

Activity 26: Gas Laws

Learning Objectives

Part 1 *Predict relationships among pressure, temperature, and volume of a gas*

Part 2 *Apply the relationship between pressure and volume to Boyle's law*

Part 3 *Apply the relationship between volume and temperature to Charles's law*

Part 4 *Apply the relationships among pressure, temperature, and volume to the combined gas law.*

Estimated Completion Time 2 Hours

Instructor Information

It is more important for the health professions student to spend time understanding the relationships occurring when conditions change than to empirically solve for the properties of a particular gas under a particular set of conditions. The ideal gas law is mentioned only in context of these other relationships.

Part 2. Simulations: It is highly recommended that the instructor become familiar with the website before entering class if he or she is demonstrating the simulation in class. Alternatively, to save time, students could explore the simulations prior to class and a discussion could be led during class.

Go the following website at University of Colorado:

http://phet.colorado.edu/simulations/sims.php?sim=Gas_Properties (Java must be installed).

Scenario 1 Set up two simulations: one with heavy gas and one with light gas. Same amount of each. Have students observe the temperature and pressure of each.

T= 300 K

Scenario 2 Change the one with the light gas to heavy gas. Double the amount. Keep the container the same size. Volume must be constant.

Scenario 3 Set the amount of gas back to the Scenario 1 level. Double the heat by increasing the bar at the bottom. Volume must be constant.

Scenario 4. Next, lower the temperature back to 300 K and cut the container size in half (right). Have temperature constant.

Scenario 5. Now, hold the pressure constant. Double the temperature.

ANSWERS TO QUESTIONS

Part 1. Relationships among Pressure, Temperature, and Volume of a Gas

1. Increase
2. $\frac{1 \text{ atm}}{14.7 \text{ psi}} \times 35 \text{ psi} = 2.4 \text{ atm}$
3. The pressures should be the same.
4. No. The type of gas present does not affect the temperature and pressure of a gas, only the amount.
5. The pressure should be double in the container, with twice the number of particles.
6. The pressure doubles.
7. There are twice as many particles in one of the containers, so the gas particles hit the sides of the container twice as often.
8. and 9. If the volume is constant and the temperature of a gas is doubled, the pressure will double.
10. In this case, the pressure doubles because the particles are moving twice as fast in the container where the temperature is doubled.
11. and 12. If the container size is cut in half (volume is decreased by half), the pressure will double.
13. The gas particles are being confined to a smaller space if the volume is reduced, and they will strike the sides of the container more often, resulting in a higher pressure.

14. and 15. If the amount of gas and the pressure are held constant and the temperature is doubled, the volume of the container will expand to double its size.

16. To keep the pressure constant at a higher temperature, the particles push the sides of the container out to double the size.

17. a. C b. B c. A

18. a. C b. A c. B

Part 2. Boyle's Law

1. 16 L

2. 2.0 cc

Part 3. Charles's Law

1. The volume will increase (expand).

2. Division by zero is not defined, so the temperature cannot have a value of zero.

3. 410 °C

Part 4. Gay Lussac's Law and the Combined Gas Law

1. 1.31 L

2. 102 mL

Part 5. The Ideal Gas Law

1. 0.245 mole

2. 336 °C

3. 33.6 g/mol

Activity 26: Skill Development—Gas Laws

Boyle's Law

1. a. 4x smaller b. It will expand.
2. $V_i = 6\text{L}$, $P_i = 14.7\text{ psi}$, $P_f = 14.7 + 7.35\text{ psi} = 22\text{ psi}$, therefore, $V_f = 4\text{L}$
3. There is more pressure pushing on the lungs (outside); therefore, the tank air must be at a higher pressure than 1 atm for air to go into the lungs.
4. 12.5 L
5. 10. L

Charles's Law

6. Pressure
7. The volume of air in the tires went down due to a decrease in temperature overnight.
8. $V_i = 10.\text{ L}$, $T_i = 291\text{ K}$, $T_f = 311\text{ K}$, therefore, $V_f = 11\text{ L}$
9. $V_i = 2\text{L}$, $T_i = 299\text{ K}$, $T_f = 77\text{ K}$, therefore, $V_f = 0.5\text{L}$
10. $V_i = 1000\text{ L}$, $T_i = 291\text{K}$, $V_f = 2500\text{L}$, therefore, $T_f = 800\text{K}$

Combined Gas Law

11. a. 4.26 atm b. 3.07 atm c. 0.606 atm
12. 110 mL

Ideal Gas Law

13. 22.4L