

PROBLEMS/SOLUTIONS

1. The mixing ratio of oxygen in the atmosphere is 20.95%. Calculate the concentration in mol L⁻¹ and in g m⁻³ at P° (101 325 Pa, 1.00 atm) and 25°C.

Solution

The mixing ratio for O₂ (g) is 20.95% (Table 2.1). Use the 'Ideal Gas' law (PV = nRT) to calculate the total number of moles of gas in 1.00 L for the given conditions. Constants are given in Appendices B.1 and C.1.

T = 25°C (298 K), P = 1.01325 x 10⁵ Pa, R = 8.315 J K⁻¹ mol⁻¹, and V = 1.00 L = 1.00 x 10⁻³ m³

The total number of moles of gas in 1.00 L is

$$\begin{aligned} n &= PV/RT \\ n &= 0.04089 \text{ mol} \end{aligned}$$

The number of moles of oxygen can be calculated from the mole fraction (which is the same as the mixing ratio).

$$\% \text{ O}_2 = 20.95, \text{ mole fraction} = 0.2095$$

The number of moles of O₂ in 1.00 L is: 0.2095 x 0.04089 = 0.00857 mol

The concentration of O₂ (g) is: 8.57 x 10⁻³ mol L⁻¹.

The concentration of O₂ (g) in units of g m⁻³ is determined as follows:

1 m³ = 1000 L, therefore, 1000 L contains 8.57 moles of O₂ (g). (M.M. of O₂ is 31.9988 g mol⁻¹)

$$31.9988 \text{ g mol}^{-1} \times 8.57 \text{ mol m}^{-3} = 274 \text{ g m}^{-3}$$

The O₂ (g) concentration can be expressed as either 8.57 x 10⁻³ mol L⁻¹ or 274 g m⁻³.

2. Calculate the atmospheric pressure at the stratopause. What are the concentrations (mol m⁻³) of dioxygen and dinitrogen at this altitude? How do these concentrations compare with the corresponding values at sea level?

Solution

Use Equation 2.3 to calculate the pressure at 50 km (stratopause).

$$P_h = P^\circ e^{-\bar{M}_a g h}$$

R = 8.315 J K⁻¹ mol⁻¹, P° = 101 325 Pa, g = 9.81 m s⁻², \bar{M}_a = 0.02896 kg mol⁻¹ (average molar mass of air), h = 50 km (50 000 m) and T = -2°C (271 K). Note: these last two parameters are the approximate altitude and temperature at the stratopause.

Solutions Manual For Environmental Chemistry

Louis J. Thibodeaux



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Elements of Environmental Chemistry Ronald A. Hites, Jonathan D. Raff, 2013-08-26 From

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