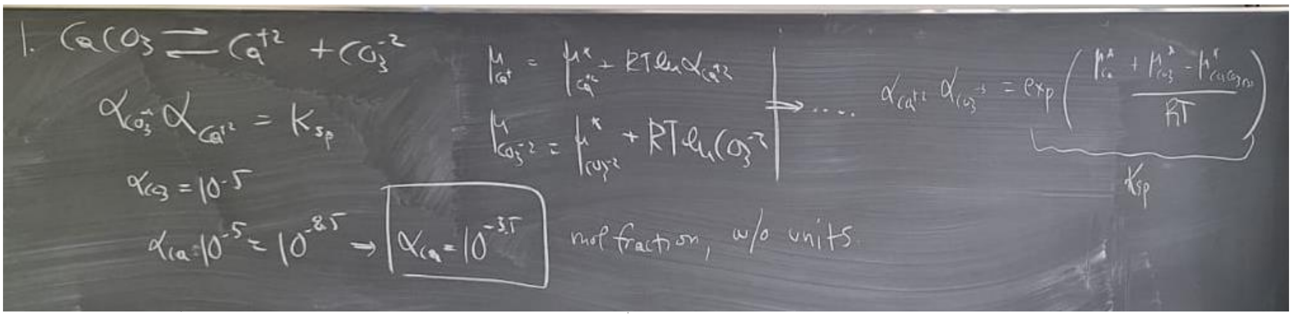
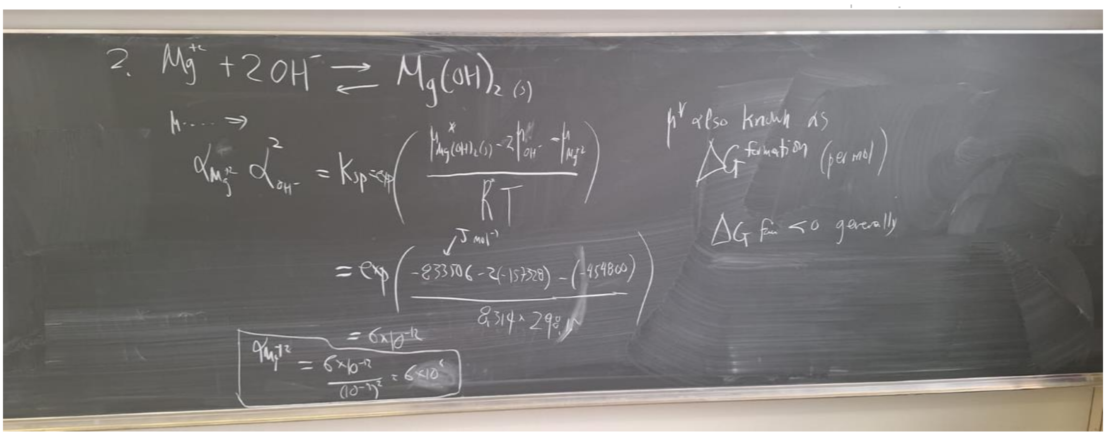
ENV-413: Thermodynamics of the Earth systems

Exercise session for Lecture 7

1. Calcite ($CaCO_3$) is in equilibrium with water in which the carbonate ion activity is 10^{-5}. What is the activity of calcium ions Ca^{2+} in the water? Ksp of calcite is $10^{-8.3}$.



2. Using the thermodynamic data sheets calculate the solubility product of brucite, $Mg(OH)_2$ at 25 C, 1 bar. What would be the activity of divalent magnesium Mg^{2+} in a solution in equilibrium with brucite that had an activity of OH^- = 10^{-9}.



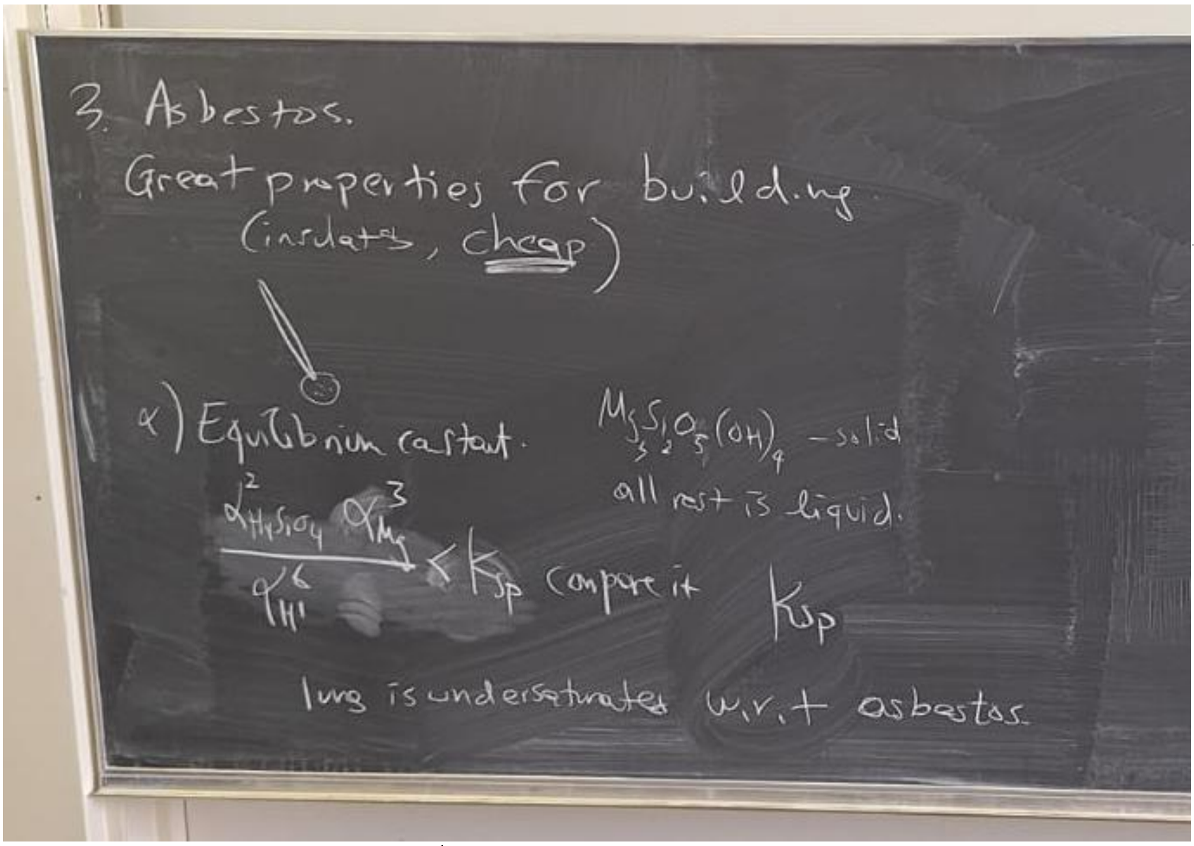
3. Asbestos minerals are considered to be a health hazard. The most common type of asbestos is chrysotile, and this mineral comprises about 95% of the asbestos in the US. Small asbestos fibers can be taken into the lung, where they can damage its lining. This problem deals with the solubility of asbestos in the lung.

The dissolution reaction for chrysotile can be written:

$$Mg_3Si_2O_5(OH)_4 \ + \ 6H^+ \ = \ 3Mg^{2+} \ + 2H_4SiO_{4\,(aq)} \ + \ H_20$$

a) Calculate the equilibrium constant for this reaction at T=37, the average temperature of the human body. Keq at 25 C = 7.11×10^{-33}.

b) For fluid in the lung tissues pH = 4 and activity of $Mg^{2+} = 8.7 \times 10^{-4}$, and activity of $H_4SiO_4 = 1.5 \times 10^{-6}$. Are the lung fluids under or oversaturated with respect to chrysotile?



3. 1 mol of $NH_{3(g)}$ is placed in a container with 1 mol of $H_2SO_{4(g)}$ to form $(NH_4)_2SO_{4(s)}$, according to the following reaction:

$$2\ NH_{3(g)} + H_2SO_{4(g)} = (NH_4)_2SO_{4(s)}$$

Calculate the amount of NH_3, H_2SO_4 and $(NH_4)_2SO_4$ you have at equilibrium. The equilibrium constant $K_{eq} = 1.406\times10^{-10}$. You might need to consult an equation solver to obtain you solution (e.g., http://home.sc.rr.com/nbhsa/freeonlinealgebraicequationsolver.htm).