

YOUR NAME: _____

AT 621
Atmospheric Chemistry

Exam 2

Thursday,
November 20, 2003

Exam is 1 hour
FOUR PROBLEMS
Unequally weighted

CLOSED BOOK

CLOSED NOTES

1. [40 points]

Below are data obtained for an atmospheric aerosol sample.

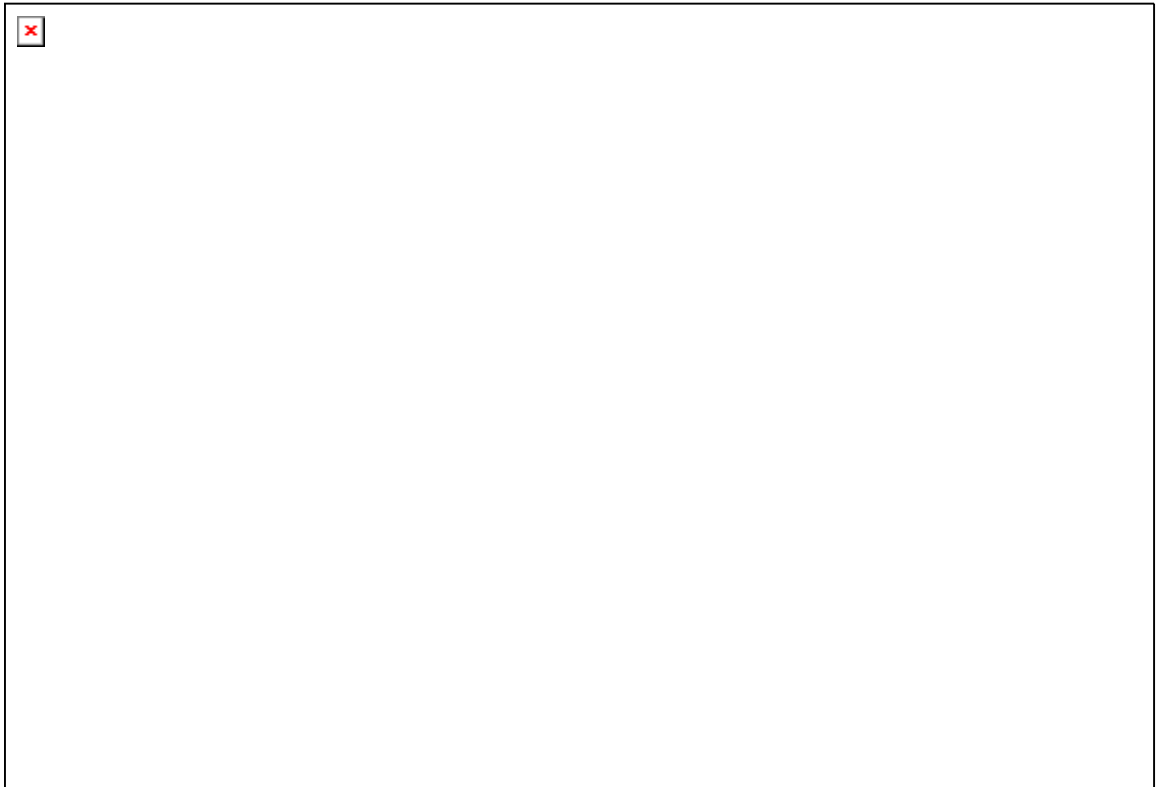
(a) Compute and *sketch* the **volume** distribution function, $dV/d\log D_p$, in units of cubic microns per cubic centimeter, as a histogram on the grid provided (next page).

(b) Estimate the total number of particles in this sample.

DATA:

Density of the particulate matter: 1.8 g cm^{-3}

Lower diameter limit (microns)	Upper diameter limit (microns)	Mean diameter in bin (microns)	Mass concentration ($\mu\text{g m}^{-3}$)			
0.1	0.2	0.1414	1.45			
0.2	0.5	0.316	9.84			
0.5	1.0	0.707	12.8			
1.0	2.5	1.58	8.2			
2.5	5.0	3.54	0.7			



Problem 1, continued.

2. [30 points]

A cloudwater sample was determined to have in it the following dominant ionic species:

dissolved SO_2 , sulfate (SO_4^{2-}), sodium (Na^+), and calcium (Ca^{2+}).

- (a) Write the electroneutrality equation for the cloudwater solution.
- (b) Develop an equation that could be used to solve for pH of the cloudwater in terms ONLY of the measured concentrations of the ions sulfate, sodium, and calcium, and the measured total dissolved SO_2 (expressed as dissolved S(IV)). Use appropriate symbols for any equilibrium constants you require, but please define them.

Problem 2 / 4

(Problem 2, continued)

3. [20 points]

- (a) Define the terms comprising the total extinction coefficient and indicate briefly what species contribute to each.
- (b) Following are data for the composition and mass distribution of an atmospheric aerosol sample, obtained at a very dry relative humidity. Use the data and the accompanying figures to estimate the dry aerosol extinction coefficient.

Ammonium sulfate: total mass, $20 \mu\text{g m}^{-3}$. Narrow mass size distribution centered at $0.2 \mu\text{m}$ diameter.

Elemental carbon: total mass, $2 \mu\text{g m}^{-3}$. Narrow, bimodal size distributions with medians at 0.01 and $0.1 \mu\text{m}$ diameter. 80% of the mass in is the larger mode.

Refractive indices: dry ammonium sulfate, $1.53 - 0i$; elemental carbon, $2.0 - 0.25i$.

[figures: 22.8 from text]

Problem 3/ 4

(Problem 3, continued)

4. [10 points]

Briefly discuss the pathways by which the major acidic species in clouds and precipitation, sulfate and nitrate, are incorporated into cloudwater and precipitation.

