One way to think about the gas solubilities is to consider alveolar-capillary exchange in the lung. At 37°C, water solubility of CO_2 is 0.574742 ml/ml at 1 atm or 760 mmHg atmospheric pressure as calculated from the following equation:

*AlphaCO2w37 = 1.052*exp(-0.0571*37) + 0.6821*exp(-0.012*37)* Eq 1.

where AlphaCO2w37 is the water solubility of CO_2, 37 has units of °C. See equation 4b. of Christmas and Bassingthwaighte 2017 for more details about the coefficient values. Figure 1 shows the time course of exchange of CO_2 between a 100 ml solution of CO_2 in water at a pCO_2 of 50 mmHg and CO_2 in 57.4742 ml of alveolar air at a pCO_2 of 10 mmHg. The exchange is driven by the gas tensions on the two sides, and progresses to an equilibrium at pCO_2 of 30 mmHg, at which time the air volume of 55.4742 ml air (dry) contains same amount of CO_2, namely $9.953.10^{-5}$ mol, as are in the 100 ml water.

The time taken for this exchange depends on the membrane permeability-surface area product, Ps_{alv}, and the volumes of the spaces. The driving forces for the bidirectional fluxes across the membrane are the partial pressures for CO_2:

d pCO2w/dt = - PSalv(pCO2w - pCO2alv)/(Vw*AlphaCO2w37);* Eq 2.
d pCO2alv/dt = PSalv(pCO2w – pCO2alv)/Valv* Eq 3.

where the rates of concentration or pCO2 changes in the water and alveolar spaces due to the net fluxes of the gas equals the conductance, Psalv, times the difference in the partial pressures, divided by the effective volume. To account for the solubility in water, its volume Vw is multiplied by the solubility for the gas. Thus, the solubility, AlphaCO2w37, is like a partition coefficient for Vw, and is less than 1.0 at 37°C.

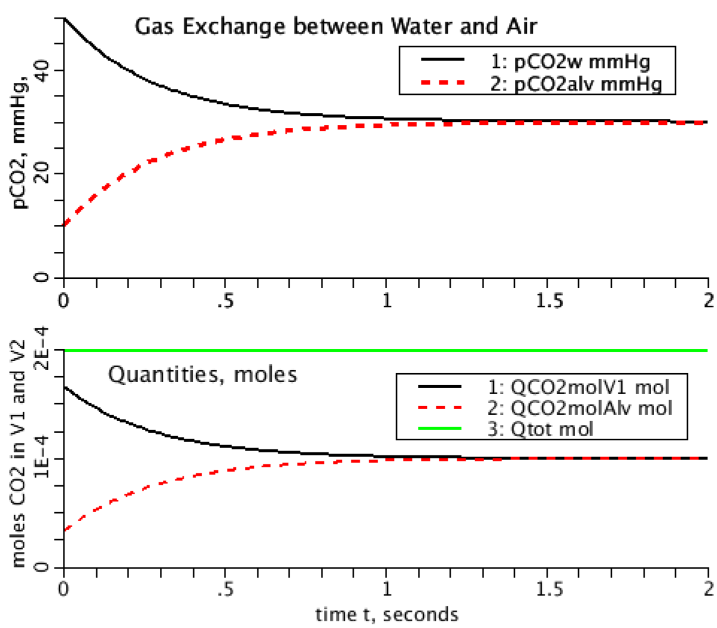

Figure 1. Alveolar-capillary exchange of carbon dioxide between gas phase and solution in water..
Upper panel: Partial pressures, mmHg, in gas phase (black) and in water (red dashes), equilibrate.
Lower panel: Molar amounts in the two phases become identical when the air space volume is

reduced by multiplying by the water solubility for the gas. (Program for figure available at www.physiome.org/jsim/models/webmodel/NSR/AlvCapExch/ .)

REFERENCE:

1. Christmas KM and Bassingthwaighte JB. Equations for O2 and CO2 solubilities in saline and plasma:
Combining temperature and density dependencies. J Appl Physiol 122: 1313-1320, 2017.