marks)

4. A deuterium nucleus and a tritium nucleus fuse together to form a helium nucleus, releasing a particle X in the process, according to the equation

$$ {}^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + \mathrm{X} $$

Which one of the following correctly identifies X?

A electron

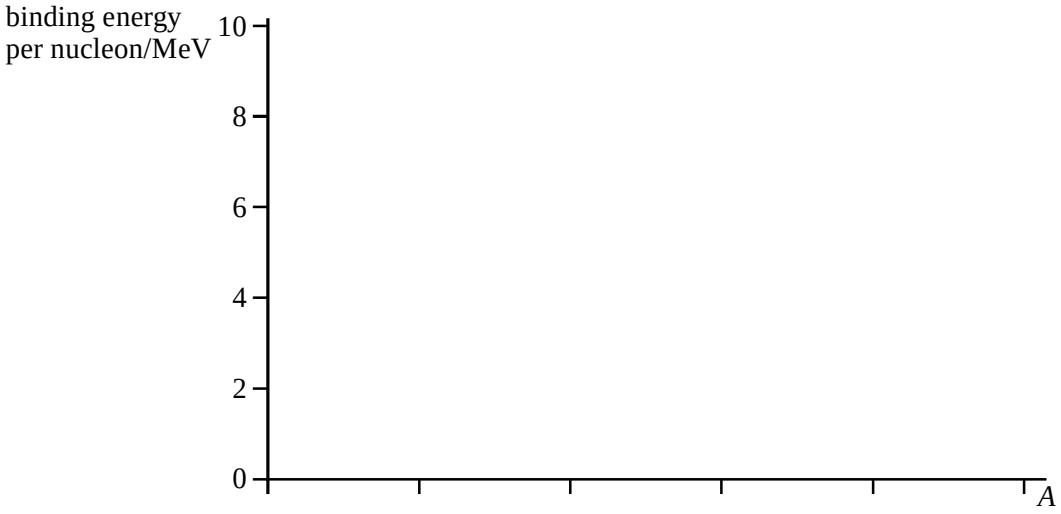
B neutron

C positron

D proton

(Total 2 marks)

5.



(a) Copy the axes above, and sketch a graph to show how the average binding energy per nucleon depends on the nucleon number, *A*, for the naturally occurring nuclides. Show appropriate values for *A* on the horizontal axis of the graph.

(3)

(b) (i) Briefly explain what is meant by *nuclear fission* and by *nuclear fusion.*

(ii) Describe how the graph in part (a) indicates that large amounts of energy are available from both the fission and the fusion processes.

(3)
(Total 6 marks)

6. (a) With reference to the process of nuclear fusion, explain why energy is released when two small nuclei join together, and why it is difficult to make two nuclei come together

(3)

(b) A fusion reaction takes place when two deuterium nuclei join, as represented by

$$^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$$

mass of ^{2}H nucleus = 2.01355 u
mass of ^{3}He nucleus = 3.01493 u
mass of neutron = 1.00867 u

Calculate

(i) the mass difference produced when two deuterium nuclei undergo fusion,
(ii) the energy released, in J, when this reaction takes place.

(3)
(Total 6 marks)