

Assignment 5:

1. Plot the following data as an adsorption isotherm and compute the K_d .

Vw (ml)	Ms (g)	Co (g ml ⁻¹)	Cw(g ml ⁻¹)
100	10	1	0.903
100	10	2	1.85
100	10	3	2.8
100	10	4	3.7
100	10	5	4.59

2. You are working as a consultant for a southwestern US city. They want to operate recharge basins on former farm land contaminated with Toxaphene. To improve modeling efforts, you want to measure the adsorption isotherm directly for the site soils. You begin by looking up the K_{oc} of Toxaphene. The soil f_{oc} value averages 0.0001. Using these values as a starting point, propose (and justify) an appropriate solid/solution ratio to use in the batch adsorption measurements.
3. There is a master's student working for an important professor in Oregon. The student is interested in sorption and the effects of solid/solution ratio because of the potential problems for the results such an effect would suggest for centrifugation as a means of separating solid and solution. He collects the following data:

Vw (ml)	Ms (g)	Co (mg L ⁻¹)	Cw (mg L ⁻¹)
10	10	1	0.95
1000	10	1	0.84
1000	1	1	0.91
1000	0.1	1	0.93
10000	0.1	1	0.8

He and the professor publish a paper concluding that there is a significant effect of the solid solution ratio on the adsorbed concentration C_s based on a plot of $\log(Ms/Vw)$ vs. $\log C_s$ (or $\log K_d$). Make the plot and explain why the student's results (and the professor's paper) are flawed. Bowman and Sans [1985] may help.

4. You are a very ambitious Ph.D. student and you want to measure the adsorption of TCE over a very broad range of concentrations. You have eliminated volatilization and degradation. You collect the following data:

Vw	Ms	Co	Cw
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(ml)	(g)	(mg L ⁻¹)	(mg L ⁻¹)
1000	10	0.004805	0.000956
1000	10	0.01999	0.006026
1000	10	0.037336	0.013183
1000	10	0.777729	0.479034
1000	10	5.262662	3.953834
1000	10	106.7595	94.67231
1000	10	577.8422	537.1032

Plot the data as C_w vs. C_s and as $\log C_w$ vs. $\log C_s$. Fit a Freundlich isotherm, give the Freundlich parameters and their units, and plot a smooth Freundlich isotherm as a solid line on the graph of C_w vs. C_s where the original data are shown as points.

5. You are working of the movement of phosphorous contained in canal water into Everglades National Park by transport in ground water. You find the following data on the sorption of P to the limestone in the literature [Zhou and Li, 2001]:

C_w ($\mu\text{g ml}^{-1}$)	C_s ($\mu\text{g g}^{-1}$)
0.05	0.73
0.80	3.21
1.82	3.06
4.51	7.67
18.91	17.79

Plot the data as C_w vs. C_s and as C_w vs. C_w/C_s . Fit a Langmuir isotherm, give the Langmuir parameters and their units, and plot a smooth Langmuir isotherm as a solid line on the graph of C_w vs. C_s where the original data are shown as points.

6. You are evaluating the sorption rate of a pesticide onto a soil. You begin with a concentration of 1 mg L^{-1} and make the following observations:

Time (min)	Concentration (mg L^{-1})
10	0.372972
20	0.15018
30	0.051686
40	0.022435
50	0.007959
60	0.002594
70	0.000973
80	0.000425
90	0.000147
100	4.61E-05

Plot the data as time vs. C/C_0 and as time vs. $\ln(C/C_0)$. Determine the rate constant of the reaction and give the half life.

7. Explain the terms in and the meaning of the following equation:

$$\frac{dC_{s_2}}{dt} = \alpha[(1 - F)KdC_w - C_{s_2}] \quad (1)$$

References:

Zhou, M. and Y. Li 2001. Phosphorous-sorption characteristics of calcareous soils and limestone from the southern Everglades and adjacent farmlands, *Soil Sci. Soc. Am. J.* 65:1404-1412.

Bowman, B. T. and Sans, W. W. 1985. Partitioning behavior of insecticides in soil-water systems: I. Adsorption concentration effects. *J. Environ. Qual.* 14: 265–269.