KEY

Quiz 2—Environmental Chemistry

CENG 340–Introduction to Environmental Engineering
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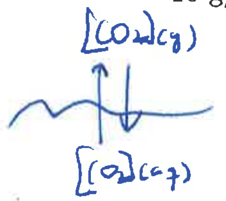
Name:

Since the industrial revolution, atmospheric CO_2 concentrations have risen from approximately 320 ppm_v to 390 ppm_v. Because the concentration of CO_2 in the air is in *equilibrium* with the concentration of dissolved CO_2, this increase has led to a change in the aqueous (= dissolved) CO_2 concentration in the ocean.

Calculate this change in the aqueous concentration of CO_2 in the ocean (ignoring effects of salinity). Assume T = 25 ^{0}C; P_{air} = 1 atm; Henry's constant for CO_2, $K_H = 0.0246 \frac{moles}{L \times atm}$.

Additional information that may be useful: the ideal gas constant $R = 8.205 \times 10^{-5} \frac{m^3 \times atm}{mole \times K}$, temperature in Kelvin (K) = temperature in Celsius (^{0}C) + 273.15; (2) MW_C = 12 g/mole and MW_O = 16 g/mole.



$$[CO_2]_{(g)} \underset{}{\overset{K_H}{\rightleftharpoons}} [CO_2]_{(aq)}$$

$$K_H = \frac{[CO_2]_{(aq)}}{[CO_2]_{(g)}} = 0.0246 \frac{mole}{L \cdot atm}$$

aq

g

Since K_H comes in different units, check units to make sure eqn was written correctly. In this case, the eqn. is written correctly.

$$[CO_2]_{(g)-1} = 320\ ppm_v = \frac{P_{CO_2} \times 10^6}{P_{tot}}$$

unitless mol. fraction

1 atm

$$[CO_2]_{(g)-1} = P_{CO_2-1} = \frac{320\ ppm_v\ P_{tot}}{10^6} = 3.2 \times 10^{-4}\ atm$$

similarly

$$[CO_2]_{(g)-2} = P_{CO_2-2} = 3.9 \times 10^{-4}\ atm$$

$$[CO_2]_{(aq)-1} = K_H \cdot [CO_2]_{(g)-1} = 0.0246 \frac{mole}{L \cdot \cancel{atm}} \times 3.2 \times 10^{-4}\ \cancel{atm} = 7.87 \times 10^{-6}\ mole/L$$

$$[CO_2]_{(aq)-2} = K_H [CO_2]_{(g)-2} = 0.0246 \frac{mole}{L \cdot atm} \times 3.9 \times 10^{-4}\ atm = 9.59 \times 10^{-6}\ mole/L$$

$$\Delta [CO_2]_{(aq)} = [CO_2]_{(aq)-2} - [CO_2]_{(aq)-1} = (9.59 - 7.87) \times 10^{-6}\ mole/L$$

$$\boxed{\Delta [CO_2]_{(aq)} = 1.72 \times 10^{-6}\ mole/L}$$