

**Instructor's guide** This activity follows Planck spectral distribution

Google “phet blackbody spectrum” and open the simulation.

1. a) At what wavelength is the peak in spectral intensity
  - $\lambda_{\text{peak}}$  for a black rock on the Earth's surface,
  - $\lambda_{\text{peak}}$  for the black walls of a pizza oven,
  - $\lambda_{\text{peak}}$  for a light bulb,
  - $\lambda_{\text{peak}}$  for the sun.
 b) Check that the peak wavelength decreases with temperature following a  $1/T$  relationship.
2. a) Use the numerical integration feature (the checkbox labelled “intensity” near the upper-right corner of the graph) to find the total intensity, in units of  $\text{W}/\text{m}^2$ , emitted by
  - a black rock on the Earth's surface,
  - the black walls of a pizza oven,
  - the surface of a tungsten light bulb filament,
  - the surface of the sun.
 b) Check that these intensities are proportional to  $T^4$ . Note, the quick way to check involves ratios: Does  $\frac{I_1}{I_2} = \left(\frac{T_1}{T_2}\right)^4$ ?
3. How cold should you make an object if you want zero thermal radiation emitted?
4. (Extra—if your group has time)
  - a) For an incandescent light bulb with a filament surface area of  $A$ , estimate how efficiently it converts electrical energy into visible photons. Hint: you will need to estimate the following ratio:

$$\frac{\text{Electromagnetic radiation in visible wavelengths}}{\text{Total electromagnetic radiation}} = \frac{A \int_{400 \text{ nm}}^{700 \text{ nm}} S_{\lambda}(\lambda, T) d\lambda}{A \int_0^{\infty} S_{\lambda}(\lambda, T) d\lambda}$$

- b) Estimate the filament surface area  $A$  for a 60 W light bulb.