13.1 PRESSURE

One standard atmosphere of pressure is equivalent to approximately _____ pascals.

A pressure of 760 mm Hg is equivalent to approximately _____ kilopascals.

PROBLEMS

Convert the following pressures into atmospheres.

a. 540 mm Hg
b. 9.00×10^5 Pa
c. 890. torr
d. 133 kPa

Convert the following pressures into mm Hg.

a. 0.403 atm
b. 103,400 Pa
c. 205 kPa
d. 842 torr

Convert the following pressures into pascals.

a. 744 mm Hg
b. 132 kPa
c. 0.994 atm
d. 599 torr

13.2 Pressure and Volume: Boyle's Law

QUESTIONS

When the pressure on a sample of gas is increased (at constant temperature), the volume of the sample _____.

The volume of a sample of ideal gas is _____ proportional to the pressure on it at constant temperature.

PROBLEMS

For each of the following sets of pressure/volume data, calculate the missing quantity. Assume the temperature and the amount of gas remain constant.

a. V = 43.0 L at 1.04 atm; V = ? at 2.94 atm
b. V = 234 mL at 723 mm Hg; V = 434 mL at ? mm Hg
c. V = 23.5 L at 655 torr; V = ? at 1.04 atm

For each of the following sets of pressure/volume data, calculate the missing quantity. Assume the temperature and the amount of gas remain constant.

a. V = 55 mL at 190 torr; V = ? at 1.0 atm
b. V = 100. L at 1.043 kPa; V = ? at 1.0 atm
c. V = 245 mL at 1.0233 atm; V = ? at 385 torr

A 4.20-L sample of gas has its pressure decreased from 3.43 atm to 1.29 atm. What does the volume of the gas become?

An aerosol can contains 400. mL of compressed gas at 5.2 atm pressure. When the gas is sprayed into a large plastic bag, the bag inflates to a volume of 2.14 L. What is the pressure of gas inside the plastic bag?

One standard atmosphere of pressure is equivalent to _____ mm Hg.

During stormy weather, the atmospheric pressure is "low"; this means a barometer will read _____ than 760 mm Hg.

Convert the following pressures to units of atmospheres.

a. 110.2 kPa
b. 74.2 cm Hg
c. 441 mm Hg
d. 921 torr

Convert the following pressures to units of mm Hg.

a. 1.02 atm
b. 121.4 kPa
c. 792 torr
d. 1.09×10^4 Pa

Convert the following pressures to units of kilopascals.

a. 2.07×10^6 Pa
b. 795 mm Hg
c. 10.9 atm
d. 659 torr

When the volume of a sample of gas is decreased, the pressure inside the sample of gas _____.

A mathematical expression that summarizes Boyle's law is _____.

For each of the following sets of pressure/volume data, calculate the missing quantity. Assume the temperature and the mass of gas remain constant.

a. V = 541 mL at 1.00 atm; V = ? at 699 torr
b. V = 2.32 L at 110.2 kPa; V = ? at 0.995 atm
c. V = 4.15 mL at 135 atm; V = 10.0 mL at ? mm Hg

For each of the following sets of pressure/volume data, calculate the missing quantity. Assume the temperature and the mass of gas remain constant.

a. V = 561 mL at 1.82 atm; V = ? at 245 mm Hg
b. V = 561 mL at 1.82 atm; V = ? at 1.82 kPa
c. V = 561 mL at 1.82 atm; V = ? at 2.45×10^4 Pa

If the pressure exerted on the gas in a weather balloon decreases from 1.01 atm to 0.562 atm as it rises, by what factor will the volume of the gas in the balloon increase as it rises?

What pressure (in atmospheres) is required to compress 1.00 L of gas at 760. mm Hg pressure to a volume of 50.0 mL?

13.3 Volume and Temperature: Charles's Law

QUESTIONS

25. When the temperature of a sample of ideal gas is increased under constant pressure conditions, the _____ of the sample also increases.
26. The lowest possible temperature that can exist is referred to as _____ and is equivalent to −273 °C.
27. The volume of a sample of ideal gas is _____ proportional to its temperature (K) at constant pressure.
28. A mathematical expression that summarizes Charles's law is _____.

PROBLEMS

29. When 500. mL of helium gas at 25 °C is cooled at constant pressure to 10.0 K, what does the volume of the gas become?
30. If 525 mL of gas at 25 °C is heated to 50 °C, at constant pressure, calculate the new volume of the sample.
31. For each of the following sets of volume/temperature data, calculate the missing quantity. Assume the pressure and the amount of gas remain constant.
    a. V = 10. L at 25 °C; V = ? at 250. °C
    b. V = 250. mL at 300. K; V = ? at 0°C
    c. V = 35 L at 1500 °C; V = ? at 1 K
32. For each of the following sets of volume/temperature data, calculate the missing quantity. Assume the pressure and the mass of gas remain constant.
    a. V = 25.0 L at 0 °C; V = 50.0 L at ? °C
    b. V = 247 mL at 25 °C; V = 255 mL at ? °C
    c. V = 1.00 mL at −272 °C; V = ? at 25 °C
33. For each of the following sets of volume/temperature data, calculate the missing quantity. Assume the pressure and the amount of gas remain constant.
    a. V = 25 mL at 25 °C; V = ? at 0 °C
    b. V = 10.2 L at 100. °C; V = ? at 100 K
    c. V = 551 mL at 75 °C; V = 1.00 mL at ? °C
34. For each of the following sets of volume/temperature data, calculate the missing quantity. Assume the pressure and the mass of gas remain constant.
    a. V = 2.01×10^2 L at 1,150 °C; V = 5.00 L at ? °C
    b. V = 44.2 mL at 298 K; V = ? at 0 K
    c. V = 44.2 mL at 298 K; V = ? at 0 °C
35. To what temperature must 500. mL of gas at 22 °C be cooled, at constant pressure, so that the volume of the gas is reduced to 1.00 mL?
36. A 113 L sample of helium at 27 °C is cooled at constant pressure to −78 °C. Calculate the new volume of the helium.
37. The label on an aerosol spray can contains a warning that the can should not be heated to over 130 °F because of the danger of explosion. Although the pressure in an aerosol can also increases if it is heated (which contributes to the danger of explosion), calculate the potential volume of the gas contained in a 500.-mL aerosol can when it is heated from 25 °C to 54 °C (approximately 130 °F).
38. As we noted in Example 13.6, gas volume was formerly used as a way to measure temperature by applying Charles's law. Suppose a sample in a gas thermometer has a volume of 135 mL at 11 °C. Indicate what temperature would correspond to each of the following volumes, assuming that the pressure remains constant: 113 mL, 142 mL, 155 mL, 127 mL.

13.4 Volume and Moles: Avogadro's Law

QUESTIONS

39. At conditions of constant temperature and pressure, the volume of a sample of ideal gas is _____ proportional to the number of moles of gas present.
40. A mathematical expression that summarizes Avogadro's law is _____.

PROBLEMS

41. If 5.00 g of O_2 gas has a volume of 7.20 L at a certain temperature and pressure, what volume does 15.0 g of O_2 have under the same conditions?
42. If 0.500 mol of nitrogen gas occupies a volume of 11.2 O °C, what volume will 2.00 mol of nitrogen occupy the same conditions?
43. If 3.25 mol of argon gas occupies a volume of 100.L at a particular temperature and pressure, what volume does 14.15 mol of argon occupy under the same conditions?
44. If 46.2 g of oxygen gas occupies a volume of 100. particular temperature and pressure, what volume 5.00 g of oxygen gas occupy under the same conditions?

The Ideal Gas Law

QUESTIONS

What is an "ideal" gas? Under what conditions of pressure do real gases behave most nearly ideally?

Why must we always express the temperature of a gas in kelvins when using the ideal gas law?

PROBLEMS

Given each of the following sets of values for three of the gas variables, calculate the unknown quantity.

a. P = 10.4 atm; V = 256 mL; n = 0.302 mol; T = ? °C

b. P = ? atm; V = 22.4 L; n = 1.00 mol; T = 273 K

c. P = 755 torr; V = ? L; n = 0.341 mol; T = 22 °C

Given each of the following sets of values for three of the gas variables, calculate the unknown quantity.

a. $P = 7.74 \times 10^3$ Pa; V = 12.2 mL; n = ? mol; T = 298 K

b. P = ? mm Hg; V = 43.0 mL; n = 0.421 mol; T = 223 K

c. P = 455 mm Hg; V = ? mL; $n = 4.4 \times 10^{-2}$ mol; T = 331 °C

53. What volume is occupied by 2.0 g of He at 25 °C and a pressure of 775 mm Hg?

55. What mass of hydrogen gas, H_2, is needed to fill an 80.0-L tank to a pressure of 150. atm at 27 °C?

57. At what temperature will a 1.0-g sample of neon gas exert a pressure of 500. torr in a 5.0-L container?

59. What is the pressure in a 25-L vessel containing 1.0 kg of oxygen gas at 300. K?

61. When 500. mL of O_2 gas at 25 °C and 1.045 atm is cooled to −40. °C and the pressure is increased to 2.00 atm, what is the new volume of the gas sample?

63. What is the final pressure for a sample of gas when 500. mL of the gas is cooled from 25 °C and 1.00 atm to −272 °C with no change in the volume of the sample?

46. What are the *units* of the universal gas constant (R) when the constant has the numerical value 0.08206?

48. Show how Boyle's, Charles's, and Avogadro's gas laws may be derived from the ideal gas law.

50. Given each of the following sets of values for an ideal gas, calculate the unknown quantity.

a. P = 782 mm Hg; V = ?; n = 0.210 mol; T = 27 °C

b. P = ? mm Hg; V = 644 mL; n = 0.0921 mol; T = 303 K

c. P = 745 mm Hg; V = 11.2 L; n = 0.401 mol; T = ? K

52. Given each of the following sets of values for an ideal gas, calculate the unknown quantity.

a. P = 1.01 atm; V = ?; n = 0.00831 mol; T = 25 °C

b. P = ? atm; V = 602 mL; $n = 8.01 \times 10^{-3}$ mol; T = 310 K

c. P = 0.998 atm; V = 629 mL; n = ? mol; T = 35 °C

54. What volume is occupied by 5.03 g of O_2 at 28 °C and a pressure of 0.998 atm?

56. Suppose two 200.0-L tanks are to be filled separately with the gases helium and hydrogen. What mass of each gas is needed to produce a pressure of 135 atm in its respective tank at 24 °C?

58. At what temperature does 16.3 g of nitrogen gas have a pressure of 1.25 atm in a 25.0-L tank?

60. Calculate the pressure in a 212-L tank containing 51.3 lb of argon gas at 25 °C?

62. What will be the new volume if 125 mL of He gas at 100 °C and 0.981 atm is cooled to 25 °C and the pressure is increased to 1.15 atm?

64. At what temperature does 5.00 g of H_2 occupy a volume of 50.0 L at a pressure of 761 mm Hg?