

PRINCIPLES OF GEOCHEMISTRY  
GEOL 423  
PROBLEM SET #2  
FALL 2009

Problem 1: Ammonia ( $\text{NH}_3$ ) occurs in the atmosphere naturally at a concentration of 1 ppb (0.001 ppm). You are to determine whether or not this concentration is a result of equilibrium, or steady state.

- a) Convert the concentration of  $\text{NH}_3$  to its partial pressure, assuming an atmospheric pressure of 1 bar.
- b) Write the appropriate chemical reaction you would expect to govern the concentration of  $\text{NH}_3$  in the atmosphere (hint: write the reaction in terms of major components of the atmosphere).
- c) Calculate the equilibrium constant of the above reaction given  $\Delta_f G^\circ(\text{NH}_3, \text{g}) = -3.94 \text{ kcal/mole}$ .
- d) Calculate the partial pressure you would expect if  $\text{NH}_3$  was controlled by chemical equilibrium.
- e) Is the concentration of  $\text{NH}_3$  in the atmosphere a result of chemical equilibrium?

Problem 2: Assuming that the concentrations of hydrogen sulfide, ammonia, carbon disulfide and methyl chloride are controlled by steady state processes, use the data in Table 3.3 (Andrews et al., 2004) to calculate the annual fluxes of each of these trace gases into and out of the atmosphere.

Problem 3: Of the trace gases listed in Table 3.3, which ones are likely to present the greatest long-term pollution hazard and why?

Problem 4: Using data from Tables 1 (Box 3.4), 3.1 and 3.3 in Andrews et al. (2004), calculate the concentration (in moles/L) of the following gases in a rain droplet in equilibrium with the atmosphere at  $15^\circ\text{C}$ : ammonia, carbon monoxide and oxygen.

Problem 5: Look up the pK values for the first dissociation of the following acids: HCl, HF, acetic acid ( $\text{CH}_3\text{COOH}$ ), phosphoric acid ( $\text{H}_3\text{PO}_4$ ) and boric acid ( $\text{H}_3\text{BO}_3$ ). Place these in order of decreasing acidity.

Problem 6: Calculate the partial pressure of neon at 52 km height above the surface of the Earth using data from Table 3.1 (Andrews et al.).