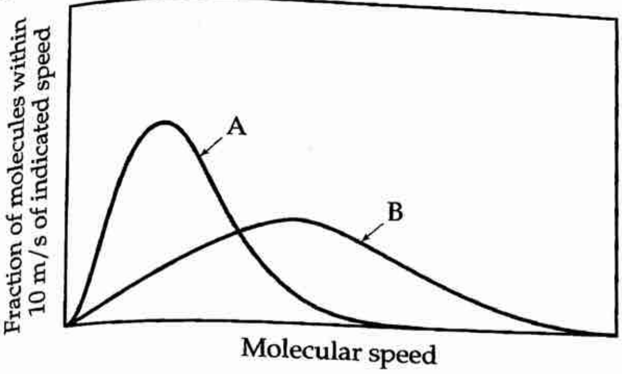
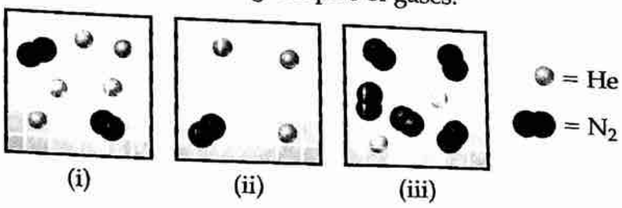
the same gas at two different temperatures, which represents the higher temperature? [Section 10.7]



10.8 Consider the following samples of gases:



If the three samples are all at the same temperature, rank them with respect to **(a)** total pressure, **(b)** partial pressure of helium, **(c)** density, **(d)** average kinetic energy of particles. [Section 10.7]

EXERCISES

Gas Characteristics; Pressure

10.9 How does a gas differ from a liquid with respect to each of the following properties: **(a)** density, **(b)** compressibility, **(c)** ability to mix with other substances of the same phase to form homogeneous mixtures?

10.10 **(a)** Both a liquid and a gas are moved to larger containers. How does their behavior differ? Explain the difference in molecular terms. **(b)** Although water and carbon tetrachloride, $CCl_4(l)$, do not mix, their vapors form homogeneous mixtures. Explain. **(c)** The densities of gases are generally reported in units of g/L, whereas those for liquids are reported as g/mL. Explain the molecular basis for this difference.

10.11 Suppose that a woman weighing 130 lb and wearing high-heeled shoes momentarily places all her weight on the heel of one foot. If the area of the heel is 0.50 in.^{2}, calculate the pressure exerted on the underlying surface in kilopascals.

10.12 A set of bookshelves rests on a hard floor surface on four legs, each having a cross-sectional dimension of 3.0×4.1 cm in contact with the floor. The total mass of the shelves plus the books stacked on them is 262 kg. Calculate the pressure in pascals exerted by the shelf footings on the surface.

10.13 **(a)** How high in meters must a column of water be to exert a pressure equal to that of a 760-mm column of mercury? The density of water is 1.0 g/mL, whereas that of mercury is 13.6 g/mL. **(b)** What is the pressure in atmospheres on the body of a diver if he is 36 ft below the surface of the water when atmospheric pressure at the surface is 0.95 atm?

10.14 The compound 1-iodododecane is a nonvolatile liquid with a density of 1.20 g/mL. The density of mercury is 13.6 g/mL. What do you predict for the height of a barometer column based on 1-iodododecane, when the atmospheric pressure is 752 torr?

10.15 Each of the following statements concerns a mercury barometer such as that shown in Figure 10.2. Identify any incorrect statements, and correct them. **(a)** The tube must be 1 cm^2 in cross-sectional area. **(b)** At equilibrium the force of gravity per unit area acting on the mercury column at the level of the outside mercury equals the force of gravity per unit area acting on the atmosphere. **(c)** The column of mercury is held up by the vacuum at the top of the column.

10.16 Suppose you make a mercury barometer using a glass tube about 50 cm in length, closed at one end. What would you expect to see if the tube is filled with mercury and inverted in a mercury dish, as in Figure 10.2? Explain.

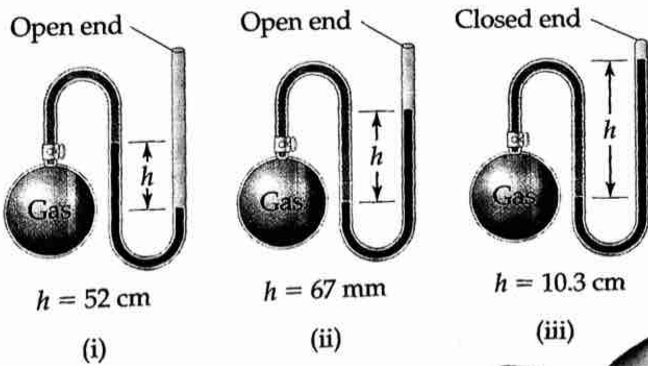
10.17 The typical atmospheric pressure on top of Mt. Everest (29,028 ft) is about 265 torr. Convert this pressure to **(a)** atm, **(b)** mm Hg, **(c)** pascals, **(d)** bars.

10.18 Perform the following conversions: **(a)** 0.850 atm to torr, **(b)** 785 torr to kilopascals, **(c)** 655 mm Hg to atmospheres, **(d)** 1.323×10^5 Pa to atmospheres, **(e)** 2.50 atm to bars.

10.19 In the United States, barometric pressures are reported in inches of mercury (in. Hg). On a beautiful summer day in Chicago the barometric pressure is 30.45 in. Hg. **(a)** Convert this pressure to torr. **(b)** A meteorologist explains the nice weather by referring to a "high-pressure area." In light of your answer to part (a), explain why this term makes sense.

10.20 **(a)** On Titan, the largest moon of Saturn, the atmospheric pressure is 1.63105 Pa. What is the atmospheric pressure of Titan in atm? **(b)** On Venus the surface atmospheric pressure is about 90 Earth atmospheres. What is the Venusian atmospheric pressure in kilopascals?

10.21 If the atmospheric pressure is 0.985 atm, what is the pressure of the enclosed gas in each of the three cases depicted in the drawing?



10.22 An open-end manometer containing mercury is connected to a container of gas, as depicted in Sample Exercise 10.2. What is the pressure of the enclosed gas in torr in each of the following situations? **(a)** The mercury in the arm attached to the gas is 10.7 cm higher than in the one open to the atmosphere; atmospheric pressure is 0.977 atm. **(b)** The mercury in the arm attached to the gas is 9.5 mm lower than in the one open to the atmosphere; atmospheric pressure is 1.02 atm.

The Gas Laws

10.23 Assume that you have a cylinder with a movable piston. What would happen to the gas pressure inside the cylinder if you do the following? **(a)** Decrease the volume to one-fourth the original volume while holding the temperature constant. **(b)** Reduce the Kelvin temperature to half its original value while holding the volume constant. **(c)** Reduce the amount of gas to half while keeping the volume and temperature constant.

10.24 A fixed quantity of gas at 23°C exhibits a pressure of 735 torr and occupies a volume of 5.22 L. **(a)** Use Boyle's law to calculate the volume the gas will occupy if the pressure is increased to 1.88 atm while the temperature is held constant. **(b)** Use Charles's law to calculate the volume the gas will occupy if the temperature is increased to 165°C while the pressure is held constant.

10.25 **(a)** How is the law of combining volumes explained by Avogadro's hypothesis? **(b)** Consider a 1.0-L flask containing neon gas and a 1.5-L flask containing xenon gas. Both gases are at the same pressure and temperature. According to Avogadro's law, what can be said about the ratio of the number of atoms in the two flasks?

10.26 Nitrogen and hydrogen gases react to form ammonia gas as follows:

$$N_2(g) + 3\,H_2(g) \longrightarrow 2\,NH_3(g)$$

At a certain temperature and pressure, 1.2 L of N_2 reacts with 3.6 L of H_2. If all the N_2 and H_2 are consumed, what volume of NH_3, at the same temperature and pressure, will be produced?

The Ideal-Gas Equation

10.27 **(a)** Write the ideal-gas equation, and give the units used for each term in the equation when $R = 0.0821$ L-atm/mol-K. **(b)** What is an ideal gas?

10.28 **(a)** What conditions are represented by the abbreviation STP? **(b)** What is the molar volume of an ideal gas at STP? **(c)** Room temperature is often assumed to be 25°C. Calculate the molar volume of an ideal gas at room temperature and 1 atm pressure.

10.29 Suppose you are given two 1-L flasks and told that one contains a gas of molar mass 30, the other a gas of molar mass 60, both at the same temperature. The pressure in flask A is X atm, and the mass of gas in the flask is 1.2 g. The pressure in flask B is 0.5X atm, and the mass of gas in that flask is 1.2 g. Which flask contains gas of molar mass 30, and which contains the gas of molar mass 60?

10.30 Suppose you are given two flasks at the same temperature, one of volume 2 L and the other of volume 3 L. The 2-L flask contains 4.8 g of gas, and the gas pressure is X atm. The 3-L flask contains 0.36 g of gas, and the gas pressure is 0.1X. Do the two gases have the same molar mass? If not, which contains the gas of higher molar mass?

10.31 Complete the following table for an ideal gas:

P	*V*	*n*	*T*
2.00 atm	1.00 L	0.500 mol	? K
0.300 atm	0.250 L	? mol	27°C
650 torr	? L	0.333 mol	350 K
? atm	585 mL	0.250 mol	295 K

10.32 Calculate each of the following quantities for an ideal gas: **(a)** the volume of the gas, in liters, if 1.75 mol has a pressure of 0.985 atm at a temperature of −6°C; **(b)** the absolute temperature of the gas at which 3.33×10^{-3} mol occupies 255 mL at 720 torr; **(c)** the pressure, in atmospheres, if 0.0467 mol occupies 413 mL at 122°C; **(d)** the quantity of gas, in moles, if 67.5 L at 54°C has a pressure of 11.25 kPa.

10.33 The *Hindenburg* was a hydrogen-filled dirigible that exploded in 1937. If the *Hindenburg* held $2.0 \times 10^5\ m^3$ of hydrogen gas at 23°C and 1.0 atm, what mass of hydrogen was present?

10.34 A neon sign is made of glass tubing whose inside diameter is 2.5 cm and whose length is 5.5 m. If the sign contains neon at a pressure of 1.78 torr at 35°C, how many grams of neon are in the sign? (The volume of a cylinder is $\pi r^2 h$.)

10.35 Calculate the number of molecules in a deep breath of air whose volume is 2.50 L at body temperature, 37°C, and a pressure of 735 torr.

10.36 If the pressure exerted by ozone, O_3, in the stratosphere is 3.0×10^{-3} atm and the temperature is 250 K, how many ozone molecules are in a liter?

10.37 A scuba diver's tank contains 0.29 kg of O_2 compressed into a volume of 2.3 L. **(a)** Calculate the gas pressure inside the tank at 9°C. **(b)** What volume would this oxygen occupy at 26°C and 0.95 atm?

10.38 An aerosol spray can with a volume of 250 mL contains 2.30 g of propane gas (C_3H_8) as a propellant. **(a)** If the can is at 23°C, what is the pressure in the can? **(b)** What volume would the propane occupy at STP? **(c)** The can says that exposure to temperatures above 130°F may cause the can to burst. What is the pressure in the can at this temperature?

10.39 Chlorine is widely used to purify municipal water supplies and to treat swimming pool waters. Suppose that the volume of a particular sample of Cl_2 gas is 8.70 L at

895 torr and 24°C. **(a)** How many grams of Cl_2 are in the sample? **(b)** What volume will the Cl_2 occupy at STP? **(c)** At what temperature will the volume be 15.00 L if the pressure is 8.76×10^2 torr? **(d)** At what pressure will the volume equal 6.00 L if the temperature is 58°C?

10.40 Many gases are shipped in high-pressure containers. Consider a steel tank whose volume is 65.0 L and which contains O_2 gas at a pressure of 16,500 kPa at 23°C. **(a)** What mass of O_2 does the tank contain? **(b)** What volume would the gas occupy at STP? **(c)** At what temperature would the pressure in the tank equal 150.0 atm? **(d)** What would be the pressure of the gas, in kPa, if it were transferred to a container at 24°C whose volume is 55.0 L?

10.41 In an experiment reported in the scientific literature, male cockroaches were made to run at different speeds on a miniature treadmill while their oxygen consumption was measured. In one hour the average cockroach running at 0.08 km/hr consumed 0.8 mL of O_2 at 1 atm pressure and 24°C per gram of insect weight. **(a)** How many moles of O_2 would be consumed in 1 hr by a 5.2-g cockroach moving at this speed? **(b)** This same cockroach is caught by a child and placed in a 1-qt fruit jar with a tight lid. Assuming the same level of continuous activity as in the research, will the cockroach consume more than 20% of the available O_2 in a 48-hr period? (Air is 21 mol percent O_2)

10.42 After the large eruption of Mount St. Helens in 1980, gas samples from the volcano were taken by sampling the downwind gas plume. The unfiltered gas samples were passed over a gold-coated wire coil to absorb mercury (Hg) present in the gas. The mercury was recovered from the coil by heating it, and then analyzed. In one particular set of experiments scientists found a mercury vapor level of 1800 ng of Hg per cubic meter in the plume, at a gas temperature of 10°C. Calculate **(a)** the partial pressure of Hg vapor in the plume, **(b)** the number of Hg atoms per cubic meter in the gas, **(c)** the total mass of Hg emitted per day by the volcano if the daily plume volume was 1600 km^3.

Further Applications of the Ideal-Gas Equation

10.43 Which gas is most dense at 1.00 atm and 298 K? **(a)** CO_2, **(b)** N_2O, **(c)** Cl_2. Explain.

10.44 Which gas is least dense at 1.00 atm and 298 K? **(a)** SO_2, **(b)** HBr, **(c)** CO_2. Explain.

10.45 Which of the following statements best explains why a closed balloon filled with helium gas rises in air?

(a) Helium is a monatomic gas, whereas nearly all the molecules that make up air, such as nitrogen and oxygen, are diatomic.

(b) The average speed of helium atoms is higher than the average speed of air molecules, and the higher speed of collisions with the balloon walls propels the balloon upward.

(c) Because the helium atoms are of lower mass than the average air molecule, the helium gas is less dense than air. The balloon thus weighs less than the air displaced by its volume.

(d) Because helium has a lower molar mass than the average air molecule, the helium atoms are in faster motion. This means that the temperature of the helium is higher than the air temperature. Hot gases tend to rise.

10.46 Which of the following statements best explains why nitrogen gas at STP is less dense than Xe gas at STP?

(a) Because Xe is a noble gas, there is less tendency for the Xe atoms to repel one another, so they pack more densely in the gas state.

(b) Xe atoms have a higher mass than N_2 molecules. Because both gases at STP have the same number of molecules per unit volume, the Xe gas must be denser.

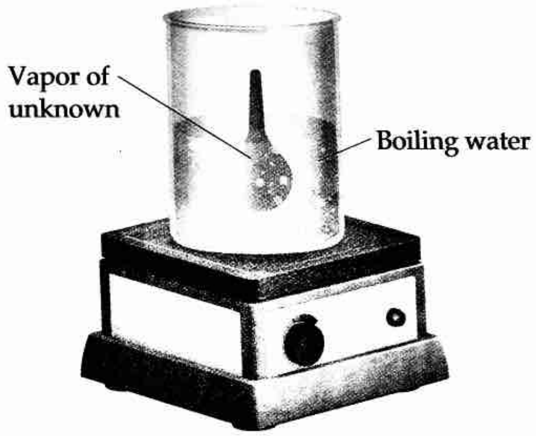
(c) The Xe atoms are larger than N_2 molecules and thus take up a larger fraction of the space occupied by the gas.

(d) Because the Xe atoms are much more massive than the N_2 molecules, they move more slowly and thus exert less upward force on the gas container and make the gas appear denser.

10.47 **(a)** Calculate the density of NO_2 gas at 0.970 atm and 35°C. **(b)** Calculate the molar mass of a gas if 2.50 g occupies 0.875 L at 685 torr and 35°C.

10.48 **(a)** Calculate the density of sulfur hexafluoride gas at 678 torr and 28°C. **(b)** Calculate the molar mass of a vapor that has a density of 7.135 g/L at 12°C and 743 torr.

10.49 In the Dumas-bulb technique for determining the molar mass of an unknown liquid, you vaporize the sample of a liquid that boils below 100°C in a boiling-water bath and determine the mass of vapor required to fill the bulb (see drawing). From the following data, calculate the molar mass of the unknown liquid: mass of unknown vapor, 1.012 g; volume of bulb, 354 cm^3; pressure, 742 torr; temperature, 99°C.



10.50 The molar mass of a volatile substance was determined by the Dumas-bulb method described in Exercise 10.49. The unknown vapor had a mass of 0.846 g; the volume of the bulb was 354 cm^3, pressure 752 torr, and temperature 100°C. Calculate the molar mass of the unknown vapor.

10.51 Magnesium can be used as a "getter" in evacuated enclosures, to react with the last traces of oxygen. (The magnesium is usually heated by passing an electric current through a wire or ribbon of the metal.) If an enclosure of

0.382 L has a partial pressure of O_2 of 3.5×10^{-6} torr at 27°C, what mass of magnesium will react according to the following equation?

$$2\,Mg(s) + O_2(g) \longrightarrow 2\,MgO(s)$$

10.52 Calcium hydride, CaH_2, reacts with water to form hydrogen gas:

$$CaH_2(s) + 2\,H_2O(l) \longrightarrow Ca(OH)_2(aq) + 2\,H_2(g)$$

This reaction is sometimes used to inflate life rafts, weather balloons, and the like, where a simple, compact means of generating H_2 is desired. How many grams of CaH_2 are needed to generate 53.5 L of H_2 gas if the pressure of H_2 is 814 torr at 21°C?

10.53 The metabolic oxidation of glucose, $C_6H_{12}O_6$, in our bodies produces CO_2, which is expelled from our lungs as a gas:

$$C_6H_{12}O_6(aq) + 6\,O_2(g) \longrightarrow 6\,CO_2(g) + 6\,H_2O(l)$$

Calculate the volume of dry CO_2 produced at body temperature (37°C) and 0.970 atm when 24.5 g of glucose is consumed in this reaction.

10.54 Consider the following unbalanced chemical equation:

$$C_5H_{12}(l) + O_2(g) \longrightarrow CO_2(g) + H_2O(g)$$

What volume of oxygen gas, measured at 23°C and 0.980 atm, is needed to react with 2.50 g of C_5H_{12}? What volume of each product is produced under the same conditions?

10.55 Hydrogen gas is produced when zinc reacts with sulfuric acid:

$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

If 159 mL of wet H_2 is collected over water at 24°C and a barometric pressure of 738 torr, how many grams of Zn have been consumed? (The vapor pressure of water is tabulated in Appendix B.)

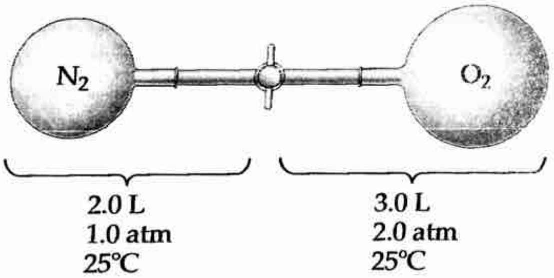
10.56 Acetylene gas, $C_2H_2(g)$, can be prepared by the reaction of calcium carbide with water:

$$CaC_2(s) + 2\,H_2O(l) \longrightarrow Ca(OH)_2(s) + C_2H_2(g)$$

Calculate the volume of C_2H_2 that is collected over water at 26°C by reaction of 0.887 g of CaC_2 if the total pressure of the gas is 726 torr. (The vapor pressure of water is tabulated in Appendix B.)

Partial Pressures

10.57 Consider the apparatus shown in the drawing. **(a)** When the stopcock between the two containers is opened and the gases allowed to mix, how does the volume occupied by the N_2 gas change? What is the partial pressure of N_2 after mixing? **(b)** How does the volume of the O_2 gas change when the gases mix? What is the partial pressure of O_2 in the mixture? **(c)** What is the total pressure in the container after the gases mix?



10.58 Consider a mixture of two gases, A and B, confined to a closed vessel. A quantity of a third gas, C, is added to the same vessel at the same temperature. How does the addition of gas C affect the following: **(a)** the partial pressure of gas A, **(b)** the total pressure in the vessel, **(c)** the mole fraction of gas B?

10.59 A mixture containing 0.538 mol He(g), 0.315 mol Ne(g), and 0.103 mol Ar(g) is confined in a 7.00-L vessel at 25°C. **(a)** Calculate the partial pressure of each of the gases in the mixture. **(b)** Calculate the total pressure of the mixture.

10.60 A mixture containing 2.50 g each of $CH_4(g)$, $C_2H_4(g)$, and $C_4H_{10}(g)$ is contained in a 2.00-L flask at a temperature of 15°C. **(a)** Calculate the partial pressure of each of the gases in the mixture. **(b)** Calculate the total pressure of the mixture.

10.61 A piece of solid carbon dioxide with a mass of 5.50 g is placed in a 10.0-L vessel that already contains air at 705 torr and 24°C. After the carbon dioxide has totally vaporized, what is the partial pressure of carbon dioxide and the total pressure in the container at 24°C?

10.62 A sample of 4.00 mL of diethylether ($C_2H_5OC_2H_5$; density = 0.7134 g/mL) is introduced into a 5.00-L vessel that already contains a mixture of N_2 and O_2, whose partial pressures are $P_{N_2} = 0.751$ atm and $P_{O_2} = 0.208$ atm. The temperature is held at 35.0°C, and the diethylether totally evaporates. **(a)** Calculate the partial pressure of the diethylether. **(b)** Calculate the total pressure in the container.

10.63 A mixture of gases contains 0.75 mol N_2, 0.30 mol O_2, and 0.15 mol CO_2. If the total pressure of the mixture is 1.56 atm, what is the partial pressure of each component?

10.64 A mixture of gases contains 10.25 g of N_2, 2.05 g of H_2, and 7.63 g of NH_3. If the total pressure of the mixture is 2.35 atm, what is the partial pressure of each component?

10.65 At an underwater depth of 250 ft, the pressure is 8.38 atm. What should the mole percent of oxygen be in the diving gas for the partial pressure of oxygen in the mixture to be 0.21 atm, the same as in air at 1 atm?

10.66 **(a)** What are the mole fractions of each component in a mixture of 5.08 g of O_2, 7.17 g of N_2, and 1.32 g of H_2? **(b)** What is the partial pressure in atm of each component of this mixture if it is held in a 12.40-L vessel at 15°C?

10.67 A quantity of N_2 gas originally held at 4.75 atm pressure in a 1.00-L container at 26°C is transferred to a 10.0-L container at 20°C. A quantity of O_2 gas originally at 5.25 atm and 26°C in a 5.00-L container is transferred to this same container. What is the total pressure in the new container?

10.68 A sample of 4.00 g of $SO_2(g)$ originally in a 5.00-L vessel at 26°C is transferred to a 10.0-L vessel at 25°C. A sample of 2.35 g $N_2(g)$ originally in a 2.50-L vessel at 20°C is transferred to this same 10.0-L vessel. **(a)** What is the partial pressure of $SO_2(g)$ in the larger container? **(b)** What is the partial pressure of $N_2(g)$ in this vessel? **(c)** What is the total pressure in the vessel?

Kinetic-Molecular Theory; Graham's Law

10.69 What change or changes in the state of a gas bring about each of the following effects? **(a)** The number of impacts per unit time on a given container wall increases. **(b)** The average energy of impact of molecules with the wall of the container decreases. **(c)** The average distance between gas molecules increases. **(d)** The average speed of molecules in the gas mixture is increased.

10.70 Indicate which of the following statements regarding the kinetic-molecular theory of gases are correct. For those that are false, formulate a correct version of the statement. **(a)** The average kinetic energy of a collection of gas molecules at a given temperature is proportional to $m^{1/2}$. **(b)** The gas molecules are assumed to exert no forces on each other. **(c)** All the molecules of a gas at a given temperature have the same kinetic energy. **(d)** The volume of the gas molecules is negligible in comparison to the total volume in which the gas is contained.

10.71 What property or properties of gases can you point to that support the assumption that most of the volume in a gas is empty space?

10.72 Newton had an incorrect theory of gases in which he assumed that all gas molecules repel one another and the walls of their container. Thus, the molecules of a gas are statically and uniformly distributed, trying to get as far apart as possible from one another and the vessel walls. This repulsion gives rise to pressure. Explain why Charles's law argues for the kinetic-molecular theory and against Newton's model.

10.73 Vessel A contains $CO(g)$ at 0°C and 1 atm. Vessel B contains $SO_2(g)$ at 20°C and 0.5 atm. The two vessels have the same volume. **(a)** Which vessel contains more molecules? **(b)** Which contains more mass? **(c)** In which vessel is the average kinetic energy of molecules higher? **(d)** In which vessel is the rms speed of molecules higher?

10.74 Suppose you have two 1-L flasks, one containing N_2 at STP, the other containing CH_4 at STP. How do these systems compare with respect to **(a)** number of molecules, **(b)** density, **(c)** average kinetic energy of the molecules, **(d)** rate of effusion through a pinhole leak?

10.75 **(a)** Place the following gases in order of increasing average molecular speed at 25°C: Ne, HBr, SO_2, NF_3, CO. **(b)** Calculate the rms speed of NF_3 molecules at 25°C.

10.76 **(a)** Place the following gases in order of increasing average molecular speed at 300 K: CO, SF_6, H_2S, Cl_2, HBr. **(b)** Calculate and compare the rms speeds of CO and Cl_2 molecules at 300 K.

10.77 Hydrogen has two naturally occurring isotopes, ^1H and ^2H. Chlorine also has two naturally occurring isotopes, ^{35}Cl and ^{37}Cl. Thus, hydrogen chloride gas consists of four distinct types of molecules: $^1H^{35}Cl$, $^1H^{37}Cl$, $^2H^{35}Cl$, and $^2H^{37}Cl$. Place these four molecules in order of increasing rate of effusion.

10.78 As discussed in the "Chemistry at Work" box in Section 10.8, enriched uranium is produced via gaseous diffusion of UF_6. Suppose a process were developed to allow diffusion of gaseous uranium atoms, $U(g)$. Calculate the ratio of diffusion rates for ^{235}U and ^{238}U, and compare it to the ratio for UF_6 given in the essay.

10.79 Arsenic(III) sulfide sublimes readily, even below its melting point of 320°C. The molecules of the vapor phase are found to effuse through a tiny hole at 0.28 times the rate of effusion of Ar atoms under the same conditions of temperature and pressure. What is the molecular formula of arsenic(III) sulfide in the gas phase?

10.80 A gas of unknown molecular mass was allowed to effuse through a small opening under constant-pressure conditions. It required 105 s for 1.0 L of the gas to effuse. Under identical experimental conditions it required 31 s for 1.0 L of O_2 gas to effuse. Calculate the molar mass of the unknown gas. (Remember that the faster the rate of effusion, the shorter the time required for effusion of 1.0 L; that is, rate and time are inversely proportional.)

Nonideal-Gas Behavior

10.81 **(a)** List two experimental conditions under which gases deviate from ideal behavior. **(b)** List two reasons the gases deviate from ideal behavior. **(c)** Explain how the function PV/RT can be used to show how gases behave nonideally.

10.82 The planet Jupiter has a mass 318 times that of Earth, and its surface temperature is 140 K. Mercury has a mass 0.05 times that of Earth, and its surface temperature is between 600 K and 700 K. On which planet is the atmosphere more likely to obey the ideal-gas law? Explain.

10.83 Based on their respective van der Waals constants (Table 10.3), is Ar or CO_2 expected to behave more nearly like an ideal gas at high pressures? Explain.

10.84 Briefly explain the significance of the constants *a* and *b* in the van der Waals equation.

10.85 Calculate the pressure that CCl_4 will exert at 40°C if 1.00 mol occupies 28.0 L, assuming that **(a)** CCl_4 obeys the ideal-gas equation; **(b)** CCl_4 obeys the van der Waals equation. (Values for the van der Waals constants are given in Table 10.3.)

10.86 It turns out that the van der Waals constant *b* equals four times the total volume actually occupied by the molecules of a mole of gas. Using this figure, calculate the fraction of the volume in a container actually occupied by Ar atoms **(a)** at STP, **(b)** at 100 atm pressure and 0°C. (Assume for simplicity that the ideal-gas equation still holds.)