B8 · The ideal gas law, PV = nRT · 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 a volume

Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. What is the volume of 1.50 mol of gas at 110 kPa and 25 °C?

1. n = 1.50 mol, P = 110 kPa, T = 25 °C. The unknown is V.
2. T = 25 + 273 = 298 K.
3. V = nRT / P = (1.50 mol × 8.314 × 298 K) / 110 kPa = 33.8 L.

Answer: The volume is 33.8 L.

Example 2 · Find moles, then mass

Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. The molar mass of methane, CH_4, is 16.05 g/mol. What is the mass of 8.00 L of methane gas at 120 kPa and 18 °C?

1. P = 120 kPa, V = 8.00 L, T = 18 °C. The unknown is n, then the mass.
2. T = 18 + 273 = 291 K.
3. n = PV / (RT) = (120 kPa × 8.00 L) / (8.314 × 291 K) = 0.3968 mol.
4. m = 0.3968 mol × 16.05 g/mol = 6.37 g.

Answer: The mass is 6.37 g.

Example 3 · Find a temperature

Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. A 10.0 L tank holds 0.750 mol of gas at 200 kPa. What is the temperature, in kelvin and in °C?

1. P = 200 kPa, V = 10.0 L, n = 0.750 mol. The unknown is T.
2. T = PV / (nR) = (200 kPa × 10.0 L) / (0.750 mol × 8.314) = 321 K.
3. 321 − 273 = 48 °C.

Answer: The temperature is 321 K, which is 48 °C.

Practice

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

EASY

1. R is 8.314 kPa·L/(mol·K). A volume is given as 250 mL. What must you do before you use it in PV = nRT? Give the new value.

1. R uses litres, so change mL to L.
2. 250 mL = 0.250 L.

EASY

2. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. What is the volume of 1.00 mol of gas at 100 kPa and 20 °C?

1. n = 1.00 mol, P = 100 kPa, T = 20 °C. The unknown is V.
2. T = 20 + 273 = 293 K.
3. V = nRT / P = (1.00 mol × 8.314 × 293 K) / 100 kPa = 24.4 L.

EASY

3. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. 2.00 mol of gas is in a 10.0 L tank at 0 °C. What is the pressure?

1. n = 2.00 mol, V = 10.0 L, T = 0 °C. The unknown is P.
2. T = 0 + 273 = 273 K.
3. P = nRT / V = (2.00 mol × 8.314 × 273 K) / 10.0 L = 454 kPa.

EASY

4. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. How many moles of gas are in 5.00 L at 100 kPa and 27 °C?

1. P = 100 kPa, V = 5.00 L, T = 27 °C. The unknown is n.
2. T = 27 + 273 = 300 K.
3. n = PV / (RT) = (100 kPa × 5.00 L) / (8.314 × 300 K) = 0.200 mol.

MEDIUM

5. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. What is the volume of 0.250 mol of gas at 96.0 kPa and 18 °C?

1. n = 0.250 mol, P = 96.0 kPa, T = 18 °C. The unknown is V.
2. T = 18 + 273 = 291 K.
3. V = nRT / P = (0.250 mol × 8.314 × 291 K) / 96.0 kPa = 6.30 L.

MEDIUM

6. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. 1.20 mol of gas is in a 25.0 L tank at −10 °C. What is the pressure?

1. n = 1.20 mol, V = 25.0 L, T = −10 °C. The unknown is P.
2. T = −10 + 273 = 263 K.
3. P = nRT / V = (1.20 mol × 8.314 × 263 K) / 25.0 L = 105 kPa.

MEDIUM

7. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. How many moles of gas are in 750 mL at 102 kPa and 22 °C?

1. V = 750 mL = 0.750 L.
2. P = 102 kPa, V = 0.750 L, T = 22 °C. The unknown is n.
3. T = 22 + 273 = 295 K.
4. n = PV / (RT) = (102 kPa × 0.750 L) / (8.314 × 295 K) = 0.0312 mol.

MEDIUM

8. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. A 4.00 L flask holds 0.400 mol of gas at 250 kPa. What is the temperature, in kelvin and in °C?

1. P = 250 kPa, V = 4.00 L, n = 0.400 mol. The unknown is T.
2. T = PV / (nR) = (250 kPa × 4.00 L) / (0.400 mol × 8.314) = 301 K.
3. 301 − 273 = 28 °C.

HARDER

9. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. The molar mass of oxygen, O_2, is 32.00 g/mol. A 20.0 L tank holds oxygen gas at 150 kPa and 30 °C. What is the mass of the oxygen?

1. P = 150 kPa, V = 20.0 L, T = 30 °C. The unknown is n, then the mass.
2. T = 30 + 273 = 303 K.
3. n = PV / (RT) = (150 kPa × 20.0 L) / (8.314 × 303 K) = 1.191 mol.
4. m = 1.191 mol × 32.00 g/mol = 38.1 g.

HARDER

10. Use the ideal gas law, PV = nRT, with R = 8.314 kPa·L/(mol·K), and T (K) = t (°C) + 273. STP is 0 °C and 101.325 kPa. Use the ideal gas law to find the volume of 1.00 mol of gas at STP. Then compare your answer with the molar volume at STP, 22.4 L/mol.

1. n = 1.00 mol, P = 101.325 kPa, T = 0 °C. The unknown is V.
2. T = 0 + 273 = 273 K.
3. V = nRT / P = (1.00 mol × 8.314 × 273 K) / 101.325 kPa = 22.4 L.
4. This matches the molar volume at STP, 22.4 L/mol.