Chemistry of Tropospheric Hydrocarbons

1. Given that global average concentration of methane is 1.7 ppm_v, calculate the concentration of methane in mg/m^3 and $molecules/cm^3$.

[*Answer: 1.2_1 mg/m^3* $\mathbf{CH_4}$ *and $4.5_7 \times 10^{13}$ molecules/cm^3; assuming STP*]

2. Atmospheric methane reacts with hydroxyl radicals much more slowly than hexane as indicated by the rate constants given below.

$$\mathbf{CH_4} + \mathbf{OH} \rightarrow \text{pdts} \qquad k_1 = 8.36 \times 10^{-15}\ \text{cm}^3\ \text{molec}^{-1}\ \text{s}^{-1}$$

$$\mathbf{C_6H_{14}} + \mathbf{OH} \rightarrow \text{pdts} \qquad k_2 = 5.61 \times 10^{-12}\ \text{cm}^3\ \text{molec}^{-1}\ \text{s}^{-1}$$

An urban airshed has an atmospheric concentration of methane of 1.7 ppm_v, hexane concentration of 100 μg/m^3, with an average steady state [**OH**] $\approx 2.0 \times 10^6$ molec cm^{-3}

a) Calculate the rate of loss of methane and hexane under these conditions.
b) Determine the chemical loss lifetime of both species.

[*Answer:* *a)* *rate of methane loss* = 7.7×10^5 *molec cm*$^{-3}$ *s*$^{-1}$
rate of hexane loss = 7.8×10^6 *molec cm*$^{-3}$ *s*$^{-1}$

b) $\tau_{CH4}^{OH} = 6 \times 10^7\ s \approx 700\ d$
$\tau_{C6H14}^{OH} = 9 \times 10^4\ s \approx 1\ d$]

3. Using the information in the kinetic scheme below, estimate the steady state atmospheric concentration of formaldehyde (**H_2CO**).

where;

$k_1 = 8 \text{ x } 10^{-15}$ cm^3 molec^{-1} s^{-1}

$k_5 = 1.3 \text{ x } 10^{-11}$ cm^3 molec^{-1} s^{-1}

$f_5 + f_6 = 4.5 \text{ x } 10^{-5}$ s^{-1}

[*Answer: [**H_2CO**] ≈ 1 x 10^{10} molec cm^3*]