

Gas Law Problems

Abbreviations

atm - atmosphere
mmHg - millimeters of mercury
torr - another name for mmHg
Pa - Pascal (kPa = kilo Pascal)
K - Kelvin
°C - degrees Celsius

Conversions

$$K = ^\circ C + 273$$

$$1 \text{ cm}^3 (\text{cubic centimeter}) = 1 \text{ mL (milliliter)}$$

$$1 \text{ dm}^3 (\text{cubic decimeter}) = 1 \text{ L (liter)} = 1000 \text{ mL}$$

Standard Conditions

$$0.00 \text{ } ^\circ C = 273 \text{ K}$$

$$1.00 \text{ atm} = 760.0 \text{ mmHg} = 101.325 \text{ kPa} = 101,325 \text{ Pa}$$

Boyle's Law

1. A gas occupies 12.3 liters at a pressure of 40.0 mmHg. What is the volume when the pressure is increased to 60.0 mmHg?
2. If a gas at 25.0 °C occupies 3.60 liters at a pressure of 1.00 atm, what will be its volume at a pressure of 2.50 atm?
3. To what pressure must a gas be compressed in order to get into a 3.00 cubic foot tank the entire weight of a gas that occupies 400.0 cu. ft. at standard pressure?
4. A gas occupies 1.56 L at 1.00 atm. What will be the volume of this gas if the pressure becomes 3.00 atm?
5. A gas occupies 11.2 liters at 0.860 atm. What is the pressure if the volume becomes 15.0 L?
6. 500.0 mL of a gas is collected at 745.0 mmHg. What will the volume be at standard pressure?
7. Convert 350.0 mL at 740.0 mm of Hg to its new volume at standard pressure.
8. Convert 338 L at 63.0 atm to its new volume at standard pressure.
9. Convert 273.15 mL at 166.0 mm of Hg to its new volume at standard pressure.
10. Convert 77.0 L at 18.0 mm of Hg to its new volume at standard pressure.
11. When the pressure on a gas increases, will the volume increase or decrease?
12. If the pressure on a gas is decreased by one-half, how large will the volume change be?
13. A gas occupies 4.31 liters at a pressure of 0.755 atm. Determine the volume if the pressure is increased to 1.25 atm.
14. 600.0 mL of a gas is at a pressure of 8.00 atm. What is the volume of the gas at 2.00 atm?
15. 400.0 mL of a gas are under a pressure of 800.0 torr. What would the volume of the gas be at a pressure of 1000.0 torr?
16. 4.00 L of a gas are under a pressure of 6.00 atm. What is the volume of the gas at 2.00 atm?
17. A gas occupies 25.3 mL at a pressure of 790.5 mmHg. Determine the volume if the pressure is reduced to 0.804 atm.
18. A sample of gas has a volume of 12.0 L and a pressure of 1.00 atm. If the pressure of gas is increased to 2.00 atm, what is the new volume of the gas?
19. A container of oxygen has a volume of 30.0 mL and a pressure of 4.00 atm. If the pressure of the oxygen gas is reduced to 2.00 atm and the temperature is kept constant, what is the new volume of the oxygen gas?
20. A tank of nitrogen has a volume of 14.0 L and a pressure of 760.0 mmHg. Find the volume of the nitrogen when its pressure is changed to 400.0 mmHg while the temperature is held constant.
21. A 40.0 L tank of ammonia has a pressure of 8.00 atm. Calculate the volume of the ammonia if its pressure is changed to 12.0 atm while its temperature remains constant.
22. Two hundred liters of helium at 2.00 atm and 28.0 °C is placed into a tank with an internal pressure of 600.0 kPa. Find the volume of the helium after it is compressed into the tank when the temperature of the tank remains 28.0 °C.
23. You are now wearing scuba gear and swimming under water at a depth of 66.0 ft. You are breathing air at 3.00 atm and your lung volume is 10.0 L. Your scuba gauge indicate that your air supply is low so, to conserve air, you make a terrible and fatal mistake: you hold your breath while you surface. What happens to your lungs?
24. Solve Boyle's Law equation for V_2 .
25. Boyle's Law deals what quantities?
 - a. pressure/temperature
 - b. pressure/volume
 - c. volume/temperature
 - d. volume temperature/pressure

26. A 1.5 liter flask is filled with nitrogen at a pressure of 12 atmospheres. What size flask would be required to hold this gas at a pressure of 2.0 atmospheres?
27. 300 mL of O₂ are collected at a pressure of 645 mm of mercury. What volume will this gas have at one atmosphere pressure?
28. How many cubic feet of air at standard conditions (1.00 atm.) are required to inflate a bicycle tire of 0.50 cu. ft. to a pressure of 3.00 atmospheres?
29. How much will the volume of 75.0 mL of neon change if the pressure is lowered from 50.0 torr to 8.00 torr?
30. A tank of helium has a volume of 50.0 liters and is under a pressure of 2000.0 p.s.i.. This gas is allowed to flow into a blimp until the pressure in the tank drops to 40.00 p.s.i. and the pressure in the blimp is 30.00 p.s.i.. What will be the volume of the blimp?
31. What pressure is required to compress 196.0 liters of air at 1.00 atmosphere into a cylinder whose volume is 26.0 liters?

Charles' Law

32. Calculate the decrease in temperature when 2.00 L at 20.0 °C is compressed to 1.00 L.
33. 600.0 mL of air is at 20.0 °C. What is the volume at 60.0 °C?
34. A gas occupies 900.0 mL at a temperature of 27.0 °C. What is the volume at 132.0 °C?
35. What change in volume results if 60.0 mL of gas is cooled from 33.0 °C to 5.00 °C?
36. Given 300.0 mL of a gas at 17.0 °C. What is its volume at 10.0 °C?
37. A gas occupies 1.00 L at standard temperature. What is the volume at 333.0 °C?
38. At 27.00 °C a gas has a volume of 6.00 L. What will the volume be at 150.0 °C?
39. At 225.0 °C a gas has a volume of 400.0 mL. What is the volume of this gas at 127.0 °C?
40. At 210.0 °C a gas has a volume of 8.00 L. What is the volume of this gas at -23.0 °C?
41. The temperature of a 4.00 L sample of gas is changed from 10.0 °C to 20.0 °C. What will the volume of this gas be at the new temperature if the pressure is held constant?
42. Carbon dioxide is usually formed when gasoline is burned. If 30.0 L of CO₂ is produced at a temperature of 1.00×10^3 °C and allowed to reach room temperature (25.0 °C) without any pressure changes, what is the new volume of the carbon dioxide?
43. A 600.0 mL sample of nitrogen is warmed from 77.0 °C to 86.0 °C. Find its new volume if the pressure remains constant.
44. What volume change occurs to a 400.0 mL gas sample as the temperature increases from 22.0 °C to 30.0 °C?
45. A gas syringe contains 56.05 milliliters of a gas at 315.1 K. Determine the volume that the gas will occupy if the temperature is increased to 380.5 K
46. A gas syringe contains 42.3 milliliters of a gas at 98.15 °C. Determine the volume that the gas will occupy if the temperature is decreased to -18.50 °C.
47. When the temperature of a gas decreases, does the volume increase or decrease?
48. If the Kelvin temperature of a gas is doubled, the volume of the gas will increase by ____.
49. Solve the Charles' Law equation for V₂.
50. Charles' Law deals with what quantities?
- a. pressure/temperature
 - b. pressure/volume
 - c. volume/temperature
 - d. volume/temperature/pressure
51. If 540.0 mL of nitrogen at 0.00 °C is heated to a temperature of 100.0 °C what will be the new volume of the gas?
52. A balloon has a volume of 2500.0 mL on a day when the temperature is 30.0 °C. If the temperature at night falls to 10.0 °C, what will be the volume of the balloon if the pressure remains constant?
53. When 50.0 liters of oxygen at 20.0 °C is compressed to 5.00 liters, what is the new temperature?
54. If 15.0 liters of neon at 25.0 °C is allowed to expand to 45.0 liters, what is the new temperature?
55. 3.50 liters of a gas at 727.0 °C will occupy how many liters at 153.0 °C?

Gay-Lussac's Law

56. Determine the pressure change when a constant volume of gas at 1.00 atm is heated from 20.0 °C to 30.0 °C.
57. A gas has a pressure of 0.370 atm at 50.0 °C. What is the pressure at standard temperature?
58. A gas has a pressure of 699.0 mmHg at 40.0 °C. What is the temperature at standard pressure?
59. If a gas is cooled from 323.0 K to 273.15 K and the volume is kept constant what final pressure would result if the original pressure was 750.0 mmHg?
60. If a gas in a closed container is pressurized from 15.0 atmospheres to 16.0 atmospheres and its original temperature was 25.0 °C, what would the final temperature of the gas be?
61. A 30.0 L sample of nitrogen inside a metal container at 20.0 °C is placed inside an oven whose temperature is 50.0 °C. The pressure inside the container at 20.0 °C was at 3.00 atm. What is the pressure of the nitrogen after its temperature is increased?
62. A sample of gas at 3.00×10^3 mmHg inside a steel tank is cooled from 500.0 °C to 0.00 °C. What is the final pressure of the gas in the steel tank?
63. The temperature of a sample of gas in a steel container at 30.0 kPa is increased from -100.0 °C to 1.00×10^3 °C. What is the final pressure inside the tank?
64. Calculate the final pressure inside a scuba tank after it cools from 1.00×10^3 °C to 25.0 °C. The initial pressure in the tank is 130.0 atm.

Dalton's Law

65. A container holds three gases: oxygen, carbon dioxide, and helium. The partial pressures of the three gases are 2.00 atm, 3.00 atm, and 4.00 atm, respectively. What is the total pressure inside the container?
66. A container with two gases, helium and argon, is 30.0% by volume helium. Calculate the partial pressure of helium and argon if the total pressure inside the container is 4.00 atm.
67. If 60.0 L of nitrogen is collected over water at 40.0 °C when the atmospheric pressure is 760.0 mmHg, what is the partial pressure of the nitrogen?
68. 80.0 liters of oxygen is collected over water at 50.0 °C. The atmospheric pressure in the room is 96.00 kPa. What is the partial pressure of the oxygen?
69. A tank contains 480.0 grams of oxygen and 80.00 grams of helium at a total pressure of 7.00 atmospheres. Calculate the following.
- a) How many moles of O₂ are in the tank?
 - b) How many moles of He are in the tank?
 - c) Total moles of gas in tank.
 - d) Mole fraction of O₂.
 - e) Mole fraction of He.
 - f) Partial pressure of O₂.
 - g) Partial pressure of He.
70. A tank contains 5.00 moles of O₂, 3.00 moles of neon, 6.00 moles of H₂S, and 4.00 moles of argon at a total pressure of 1620.0 mmHg. Complete the following table

	O ₂	Ne	H ₂ S	Ar	Total
Moles					18.00
Mole fraction					1
Pressure fraction					1
Partial Pressure					1620.0

71. A mixture of 14.0 grams of hydrogen, 84.0 grams of nitrogen, and 2.0 moles of oxygen are placed in a flask. When the partial pressure of the oxygen is 78.00 mm of mercury, what is the total pressure in the flask?

72. A flask contains 2.00 moles of nitrogen and 2.00 moles of helium. How many grams of argon must be pumped into the flask in order to make the partial pressure of argon twice that of helium?

Combined Gas Law

73. A gas has a volume of 800.0 mL at $-23.00\text{ }^{\circ}\text{C}$ and 300.0 torr. What would the volume of the gas be at $227.0\text{ }^{\circ}\text{C}$ and 600.0 torr of pressure?

74. 500.0 liters of a gas are prepared at 700.0 mmHg and $200.0\text{ }^{\circ}\text{C}$. The gas is placed into a tank under high pressure. When the tank cools to $20.0\text{ }^{\circ}\text{C}$, the pressure of the gas is 30.0 atm. What is the volume of the gas?

75. What is the final volume of a 400.0 mL gas sample that is subjected to a temperature change from $22.0\text{ }^{\circ}\text{C}$ to $30.0\text{ }^{\circ}\text{C}$ and a pressure change from 760.0 mmHg to 360.0 mmHg?

76. What is the volume of gas at 2.00 atm and 200.0 K if its original volume was 300.0 L at 0.250 atm and 400.0 K.

77. At conditions of 785.0 torr of pressure and $15.0\text{ }^{\circ}\text{C}$ temperature, a gas occupies a volume of 45.5 mL. What will be the volume of the same gas at 745.0 torr and $30.0\text{ }^{\circ}\text{C}$?

78. A gas occupies a volume of 34.2 mL at a temperature of $15.0\text{ }^{\circ}\text{C}$ and a pressure of 800.0 torr. What will be the volume of this gas at standard conditions?

79. The volume of a gas originally at standard temperature and pressure was recorded as 488.8 mL. What volume would the same gas occupy when subjected to a pressure of 100.0 atm and temperature of $-245.0\text{ }^{\circ}\text{C}$?

80. At a pressure of 780.0 mmHg and $24.2\text{ }^{\circ}\text{C}$, a certain gas has a volume of 350.0 mL. What will be the volume of this gas under STP

81. A gas sample occupies 3.25 liters at $24.5\text{ }^{\circ}\text{C}$ and 1825 mmHg. Determine the temperature at which the gas will occupy 4250 mL at 1.50 atm.

82. If 10.0 liters of oxygen at STP are heated to $512\text{ }^{\circ}\text{C}$, what will be the new volume of gas if the pressure is also increased to 1520.0 mm of mercury?

83. What is the volume at STP of 720.0 mL of a gas collected at $20.0\text{ }^{\circ}\text{C}$ and 3.00 atm pressure?

84. 2.00 liters of hydrogen, originally at $25.0\text{ }^{\circ}\text{C}$ and 750.0 mm of mercury, are heated until a volume of 20.0 liters and a pressure of 3.50 atmospheres is reached. What is the new temperature?

85. A gas balloon has a volume of 106.0 liters when the temperature is $45.0\text{ }^{\circ}\text{C}$ and the pressure is 740.0 mm of mercury. What will its volume be at $20.0\text{ }^{\circ}\text{C}$ and 780.0 mm of mercury pressure?

86. If the absolute temperature of a given quantity of gas is doubled and the pressure tripled, what happens to the volume of the gas?

87. 73.0 mL of nitrogen at STP is heated to $80.0\text{ }^{\circ}\text{C}$ and the volume increase to 4.53 L. What is the new pressure?

88. 500.0 mL of a gas was collected at $20.0\text{ }^{\circ}\text{C}$ and 720.0 mmHg. What is its volume at STP?

89. A sample of gas occupies 50.0 L at $15.0\text{ }^{\circ}\text{C}$ and 640.0 mmHg pressure. What is the volume at STP?

90. A gas is heated from 263.0 K to 298.0 K and the volume is increased from 24.0 liters to 35.0 liters by moving a large piston within a cylinder. If the original pressure was 1.00 atm, what would the final pressure be?

91. The pressure of a gas is reduced from 1200.0 mmHg to 850.0 mmHg as the volume of its container is increased by moving a piston from 85.0 mL to 350.0 mL. What would the final temperature be if the original temperature was $90.0\text{ }^{\circ}\text{C}$?

92. If a gas is heated from 298.0 K to 398.0 K and the pressure is increased from 2.230×10^3 mmHg to 4.560×10^3 mmHg what final volume would result if the volume is allowed to change from an initial volume of 60.0 liters?

Combined Gas Law (requires Dalton's Law also)

IMPORTANT NOTE: A gas collected over water is always considered to be saturated with water vapor. The vapor pressure of water varies with temperature and must be looked up in a reference source.

93. 690.0 mL of oxygen are collected over water at 26.0 °C (v.p. of H₂O = 25.2 mm) and a total pressure of 725.0 mm of mercury. What is the volume of dry oxygen at 52.0 °C and 800.0 mm pressure?
94. 400.0 mL of hydrogen are collected over water at 18.0 °C and a total pressure of 740.0 mm of mercury. (v.p. of H₂O at 18° = 15.5 mm)
- a) What is the partial pressure of H₂? c) What is the volume of DRY hydrogen at STP?
- b) What is the partial pressure of H₂O?
95. 45.0 mL of wet argon gas is collected at 729.3 mmHg and 25.0 °C. What would be the volume of this dry gas at standard conditions?
96. 19.1 L of He gas is collected over water at 681.3 mmHg and 18.5 °C. What would be the volume of this dry gas at standard conditions?
97. 407 mL of H₂ gas is collected over water at 785.3 mmHg and 23.5 °C. What would be the volume of this dry gas at standard conditions?
98. 93.0 mL of O₂ gas is collected over water at 0.930 atm and 10.0 °C. What would be the volume of this dry gas at standard conditions?
99. 6.12 L of wet xenon gas is collected at 2.00×10^5 Pa and 80.0 °C. What would be the volume of this dry gas at standard conditions?
100. A sample of oxygen collected over water when the atmospheric pressure was 1.002 atm and the room temperature, 25.5 °C occupied 105.8 mL. What would be the volume of this dry gas at standard conditions?
101. 1.000 L of hydrogen gas is collected over water at 30.0 °C at a pressure of 831.8 mmHg. Find the volume of dry hydrogen collected at STP.
102. 50.6 mL of a gas is collected over water at 18.0 °C and 755.5 mmHg pressure. What is the volume of dry gas at STP?
103. Write the combined gas law in equation form. Solve the combined gas law for V₂.

Ideal Gas Law (some also using Dalton's Law)

104. How many moles of gas are contained in 890.0 mL at 21.0 °C and 750.0 mmHg pressure?
105. 1.09 g of H₂ is contained in a 2.00 L container at 20.0 °C. What is the pressure in this container in mmHg?
106. Calculate the volume 3.00 moles of a gas will occupy at 24.0 °C and 762.4 mmHg.
107. What volume will 20.0 g of Argon occupy at STP?
108. How many moles of gas would be present in a gas trapped within a 100.0 mL vessel at 25.0 °C at a pressure of 2.50 atmospheres?
109. How many moles of a gas would be present in a gas trapped within a 37.0 liter vessel at 80.00 °C at a pressure of 2.50 atm?
110. If the number of moles of a gas are doubled at the same temperature and pressure, will the volume increase or decrease?
111. What volume will 1.27 moles of helium gas occupy at STP?
112. At what pressure would 0.150 mole of nitrogen gas at 23.0 °C occupy 8.90 L?
113. What volume would 32.0 g of NO₂ gas occupy at 3.12 atm and 18.0 °C?
114. Find the volume of 2.40 mol of gas whose temperature is 50.0 °C and whose pressure is 2.00 atm.
115. Calculate the molecular weight of a gas if 35.44 g of the gas stored in a 7.50 L tank exerts a pressure of 60.0 atm at a constant temperature of 35.5 °C
116. How many moles of gas are contained in a 50.0 L cylinder at a pressure of 100.0 atm and a temperature of 35.0 °C?
117. Determine the number of moles of Krypton contained in a 3.25 liter gas tank at 5.80 atm and 25.5 °C. If the gas is Oxygen instead of Krypton, will the answer be the same? Why or Why not?
118. Determine the number of grams of carbon dioxide in a 450.6 milliliter tank at 1.80 atm and -50.5 °C. Determine the number of grams of oxygen that the same container will contain under the same temperature and pressure.

119. Determine the volume of occupied by 2.34 grams of carbon dioxide gas at STP.
120. A sample of argon gas at STP occupies 56.2 liters. Determine the number of moles of argon and the mass in the sample.
121. At what temperature will 0.654 moles of neon gas occupy 12.30 liters at 1.95 atmospheres?
122. A 30.6 g sample of gas occupies 22.4 L at STP. What is the molecular weight of this gas?
123. A 40.0 g gas sample occupies 11.2 L at STP. Find the molecular weight of this gas.
124. A 12.0 g sample of gas occupies 19.2 L at STP. What is the molecular weight of this gas?
125. 96.0 g. of a gas occupies 48.0 L at 700.0 mmHg and 20.0 °C. What is its molecular weight?
126. 20.83 g. of a gas occupies 4.167 L at 79.97 kPa at 30.0 °C. What is its molecular weight?
127. At STP 3.00 liters of an unknown gas has a mass of 9.50 grams. Calculate its molar mass.
128. At STP 0.250 liter of an unknown gas has a mass of 1.00 gram. Calculate its molar mass.
129. At STP 150.0 mL of an unknown gas has a mass of 0.250 gram. Calculate its molar mass.
130. 1.089 g of a gas occupies 4.50 L at 20.5 °C and 0.890 atm. What is its molar mass?
131. 0.190 g of a gas occupies 250.0 mL at STP. What is its molar mass? What gas is it? Hint - calculate molar mass of the gas.
132. If 9.006 grams of a gas are enclosed in a 50.00 liter vessel at 273.15 K and 2.000 atmospheres of pressure, what is the molar mass of the gas? What gas is this?
133. What is the value of and units on R? What is R called ("A letter" is not the correct answer!)?
134. problem deleted

Graham's Law Problems

135. If equal amounts of helium and argon are placed in a porous container and allowed to escape, which gas will escape faster and how much faster?
136. What is the molecular weight of a gas which diffuses 1/50 as fast as hydrogen?
137. Two porous containers are filled with hydrogen and neon respectively. Under identical conditions, 2/3 of the hydrogen escapes in 6 hours. How long will it take for half the neon to escape?
138. If the density of hydrogen is 0.090 g/L and its rate of diffusion is 6 times that of chlorine, what is the density of chlorine?
139. How much faster does hydrogen escape through a porous container than sulfur dioxide?

Miscellaneous

140. What temperature scale must always be used when working gas law problems?
141. The boiling point of water on the Kelvin scale is_____.
142. 0 K is also known as_____.
143. 40.00 °C is what temperature on the Kelvin scale?
144. -20.00 °C is what temperature on the Kelvin scale?
145. Convert 20.0 °C to K
146. Convert 252 K to °C
147. Convert -145.0 °C to K
148. Convert 298 K to °C
149. A gas sample has a pressure of 800.0 mmHg. What is the pressure of this gas sample in atmospheres and in kilopascals.
150. A tank of oxygen is under a pressure of about 4.00×10^3 kPa. Express this pressure in millimeters of mercury.
151. Convert 1.69 atm to mmHg
152. Convert 0.3587 atm to Pa
153. Convert 820.1 mmHg to atm
154. Convert 689 mmHg to Pa
155. Convert 725.0 torr to mmHg
156. Convert 98.8 kPa to mmHg
157. What is the pressure at STP?
158. What is the temperature at STP?