ESM 321 **HW #2**

Please complete the following problems (engineering paper is recommended, although not required).
You may submit a print-out from Excel that clearly shows all the work and is properly annotated with comments describing your process. If I can't easily trace your steps, I won't be able to assign partial credit.

Date due: Tues, Feb 28, 2017 in class. No submissions by email. (60 pts available)

Concepts to consider:

- Mass = concentration x volume
- Net flux = inputs – outputs
- Wet vs. dry deposition
- Calculate volume of rain given rainfall depth and area of watershed
- Use metric units
- Molar masses of P vs. PO_4^{3-} are different
- Average flux = (Total inputs + Total outputs)/2
- Residence time = standing stock / flux into **or** out of pool
- New growth = flux into pool of live biomass

Questions 1-3 relate to one ecosystem, and questions 4-5 relate to another one. You may find it helpful to start out by drawing a box model that shows inputs, outputs, and storage in each system, to or

1. (10 points) Below you are given the average monthly streamflow from the Saltzmann Creek watershed in Forest Park. If phosphate (PO_4^{3-}) concentration in the streamflow was found to average 0.155 mg/L throughout the year, estimate (a) the total volume of water (in L) and (b) the total mass of streamwater-exported PO_4^{3-} (in kg of PO_4^{3-}) leaving the watershed in an average year.

Month	Mean Q [cfs]		Month	Mean Q [cfs]
Oct	0.493		Apr	2.486
Nov	1.669		May	1.358
Dec	2.348		Jun	0.500
Jan	2.631		Jul	0.333
Feb	2.349		Aug	0.199
Mar	2.014		Sep	0.191

2. (10 points) Suppose that precipitation for an average year in the Saltzmann Creek watershed in Forest Park was 39.5 inches and that average P concentration in rainfall was 6.4×10^{-2} mg P/L. Further, suppose that an average of dryfall P deposition rate was found to be 1.60×10^{-5} kg P ha^{-1} hr^{-1}. Suppose that in an average year it rains for a total of 1060 hours. Assume the drainage area of the watershed is 2.50×10^{2} ha. What is the total mass of atmospheric P input to the watershed in a year?

3. (10 points) (a) If rock weathering represents 83% of P inputs and atmospheric P represents 17% of total inputs, how much P enters the watershed annually from rock weathering? (b) Based on your computations in problems 1 and 2, compute the net flux of P to/from the watershed on an annual basis. (c) State what percentage of total P inputs are retained (you can assume that PO_4^{3-} is the dominant form of P being exported in stream water)

4. (15 points) The values in the table were found in a mature forest in central Oregon (Sollins et al. 1980. *Ecol. Monog.* 50:261-285). Assume these values are representative of conditions at the Saltzmann Creek watershed. What is the total mass of P in (a) the top meter of soil, (b) live biomass, (c) dead biomass, and (d) the entire watershed?

Ecosystem Component	Mass (Mg/ha)	P %
Foliage	1.39×10^{1}	0.22
Aboveground live wood	7.05×10^{2}	0.008
Roots	1.53×10^{2}	0.01
Conifer leaf litter	1.86	0.16
Broad leaf litter	0.48	0.088
Woody litter	1.12	0.045
Soil (1m depth)	1.50×10^{4}	0.0057

5. (15 points) Assume that live root growth represents 10.0% of total root biomass and new foliage represents 25.0% of total foliage each year. Assume that the system is roughly in equilibrium with respect to P flux. Assume that PO_4^{3-} represents the dominant form of P in the stream and atmospheric inputs. Estimate the residence times of P for (a) living biomass and (b) the entire watershed. (c) Briefly discuss the relative importance of the soil vs. the live biomass in maintaining P in this watershed ecosystem.