Chemistry 1

Volume 5

Worksheet 19

Dalton’s Law of Partial Pressures – Part 2

1. A mixture of 4.5% H_2, 76% O_2, and 19.5% N_2 has a total pressure of 2.3 atm. What is the partial pressure of each of the gases?

2. A 2.5 L sample at 273 K contains 0.006 mol H_2, 0.0024 mol O_2, and 0.0002 mol CH_4. What is the partial pressure of O_2?

3. A 1.5 L sample at 298 K contains 0.030 mol N_2 and 0.0020 mol O_2. If the total pressure of the system is 0.52 atm, what is the partial pressure of the two gases?

4. A 500.0 mL sample of gases is at 307 K and contains N_2 at a pressure of 1.4 atm and O_2 at a pressure of 0.24 atm. What is the mole fraction of each of the two gases?

5. If a mixture of Ne and Ar has a total pressure of 1.5 atm at 296 K in a 0.5 L container, what is the partial pressure of Ne if Ar is present in a mole fraction of 0.34?

6. A mixture of H_2 and NH_3 has a total pressure of 1.02 atm at 273 K in a 0.75 L container. If H_2 is present in a mole fraction of 0.21, how many moles of NH_3 are present?

7. A mixture of unknown gases, A and B have partial pressure of $P_A = 0.35$ atm and $P_B = 0.45$ atm. If the gas mixture is at 256 K in a 1.1 L container how many moles of gas are present?

8. At 304 K, a 5.6 L container with H_2 and N_2 has a total pressure of 1.55 atm. If there are 0.034 moles of H_2, what is the partial pressure of N_2?

Answer Key

1. A mixture of 4.5% H_2, 76% O_2, and 19.5% N_2 has a total pressure of 2.3 atm. What is the partial pressure of each of the gases?

   P_{H_2} = (0.045)(2.3 atm) = 0.10 atm
   P_{O_2} = (0.76)(2.3 atm) = 1.75 atm
   P_{N_2} = (0.195)(2.3 atm) = 0.45 atm

   Check your answer by adding the individual gases:
   0.10 atm + 1.75 atm + 0.45 atm = 2.30 atm.

   Since the answer matches original total pressure of 2.3 atm, the answer is correct.

   Correct answer: P_{H_2} = 0.10 atm; P_{O_2} = 1.75 atm; P_{N_2} = 0.45 atm

2. A 2.5 L sample at 273 K contains 0.006 mol H_2, 0.0024 mol O_2, and 0.0002 mol CH_4. What is the partial pressure of O_2?

   Each of the gases in a mixture obeys the Ideal Gas law individually.

   Thus:

   P_{O_2}V= n_{O_2}RT

   P_{O_2}(2.5L) = (0.0024 mol)(0.08206 L atm/mol K)(273 K)
   P_{O_2}= 0.022 atm

   Correct answer: 0.022 atm

3. A 1.5 L sample at 298 K contains 0.030 mol N_2 and 0.0020 mol O_2. If the total pressure of the system is 0.52 atm, what is the partial pressure of the two gases?

There are two methods to solve this problem.

Method 1: Use mole fractions

Step 1:

Calculate the mol fraction of each of the gases.

$x_{N_2} = \frac{n_{N_2}}{(n_{N_2} + n_{O_2})}$

$x_{N_2} = \frac{0.030\ mol}{(0.030\ mol + 0.0020\ mol)}$

$x_{N_2} = 0.94$

$x_{O_2} = 1.00 - 0.94 = 0.06$

Step 2:

Multiply the mole fraction by the total pressure.

$\mathrm{P}_{\mathrm{N}_2} = (0.94)(0.52\text{ atm}) = 0.49\text{ atm}$

$\mathrm{P}_{\mathrm{O}_2} = (0.06)(0.52\text{ atm}) = 0.03\text{ atm}$

Method 2: Use the Ideal Gas Law

$\mathrm{P}_{\mathrm{N}_2}(1.5\text{ L}) = (0.030\text{ mol})(0.08206\text{ L atm/mol K})(298\text{ K})$

$\mathrm{P}_{\mathrm{N}_2} = 0.49\text{ atm}$

$\mathrm{P}_{\mathrm{O}_2}(1.5\text{ L}) = (0.0020\text{ mol})(0.08206\text{ L atm/mol K})(298\text{ K})$

$\mathrm{P}_{\mathrm{O}_2} = 0.03\text{ atm}$

Each method gives the same answer!

Correct answer: $\mathbf{P_{N_2}}$ = 0.49 atm; $\mathbf{P_{O_2}}$ = 0.03 atm

4. A 500.0 mL sample of gases is at 307 K and contains N_2 at a pressure of 1.4 atm and O_2 at a pressure of 0.24 atm. What is the mole fraction of each of the two gases?

Step 1:
Calculate the number of moles of each of the two gases using the Ideal Gas Law.

Moles N_2:
$P_{N_2}V = n_{N_2}RT$

$(1.4 \text{ atm})(0.5000 \text{ L}) = n_{N_2}(0.08206 \text{ L atm/mol K})(307 \text{ K})$

$n_{N_2} = 0.028$ mol

Moles O_2:
$P_{O_2}V = n_{O_2}RT$

$(0.24 \text{ atm})(0.5000 \text{ L}) = n_{O_2}(0.08206 \text{ L atm/mol K})(307 \text{ K})$

$n_{O_2} = 0.0048$ mol

Step 2:
Calculate the mol fraction of each gas using.

$$x_{N_2} = \frac{0.028\, mol}{(0.028\, mol + 0.0048\, mol)} = 0.85 \text{ x } 100\% = 85\ \%$$

$$x_{O_2} = \frac{0.0048\, mol}{(0.028\, mol + 0.0048\, mol)} = 0.15 \text{ x } 100\% = 15\%$$

Check your answer by making sure the percentages add up to 100%:
85% + 15% = 100%

Correct answer: x_{N_2} = 85 %; x_{O_2} = 15%

5. If a mixture of Ne and Ar has a total pressure of 1.5 atm at 296 K in a 0.5 L container, what is the partial pressure of Ne if Ar is present in a mole fraction of 0.34?

Step 1:
Calculate the mole fraction of Ne:

$x_{Ne} = 1 - x_{Ar}$

$x_{Ne} = 1 – 0.34$

$x_{Ne} = 0.66$

Step 2:
Use Dalton's Law of Partial Pressures to calculate the partial pressure of Ne.

$P_{Ne} = (P_{Tot})(x_{Ne})$

$P_{Ne} = (1.5 \text{ atm})(0.66)$

$P_{Ne} = 0.99 \text{ atm}$

Correct answer: 0.99 atm

6. A mixture of H_2 and NH_3 has a total pressure of 1.02 atm at 273 K in a 0.75 L container. If H_2 is present in a mole fraction of 0.21, how many moles of NH_3 are present?

Step 1:
Calculate the mole fraction of NH_3.

$x_{NH_3} = 1 - x_{H_2}$

$x_{NH_3} = 1 - 0.21$

$x_{NH_3} = 0.79$

Step 2:
Calculate the partial pressure of NH_3.

$P_{NH_3} = (P_{Tot})(x_{NH_3})$

$P_{NH_3} = (1.02 \text{ atm})(0.79)$

$P_{NH_3} = 0.81 \text{ atm}$

Step 3:
Use the Ideal Gas Law to calculate the number of moles NH_3.

$P_{NH_3}V = n_{NH_3}RT$

$(0.81 \text{ atm})(0.75 \text{ L}) = n_{NH_3}(0.08206 \text{ L atm/mol K})(273 \text{ K})$

$n_{NH_3} = 0.027 \text{ mol } NH_3$

Correct answer: 0.027 mol NH_3

7. A mixture of unknown gases, A and B have partial pressure of P_A = 0.35 atm and P_B = 0.45 atm. If the gas mixture is at 256 K in a 1.1 L container how many moles of gas are present?

   Step 1:
   Determine the total pressure of the mixture by adding the partial pressures.

   $P_{Tot} = P_A + P_B$

   P_{Tot} = 0.35 atm + 0.45 atm

   P_{Tot} = 0.80 atm

   Step 2:
   Use the Ideal Gas Law to calculate the number of moles present.

   $PV=nRT$

   (0.80 atm)(1.1 L) = n(0.08206 L atm/mol K)(256 K)

   n = 0.042 mol

   Correct answer: 0.042 mol of total gas

8. At 304 K, a 5.6 L container with H_2 and N_2 has a total pressure of 1.55 atm. If there are 0.034 moles of H_2, what is the partial pressure of N_2?

Step 1:
Calculate the partial pressure of H_2.

$P_{H_2}V = n_{H_2}RT$

P_{H_2}(5.6 L) = (0.034 mol)(0.08206 L atm/mol K)(304 K)

P_{H_2} = 0.15 atm

Step 2:
Calculate the partial pressure of N_2.

$P_{N_2} = P_{Tot} - P_{H_2}$

P_{N_2} = 1.55 atm – 0.15 atm

P_{N_2} = 1.4 atm

Correct answer: 1.4 atm