Name _____ Date _____ Period _____

**Zorn**Science
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# Gas Laws Virtual Lab

Chemistry

Open **activities.zornscience.org/gas-laws/** and follow each step. To type a value, click the number box, type, and press Enter. Show your work with units.

## Objective

Lock two variables at a time to find how the **pressure**, **volume**, **temperature** and **amount** of a gas are related, and explain each gas law with moving particles.

**NGSS alignment:** HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
**Practices and concepts:** Developing and using models; Analyzing and interpreting data; Using mathematics; Patterns; Scale, proportion, and quantity.

## Meet the simulation




Figure 1. The Gas Laws Sandbox.

(1) Gas law menu. Each law locks two variables.

(2) Reset: 1.00 atm, 273 K, 1.00 mol, 22.4 L.

(3) Readouts of P, V, T and n (3 significant figures).

(4) to (6) Number boxes for pressure, volume and temperature. The amount (n) box is below them. Locked variables are gray.

The live graph and a PV = nRT check are below the controls (Figure 2). The simulation uses R = 0.0821 L·atm/(mol·K).

## Pre-lab

**1.** Gas law calculations must use kelvins, not °C. Convert 27 °C to kelvins. Then explain why doubling a temperature in °C does not double the particle energy.

**2.** Predict: a gas at 1.00 atm fills 22.4 L. At the same temperature, it is squeezed to 11.2 L. What will the pressure be? Use $P_1V_1 = P_2V_2$.


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## Part A. Boyle's law (T and n locked)

1. Select **Reset**. Choose **Boyle's law · lock T and n**.
2. Type each volume below in the Volume box and record the pressure readout. Calculate P × V.

| Volume (L) | Pressure (atm) | P × V (atm·L) |
|---|---|---|
| 40.0 | | |
| 20.0 | | |
| 10.0 | | |
| 5.00 | | |

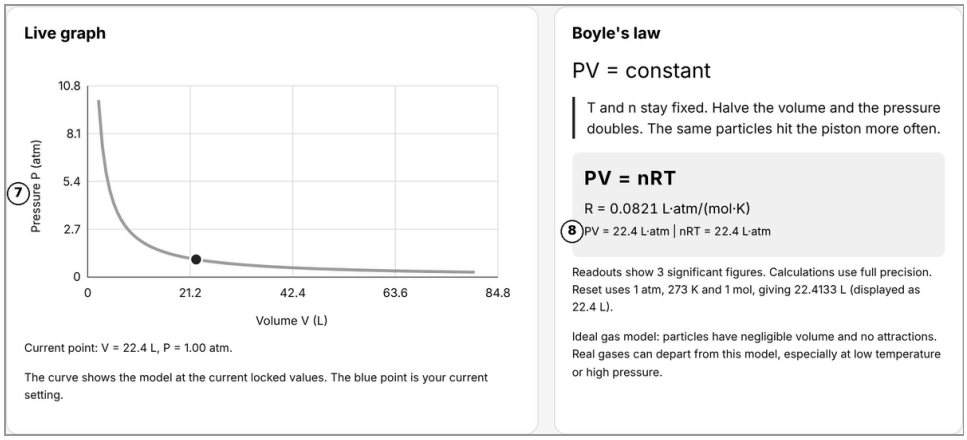



Figure 2. The live graph (7) for Boyle's law and the PV = nRT check (8).

**3.** Describe the relationship between pressure and volume (direct or inverse). What shape is the graph in Figure 2? Use two rows of your table to show the pattern.

**4.** Watch the particle model as you change from 40.0 L to 5.00 L. Use particles to explain why the pressure goes up.

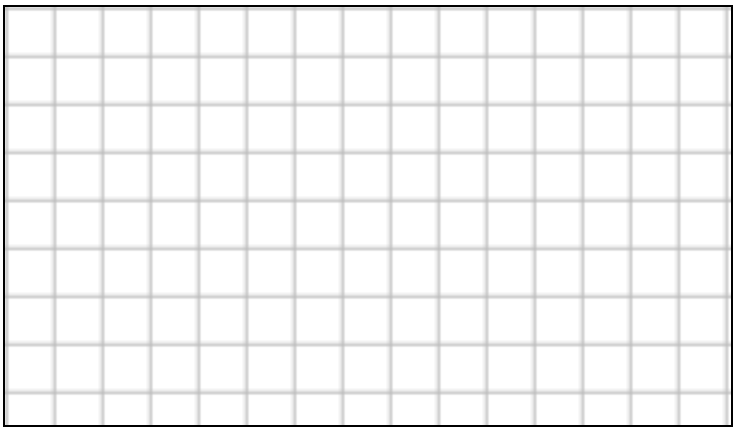
## Part B. Charles's law (P and n locked)

1. Select **Reset**. Choose **Charles's law · lock P and n**.
2. Type each temperature below and record the volume. Calculate V / T.

| Temperature (K) | Volume (L) | V / T (L/K) |
|---|---|---|
| 100 | | |
| 200 | | |
| 273 | | |
| 400 | | |
| 600 | | |


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**5.** Graph volume (y-axis) against kelvin temperature (x-axis) for Part B. Label both axes with units and draw a line of best fit. Extend your line to where the volume would be zero.



**6.** Describe the relationship between volume and kelvin temperature. Explain with particles why the gas expands when it is heated at constant pressure.

## Part C. Gay-Lussac's law (V and n locked)

1. Select **Reset**. Choose **Gay-Lussac's law · lock V and n**.
2. Type each temperature below and record the pressure. Calculate P / T.

| Temperature (K) | Pressure (atm) | P / T (atm/K) |
|---|---|---|
| 150 | | |
| 300 | | |
| 600 | | |
| 900 | | |

**7.** What happens to the pressure when the kelvin temperature doubles? Explain with particles why a sealed, rigid container of gas can burst when heated.


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## Part D. Avogadro's law (P and T locked)

1. Select **Reset**. Choose **Avogadro's law · lock P and T**.
2. Type each amount below in the n box and record the volume.

| Amount of gas, n (mol) | Volume (L) | V / n (L/mol) |
|---|---|---|
| 0.500 | | |
| 1.00 | | |
| 2.00 | | |
| 3.00 | | |

**8.** Describe the relationship between volume and amount of gas. At 1.00 atm and 273 K, what volume does 1 mole of any ideal gas fill?

## Analysis

**9.** A gas is at 2.24 atm, 10.0 L and 273 K. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, to predict the pressure if it is heated to 546 K in the same 10.0 L. Then test it: Reset, choose Boyle's law, type V = 10.0 L, switch to Gay-Lussac's law, and type T = 546 K. Record the pressure readout.

**10.** The simulation is an ideal gas model. Give two ways a real gas, or a real gas law lab, would differ from it.

## Conclusion

**11.** Write a claim that answers the objective. Support it with evidence from at least three parts (specific numbers), then explain your reasoning with particle motion.


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