RADLEY

Information about stars

A.C. Norman

Radley College

Today we shall

1. see how to derive the Stefan–Boltzmann law.
2. know some applications of the law.
3. be able to use the law in calculations and to answer questions.

Textbook p. 119 [APFY]

Specification Requirement

7 Using radiation to investigate stars

(d) Wien's displacement law, Stefan's law and the inverse square law to investigate the properties of stars – luminosity, size, temperature and distance [NB stellar brightness in magnitudes will not be required]

[Eduqas A Level Physics Specification, 2009/10 onwards]

There are two main equations you need to use

Wien's displacement law

$$\lambda_{Peak} = \frac{W}{T},$$

(where $W = 2.9 \times 10^{-3}\,\mathrm{K\,m}$.)

Stefan–Boltzmann law

$$F = \frac{P}{A} = \sigma T^4,$$

($\sigma = 5.67 \times 10^{-8}\,\mathrm{W\,m^{-2}\,K^{-4}}$.)

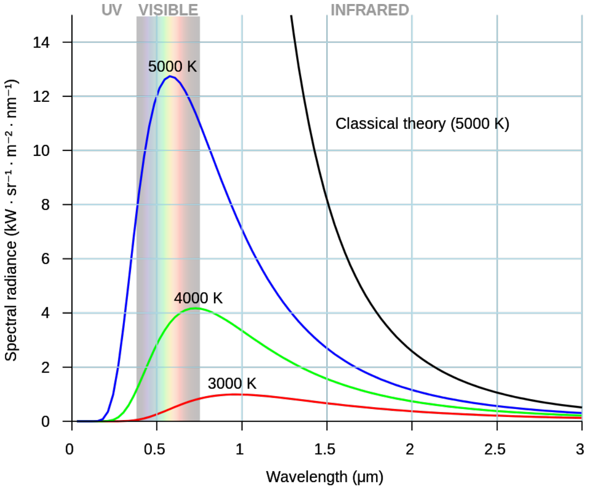
(plus of course the inverse square law, $F = \dfrac{L}{4\pi r^2}\ldots$)

Warm up questions: Practising Wien's displacement law

What is the colour (think about wavelength) of a star at

1. 3000 K?
2. 4000 K?
3. 1000 K?
4. 8000 K?

As $T \uparrow$, intensity $\uparrow$ ($F \sim T^4$) and peak moves to shorter λ ($\lambda_P \sim T^{-1}$)



Finding out about a star

A star is measured to be 3.47×10^{17} m from the Earth (how?) and its energy flux at the Earth is recorded as 3.09×10^{-8} W/m^2, with the peak wavelength being 674 nm.

1. What is the temperature of this star?
2. What is its total power emitted (luminosity)?
3. What is the radius of the star?