Problem 1.
The sorption of nonionic organic contaminants is caused by “hydrophobic” interactions. Thus, the sorptive distribution coefficients ($K_d$) of contaminants are related to parameters that describe the affinity for water (or hydrophobicity) of the contaminant and the soil. These parameters are the octanol/water partition coefficient, $K_{ow}$, which serves as a measure of contaminant hydrophobicity, and the weight fraction of organic carbon in soils ($f_{oc}$) which serves as a measure of the soil’s hydrophobicity. Several correlations have been published including the following:

$$\log K_d = 0.72 \log K_{ow} + \log f_{oc} + 0.49.$$  

This equation is empirical, and yields $K_d$ values with units of mL/g.

Determine the velocity of a contaminant front relative to that of the pore water in an aquifer subject to the following conditions. The $K_{ow}$ value for the contaminant is 100, the porosity of the aquifer is 0.2, the bulk density of the aquifer material is $2.0 \times 10^6$ g/m$^3$, and the fraction of organic carbon in the soil is 0.15.  

Ans.: the contaminant moves 128.7x more slowly

Problem 2.
(From the 1990 2nd prelim). An aquifer is contaminated with a toxic organic compound that is partially sorbed ($K_d = 4$ cm$^3$/g) to the aquifer media. The aquifer has a porosity of 0.33, a bulk density of 1.8 g/cm$^3$, a hydraulic conductivity of 150 m/day and a cross-sectional area (perpendicular to flow) of 100m$^2$. It was decided to decontaminate the aquifer by sinking a well 200 meters down-gradient from the contamination and pumping the groundwater to a treatment facility. The groundwater elevation difference between the contamination site and the withdrawal well is 0.1 meters after steady state pumping is reached. Neglect dispersion of the toxic compound. Determine the volume of clean water that has to be pumped before the toxic material begins to appear in the withdrawal well.  

Ans.: $1.51 \times 10^5$ m$^3$

Problem 3.
In laboratory experiments using pesticide and samples from a sandy aquifer, it is observed that when water with the pesticide is equilibrated at various concentrations with the sand samples, the partitioning of the pesticide between the liquid and solid phases is as follows:

<table>
<thead>
<tr>
<th>test number</th>
<th>amount sorbed (µg/g)</th>
<th>solution conc. (µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>110</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>220</td>
</tr>
<tr>
<td>3</td>
<td>600</td>
<td>560</td>
</tr>
<tr>
<td>4</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>
What distribution coefficient (in ml/g) is indicated by these data? If the sand porosity is 35% and its bulk density is 1.7 g/ml, estimate the velocity of the pesticide relative to that of the pore water in the aquifer. **Ans.: the pesticide travels 6.29x more slowly**

**Problem 4.**
A water-saturated 100 cm$^3$ soil core is found to contain 40 cm$^3$ of pore water. The total contaminant in the core is 50 mg, of which 5 mg is dissolved in the pore water and the rest is sorbed on the soil. If the soil in the core has a bulk density of 1.8 g/cm$^3$, what is the retardation coefficient of the contaminant (R)? **Ans.: R = 10.**

**Problem 5.**
Do STELLA Exercise #5. Please remember to turn it in separately from the rest of your homework assignments.