# B4 · Charles's law: volume and temperature · 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 volume

Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 2.40 L at 15 °C. It is heated to 75 °C. What is the new volume?

1. $T_1$ = 15 + 273 = 288 K. $T_2$ = 75 + 273 = 348 K.
2. $V_2 = V_1T_2 / T_1$ = (2.40 L × 348 K) / 288 K = 2.90 L.
3. Check: the gas got hotter, so the volume went up.

**Answer: The new volume is 2.90 L.**

### Example 2 · Find the new temperature

Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 3.00 L at 27 °C. It is cooled until it fills 2.50 L. What is the new temperature?

1. $T_1$ = 27 + 273 = 300 K.
2. $T_2 = T_1V_2 / V_1$ = (300 K × 2.50 L) / 3.00 L = 250 K.
3. 250 − 273 = −23 °C.
4. Check: the volume went down, so the gas got colder.

**Answer: The new temperature is 250 K, which is −23 °C.**

## Practice

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

EASY

**1.** The kelvin temperature of a gas doubles at the same pressure. Explain what happens to its volume.

1. The volume doubles.
2. Volume is directly related to kelvin temperature.

EASY

**2.** Use T (K) = t (°C) + 273. A gas is at 27 °C. What temperature do you put into Charles's law?

1. Charles's law needs kelvin.
2. 27 + 273 = 300 K.

EASY

**3.** Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 2.00 L at 27 °C. It is heated to 177 °C. What is the new volume?

1. $T_1$ = 27 + 273 = 300 K. $T_2$ = 177 + 273 = 450 K.
2. $V_2 = V_1T_2 / T_1$ = (2.00 L × 450 K) / 300 K = 3.00 L.
3. Check: the gas got hotter, so the volume went up.

EASY

**4.** Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 500 mL at 0 °C. It is heated to 91 °C. What is the new volume?

1. $T_1 = 0 + 273 = 273$ K. $T_2 = 91 + 273 = 364$ K.
2. $V_2 = V_1T_2 / T_1 = (500 \text{ mL} \times 364 \text{ K}) / 273 \text{ K} = 667$ mL.
3. Check: the gas got hotter, so the volume went up.

MEDIUM

**5.** Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 3.60 L at 45 °C. It is cooled to 5 °C. What is the new volume?

1. $T_1 = 45 + 273 = 318$ K. $T_2 = 5 + 273 = 278$ K.
2. $V_2 = V_1T_2 / T_1 = (3.60 \text{ L} \times 278 \text{ K}) / 318 \text{ K} = 3.15$ L.
3. Check: the gas got colder, so the volume went down.

MEDIUM

**6.** Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 1.80 L at 20 °C. It is warmed until it fills 2.10 L. What is the new temperature, in kelvin and in °C?

1. $T_1 = 20 + 273 = 293$ K.
2. $T_2 = T_1V_2 / V_1 = (293 \text{ K} \times 2.10 \text{ L}) / 1.80 \text{ L} = 342$ K.
3. $342 - 273 = 69$ °C.
4. Check: the volume went up, so the gas got hotter.

MEDIUM

**7.** Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 725 mL at −10 °C. It is heated to 30 °C. What is the new volume?

1. $T_1 = -10 + 273 = 263$ K. $T_2 = 30 + 273 = 303$ K.
2. $V_2 = V_1T_2 / T_1 = (725 \text{ mL} \times 303 \text{ K}) / 263 \text{ K} = 835$ mL.
3. Check: the gas got hotter, so the volume went up.

MEDIUM

**8.** Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 6.00 L at 77 °C. It is cooled until it fills 4.80 L. What is the new temperature, in kelvin and in °C?

1. $T_1 = 77 + 273 = 350$ K.
2. $T_2 = T_1V_2 / V_1 = (350 \text{ K} \times 4.80 \text{ L}) / 6.00 \text{ L} = 280$ K.
3. $280 - 273 = 7$ °C.
4. Check: the volume went down, so the gas got colder.

HARDER

**9.** Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A balloon holds 4.20 L of air at 22 °C. It is left in a car at 58 °C. Find the new volume. Then explain, using particles, why the balloon grew.

1. $T_1$ = 22 + 273 = 295 K. $T_2$ = 58 + 273 = 331 K.
2. $V_2 = V_1T_2 / T_1$ = (4.20 L × 331 K) / 295 K = 4.71 L.
3. Check: the gas got hotter, so the volume went up.
4. The hotter particles move faster.
5. They hit the skin harder and more often, and push it out.

HARDER

**10.** Use Charles's law, $V_1/T_1 = V_2/T_2$, and T (K) = t (°C) + 273. The pressure and the amount of gas do not change. A gas fills 1.00 L at 10 °C. It is heated to 20 °C. A student says the volume doubles to 2.00 L. Find the correct volume. Then say what the student did wrong.

1. $T_1$ = 10 + 273 = 283 K. $T_2$ = 20 + 273 = 293 K.
2. $V_2 = V_1T_2 / T_1$ = (1.00 L × 293 K) / 283 K = 1.04 L.
3. Check: the gas got hotter, so the volume went up.
4. The student used degrees Celsius. Charles's law needs kelvin.