

## Stars

### Questions

Q1.

Stars may originate as a nebula.

(i) Describe the process that then occurs to produce the conditions necessary for nuclear fusion in a new star.

(3)

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..... (ii)

The energy,  $E$ , released in nuclear fusion is equivalent to loss in mass,  $m$ , according to the equation.

$$E = mc^2$$

where  $c$  is the velocity of light.

$$c = 3.00 \times 10^8 \text{ m/s}$$

In 1 second, the energy radiated by the Sun is  $3.86 \times 10^{26} \text{ J}$ .

Calculate the loss in mass of the Sun in 1 second.

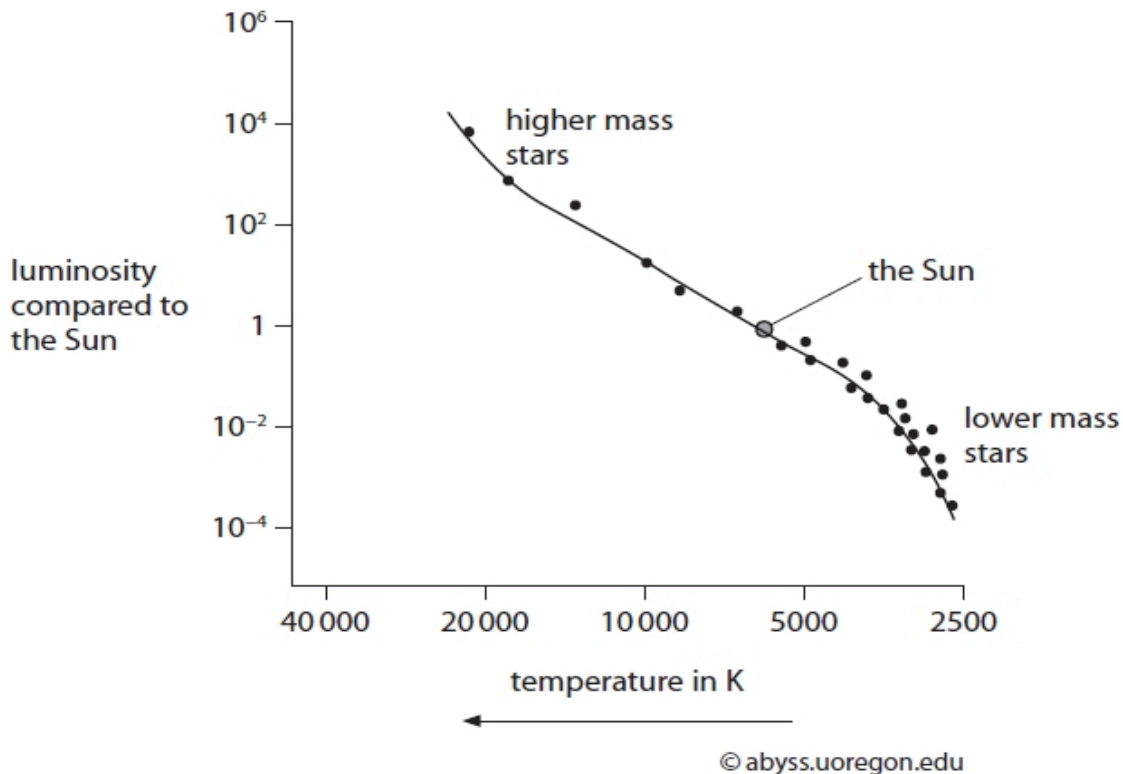
(2)

loss in mass = ..... kg

(Total for question = 5 marks)

Q2.

Figure 18 is a diagram giving some information about main sequence stars. Luminosity is a measure of how bright something is. An increase in luminosity means an increase in brightness.



**Figure 18**

(i) Estimate the temperature of the Sun.

(1)

temperature of the Sun = ..... K

(ii) State how the brightness of a main sequence star changes with its temperature.

(1)

.....  
 .....

(iii) State how the brightness of a main sequence star changes with its mass.

(1)

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 .....

(Total for question = 3 marks)

Q3.

A nebula may evolve into a main sequence star, such as the Sun.

Explain how a nebula may evolve into a main sequence star.

(3)

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(Total for question = 3 marks)

Q4.

A star has evolved to become a neutron star.

The mass, M, of the neutron star, of radius R, is given by

$$M = \frac{4 \times \pi \times D \times R^3}{3} \quad \text{where D is a constant}$$

$$M = 4 \times 10^{30} \text{ kg}$$

$$D = 6 \times 10^{17} \text{ kg/m}^3$$

Use the equation to calculate the value for R.

(2)

$$R = \text{..... m}$$

(Total for question = 2 marks)

## Mark Scheme - Stars

Q1.

Question Number	Answer	Additional guidance	Mark
(i)	<p>a description to include:</p> <p>nebula collapses (1)</p> <p>under <b>gravity</b> (1)</p> <p>plus any one from:</p> <p>GPE converted into KE (1)</p> <p>OR</p> <p>(very) <b>high</b> temperatures/pressures reached (1)</p>	<p>allow gas/dust for nebula</p> <p>allow condensing/coming together for collapses</p> <p>allow gravitational force</p> <p>producing (large) increase in <b>KE</b> of particles / more (frequent) collisions</p> <p>Ignore references to hot / heat</p>	(3)
Question Number	Answer	Additional guidance	Mark
(ii)	<p>rearrangement <b>and</b> substitution (1)</p> <p>(m =) <math>\frac{3.86 \times 10^{26}}{(3.00 \times 10^8)^2}</math></p> <p>evaluation (1)</p> <p>(m =) <math>4.29 \times 10^9</math> (kg)</p>	<p>ignore Power Of Ten (POT) error until evaluation</p> <p>allow numbers <b>that</b> round to <math>4.3 \times 10^9</math> (kg)</p> <p>award full marks for the correct answer without working</p> <p>4.3 to any other power of ten scores 1 mark</p>	(2)

Q2.

Question number	Answer	Additional guidance	Mark
(i)	accept any temperature between 5500 and 7500 (K) (1)		(1)

Question number	Answer	Additional guidance	Mark
(ii)	the higher the brightness the greater the temperature	or reverse argument  allow luminosity for brightness allow heat for temperature	(1)

Question number	Answer	Additional guidance	Mark
(iii)	the greater the mass the higher the brightness	or reverse argument allow luminosity for brightness allow bigger/heavier for greater mass in this context	(1)

Q3.

Question number	Answer	Additional guidance	Mark
	<p>An explanation to include any three from:</p> <p>nebula as a cloud of gas/dust (1)</p> <p>gas / atoms pulled together / towards each other (1)</p> <p>by gravitational force (1)</p> <p>temperature increase (1)</p> <p>hot enough for nuclear fusion (1)</p>	<p>density increase</p> <p>gravity (acting)</p> <p>(resultant) heating s</p>	<b>(3)</b>

Q4.

Question Number	Answer	Additional guidance	Mark
	<p>rearrangement (1)</p> $R^3 = \frac{3M}{4 \times \pi \times D}$ <p>evaluation (1)</p> <p>(R =) <math>1.17 \times 10^4</math> m</p>	<p>may be seen as substituted values or as the cube-root form or</p> $R^3 = 1.59 \times 10^{12}$ <p>allow numbers that round to <math>1.2 \times 10^4</math> (m)</p> <p>award full marks for the correct answer without working</p>	<b>(2)</b>