29. How can Gay-Lussac's law of combining volumes be used to deduce chemical formulas?

30. Write the equation that expresses Dalton's law of partial pressures.

PRACTICE PROBLEMS

PROBLEM SOLVING SKILL

Sample Problem A Converting Pressure Units

31. The standard pressure at sea level is 101 325 pascals. What force is being exerted on each square meter of Earth's surface?

32. The vapor pressure of hydrogen peroxide is 100.0 torr at 97.9°C. What is this pressure in kPa?

33. The gauge pressure in a tire is 28 psi, which adds to atmospheric pressure of 14.0 psi. What is the internal tire pressure in kPa?

34. The weather bureau reports the atmospheric pressure as 925 millibars. What is this pressure in kPa?

Sample Problem B Solving Pressure-Volume Problems

35. A gas sample has a volume of 125 mL at 91.0 kPa. What will its volume be at 101 kPa?

36. A 125 mL sample of gas at 105 kPa has its volume reduced to 75.0 mL. What is the new pressure?

37. A diver at a depth of 1.0×10^2 m, where the pressure is 11.0 atm, releases a bubble with a volume of 100.0 mL. What is the volume of the bubble when it reaches the surface? Assume a pressure of 1.00 atm at the surface.

38. In a deep-sea station 2.0×10^2 m below the surface, the pressure in the module is 20.0 atm. How many liters of air at sea level are needed to fill the module with 2.00×10^7 L of air?

39. The pressure on a 240.0 mL sample of helium gas is increased from 0.428 atm to 1.55 atm. What is the new volume, assuming constant temperature?

40. A sample of air with volume 6.6×10^7 L changes pressure from 99.4 kPa to 88.8 kPa. Assuming constant temperature, what is the new volume?

Sample Problem C Solving Volume-Temperature Problems

41. Use Charles's law to solve for the missing value in the following. $V_1 = 80.0$ mL, $T_1 = 27°C$, $T_2 = 77°C$, $V_2 = ?$

42. A balloon filled with helium has a volume of 2.30 L on a warm day at 311 K. It is brought into an air-conditioned room where the temperature is 295 K. What is its new volume?

43. The balloon in item 42 is dipped into liquid nitrogen at −196°C. What is its new volume?

44. A gas at 65°C occupies 4.22 L. At what Celsius temperature will the volume be 3.87 L, at the same pressure?

45. A person breathes 2.6 L of air at −11°C into her lungs, where it is warmed to 37°. What is its new volume?

46. A scientist warms 26 mL of gas at 0.0°C until its volume is 32 mL. What is its new temperature in degrees Celsius?

Sample Problem D Solving Pressure-Temperature Problems

47. Use Gay-Lussac's law to solve for the unknown. $P_1 = 111$ kPa, $T_1 = 273$ K, $T_2 = 373$ K, $P_2 = ?$

48. A sample of hydrogen exerts a pressure of 0.329 atm at 47°C. What will the pressure be at 77°C, assuming constant volume?

49. A sample of helium exerts a pressure of 101 kPa at 25°C. Assuming constant volume, what will its pressure be at liquid nitrogen temperature, −196°C?

50. The pressure inside a tire is 39 psi at 20°C. What will the pressure be after the tire is driven at high speed on a hot highway, when the temperature in the tire is 48°C?

51. A tank of oxygen for welding is at 31°C and 11 atm. What is the pressure when it is taken to the South Pole, where the temperature is −41°C?

52. A cylinder of gas at 555 kPa and 22°C is heated until the pressure is 655 kPa. What is the new temperature?

Sample Problem E Using the Ideal Gas Law

53. How many moles of argon are there in 20.0 L, at 25°C and 96.8 kPa?

54. How many moles of air are in 1.00 L at −23°C and 101 kPa?

55. A 4.44 L container holds 15.4 g of oxygen at 22.55°C. What is the pressure?

56. A polyethylene plastic weather balloon contains 65 L of helium, which is at 20.0°C and 94.0 kPa. How many moles of helium are in the balloon?

57. What will be the volume of the balloon in item 56 in the stratosphere at −61°C and 1.1×10^3 Pa?

58. A polyethylene weather balloon is inflated with 12.0 g of helium at −23°C and 100.0 kPa. What is its volume?

Sample Problem F Comparing Molecular Speeds

59. An unknown gas effuses at a speed one-quarter of that of helium. What is the molar mass of the unknown gas? It is either sulfur dioxide or sulfur trioxide. Which gas is it?

60. An unknown gas effuses at one half the speed of oxygen. What is the molar mass of the unknown? It is either HBr or HI. Which gas is it?

61. Oxygen molecules have an average speed of 4.80×10^2 m/s at 25°C. What is the average speed of H_2 molecules at the same temperature?

62. Oxygen molecules have an average speed of 480 m/s at 25°C. What is the average speed of HI molecules at that temperature?

Sample Problem G Using the Ideal Gas Law to Solve Stoichiometry Problems

63. How many liters of hydrogen gas can be produced at 300.0 K and 104 kPa if 20.0 g of sodium metal is reacted with water according to the following equation?

$$2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$$
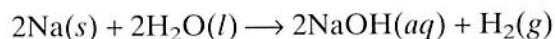
64. Magnesium will burn in oxygen to form magnesium oxide as represented by the following equation.

$$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$$
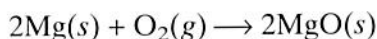
What mass of magnesium will react with 500.0 mL of oxygen at 150.0°C and 70.0 kPa?

65. Suppose a certain automobile engine has a cylinder with a volume of 500.0 mL that is filled with air (21% oxygen) at a temperature of 55°C and a pressure of 101.0 kPa. What mass of octane must be injected to react with all of the oxygen in the cylinder?

$$2C_8H_{18}(l) + 25O_2(g) \longrightarrow 16CO_2(g) + 18H_2O(g)$$
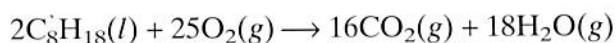
66. Methanol, CH_3OH, is made by using a catalyst to react carbon monoxide with hydrogen at high temperature and pressure. Assuming that 450.0 mL of CO and 825 mL of H_2 are allowed to react, answer the following questions. (Hint: First write the balanced chemical equation for this reaction.)
   a. Which reactant is in excess?
   b. How much of that reactant remains when the reaction is complete?
   c. What volume of $CH_3OH(g)$ is produced?

67. What volume of oxygen, measured at 27°C and 101.325 kPa, is needed for the combustion of 1.11 kg of coal? (Assume coal is 100% carbon.)

$$C(s) + O_2(g) \longrightarrow CO_2(g)$$