B3 · Boyle's law: pressure and volume · Practice key

This is the worked key. Every practice question is worked step by step.

Worked examples

Read these first. There is one for each kind of question in this lesson.

Example 1 · Find the new pressure

Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 6.00 L at 120 kPa. It is squeezed to 4.00 L. What is the new pressure?

1. Before: P_1 = 120 kPa, V_1 = 6.00 L. After: V_2 = 4.00 L. The unknown is P_2.
2. $P_2 = P_1V_1 / V_2$ = (120 kPa × 6.00 L) / 4.00 L = 180 kPa.
3. Check: the volume went down, so the pressure went up.

Answer: The new pressure is 180 kPa.

Example 2 · Find the new volume

Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 450 mL at 96.0 kPa. The pressure is raised to 144 kPa. What is the new volume?

1. Before: P_1 = 96.0 kPa, V_1 = 450 mL. After: P_2 = 144 kPa. The unknown is V_2.
2. $V_2 = P_1V_1 / P_2$ = (96.0 kPa × 450 mL) / 144 kPa = 300 mL.
3. Check: the pressure went up, so the volume went down.

Answer: The new volume is 300 mL.

Practice

Questions 1 to 4 are easy. Questions 5 to 8 are medium. Questions 9 and 10 are harder.

EASY

1. A trapped gas is squeezed to half its volume at the same temperature. Explain what happens to its pressure.

1. The pressure doubles.
2. Pressure and volume are inversely related, so pressure times volume stays the same.

EASY

2. Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 2.00 L at 100 kPa. It is squeezed to 1.00 L. What is the new pressure?

1. Before: P_1 = 100 kPa, V_1 = 2.00 L. After: V_2 = 1.00 L. The unknown is P_2.
2. $P_2 = P_1V_1 / V_2$ = (100 kPa × 2.00 L) / 1.00 L = 200 kPa.
3. Check: the volume went down, so the pressure went up.

EASY

3. Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 10.0 L at 50.0 kPa. The pressure is raised to 100 kPa. What is the new volume?

1. Before: P_1 = 50.0 kPa, V_1 = 10.0 L. After: P_2 = 100 kPa. The unknown is V_2.
2. $V_2 = P_1V_1 / P_2$ = (50.0 kPa × 10.0 L) / 100 kPa = 5.00 L.
3. Check: the pressure went up, so the volume went down.

EASY

4. A trapped gas has a pressure of 80.0 kPa and a volume of 3.00 L. What is its pressure times its volume? The gas is then squeezed at the same temperature. What is pressure times volume now?

1. 80.0 kPa × 3.00 L = 240 kPa·L.
2. It is still 240 kPa·L. Pressure times volume stays the same.

MEDIUM

5. Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 12.5 L at 96.0 kPa. It expands to 20.0 L. What is the new pressure?

1. Before: P_1 = 96.0 kPa, V_1 = 12.5 L. After: V_2 = 20.0 L. The unknown is P_2.
2. $P_2 = P_1V_1 / V_2$ = (96.0 kPa × 12.5 L) / 20.0 L = 60.0 kPa.
3. Check: the volume went up, so the pressure went down.

MEDIUM

6. Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A syringe holds 60.0 mL of air at 101 kPa. It is squeezed until the pressure is 152 kPa. What is the new volume?

1. Before: P_1 = 101 kPa, V_1 = 60.0 mL. After: P_2 = 152 kPa. The unknown is V_2.
2. $V_2 = P_1V_1 / P_2$ = (101 kPa × 60.0 mL) / 152 kPa = 39.9 mL.
3. Check: the pressure went up, so the volume went down.

MEDIUM

7. Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 2.40 L at 1.25 atm. The pressure drops to 0.800 atm. What is the new volume?

1. Before: P_1 = 1.25 atm, V_1 = 2.40 L. After: P_2 = 0.800 atm. The unknown is V_2.
2. $V_2 = P_1V_1 / P_2$ = (1.25 atm × 2.40 L) / 0.800 atm = 3.75 L.
3. Check: the pressure went down, so the volume went up.

MEDIUM

8. Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A gas fills 750 mL at 88.0 kPa. It is squeezed to 550 mL. What is the new pressure?

1. Before: P_1 = 88.0 kPa, V_1 = 750 mL. After: V_2 = 550 mL. The unknown is P_2.
2. $P_2 = P_1V_1 / V_2$ = (88.0 kPa × 750 mL) / 550 mL = 120 kPa.
3. Check: the volume went down, so the pressure went up.

HARDER

9. Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. Use 1 atm = 101.325 kPa = 760 mm Hg. A gas fills 5.00 L at 740 mm Hg. Its pressure changes to 125 kPa. First change 740 mm Hg to kilopascals. Then find the new volume.

1. The two pressures must be in the same unit.
2. 740 mm Hg × 101.325 kPa / 760 mm Hg = 98.7 kPa.
3. Before: P_1 = 98.7 kPa, V_1 = 5.00 L. After: P_2 = 125 kPa. The unknown is V_2.
4. $V_2 = P_1V_1 / P_2$ = (98.7 kPa × 5.00 L) / 125 kPa = 3.95 L.
5. Check: the pressure went up, so the volume went down.

HARDER

10. Use Boyle's law, $P_1V_1 = P_2V_2$. The temperature and the amount of gas do not change. A weather balloon holds 800 L of helium at 100 kPa on the ground. High up, the pressure is 25.0 kPa. Find the new volume. Then explain, using particles, why the balloon is bigger.

1. Before: P_1 = 100 kPa, V_1 = 800 L. After: P_2 = 25.0 kPa. The unknown is V_2.
2. $V_2 = P_1V_1 / P_2$ = (100 kPa × 800 L) / 25.0 kPa = 3200 L.
3. Check: the pressure went down, so the volume went up.
4. High up, the air outside pushes less on the balloon.
5. The helium particles spread into a bigger space.