

PLSC 608
 Environmental Soil Chemistry
 Examination 1
 April 28, 2004

Name : _____

(5) I. Given:

Z = valence
 IR = ionic radius

<u>Ion</u>	<u>Z</u>	<u>IR</u> (nm)
O	-2	0.140
Si	+4	0.039

In terms of Pauling's Rules, give the cation-anion distance, the relationship to coordinate number, and the electrostatic bond strength for Al-O in a clay structure.

(52) II. Given the following chemical and mineralogical properties for a soil:

<u>pH</u>	<u>SOM</u>	<u>Clay Content</u>	<u>Goethite</u>	<u>Clay Mineral Suite</u>
-----%-----				
6.0	2	15	5	Chlorite, Quartz, Vermiculite, Montmorillonite,

Answer the following:

1. Give the half-cell formula for montmorillonite in the soil. Is montmorillonite dioctahedral or trioctahedral? Why?

6. Sketch the potential (ψ) vs. distance (x) for the soil according to the Gouy-Chapman double layer theory. Make sketches at low and high electrolyte concentration. Show the thickness of the double-layer ($1/\kappa$) for both concentrations. How would $1/\kappa$ be affected by using 1 M AlCl_3 vs. 1 M NaCl ? Water vs. Methanol?
7. You apply the constant capacitance model (CCM) to describe arsenate adsorption on the soil. Sketch this model, showing the different layers and what species (ligands, metals, etc.) are contained in each layer. What is the balance of surface charge equation for the CCM?
8. Assume the half-cell chemical formula for chlorite in the soil is $(\text{Mg}_2\text{Al}, \text{OH}_6)(\text{Si}_3, \text{Al})\text{Mg}_3\text{O}_{10}(\text{OH})_2$.
- a) Calculate the layer charge of the clay (half-cell formula unit).
- b) Set up the formula for calculating the CEC of the clay.

c) Give the elements in the tetrahedral layer.

d) Is the clay dioctahedral or trioctahedral? Why?

9. Sketch a monodentate inner-sphere complex between Pb^{2+} and the goethite of the soil.

10. If Ni^{2+} were adsorbed on the soil, what adsorption complexes would you expect and why?

11. Assume that surface precipitation occurred on the soil and that a layered double hydroxide precipitate phase formed. Sketch what the phase would look like. What would be the possible mechanism(s) for the formation?
12. You sorb Co^{2+} on the soil at a low ionic strength ($0.006M$) and a high ionic strength ($0.1M$) and you do XAFS analyses. At the high ionic strength, the predominant Co complex is inner-sphere, while at the low ionic strength, the major complex is an outer-sphere. What would explain this?
13. Assume you collected XAFS data for Ni sorbed on the DE soil. You determine that the coordination number (N) for the second neighbor Ni (Ni-Ni) increases with reaction time. What can you conclude, based on these data?

7. Given the figure below for goethite, label a Lewis acid, a Lewis base, and a Lewis acid site. Based on the diagram, what would be the adsorption mechanism for phosphate sorption on goethite?

8. You study Zn^{2+} sorption on a soil using the Langmuir equation. You observe one slope. What parameters can be obtained? What do they mean? What can you conclude about the mechanism of Cd^{2+} sorption?

9. Sketch a L-curve adsorption isotherm. Label the axes.

10. Define XANES and EXAFS. What information can be gleaned from an EXAFS analyses?

11. What are the three major types of complexants or ligands in soils?