Problem 2.4

a)

$X_G = 3.774 \times 10^{-4}$ (CO_2 mole fraction in air)

$C_{He,290} = 1.28 \times 10^8$ Pa (C_{He} at 290 K)

$C_{He,300} = 1.71 \times 10^8$ Pa (C_{He} at 300 K)

Apply Henry's law to the interphase

$P_0 = 101330$ Pa

$X_{L,290} = P_0 X_G / C_{He,290} = 2.988 \times 10^{-7}$

$X_{L,300} = P_0 X_G / C_{He,300} = 2.236 \times 10^{-7}$

$$m_{L,290} = X_{L,290} \frac{M_{CO_2}}{M_{H_2O}} = 7.30 \times 10^{-7}$$

$$m_{L,300} = X_{L,300} \frac{M_{CO_2}}{M_{H_2O}} = 5.47 \times 10^{-7}$$

b) Interpolation gives, at 287.5 °C

$C_{He} = 1.17 \times 10^8$ Pa

$$X_L = P_0 \frac{X_G}{C_{He}} = 3.264 \times 10^{-7}$$

$m_L = X_L M_{CO_2} / M_{H_2O} = 7.98 \times 10^{-7}$

c) $\forall_W = 1.35 \times 10^{18}$ m^3

$Mass_W = \rho_L \forall_W = 1.35 \times 10^{21}$ kg (Water mass)

$Mass_{CO_2} = Mass_W m_L = 1.077 \times 10^{15}$ kg

2.4-2

$$x_{G,1} = 3.756 \times 10^{-4}$$

$$x_{L,1} = P_0 x_{G,1} / C_{He} = 3.248 \times 10^{-7}$$

$$m_{L,1} = x_{L,1} M_{CO2} / M_{H2O} = 7.94 \times 10^{-7}$$

$$mass_{CO2,1} = \forall_w m_{L,1} = 1.072 \times 10^{15}$$

$$\Delta mass_{CO2} = mass_{CO2} - mass_{CO2,1} = 5.137 \times 10^{12} \text{ kg}$$

This is change in the mass of dissolved CO_2, if the oceans remain at equilibrium with the atmosphere.

$$\text{Ratio} = \frac{\Delta mass_{CO2}}{7.25 \times 10^{12}} = 0.7086$$