

9 (a) State what is meant by the mass defect of a nucleus.

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..... [2]

(b) The nuclear fusion reaction for the formation of helium-4 from deuterium is represented by

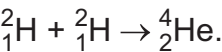


Table 9.1 shows the masses of the nuclides involved in this reaction.

Table 9.1

nuclide	nuclide mass/u
${}^2_1\text{H}$	2.013 553
${}^4_2\text{He}$	4.001 505

Calculate the energy released in the formation of 1.00 mol of helium-4.

energy = J [4]

(c) The star Sirius has a radius of $1.19 \times 10^9\text{m}$ and loses mass due to nuclear fusion at a rate of $1.09 \times 10^{11}\text{kg s}^{-1}$. Assume that the power of the radiation emitted by the star is equal to the power released by this process.

(i) Determine a value for the luminosity of Sirius. Give a unit with your answer.

luminosity = unit [2]

(ii) Use your answer in (c)(i) to determine the surface temperature of Sirius.

surface temperature = K [2]

(d) Explain how cosmologists use standard candles to estimate the distance of a galaxy from the Earth.

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..... [3]

[Total: 13]