B5 · The combined gas law · Worked examples and practice

Name: _____ Date: _____

Worked examples

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

Example 1 · Find the new pressure

Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. A gas fills 4.00 L at 98.0 kPa and 18 °C. It changes to 2.50 L and 65 °C. What is the new pressure?

1. Before: P_1 = 98.0 kPa, V_1 = 4.00 L, T_1 = 18 °C. After: V_2 = 2.50 L, T_2 = 65 °C. The unknown is P_2.
2. T_1 = 18 + 273 = 291 K. T_2 = 65 + 273 = 338 K.
3. The units match on both sides, so no unit change is needed.
4. $P_2 = P_1V_1T_2 / (T_1V_2)$ = (98.0 kPa × 4.00 L × 338 K) / (291 K × 2.50 L) = 182 kPa.

Answer: The new pressure is 182 kPa.

Example 2 · Find the volume at SATP

Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. SATP is 25 °C and 100 kPa. A gas fills 2.20 L at 115 kPa and 40 °C. What volume does it fill at SATP?

1. Before: P_1 = 115 kPa, V_1 = 2.20 L, T_1 = 40 °C. After: P_2 = 100 kPa, T_2 = 25 °C. The unknown is V_2.
2. T_1 = 40 + 273 = 313 K. T_2 = 25 + 273 = 298 K.
3. The units match on both sides, so no unit change is needed.
4. $V_2 = P_1V_1T_2 / (T_1P_2)$ = (115 kPa × 2.20 L × 298 K) / (313 K × 100 kPa) = 2.41 L.

Answer: The gas fills 2.41 L at SATP.

Example 3 · Find the new temperature

Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. A gas fills 5.00 L at 100 kPa and 27 °C. It changes to 6.00 L at 125 kPa. What is the new temperature?

1. Before: P_1 = 100 kPa, V_1 = 5.00 L, T_1 = 27 °C. After: P_2 = 125 kPa, V_2 = 6.00 L. The unknown is T_2.
2. T_1 = 27 + 273 = 300 K.
3. The units match on both sides, so no unit change is needed.
4. $T_2 = T_1P_2V_2 / (P_1V_1)$ = (300 K × 125 kPa × 6.00 L) / (100 kPa × 5.00 L) = 450 K.
5. 450 − 273 = 177 °C.

Answer: The new temperature is 450 K, which is 177 °C.

Practice

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

EASY

1. A gas at 95.0 kPa, 3.00 L and 10 °C is changed to 110 kPa and 50 °C. Sort the five values into "before" and "after", and name the unknown.

EASY

2. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. Use the values from question 1. What is the new volume?

EASY

3. The pressure of a gas does not change. Explain which simpler law the combined gas law turns into.

EASY

4. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. A gas fills 2.00 L at 100 kPa and 27 °C. It changes to 1.00 L and 327 °C. What is the new pressure?

MEDIUM

5. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. STP is 0 °C and 101.325 kPa. A gas fills 650 mL at 92.0 kPa and 35 °C. What volume does it fill at STP?

MEDIUM

6. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. A gas fills 15.0 L at 150 kPa and 22 °C. It changes to 12.0 L and 85 °C. What is the new pressure?

MEDIUM

7. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. A gas fills 2.00 L at 90.0 kPa and 7 °C. It changes to 3.00 L at 120 kPa. What is the new temperature, in kelvin and in °C?

MEDIUM

8. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. SATP is 25 °C and 100 kPa. A tank holds 8.50 L of gas at 240 kPa and 12 °C. What volume does the gas fill at SATP?

HARDER

9. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. Use 1 atm = 101.325 kPa = 760 mm Hg. A gas fills 1.50 L at 1.25 atm and 25 °C. It changes to 150 kPa and 100 °C. First change 1.25 atm to kilopascals. Then find the new volume.

HARDER

10. Use the combined gas law, $P_1V_1/T_1 = P_2V_2/T_2$, and T (K) = t (°C) + 273. The amount of gas does not change. A spray can holds 0.400 L of gas at 310 kPa and 20 °C. The can cannot change size. It warms to 55 °C in the sun. Find the new pressure. Then explain, using particles, why the pressure rose.