**ATOC 3500/CHEM 3151**

**Problem 12**

Throughout the semester we will be calculating the rate for a chemical reaction and the ‘lifetime’ of a chemical species. These quantities are very closely related. Let’s look at a very important reaction in Earth’s atmosphere, the initiation step in the oxidation of methane.

OH + CH4 🡪 H2O + CH3

The rate of this reaction is written as:

“Rate” = – d[CH4]/dt = k [OH] [CH4]

where k = 5 x 10-15 cm3 molecule-1 s-1 is the “rate coefficient” (or “rate constant”) for this reaction.

1. Calculate the “rate” of reaction (in units of “molecules cm-3 s-1) for the following concentrations of reactants:

[OH] = 6 x 105 molecule cm-3

[CH4] = 4 x 1013 molecule cm-3

The ‘lifetime’ of a chemical species is defined as the concentration of that species divided by the rate of the reaction that destroys it, as below:

Lifetime of CH4 = [CH4] / Rate

1. By substituting the expression for “Rate” at the top of the page, show that the lifetime of CH4 is independent of the concentration of CH4 (i.e., that [CH4] does not appear in the final expression for lifetime of CH4.
2. Calculate the lifetime of methane using the k and [OH] from above, and convert the answer into “years”. How does the answer compare to the lifetime Paul Monks mentions in his video?