82. A house has a volume of 770 m^3. (*a*) What is the total mass of air inside the house at 20°C? (*b*) If the temperature drops to −10°C, what mass of air enters or leaves the house?

83. From the known value of atmospheric pressure at the surface of the Earth, estimate the total number of air molecules in the Earth's atmosphere.

84. What is the rms speed of nitrogen molecules contained in a 7.6-m^3 volume at 4.2 atm if the total amount of nitrogen is 1800 mol?

85. A standard cylinder of oxygen used in a hospital has gauge pressure = 2000 psi (13,800 kPa) and volume = 16 L (0.016 m^3) at $T = 295$ K. How long will the cylinder last if the flow rate, measured at atmospheric pressure, is constant at 2.4 L/min?

86. An iron cube floats in a bowl of liquid mercury at 0°C. (*a*) If the temperature is raised to 25°C, will the cube float higher or lower in the mercury? (*b*) By what percent will the fraction of volume submerged change?

87. The density of gasoline at 0°C is 0.68×10^3 kg/m^3. What is the density on a hot day, when the temperature is 38°C? What is the percentage change?

88. If a steel band were to fit snugly around the Earth's equator at 25°C, but then was heated to 45°C, how high above the Earth would the band be (assume equal everywhere)?

89. A brass lid screws tightly onto a glass jar at 20°C. To help open the jar, it can be placed into a bath of hot water. After this treatment, the temperatures of the lid and the jar are both 60°C. The inside diameter of the lid is 8.0 cm at 20°C. Find the size of the gap (difference in radius) that develops by this procedure.

90. The first length standard, adopted in the 18th century, was a platinum bar with two very fine marks separated by what was defined to be exactly 1 m. If this standard bar was to be accurate to within $\pm 1.0\ \mu$m, how carefully would the trustees have needed to control the temperature? The coefficient of linear expansion for platinum is $9 \times 10^{-6}\ C^{\circ -1}$.

91. A scuba tank, when fully charged, has a pressure of 195 atm at 20°C. The volume of the tank is 11.3 L. (*a*) What would the volume of the air be at 1.00 atm and at the same temperature? (*b*) Before entering the water, a person consumes 2.0 L of air in each breath, and breathes 12 times a minute. At this rate, how long would the tank last? (*c*) At a depth of 20.0 m of sea water and temperature of 10°C, how long would the same tank last assuming the breathing rate does not change?

92. The escape speed from the Earth is 1.12×10^4 m/s, so a gas molecule travelling away from Earth near the outer boundary of the Earth's atmosphere would, at this speed, be able to escape from the Earth's gravitational field. At what temperature is the average speed of (*a*) oxygen molecules, and (*b*) helium atoms equal to 1.12×10^4 m/s? (*c*) Can you see why our atmosphere contains oxygen but not helium?

93. A 1.0-kg trash-can lid is suspended against gravity by tennis balls thrown vertically upward at it. How many tennis balls per second must rebound from the lid elastically, assuming they have a mass of 0.060 kg and are thrown at 12 m/s?

94. A scuba diver releases a 3.00-cm-diameter (spherical) bubble of air from a depth of 14.0 m in a lake. Assume the temperature is constant at 298 K, and the air behaves as a perfect gas. How large is the bubble when it reaches the surface?

* 95. Calculate the total water vapor pressure in the air on the following two days: (*a*) a hot summer day, with the temperature 30°C and the relative humidity at 40%; (*b*) a cold winter day, with the temperature 5°C and the relative humidity at 80%.

* 96. A sauna has 7.0 m^3 of air volume, and the temperature is 90°C. The air is perfectly dry. How much water (in kg) should be evaporated if we want to increase the relative humidity from 0% to 10%? (See Table 13–3.)

* 97. Estimate the percent difference in the density of iron at STP, and when it is a solid deep in the Earth where the temperature is 2000°C and under 5000 atm of pressure. Assume the bulk modulus (90×10^9 N/m^2) and the coefficient of volume expansion do not vary with temperature and are the same as at STP.

* 98. (*a*) Use the ideal gas law to show that, for an ideal gas at constant pressure, the coefficient of volume expansion is equal to $\beta = 1/T$, where T is the temperature in kelvins. Compare to Table 13–1 for gases at $T = 293$ K. (*b*) Show that the bulk modulus (Section 9–5) for an ideal gas held at constant temperature is $B = P$, where P is the pressure.

* 99. In humid climates, people constantly *dehumidify* their cellars to prevent rot and mildew. If the cellar in a house (kept at 20°C) has 95 m^2 of floor space and a ceiling height of 2.8 m, what is the mass of water that must be removed from it to drop the humidity from 95% to a more reasonable 30%?

Answers to Exercises

A: −40°C = −40°F.
B: 24.0 L.
C: Less.
D: 3.5×10^{-9} m/s.