

13-1 Review and Reinforcement

A Model to Explain Gas Behavior

Match each example below with the appropriate gas property it illustrates. Write the letter on the line.

Example	Gas Property
_____ 1. A bicycle tire inflates when you pump air into a valve on one side.	a. compressibility
_____ 2. A car is supported on a "cushion of air."	b. has mass
_____ 3. An air mattress springs back to its original shape after being pressed.	c. fills container
_____ 4. A balloon filled with air weighs more than an empty balloon.	d. exerts pressure
_____ 5. The color of a gas is uniform throughout the bottle containing it.	e. diffuses through other gases

If the statement is true, write "true." If it is false, change the underlined word or words to make the statement true. Write your answer on the line provided.

- _____ 6. Although air is a mixture of several gases, it behaves like a single gas.
- _____ 7. Oxygen is diatomic, and, under similar conditions, its volume is twice that of monatomic helium.
- _____ 8. Air bags are used as safety devices in cars because air cannot be compressed.
- _____ 9. Most gases are made up of single atoms.
- _____ 10. According to the kinetic-molecular theory, the collisions between gas particles are 100 percent elastic.
- _____ 11. The pressure of a gas is simply a measure of the kinetic energy of the gas particles.
- _____ 12. The volume of a gas is equal to the volume of its container.

Indicate the relationship between the pairs of gas variables below by writing "increase," "decrease," or "not be affected" in the space provided. Assume that all other variables remain constant.

13. If the molecular speed of a gas increases, its rate of diffusion will _____.
14. If the temperature of a gas increases, the pressure of the gas will _____.
15. If the molecular weight of a gas increases, the total volume of the gas will _____.
16. If the temperature of a gas decreases, the pressure of the gas will _____.

13-2 Practice Problems

1. The air pressure for a certain tire is 109 kPa. What is this pressure in atmospheres?
2. The air pressure inside a submarine is 0.62 atm. What would be the height of a column of mercury balanced by this pressure?
3. The weather news gives the atmospheric pressure as 1.07 atm. What is this atmospheric pressure in mm Hg?
4. An experiment at Sandia National Labs in New Mexico is performed at an atmospheric pressure of 758.7 mm Hg. What is this pressure in atm?
5. A bag of potato chips is sealed in a factory near sea level. The atmospheric pressure at the factory is 761.3 mm Hg. The pressure inside the bag is the same. What is the pressure inside the bag of potato chips in Pa?
6. The same bag of potato chips from Problem 5 is shipped to a town in Colorado, where the atmospheric pressure is 99.82 kPa. What is the difference (in Pa) between the pressure in the bag and the atmospheric pressure of the town?
7. The pressure gauge on a compressed air tank reads 43.2 lb/in². What is the pressure in atm?
8. The pressure in the tire of an automobile is 34.8 lb/in². What is the pressure in kPa?
9. A gas container is fitted with a manometer. The level of the mercury is 15 mm lower on the open side. Using a laboratory barometer, you find that atmospheric pressure is 750 mm Hg. What is the pressure, in atmospheres, of the gas in the container?
10. A soccer ball is attached to an open-ended manometer. The mercury level in the manometer is 10 mm higher on the side attached to the ball than on the side open to the atmosphere. Atmospheric pressure has already been determined to be 770 mm Hg. What is the gas pressure in the ball?
11. One end of an open-ended manometer is connected to a canister filled with a gas at a pressure of 771.0 mm Hg. The mercury level on the side open to the atmosphere is 11.2 mm higher than on the side connected to the canister. What is the atmospheric pressure in mm Hg?
12. Suppose you are measuring the pressure inside a sealed cabinet using an open-ended manometer. The atmospheric pressure is 762.4 mm Hg. If the mercury level on the side open to the atmosphere is 3.6 mm higher than on the side attached to the cabinet, what is the pressure inside the cabinet in units of kPa?
13. The U-tube of a manometer is 26.4 cm tall. With both ends open, it is filled until the mercury level in each tube is 13.2 cm from the top. What is the largest difference in pressure this manometer can measure in units of mm Hg?
14. A manometer contains a sample of nitrogen gas at a pressure of 88.3 kPa. The level of mercury in the U-tube is 12.8 mm lower on the end open to the atmosphere. What is the atmospheric pressure in kPa?
15. One end of an open-ended manometer is connected to a canister of unknown gas. The atmospheric pressure is 1.03 atm. The mercury level is 18.6 mm higher in the U-tube on the side open to the atmosphere than on the side attached to the canister. What is the pressure of the gas in mm Hg?

13-3 Practice Problems

1. A gas occupies a volume of 458 mL at a pressure of 1.01 kPa and temperature of 295 K. When the pressure is changed, the volume becomes 477 mL. If there has been no change in temperature, what is the new pressure?
2. A gas occupies a volume of 2.45 L at a pressure of 1.03 atm and a temperature of 293 K. What volume will the gas occupy if the pressure changes to 0.980 atm and the temperature remains unchanged?
3. The cylinder of a car's engine has a volume of 0.6250 L when the piston is at the bottom of the cylinder. When the piston is at the top of the cylinder the volume is 0.0600 L. If the cylinder is filled with air at an atmospheric pressure of 765.1 mm Hg when the piston is at the bottom, what is the pressure in units of kPa when the piston is at the top of the cylinder?
4. A discarded spray paint can contains only a small volume of the propellant gas at a pressure of 34,470 Pa. The volume of the can is 473.18 mL. If the can is run over by the garbage truck and flattened to a volume of 13.16 mL, what is the pressure in Pa assuming the can doesn't leak?
5. A sample of 10.0 L of argon gas is stored in a cylinder at a room temperature of 23.8°C and a pressure of 78.6 lb/in². The sample is transferred completely to another 2.8 L cylinder. Several hours after the transfer, the second cylinder has also attained room temperature. What is the pressure in the second cylinder in units of kPa?
6. What will be the volume of a gas sample at 309 K if its volume at 215 K is 3.42 L? Assume that pressure is constant.
7. A gas sample at 83°C occupies a volume of 1400 m³. At what temperature will it occupy 1200 m³?
8. A tank of compressed CO₂ has a temperature of 23.6°C and a volume of 31.4 L. The CO₂ is completely transferred into a smaller tank that has a volume of 25.0 L. Assuming none of the CO₂ escapes during the transfer, what is the temperature of the CO₂ in the smaller tank if the temperature is lowered to achieve the same pressure as in the larger tank?
9. A tube of mercury at a room temperature of 22.4°C has a volume of 10.6 mL between the sealed end of the tube and the mercury. The sun rises and shines through a window on the tube and warms it to 27.8°C. If the atmospheric pressure remains constant, what is the new volume between the sealed end of the tube and the mercury?
10. A gas occupies 0.105 dm³ at 100. K. At what Celsius temperature will its volume be 0.140 dm³? Assume that pressure remains constant.

13-4 Review and Reinforcement

The Ideal Gas Law

If the statement is true, write "true." If it is false, change the underlined word or words to make the statement true. Write your answer on the line provided.

- _____ 1. Real gases behave like ideal gases except at very high temperatures.
- _____ 2. The gas constant, R , is equal to 0.0821 when the pressure is expressed in kilopascals.
- _____ 3. As more gas particles are added to a container, there are fewer collisions because the particles don't go as far.
- _____ 4. The number of moles of a gas is inversely proportional to its volume at STP.
- _____ 5. Real gases behave like ideal gases except at very high pressure.
- _____ 6. At a constant temperature, the pressure exerted by one mole of a gas decreases if the volume available is increased.
- _____ 7. The ideal gas equation will only give correct values if the temperature is expressed in degrees.
- _____ 8. One mole of oxygen at 760 mm Hg and 0°C occupies a volume of one L.

Use the ideal gas equation to calculate the unknown value(s) for each row. Write your answers in the table.

	Pressure	Temperature	# Moles	R	Volume
9.	1.02 atm	300 K	0.81 mol	0.0821	
10.	762 mm Hg		2.16 mol	0.0821	48.3 L
11.	101 kPa	0°C			22.4 L
12.		20°C	0.38 mol		6.76 L

Solve each of the following problems as directed. Show all your work.

13. Calculate how many grams of methane (CH_4) are in a sealed 800-mL flask at room temperature (22°C) and 780 mm of pressure.

13-1 Review and Reinforcement (continued)

Complete the following assumptions about the nature of gases as presented in the kinetic-molecular theory by filling in the appropriate word or phrase from the list below.

- | | |
|-------------------|------------------|
| perfectly elastic | no force |
| zero | pressure |
| weak | random motion |
| kinetic energy | potential energy |

17. The volume of gas particles themselves is assumed to be _____.
18. Gas molecules are said to be in _____.
19. The collisions between gas particles are _____.
20. The temperature of a gas is a measure of the average _____ of the gas particles.
21. Gas particles exert _____ on one another.

Answer each of the following questions in the space provided.

22. Air is a mixture of colorless gases. Which properties of air are instrumental in propelling a sailboat?

23. Use your knowledge of gas properties to explain why the molecular size of the individual gas particles has no effect on the total volume of the gas.

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13-4 Practice Problems

1. What volume would be occupied by 100. g of oxygen gas at a pressure of 1.50 atm and a temperature of 25°C?
2. An air-filled balloon has a volume of 225 L at 0.94 atm and 25°C. Soon after, the pressure changes to 0.99 atm and the temperature changes to 0°C. What is the new volume of the balloon?
3. A gas confined in a 515-cm³ container exerts a pressure of 107.4 kPa at 38.6°C. At what Celsius temperature will it exert a pressure of 635.7 kPa if it is placed into a 644-cm³ container?
4. A balloon is inflated with 0.2494 g of helium to a pressure of 1.26 atm. If the desired volume of the balloon is 1.250 L, what must the temperature be in °C?
5. A welder's acetylene tank has a volume of 75.0 L. It is stored at a temperature of 23.24°C and has a pressure of 7667 kPa. How many moles of acetylene are in the tank?
6. How many grams of argon would it take to fill a light bulb with a volume of 0.475 L at STP?
7. Dry ice is carbon dioxide in the solid state. 1.28 grams of dry ice are placed into a 5.00 L evacuated chamber that is maintained at 35.1°C. What is the pressure in the chamber in kPa after all the dry ice has sublimed into CO₂ gas?
8. A sample of Br₂ gas is loaded into an evacuated demonstration bottle at STP. The volume of the bottle is 0.25 L. How many moles of Br₂ gas will be contained in the bottle?
9. A sample of gas occupies 0.308 m³ at a temperature of 325 K and a pressure of 149 kPa. Calculate the number of moles of the gas that are present.
10. What pressure is exerted by 0.625 mole of a gas in a 45.4 L container at -24.0°C?

13-3 Practice Problems (continued)

11. At 75°C, a gas has a volume of 3.22 dm³. What volume will it occupy at 75 K?
12. A gas at 300. K occupies 6.50 dm³. What will its volume be at 250. K?
13. What is the pressure of a mixture of helium, nitrogen, and oxygen if their partial pressures are 600. mm Hg, 150. mm Hg, and 102 mm Hg?
14. A flask contains a mixture of hydrogen and oxygen. The pressure being exerted by these gases is 785 mm Hg, as determined by a manometer. If the partial pressure of the hydrogen in the mixture is 395 mm Hg, what is the partial pressure of the oxygen?
15. An environmental testing lab uses a pump and cylinder to collect a sample of air near a leaking natural gas line. The lab finds the total pressure in their sample cylinder is 776.134 mm Hg. Analyzing the sample, they find it contains oxygen, nitrogen, and methane. What is the partial pressure of the methane in units of Pascal if the partial pressure of oxygen is 253.948 mm Hg and the partial pressure of nitrogen is 515.390 mm Hg?
16. The barometer shows the atmospheric pressure to be 762 mm Hg. What is the partial pressure of nitrogen if nitrogen makes up 78 percent of the air?
17. What partial pressure of oxygen is a scuba diver breathing if the total pressure is 6.3 atm, and 20. percent of the air is oxygen?
18. What is the atmospheric pressure if the partial pressures of nitrogen, oxygen, and argon are 77.75 kPa, 19.94 kPa, and 1.99 kPa, respectively?
19. The gases carbon dioxide, oxygen, and argon are mixed in a container. All gases have the same partial pressure, and the total pressure of the container is 32,680 Pa. What is the partial pressure of argon?
20. The partial pressure of water vapor in a greenhouse is 139.0 mm Hg, which is 18 percent of the total pressure. What is the total pressure in the greenhouse?



13-4 Review and Reinforcement (continued)

14. Calculate how many grams of hydrogen can be burned if the limiting factor is 40 liters of oxygen at 200 K and 1 atm.

15. The ideal gas equation describes the behavior of gases as though there were never any attraction between gas molecules. Explain why this does not hold true for a real gas.

16. Which letter in the ideal gas equation represents the gas constant? Write the numerical value for this number when the pressure-volume units are (a) atm-L and (b) Pa-m³.

Match each variable in the ideal gas equation listed on the left with the appropriate unit of measurement. You may write one or more letters on each line.

- | | | |
|-------|---------------------|-----------------|
| _____ | 17. number of moles | a. °C |
| _____ | 18. volume | b. kg |
| _____ | 19. pressure | c. mol |
| _____ | 20. temperature | d. mm Hg |
| | | e. K |
| | | f. L |
| | | g. atm |
| | | h. Pa |
| | | i. °F |
| | | j. cubic meters |