

9 (a) Define mass defect.

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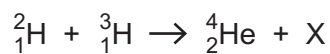
..... [2]

(b) Table 9.1 shows the mass defects of three nuclei.

**Table 9.1**

nucleus	mass defect / u
${}^2_1\text{H}$	0.002 388
${}^3_1\text{H}$	0.009 105
${}^4_2\text{He}$	0.030 377

The nuclear fusion process in a particular star is described by



where X is a particle that has no mass defect.

(i) State the name of particle X.

..... [1]

(ii) Show that the energy released when one nucleus of  ${}^4_2\text{He}$  is formed in this fusion reaction is  $2.8 \times 10^{-12} \text{ J}$ .

[3]

- (c) The star in (b) has a radius of  $2.3 \times 10^9 \text{ m}$  and a luminosity of  $1.4 \times 10^{28} \text{ W}$ .  
 All the energy released from the formation of  ${}^4_2\text{He}$  is radiated away from the star.  
 All the energy that is radiated from the star has been released in the formation of  ${}^4_2\text{He}$ .

Determine:

- (i) the mass of  ${}^4_2\text{He}$  produced per unit time by the fusion process

mass per unit time = .....  $\text{kg s}^{-1}$  [3]

- (ii) the surface temperature of the star.

temperature = ..... K [2]