* **33.** In the ionic salt KF, the separation distance between ions is about 0.27 nm. (*a*) Estimate the electrostatic potential energy between the ions assuming them to be point charges (magnitude 1*e*). (*b*) It is known that F releases 4.07 eV of energy when it "grabs" an electron, and 4.34 eV is required to ionize K. Find the binding energy of KF relative to free K and F atoms, neglecting the energy of repulsion.

* **34.** Consider a monoatomic solid with a weakly bound cubic lattice, with each atom connected to six neighbors, each bond having a binding energy of 3.9×10^{-3} eV. When this solid melts, its latent heat of fusion goes directly into breaking the bonds between the atoms. Estimate the latent heat of fusion for this solid, in J/kg. [*Hint*: show that in a simple cubic lattice (Fig. 29–34), there are *three* times as many bonds as there are atoms, when the number of atoms is large.]

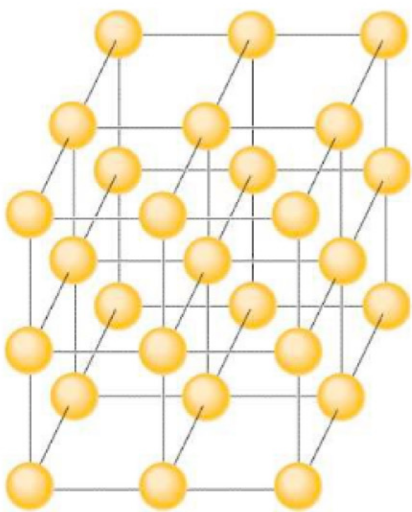

FIGURE 29–34 Problem 34.

* **35.** For O_2 with a bond length of 0.121 nm, what is the moment of inertia about the center of mass?

* **36.** A diatomic molecule is found to have an activation energy of 1.4 eV. When the molecule is disassociated, 1.6 eV of energy is released. Draw a potential energy curve for this molecule.

* **37.** When EM radiation is incident on diamond, it is found that light with wavelengths shorter than 226 nm will cause the diamond to conduct. What is the energy gap between the valence band and the conduction band for diamond?

* **38.** A TV remote control emits IR light. If the detector on the TV set is *not* to react to visible light, could it make use of silicon as a "window" with its energy gap $E_g = 1.14$ eV? What is the shortest-wavelength light that can strike silicon without causing electrons to jump from the valence band to the conduction band?

* **39.** For an arsenic donor atom in a doped silicon semiconductor, assume that the "extra" electron moves in a Bohr orbit about the arsenic ion. For this electron in the ground state, take into account the dielectric constant $K = 12$ of the Si lattice (which represents the weakening of the Coulomb force due to all the other atoms or ions in the lattice), and estimate (*a*) the binding energy, and (*b*) the orbit radius for this extra electron. [*Hint*: substitute $\epsilon = K\epsilon_0$ in Coulomb's law; see Section 17–8.]

* **40.** Most of the Sun's radiation has wavelengths shorter than 1000 nm. For a solar cell to absorb all this, what energy gap ought the material have?

* **41.** For a certain semiconductor, the longest wavelength radiation that can be absorbed is 1.92 mm. What is the energy gap in this semiconductor?

* **42.** Green and blue LEDs became available many years after red LEDs were first developed. Approximately what energy gaps would you expect to find in green (525 nm) and in blue (465 nm) LEDs?

* **43.** A zener diode voltage regulator is shown in Fig. 29–35. Suppose that $R = 1.80\text{ k}\Omega$ and that the diode breaks down at a reverse voltage of 130 V. (The current increases rapidly at this point, as shown on the far left of Fig. 29–28 at a voltage of −12 V on that diagram.) The diode is rated at a maximum current of 120 mA. (*a*) If $R_{load} = 15.0\text{ k}\Omega$, over what range of supply voltages will the circuit maintain the output voltage at 130 V? (*b*) If the supply voltage is 200 V, over what range of load resistance will the voltage be regulated?

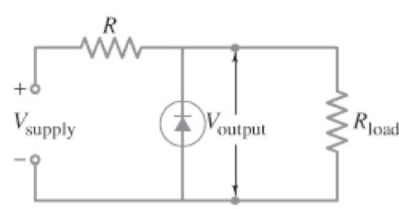

FIGURE 29–35 Problem 43.

Answers to Exercises

A: 1.30 mm, 0.87 mm, 0.65 mm.

B: 0.81 eV.