MODERN PHYSICS DAY 5: BLACKBODY RADIATION AND QUANTIZATION

CED 15.4 · Skill 1.B · FRQ: TBR

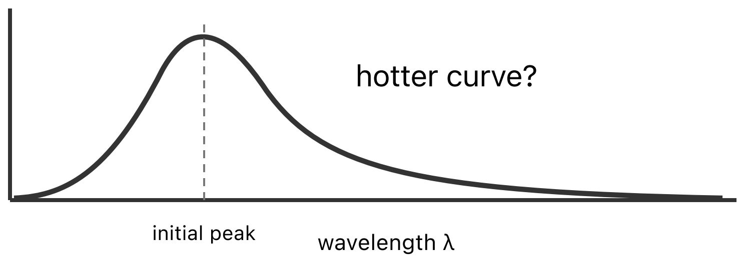
PREDICT

As a glowing object becomes hotter, how should the peak of its thermal spectrum move?

A. to shorter wavelength **B. to longer wavelength** **C. it stays fixed** **D. it splits into two peaks**

A burner or recorded source may provide the cue; the spectrum supplies the evidence.

BEFORE THE HOTTER CURVE IS REVEALED

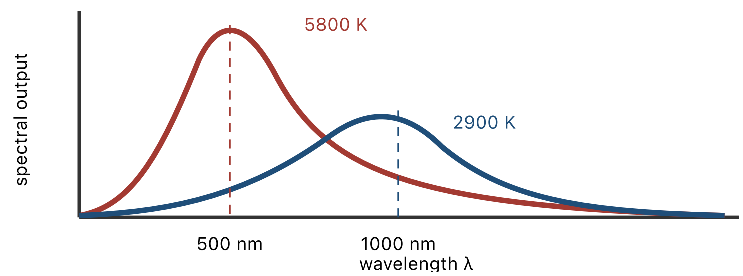


Commit to a direction for the peak shift before comparing curves.

NOTES / REASONING

READ A THERMAL SPECTRUM

TWO TEMPERATURES ON COMMON AXES



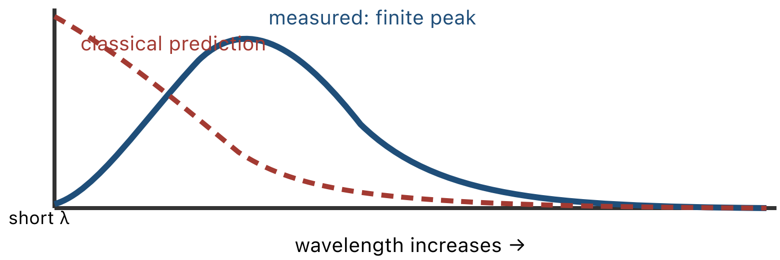
A hotter object emits more total radiation and has a peak at shorter wavelength.

$$\lambda_{max}T = b \qquad b = 2.90 \times 10^{-3}\,\mathrm{m \cdot K}$$

Use the marked peaks to verify $\lambda_{max}T$ for both curves.

WHY THE CLASSICAL MODEL FAILED

SHORT-WAVELENGTH PREDICTION VERSUS MEASUREMENT



Classical equipartition predicted that thermal output would grow without bound at very short wavelength. Measured spectra instead fall after a finite peak. Planck matched the data by allowing matter to exchange electromagnetic energy in discrete amounts proportional to frequency.

$$E = hf$$

Explain why the measured short-wavelength fall, not merely the curve's height, is the decisive evidence.

USE THE CURVE AND EQUATION

1. Calculate λ_{max} for $T = 2500\,\mathrm{K}$ and $T = 5000\,\mathrm{K}$. Report both in nanometers.

2. Sketch a third curve for $T = 3750\,\mathrm{K}$ on the common axes. Place its peak qualitatively and compare its height with the other two.

3. A student identifies the tallest plotted wavelength as "the color of the object." State one limitation of that description.