

Assignment 2 - Follow up

Q3: What is the mixing ratio of 250 $\mu\text{g}/\text{m}^3$ of acrolein (MW = 56.1 g mol^{-1}) in ppb_v at 17°C and 1.0 atm?

$$250 \frac{\mu\text{g}}{\text{m}^3} \left\{ \begin{array}{l} \leftarrow \text{mass} \\ \leftarrow \text{volume} \end{array} \right.$$

$$\text{mixing ratio} \\ \frac{\text{mol}}{\text{mol}} \quad \text{or} \quad \frac{\text{Vol}}{\text{Vol}} \quad \text{or} \quad \frac{P}{P}$$

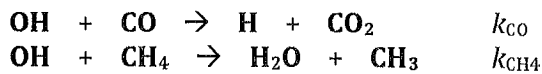
$$250 \mu\text{g acrolein} \times \frac{1 \text{ mol}}{56.1 \text{ g}} \times \frac{1 \text{ g}}{10^6 \mu\text{g}} = 4.46 \times 10^{-6} \text{ mol}$$

$$1 \text{ m}^3 \text{ air} \quad n_{\text{air}} = \frac{P \cdot V}{R \cdot T} = \frac{(1.0 \text{ atm})(10^3 \text{ L})}{(0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(290 \text{ K})} = 42.0 \text{ mol}$$

$$\therefore \text{mixing ratio} = \frac{4.46 \times 10^{-6} \text{ mol}}{42.0 \text{ mol}} = 1.06 \times 10^{-7}$$

or 106 ppb_v

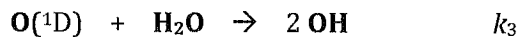
Q6: Write an expression for the residence time (τ) of OH in the troposphere, if the following reactions represent the dominant loss processes.



$$\begin{aligned} \tau_{\text{OH}} &= \frac{\text{stock of OH}}{\text{flux of OH}} = \frac{[\text{OH}]}{k_{\text{CO}}[\text{OH}][\text{CO}] + k_{\text{CH}_4}[\text{OH}][\text{CH}_4]} \\ &= \frac{1}{\underbrace{k_{\text{CO}}[\text{CO}]}_{k'_{\text{CO}}} + \underbrace{k_{\text{CH}_4}[\text{CH}_4]}_{k'_{\text{CH}_4}}} \\ &= \frac{1}{\sum k} \end{aligned}$$

where k is 1st order rate constant /s

Q7: What is the rate expression for the production of OH from the reaction below?



rate OH prodⁿ = 2 × rate H₂O loss
or 2 × rate O(^1D) loss

$$\frac{d[\text{OH}]}{dt} = -2 \frac{d[\text{O}^1\text{D}]}{dt} = -2 \frac{d[\text{H}_2\text{O}]}{dt}$$

'rate of reaction' defined as rate for 1 mol of reactant as written (ie. $\frac{d[\text{O}^1\text{D}]}{dt}$ or $\frac{d[\text{H}_2\text{O}]}{dt}$)

$$\therefore \text{Rate of OH prod}^n = 2 k_3 [\text{O}(^1\text{D})] [\text{H}_2\text{O}]$$

Q8: What is the total mass of CFC-12 (MW = 121 g mol⁻¹) in Earth's atmosphere if global average concentration is given by 400 pptv?

$$\frac{400}{10^{12}} \times (\# \text{ mols air in atmos}) \times \text{MW}_{\text{CFC-12}}$$

\uparrow \uparrow
 mass of atmos × $\frac{1}{\text{MW}_{\text{air}}}$ \uparrow 121 g/mol
 \uparrow \uparrow
 $5.27 \times 10^{18} \text{ kg}$ $0.02896 \frac{\text{kg}}{\text{mol}}$
 (Appendix or Data sheet) (Appendix or Data sheet)

$$\therefore \text{mass CFC-12} = 8.7 \times 10^{12} \text{ g} \quad \text{or} \quad 8.7 \times 10^9 \text{ kg}$$