

### Study Questions Exam 3

1. Name the four general types of soil colloids.
2. What are the three general types of layer silicate clay minerals?
3. What are the two basic building blocks (units of atoms in certain geometric configurations with respect to a central atom) of silicate clay minerals.
4. How many silicon tetrahedral sheets and aluminum octahedral sheets are there in a 1:1 aluminosilicate clay? In a 2:1? In a 2:1:1?
5. Why don't 1:1 minerals expand when these are exposed to water?
6. Of these general types of layer silicate minerals, only certain 2:1 minerals expand. Name the three general types of 2:1 minerals. Which is expanding? Which is limited-expanding? Which is non-expanding?
7. Explain why illite does not expand.
8. Are silicate clay minerals primary or secondary? Arrange 2:1 minerals, Al and Fe oxides and 1:1 minerals in their natural weathering sequence.
9. What kind of clay mineralogy might you expect in Honduras? In Ontario?
10. What is isomorphic substitution? What charge occurs if  $\text{Al}^{3+}$  is substituted for  $\text{Si}^{4+}$ ? Does this occur in the octahedral sheet or tetrahedral sheet? What if  $\text{Mg}^{2+}$  substituted for  $\text{Al}^{3+}$ ? In which sheet does this substitution occur?
11. Is electrical charge due to isomorphic substitution permanent? What's the other type of charge on soil colloids called?
12. Explain how pH-dependent charge arises in mineral and organic colloids. What functional groups are involved?
13. Define cation exchange capacity (CEC). Define AEC.
14. What happens to CEC as pH increases? What happens to AEC as pH decreases?
15. Given data (millimol (+) / 100  $\text{g}_{\text{soil}}$  or cmol (+) /  $\text{kg}_{\text{soil}}$ ) for basic cations and acidic cations in a soil, be able to calculate the CEC. Also, be able to calculate the percentage base saturation (% BS).

16. What is the general relationship between pH and % BS?
17. Rank kaolinite (a 1:1 mineral), illite, smectite and vermiculite in order of decreasing CEC. Assuming neutral soil pH, how does the CEC of humus compare to the highest CEC mineral colloid?
18. Knowing what you do about the CECs of different colloids and that there is such a thing as pH-dependent charge, what are three factors that determine the CEC of a soil?
19. Write a balanced equation that represents the cation exchange of solution phase  $K^+$  for adsorbed  $Ca^{2+}$ .
20. Cation exchange in soils is (slow / rapid) and (reversible / irreversible).
21. Explain why 1 N  $NH_4OAc$  (ammonium acetate) is used to displaced adsorbed basic cations in measurements of CEC. Would 0.01 N  $NH_4OAc$  be equally effective?  
  
Why isn't 1 N  $NH_4OAc$  used in an extraction procedure to measure acidic cations?
22. Arrange  $Na^+$ ,  $K^+$ ,  $Al^{3+}$ ,  $Mg^{2+}$ ,  $Ca^{2+}$  and  $H^+$  in order of decreasing affinity (strength) of adsorption onto soil colloids.
23. Why is  $Al^{3+}$  considered an acidic cation?
24. Why do humid region soils tend to become acidic?
25. The concentration of  $H^+$  in the soil solution is 0.00001 M. What is the pH? Is this soil acid, neutral or basic? What is the concentration of  $OH^-$ ?
26. What is the source of acidity in distinctly acid soils, say pH < 5? What about in more mildly acid soils, say pH 5 to 6.5?
27. What is the source of  $OH^-$  in alkaline soils.
28. From the standpoint of plant growth, what is the usual optimum range in soil pH?
29. What is active acidity? Exchangeable? Residual?
30. List several ways by which soil pH is altered.
31. What is pH buffering? What reactions buffer soil pH when base is added to an acid soil? When acid is added to an alkaline soil?

32. What is shown by a soil buffer curve?
33. Name three types of lime materials.
34. What material is commonly used to lower soil pH?
35. Let's say you have found that it takes 1.0 meq of  $\text{OH}^-$  per 10 g of soil to raise the pH from 5.0 to 6.6, how many Mg of  $\text{CaCO}_3$  do you need to add to the HFS. The milliequivalent weight of  $\text{CaCO}_3$  is 50 mg. Assume a HFS has a mass of 2000 Mg. How many tons of  $\text{CaCO}_3$  per AFS (1000 tons per AFS)?
36. Question 35 refers to soil A. Soil B has exactly the same shape buffer curve as soil A. It, too, is initially at pH 5.0 and you want to raise the pH to 6.6. However, the CEC of soil B is twice the CEC of soil A. Would you need to add more or less lime to soil B than to soil A? About how much lime would be needed for soil B?
37. Soil tests show that you need to add 1 ton of finely ground limestone per acre to adjust the soil pH of 10 acre contaminated site for optimal microbial degradation activity. Having a cushy budget and knowing that CaO is faster reacting, you opt for it instead of the limestone. How much do you apply?
38. Liming is a once in a life-time, permanent correction of soil acidity (True / False).
39. What effect does soil salinity have on plant uptake of water?
40. Tendency for soil salinization is greatest under which set of conditions
- | Factor           | A      | B          | C      | D          |
|------------------|--------|------------|--------|------------|
| Irrigation water | Saline | Non-saline | Saline | Non-saline |
| Soil drainage    | Good   | Good       | Poor   | Poor       |
41. What is used as a measure of soil salinity? What are two measures sodicity (Na content)?
42. Soils A and B are both alkaline. There is a whopping lot of Ca in soil A but not much Na. The composition of soil B is just the opposite, a lot of Na, not much Ca. Which likely has the higher pH?
43. Define saline, sodic and saline-sodic soils based on EC and SAR.
44. How does the salt in white alkali soils get to the surface?

45. What causes the black in black alkali soils?
46. Why is the hydraulic conductivity of sodic soils lousy?
47. What happens if you try to flush excess salts from a saline-sodic soil using water of low salt concentration? So in which case (saline, sodic or saline-sodic) is this the proper reclamation strategy?
48. How do you reclaim a sodic or saline-sodic soil?
49. List three benefits of earthworms.
50. In what way do certain nematodes adversely affect plants?
51. Explain why the rhizosphere is biologically and chemically different from the bulk soil.
52. What group of soil microflora is typically the most numerous? Which often has the greatest biomass?
53. Which three groups of soil microflora are principally responsible for organic matter decomposition?
54. What are three types of fungi?
55. What are the mutual benefits derived by plants and fungi in mycorrhizal associations? What are the two most general types of mycorrhizae?
56. Ectomycorrhizal hyphae invade root cells (True / False).
57. What are three general groups (based on morphology) of bacteria?
58. List several important reactions carried out by certain soil bacteria.
59. In regard to soil microbial activity, what do the terms mineralization and immobilization mean? Which is good for plant nutrition, net mineralization or net immobilization?