7 An object that is at a higher temperature than its surroundings loses thermal energy by emitting electromagnetic radiation. Fig. 7.1 shows the variation with wavelength λ from 400 nm to 1400 nm, of the intensity I_λ of the radiation emitted by an object at 1100 K.

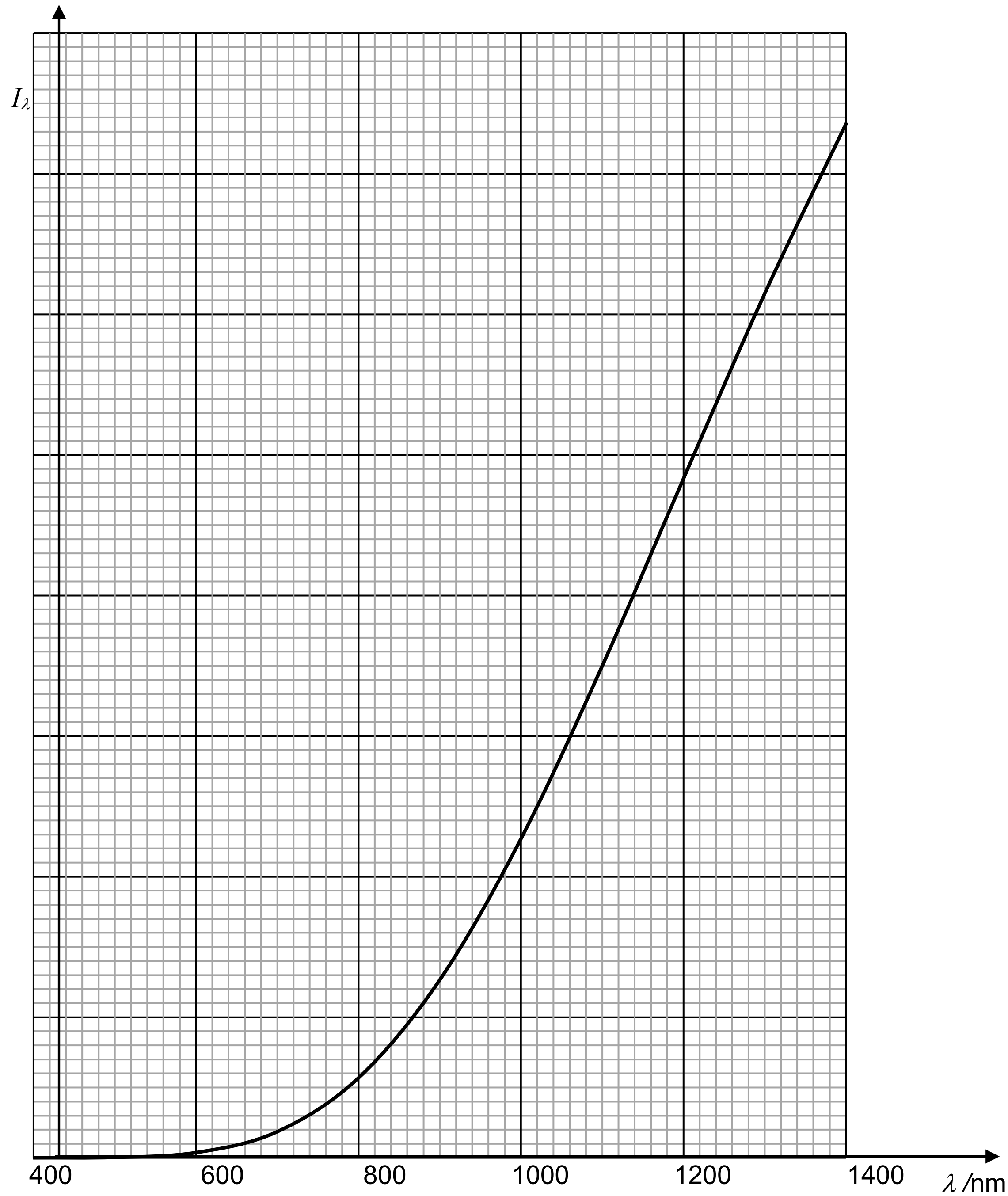

Fig. 7.1

(a) On the horizontal axis of Fig. 7.1, indicate with a cross a wavelength that is in the visible region of the electromagnetic spectrum.

[1]

(b) Hence suggest why, at a temperature of 1100 K, the object would glow with a red colour.

....

.... [2]

The distribution of intensity is different at different temperatures. This is illustrated in Fig. 7.2, which covers a larger range of wavelengths from 0 to 6000 nm.

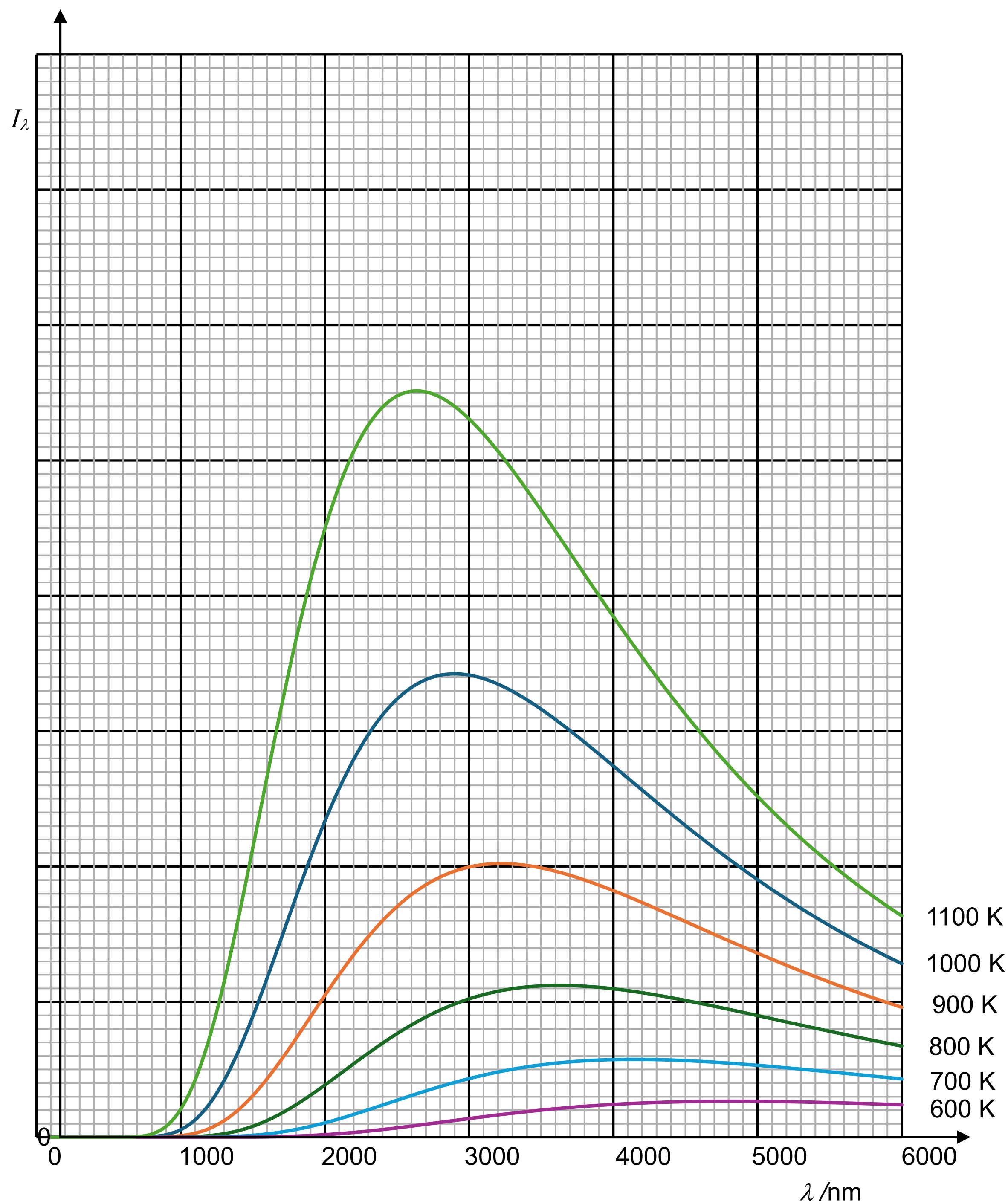

Fig. 7.2

(c) At any temperature T, the graphs in Fig. 7.2 show a peak intensity corresponding to a wavelength λ_{max}. In addition, the total intensity I_{tot} of the emitted radiation at each temperature is given by the area under the graph. Data for T and the corresponding values of λ_{max} and I_{tot} are shown in Fig. 7.3.

T/K	λ_{max} /nm	I_{tot}/W m^{-2}
600	4830	14.2
700	4140	26.0
800	3610	45.1
900	3210	69.4
1000	2900	100
1100	2630	160

Fig. 7.3

(i) Without drawing a graph, show that

$$T \times \lambda_{max} = \text{constant},$$

and determine the numerical value of the constant in metre kelvin (m K).

....

....

....

....

constant = ... m K [3]

(ii) Hence determine λ_{max} at a temperature T of 1200 K.

λ_{max} = ... m [2]

(d) Fig. 7.4 shows the values of $\lg(I_{tot}/\text{W m}^{-2})$ plotted against the corresponding values of $\lg(T/\text{K})$.

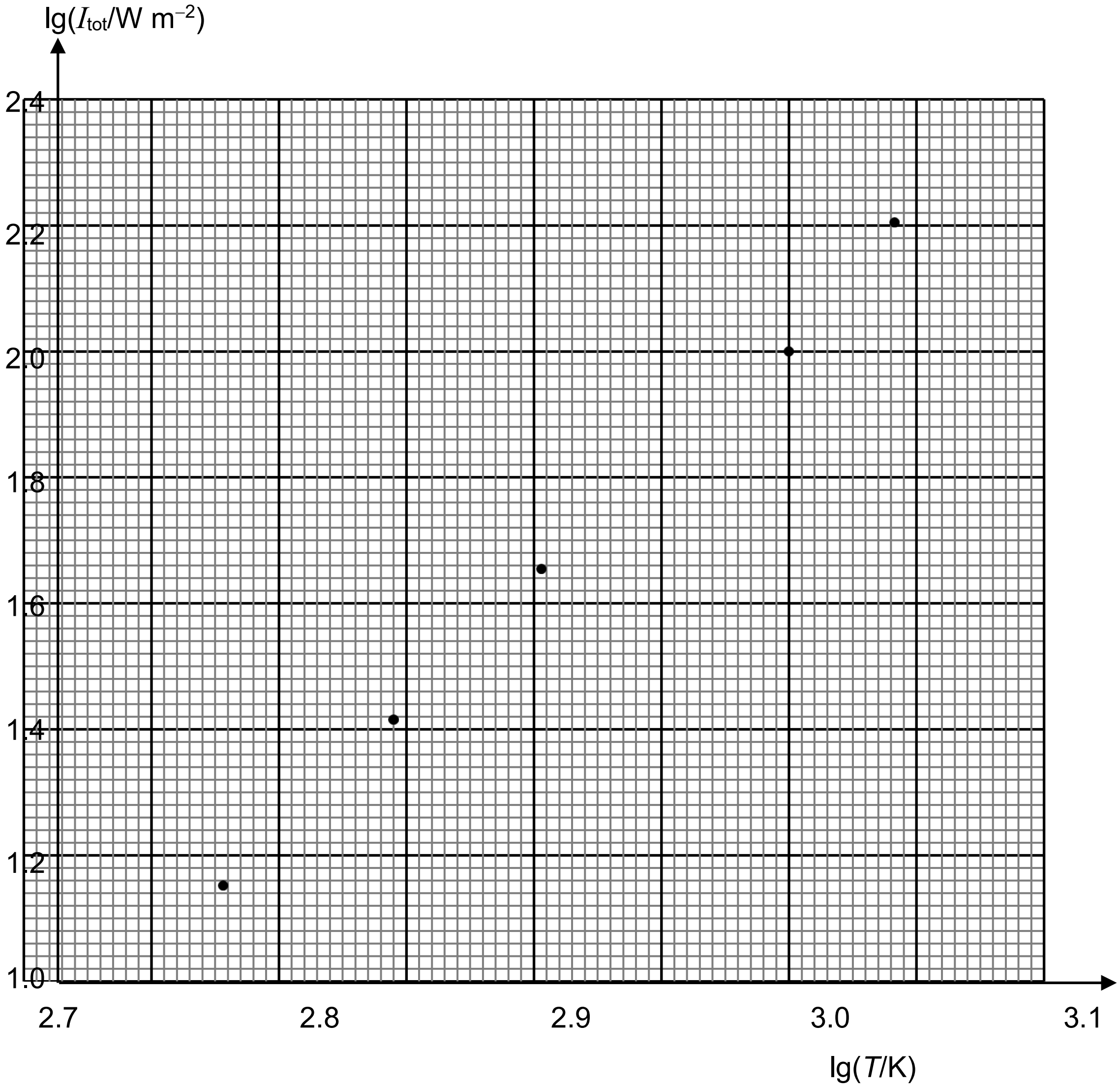

Fig. 7.4

Use the values in Fig. 7.3 to determine $\lg(I_{tot}/\text{W m}^{-2})$ for a temperature of 900 K.

(i) On Fig. 7.4, plot the point corresponding to T = 900 K [1]

(ii) Draw the line of best fit for the points. [1]

(e) It is known that I_{tot} varies with T according to the relation

$$I_{tot} = cT^n$$

where c and n are constants.

(i) Use the line drawn to determine a value for n.

n = ... [3]

(ii) By using the values in Fig. 7.3 for T = 900 K, determine I_{tot} for the object at 1200 K.

I_{tot} = ... W m^{-2} [2]

(f) Using your answer to **(c)(ii)**, sketch on Fig. 7.2, the variation with wavelength λ of intensity I_λ for a temperature of 1200 K.

[3]

(g) The radiation emitted by a hot body may be used as a means of determining the temperature of the body. Suggest and explain a property of the radiation that could be used for this purpose.

....

....

....

....

....

.... [2]

[Total: 20]