B8 · The ideal gas law, PV = nRT · 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 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.

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?

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?

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?

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?

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?

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?

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?

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?

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.