25. Astronomy and Cosmology

25.2 Stellar radii

Paper 4

Question Paper

1 **(b)** The Sun has a radius of 6.96×10^8 m and a surface temperature of 5780 K.
Light from the Sun is observed to have a peak intensity at a wavelength of 501 nm.

(i) Calculate the luminosity of the Sun. Give a unit with your answer.

luminosity = ... unit ..... [2]

(ii) Another star emits radiation that has a peak intensity at a wavelength of 624 nm.

Determine the surface temperature of this star.

surface temperature = ...K [2]

2 The Sun may be considered as a uniform sphere with a mass of 1.99×10^{30} kg and a surface temperature of 5780 K.

A probe with a mass of 2.63 kg moves in a straight line towards the Sun.
When it is at a distance x from the centre of the Sun, the probe measures the gravitational field strength g due to the Sun and the radiant flux intensity F of radiation from the Sun.

(c) (iii) Use your answer in **(c)(ii)** to determine the radius r of the Sun.

r = ... m [2]

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:

(ii) the surface temperature of the star.

temperature = ... K [2]

4 **(c)** The radiant flux intensity of the radiation from the star in **(b)** is $2.52 \times 10^{-8}\,\text{W m}^{-2}$ when observed at a distance of $4.16 \times 10^{16}\,\text{m}$ from the star.

(ii) Determine the radius of the star.

radius = ... m [2]

5 **(a)** State Wien's displacement law. Identify any symbols that you use.

.....

.....

..... [2]

(b) A cosmology student observes the electromagnetic radiation received from a star in a galaxy. The student uses Wien's law to estimate the surface temperature of the star, a standard candle to estimate the distance to the galaxy, and the Stefan–Boltzmann law to estimate the radius of the star.

The student observes that the radiation from the star is redshifted.

(iii) The true values of the quantities observed or estimated are those that are corrected to allow for redshift. However, the student does not correct for redshift.

By placing one tick (✓) in each row, complete Table 10.1 to indicate how the observations and estimates made by the student compare with the true values.

Table 10.1

	student's uncorrected value		
	too low	the same	too high
wavelength of radiation			
surface temperature of star			
distance to star			
radius of star			

[4]

6 **(a)** State Wien's displacement law.

.....

..... [1]

(b) Fig. 10.1 shows the wavelength distributions of electromagnetic radiation emitted by two stars A and B.

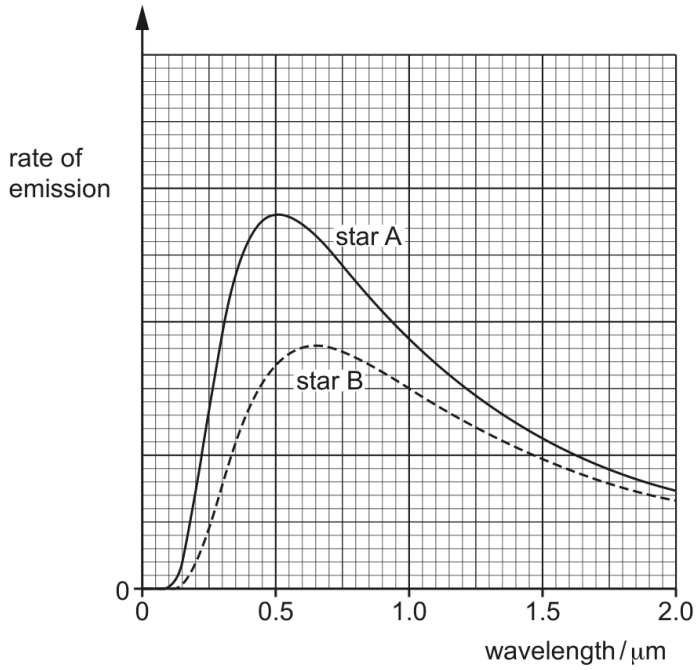


Fig. 10.1

The surface temperature of star A is known to be 5800 K.

(i) Determine the surface temperature of star B.

surface temperature = ... K [2]

(ii) Star B appears less bright than star A when viewed from the Earth.

Use Fig. 10.1 to suggest, with a reason, how else the physical appearance of star B compares with that of star A.

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..... [2]

7 **(b)** A star in the constellation Canis Major is a distance of 8.14×10^{16} m from the Earth and has a luminosity of 9.86×10^{27} W. The surface temperature of the star is 9830 K.

(ii) Determine the radius of the star.

radius = ... m [2]

(c) Explain how the surface temperature of a distant star may be determined from the wavelength spectrum of the light from the star.

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..... [3]