Quantum Physics - Wien and Planck Calculations

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Example Problems. p. 840

The temperature of the skin is approximately 35 degrees Celsius. At what wavelength does the radiation emitted from the skin reach its peak?

$T = 35 + 273 = 308 K$

$\lambda_{max} T = 0.2898 \times 10^{-2}$

$\lambda_{max} = \frac{0.2898 \times 10^{-2}}{308} = 940 \mu m$

- A 2.0 kg object is attached to a massless spring with spring constant k = 25 N/m. The spring is stretched 0.40 m from its equilibrium position and released.
- Find the total energy and frequency of oscillation according to classic calculations
- Assume Planck's law of energy quantization applies and find the quantum number n.
- How much energy would be carried way with one quantum change?

$PE_e = \frac{1}{2} k x^2 = \frac{1}{2}(25)(.4)^2 = 2.0 J$

$f = \frac{1}{2\pi}\sqrt{k/m} = \frac{1}{2\pi}\sqrt{\frac{25}{2}} = 0.56 Hz$

$E_n = nhf = 2.0 J$

$n = \frac{E}{hf} = \frac{2}{6.63 \times 10^{-34} \cdot 0.56} = 5.4 \times 10^{33}$

$\Delta E = hf = 6.63 \times 10^{-34} \cdot 0.56 = 3.7 \times 10^{-34} J$

A mass on a spring is bouncing with the maximum velocity of 0.25 m/s. The mass is 0.1 kg and the spring has a spring constant of 12 N/m. Find the frequency, total energy, size of one quantum of energy and n.

$\omega = \sqrt{k/m} = \sqrt{12/.1}$

$f = \frac{\omega}{2\pi} = \frac{\sqrt{12/.1}}{2\pi} = 1.74\ Hz$

bounces per sec

$KE_{max} = E = \frac{1}{2} m v_{max}^2$

$= 0.5 \cdot .1 \cdot 0.25^2 = 0.0031\ J$

$E = hf = 1.74 \cdot 6.63 \times 10^{-34} = 1.15 \times 10^{-33}\ J$

One quantum

↑ to go faster, you need to put in some multiple of this energy

$KE = nhf$

$1.15 \times 10^{-33} = n \cdot 6.63 \times 10^{-34} \cdot 1.74$

$n = 2.687 \times 10^{30}$

huge quantum number