

Instructor's guide follows

## 1 Classical prediction

$$\langle \text{energy rate} \rangle = \frac{2}{3} \frac{q^2}{4\pi\epsilon_0 c^3} \frac{k_B T}{m} \omega_0^2 \quad (1)$$

Draw a graph with  $\langle \text{energy rate} \rangle$  (the optical power output) on the vertical axis, and the oscillator frequency (or alternatively  $\hbar\omega_0$ ) on the horizontal axis. Sketch the relationship when

1.  $T = 300$  K
2.  $T = 600$  K

Assume the mass and charge of the the oscillators are constants.

## 2 Quantum prediction

When we account for energy quanta, the expression changes to

$$\langle \text{energy rate} \rangle = \begin{cases} \frac{2}{3} \frac{q^2}{4\pi\epsilon_0 c^3} \frac{k_B T}{m} \omega_0^2 & \text{when } \hbar\omega \ll k_B T \\ \frac{\hbar\omega^3}{4\pi^2 c^2} e^{-\frac{\hbar\omega}{k_B T}} & \text{when } \hbar\omega \gg k_B T \end{cases} \quad (2)$$

Sketch the relationship on your same graph, when

1.  $T = 300$  K
2.  $T = 600$  K

Assume the mass and charge of the the oscillators are constants.