Exercises

A. Consider an air mass containing 0.2 mL liquid water (cloudwater) per 1000 L of air. HOOH is at equilibrium between the gas phase and the aqueous phase with a mixing ratio in the gas phase of 0.5 ppbv at 298 K and P_{total} = 0.95 atm. What is [$HOOH_{(aq)}$]?

B. Consider the air mass described in Exercise A. If the gas phase contains 3 ppb of SO_2 in equilibrium with the various forms of S(IV) in the aqueous phase, whose pH is 4.5, **what is the concentration of HSO_3^-** in the aerosol phase?

C. If all the drops in the air mass in Exercise A were of 30 μm diameter, what is the surface area per unit volume?

Volume of a sphere = $(4/3)\pi r^3 = (1/6)\pi D^3$ Surface area of a sphere = $4\pi r^2 = \pi D^2$

Hint: First solve for # of drops per unit volume air = $\frac{\frac{volume\ of\ liquid\ water}{volume\ air}}{\frac{volume\ liquid\ water}{one\ drop}}$

D. Under the conditions of the air mass in Exercises A and B, and with an ozone concentration of 100 ppbv in the gas phase, what is the rate at which aqueous S(IV) is oxidized by ozone?

E. What are typical lifetimes for Aitken nuclei, accumulation mode, and coarse particles? What <u>controls</u> the lifetimes of Aitken nuclei, accumulation mode, and coarse particles?

F. Is sea-salt aerosol primary or secondary aerosol? What mode does it (mostly) belong to? What mode is mineral dust?
Oxidation of gaseous toluene can form aerosol; is this aerosol primary or secondary?
What aerosol mode would probably have most of the mass of oxidized aromatic hydrocarbons?

G. Using the data from Table 2.21 of the 3rd edition the textbook (Table 2.20 of the 2nd edition), calculate the fraction of the flux of aerosol to the atmosphere that comes from anthropogenic sources.

Problems

1. Given: The air mass described in Exercise A. Assume the calculated solution-phase concentrations of HOOH (from Exercise A) and HSO_3^- (from Exercise B) are maintained.

Question a: Calculate the rate of oxidation of S(IV) in the aerosol phase.

Question b: Calculate the pseudo-first order lifetime of S(IV) in the aerosol phase.

Question c: Calculate the pseudo-first order lifetime of SO_2 in the gas phase with respect to aqueous phase oxidation.

2. Given: A **different** air mass than the one described in Exercise A. This air mass is at 298 K and 1 atm, and has and SO_2 concentration of 1 ppbv. The aqueous phase concentration of SO_3^{2-} is 4.2×10^{-13} moles/L. Compute the pH of the aqueous phase.

3. Given: Answers to Exercise E, F, and G, as well as Table 2.21 of the 3rd edition the textbook (Table 2.20 of the 2nd edition).

Question: Why should governments bother regulating anthropogenic aerosol emissions if these only constitute a small fraction of all aerosol emissions?

Type of Answer: Qualitative. There are 4 reasons, each with a different basis:

i) knowledge of aerosol behavior from this course (quantitative arguments)
ii) basic knowledge of geography
iii) background knowledge of chemistry and human health
iv) page 22 in FP+P and Figure 2.12 in FP+P