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.
$c = 3.00 \times 10^8$ m/s
In 1 second, the energy radiated by the Sun is 3.86×10^{26} 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.

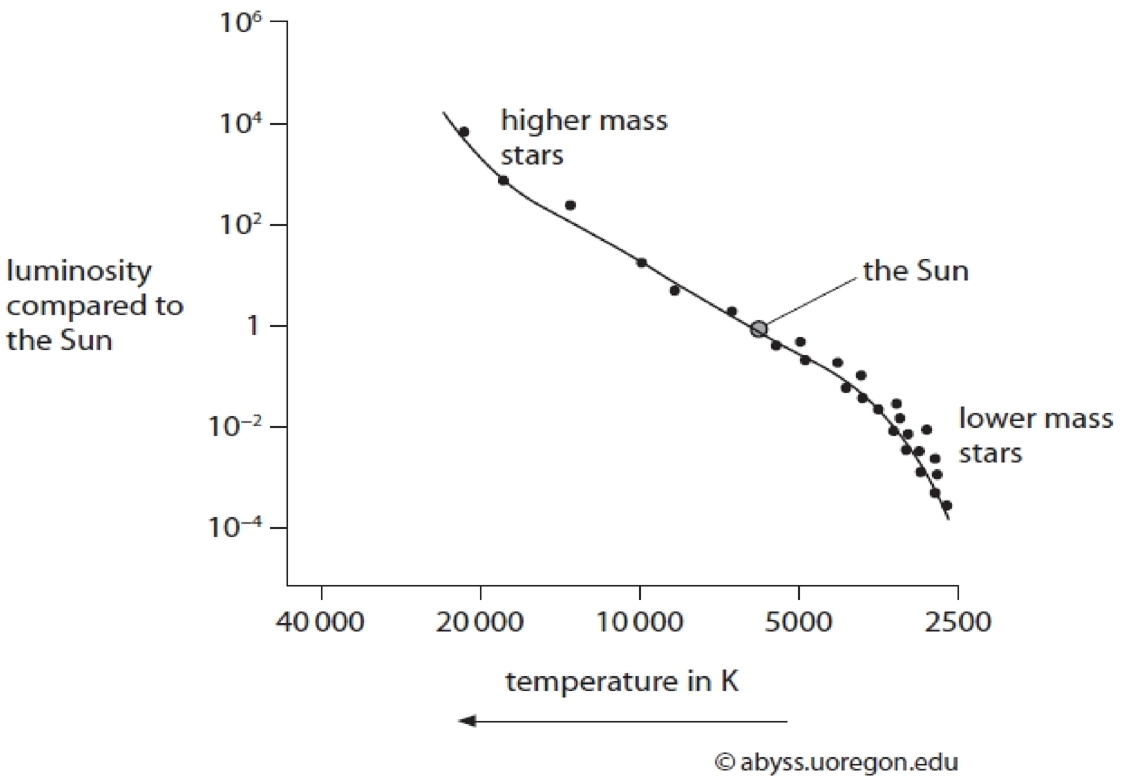

Figure 18

(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)

....

....

(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

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

$M = 4 \times 10^{30}$ kg
$D = 6 \times 10^{17}$ kg/m^3
Use the equation to calculate the value for R.

(2)

R = ... m

(Total for question = 2 marks)

Mark Scheme - Stars

Q1.

Question Number	Answer	Additional guidance	Mark
(i)	a description to include: nebula collapses (1) under **gravity** (1) plus any one from: GPE converted into KE (1) OR (very) **high** temperatures/pressures reached (1)	allow gas/dust for nebula allow condensing/coming together for collapses allow gravitational force producing (large) increase in **KE** of particles / more (frequent) collisions Ignore references to hot / heat	**(3)**

Question Number	Answer	Additional guidance	Mark
(ii)	rearrangement **and** substitution (1) (m =) $\frac{3.86 \times 10^{26}}{(3.00 \times 10^{8})^{2}}$ evaluation (1) (m =) 4.29×10^{9} (kg)	ignore Power Of Ten (POT) error until evaluation allow numbers that round to 4.3×10^{9} (kg) award full marks for the correct answer without working 4.3 to any other power of ten scores 1 mark	**(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
	An explanation to include any three from: nebula as a cloud of gas/dust (1) gas / atoms pulled together / towards each other (1) by gravitational force (1) temperature increase (1) hot enough for nuclear fusion (1)	 density increase gravity (acting) (resultant) heating s	**(3)**

Q4.

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