(2.8) In an investigation the isotope ratio $^{18}O/^{16}O$ was found to be 2.045×10^{-3} for fresh water and 2.127×10^{-3} for carbon dioxide in the atmosphere. Calculate the equilibrium constant (mole fractions!) for the reaction:

$H_2{}^{18}O(l) + C^{16}O_2(g) = H_2{}^{16}O(l) + C^{18}O^{16}O(g)$

$k = xH_2{}^{16}O(l)*xC^{18}O^{16}O(g)/xH_2{}^{18}O*xC^{16}O2(g)$ (from the given reaction)

The isotope ratio in fresh water is given by:

$x_{18w} = xH_2{}^{18}O(l)/xH_2{}^{16}O(l) = 2.045*10^{-3}$

and in the atmosphere:

$x_{18a} = xC^{18}O^{16}O(g)/(2xC^{16}O_2(g)+xC^{18}O^{16}O(g)) = 2.127*10^{-3}$

We can now rewrite the equilibrium constant as:

$k = (1/x_{18w})*2*x_{18a}$; neglect fraction $xC^{18}O^{16}(g)$ in comparison with $xC^{16}O_2(g)$.

$x_{18w} := 2.045 \cdot 10^{-3}$ $\quad x_{18a} := 2.127 \cdot 10^{-3}$ $\quad k := \frac{2 \cdot x_{18a}}{x_{18w}}$ $\quad k = 2.080$