Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Q1.

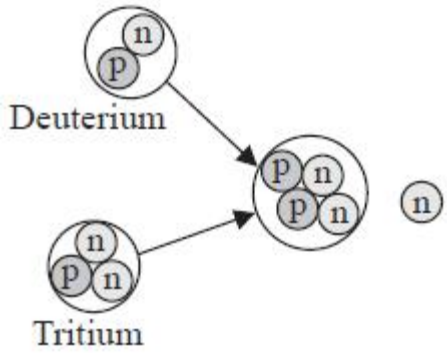
The following passage is adapted from a recent article in a British newspaper:

"Every year, one typical coal-fired power station devours several million tonnes of fuel and produces even more carbon dioxide. That volume of carbon dioxide is damaging the atmosphere and, in the longer term, the fuel will run out. It is clear that the world needs an alternative for generating energy.

Nuclear fusion looks like offering a solution to the problem. Using the equivalent of a bath tub of water, fusion has the potential to deliver the same amount of energy as 100 tonnes of coal. There would be no carbon dioxide emission, it would be inherently very safe, and would not produce any significant radioactive waste."

(Adapted from an article in The Observer newspaper, Sunday 16th September 2012)

(a) The latest proposed fusion reactor will fuse deuterium and tritium, which are isotopes of hydrogen. This fusion reaction is illustrated below.



(i) Complete the nuclear equation below to represent this fusion reaction.

(2)

$$\text{.....}^{\text{.....}}\text{H} + \text{.....}^{\text{.....}}\text{H} \rightarrow \text{.....}^{\text{.....}}\text{He} + \text{.....}^{\text{.....}}\text{n}$$

(ii) Calculate the energy released in the fusion of one deuterium nucleus with one tritium nucleus.

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Particle	Mass / GeV/c^2
Proton	0.938272
Neutron	0.939566
Deuterium	1.875600
Tritium	2.808900
Helium	3.727400

(2)

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Energy released = ...

(iii) Explain why most of the energy released in the fusion of one deuterium nucleus with one tritium nucleus is transferred to kinetic energy of the neutron.

(3)

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(b) A sample of tritium is produced. Tritium is unstable and decays by β^- emission with a half-life of 12.3 years.

Calculate the time taken, in years, for the activity of the sample to fall to 10% of its initial value.

(3)

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Time taken = ... years

*(c) The article states that "it would be inherently very safe, and would not produce any significant radioactive waste."

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Comment on this statement and outline the technical difficulties of producing a practical nuclear fusion reactor.

(5)

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(Total for question = 15 marks)

Q2.

A series of experiments was carried out in the 1970s to investigate the structure of protons using the linac at Stanford, USA.

The electron leaves the accelerator with a high energy.

Explain why electrons need high energies to investigate the structure of a proton.

(2)

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(Total for question = 2 marks)

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