

12 • Gases and Their Properties

STUDY QUESTIONS

- Convert the following pressures to atm.
 - 726 torr
 - 2.31 bar
 - 98 kPa
 - 16.33 psi
- Consider the following changes imposed upon a sample of gas, assuming the variables not mentioned remain constant:
 - What happens to the pressure if the temperature in K is doubled?
 - What happens to the volume if the pressure is tripled?
 - What happens to the volume if the temperature decreases from 300K to 200K?
 - What happens to the temperature if one-half of the gas is removed?
 - What happens to the pressure if volume decreases from 4 Liters to 2 Liters and the temperature increases from 25°C to 323°C? (Note: in the answers to 2.e., there is a wrong word (doubled should be “halved” for the volume.)
- Methane burns in air to produce carbon dioxide and water:
$$\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l})$$
What volume of carbon dioxide, at 1 atm pressure and 112°C, will be produced when 80.0 grams of methane is burned?
- What is the volume of 6 moles of helium gas at 0.34 atm pressure and 33°C? What is the density of the helium gas under these conditions?
- Jacques Charles used the reaction of hydrochloric acid on iron to produce the hydrogen for one of his balloons. For one flight in 1783 he used 1000 lbs of iron and excess acid. What volume of hydrogen gas (in cubic meters) did he produce for this flight? Assume the pressure is 1 atm and the temperature is 22°C.
$$\text{Fe}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{FeCl}_2(\text{aq}) + \text{H}_2(\text{g})$$
- If 1.0 Liter of oxygen at 2.0 atm pressure, 2.00 Liters of nitrogen at 1.0 atm pressure, and 2.0 Liters of helium at 2.0 atm pressure, are all mixed in a 3.0 Liter vessel with no change in temperature, what is the final pressure of the mixture in the 3.0 Liter vessel?

7. What is the partial pressure of oxygen in the atmosphere at the top of Mt. Everest? Atmospheric pressure at the summit of Mt. Everest is 253 torr. The partial pressure of oxygen in air at 1 atm pressure is 0.20946 atm.
8. An ideal gas occupies a volume of 10 Liters at 27°C. If the pressure on the gas is tripled at this temperature, the volume changes. To what value must the temperature change to restore the volume to the initial 10 Liters at the new pressure?
9. Using the Maxwell equation, calculate the root mean square speed of nitrogen gas at 25°C. What happens to the rms speed if the temperature is doubled to 50°C?
10. Imagine three automobiles traveling down the road at 20 mph, 34 mph, and 68 mph. Calculate the average speed and the rms speed. What is the significance of the rms speed?
11. A gas diffuses $\frac{5}{3}$ times faster than carbon dioxide. Which gas might it be?
a. O₂ b. N₂ c. CO d. He e. CH₄
12. For nitrogen, the van der Waals constants a and b have values of 1.39 and 0.0391 respectively. Calculate the pressure of 5 moles of nitrogen gas confined to a 1.0 Liter vessel at a temperature of 300K using the ideal gas equation and the van der Waals equation of state. Comment on the difference.