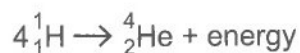


- 4 (a) Explain what is meant by *nuclear fusion*.

.....  
 ..... [2]

- (b) In the Sun, the reactions occurring can be summarised as



The mass of  ${}^1_1\text{H}$  nucleus is 1.007293 u and the mass of  ${}^4_2\text{He}$  nucleus is 4.001572 u.

- (i) Calculate the energy released in the production of one  ${}^4_2\text{He}$  nucleus.

energy released = ..... J [3]

- (ii) The average power emitted by the Sun is  $3.85 \times 10^{26} \text{ W}$ .

Calculate the average rate of loss of mass of the Sun.

average rate of loss of mass = .....  $\text{kg s}^{-1}$  [2]





(c) The current mass of the Sun is  $1.99 \times 10^{30}$  kg. Assume a constant rate of loss of mass of the Sun.

(i) Calculate how long it will take for all the mass to be lost.

time = ..... years [1]

(ii) Assess the validity of the time calculated in (c)(i).

.....  
 .....  
 ..... [2]

(d) (i) For a planet in a circular orbit about the Sun, relate Newton's law of gravitation to the centripetal acceleration that it causes and use this to show that:

$$T^2 = kr^3$$

where  $T$  is the time taken for one orbit (period),  $r$  is the radius of the orbit and  $k$  is a constant.

[3]





- (ii) The Earth orbits around the Sun with a radius of  $1.50 \times 10^{11}$  m and Jupiter orbits the Sun at a radius of  $7.79 \times 10^{11}$  m.

Compare, quantitatively, the speeds and orbital periods of Earth and Jupiter.

.....  
..... [4]

[Total: 17]

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