2019 Ph H2 Q6

Section: Particles and Waves
Topic: Blackbody Radiation and Wien's Law

Summary:
This question involves comparing blackbody spectra at different temperatures and using Wien's Law to derive a constant.

(a)
Sketch the spectrum for a hotter star (6000 K) on the same graph.

▶️ **Answer:**

- Curve must **peak at a shorter wavelength** (to the left of 5000 K curve).
- Curve must be **taller** (higher energy emitted at all wavelengths).

✅ **Marks: 2**

- 1 mark: peak shifted to left (shorter λ)
- 1 mark: higher overall energy at all λ (curve above original)

(b)
Use the data to show that
$T \times \lambda_{\text{peak}} \approx 2.9 \times 10^{-3}\,\text{m} \cdot \text{K}$

> Data:
> Multiply $T \times \lambda_{\text{peak}}$ for all 4 stars:

- $7700 \times 3.76 \times 10^{-7} = 2.895 \times 10^{-3}$
- $8500 \times 3.42 \times 10^{-7} = 2.907 \times 10^{-3}$
- $9600 \times 3.01 \times 10^{-7} = 2.890 \times 10^{-3}$
- $12000 \times 2.42 \times 10^{-7} = 2.904 \times 10^{-3}$

All values are close to 2.9×10^{-3}

▶️ **Answer:** $T\lambda_{\text{peak}} = 2.9 \times 10^{-3}\,\text{m} \cdot \text{K}$
✅ **Marks: 3**

- 2 marks: correct calculations for all 4 stars
- 1 mark: conclusion consistent with data

🔁 **Revision Tips:**

- **Wien's Law**:

$$\lambda_{\text{peak}} = \frac{2.9 \times 10^{-3}}{T}$$

- As **temperature increases, peak wavelength decreases** (hotter = bluer).
- **Blackbody spectra** shift left and rise in height as temperature increases.