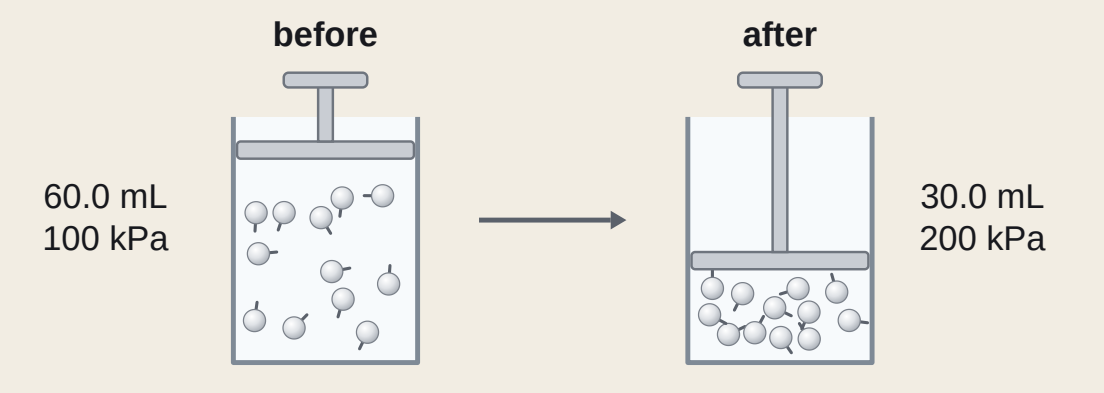
B3 · Boyle's law: pressure and volume · Completed notes

Goals: Describe how the pressure of a trapped gas changes when its volume changes. State Boyle's law and the two things that must stay the same. Use Boyle's law to find a pressure or a volume.

These are the completed notes. The blanks are filled in and each question is worked.

Slide 1 of 5 · Squeezing a trapped gas

Lessons B1 and B2 gave you the units for pressure and temperature. Now you start to link the four things we measure.



Key ideas

The syringe is sealed, so no air can get **in or out**.

The volume was cut in **half**.

The pressure **doubled**.

Example

In the syringe test, which two of the four things we measure were kept the same?

1. The syringe is sealed, so the amount of air stays the same.
2. The room does not change, so the temperature stays the same.

Try it

A trapped gas is squeezed into half its volume. What happens to its pressure?

1. The temperature and the amount of gas stay the same.
2. The pressure doubles.

Slide 2 of 5 · Pressure times volume stays the same

On the last slide the pressure doubled when the volume was cut in half. Now look at more readings.

volume (mL)	pressure (kPa)	P × V
60.0	100	6000
30.0	200	6000
20.0	300	6000
15.0	400	6000

The amount of air and the temperature stayed the same.

Key ideas

Each time the volume went down, the pressure went **up**.

Pressure times volume is always the same number.

The **amount** of air must stay the same.

The **temperature** must stay the same.

Example

A trapped gas is at 100 kPa and 40.0 mL. Its volume is cut to 10.0 mL. Use "pressure times volume stays the same" to find the new pressure.

1. Pressure times volume is 100 × 40.0 = 4000.
2. The new pressure is 4000 ÷ 10.0 = 400 kPa.

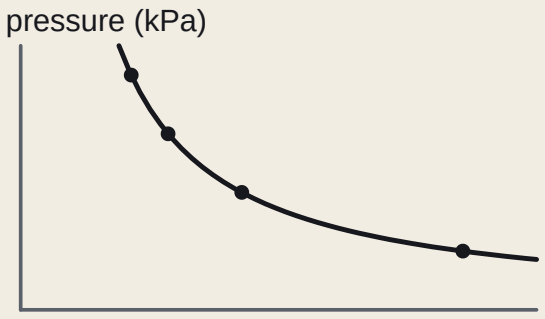
Try it

A trapped gas is at 200 kPa and 12.0 mL. Its pressure drops to 100 kPa. Use "pressure times volume stays the same" to find the new volume.

1. Pressure times volume is 200 × 12.0 = 2400.
2. The new volume is 2400 ÷ 100 = 24.0 mL.

Slide 3 of 5 · The graph for Boyle's law

The last slide showed the results as a table. A graph of the same results makes the pattern easy to see.



Volume up, pressure down.

The dots are the four results.

Key ideas

On the graph, **volume** goes along the bottom.

The dots make a **curve** that falls.

As the volume gets bigger, the pressure gets **smaller**.

Pressure and volume are **inversely related**.

Example

Draw the shape of the graph of pressure against volume for a trapped gas. Say what the shape shows.

1. The graph is a curve that falls from left to right.
2. It shows that pressure gets smaller as volume gets bigger.

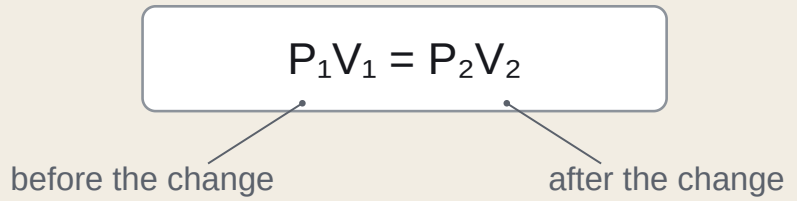
Try it

What does "inversely related" mean for pressure and volume?

1. When one goes up, the other goes down.
2. A bigger volume means a smaller pressure.

Slide 4 of 5 · Boyle's law as a formula

The last two slides showed the pattern as a table and as a graph. Now you write it as a formula.



The temperature must stay the same.
The amount of gas must stay the same.

Key ideas

P_1 and V_1 are the pressure and volume **before** a change.

P_2 and V_2 are the pressure and volume **after** the change.

Boyle's law only works when the **temperature** and the amount of gas stay the same.

Both pressures must be in the **same unit**.

Example

Write Boyle's law as a formula. Say what the small 1 and the small 2 stand for.

1. $P_1V_1 = P_2V_2$.
2. The 1 is for before the change. The 2 is for after the change.

Try it

One pressure is in kPa and the other is in atm. What must you do before you use the formula?

1. Both pressures must be in the same unit.
2. Change one of them first.

Slide 5 of 5 · Using Boyle's law

The last slide gave Boyle's law as a formula. Now you use it to find a volume and a pressure.

$P_1 = 120$ kPa, $V_1 = 6.00$ L, $P_2 = 300$ kPa, $V_2 = ?$

$V_2 = P_1V_1 / P_2$

$V_2 = (120 \text{ kPa} \times 6.00 \text{ L}) / 300 \text{ kPa}$

$V_2 = 2.40$ L

Key ideas

To find the new volume, use $V_2 = \mathbf{P_1V_1 / P_2}$.

When the pressure goes up, the volume goes **down**.

When the volume goes up, the pressure goes **down**.

Example

Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 9.00 L at 100 kPa. It is squeezed until the pressure is 150 kPa. What is the new volume?

1. $P_1 = 100$ kPa, $V_1 = 9.00$ L, $P_2 = 150$ kPa.
2. $V_2 = P_1V_1 / P_2 = (100 \text{ kPa} \times 9.00 \text{ L}) / 150 \text{ kPa} = 6.00$ L.
3. The pressure went up, so the volume went down.

Try it

Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 3.00 L at 80.0 kPa. It is squeezed to 2.00 L. What is the new pressure?

1. $P_1 = 80.0$ kPa, $V_1 = 3.00$ L, $V_2 = 2.00$ L.
2. $P_2 = P_1V_1 / V_2 = (80.0 \text{ kPa} \times 3.00 \text{ L}) / 2.00 \text{ L} = 120$ kPa.
3. The volume went down, so the pressure went up.