9 **(a)** Define mass defect.

.....

.....

..... [2]

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

Table 9.1

nucleus	mass defect / u
$^{2}_{1}H$	0.002 388
$^{3}_{1}H$	0.009 105
$^{4}_{2}He$	0.030 377

The nuclear fusion process in a particular star is described by

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

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 $^{4}_{2}He$ is formed in this fusion reaction is 2.8×10^{-12} J.

[3]

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

Determine:

(i) the mass of $^4_2$He produced per unit time by the fusion process

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

(ii) the surface temperature of the star.

temperature = ... K [2]

[Total: 11]