3-16. Find the temperature of a blackbody if its spectrum has its peak at (*a*) $\lambda_m = 700$ nm (visible), (*b*) $\lambda_m = 3$ cm (microwave region), and (*c*) $\lambda_m = 3$ m (FM radio waves).

3-17. If the absolute temperature of a blackbody is doubled, by what factor is the total emitted power increased?

3-18. Calculate the average energy $\overline{E}$ per mode of oscillation for (*a*) a long wavelength $\lambda = 10\, hc/kT$, (*b*) a short wavelength $\lambda = 0.1\, hc/kT$, and compare your results with the classical prediction kT (see Equation 3-9). (The classical value comes from the equipartition theorem discussed in Chapter 8.)

3-19. A particular radiating cavity has the maximum of its spectra distribution of radiated power at a wavelength of 27.0 μm (in the infrared region of the spectrum). The temperature is then changed so that the total power radiated by the cavity doubles. (*a*) Compute the new temperature. (*b*) At what wavelength does the new spectral distribution have its maximum value?

3-21. The energy reaching Earth from the Sun at the top of the atmosphere is 1.36×10^3 W/m^2, called the *solar constant.* Assuming that Earth radiates like a blackbody at uniform temperature, what do you conclude is the equilibrium temperature of Earth?

3-22. A 40-W incandescent bulb radiates from a tungsten filament operating at 3300 K. Assuming that the bulb radiates like a blackbody, (*a*) what are the frequency f_m and the wavelength λ_m at the maximum of the spectral distribution? (*b*) If f_m is a good approximation of the average frequency of the photons emitted by the bulb, about how many photons is the bulb radiating per second? (*c*) If you are looking at the bulb from 5 m away, how many photons enter your eye per second? (The diameter of your pupil is about 5.0 mm.)

8-3. The molar mass of oxygen gas (O_2) is about 32 g/mol and that of hydrogen gas (H_2) about 2 g/mol. Compute (*a*) the rms speed of O_2 and (*b*) the rms speed of H_2 when the temperature is 0°C.

8-5. (*a*) Find the total kinetic energy of translation of 1 mole of N_2 molecules at $T = 273$ K. (*b*) Would your answer be the same, greater, or less for 1 mole of He atoms at the same temperature? Justify your answer.

8-6. Use the Maxwell distribution of molecular speeds to calculate $\langle v^2 \rangle$ for the molecules of a gas.

8-7. Neutrons in a nuclear reactor have a Maxwell speed distribution when they are in thermal equilibrium. Find $\langle v \rangle$ and v_m for neutrons in thermal equilibrium at 300 K. Show that $n(v)$

8-10. Compute the total translational kinetic energy of one liter of oxygen held at a pressure of one atmosphere and a temperature of 20°C.

8-42. This problem is related to the equipartition theorem. Consider a system in which the energy of a particle is given by $E = Au^2$, where A is a constant and u is any coordinate or momentum that can vary from $-\infty$ to $+\infty$. (*a*) Write the probability of the particle having u in the range du and calculate the normalization constant C in terms of A. (*b*) Calculate the average energy $\langle E \rangle = \langle Au^2 \rangle$ and show that $\langle E \rangle = \frac{1}{2}kT$.

8-43. Calculate the average value of the magnitude of v_x from the Maxwell distribution.