CRSS/FORS 3060 / Spring 2007 Name _____
Hourly Exam 2 Lab Section # _____

I. Multiple Choice: circle the one best answer; 2 pts. each.

1. The "Law of the Minimum" states that--
A. the minimum amount of nutrient added is the best.
B. the minimum level of input gives the highest profit
C. the most limiting growth factor limits the overall yield.
D. the growth factor in greatest supply maximizes yield.
F. the average of all growth factors determines yield.

2. Over 90% of the total of most nutrients is held in soil as--
A. soluble ions in solution.
B. atoms bound within mineral or organic structures.
C. ions weakly adsorbed on mineral surfaces.
D. ions strongly adsorbed to soil minerals
E. ions held on cation or anion exchange sites

3. Which of the following is a major nutritional problem on highly weathered, acidic ultisols?
A. high levels of Mg released by mineral weathering.
B. low P availability due to strong adsorption on oxides.
C. N deficiency due to fixation by 2:1 clay minerals.
D. direct toxicity of H^+ ions to plant roots.
E. Fe and Mn deficiency caused by excessive leaching.

4. Which of the following is NOT an important function of micro-organisms in forest and agricultural soils?
A. synthesizing humus as part of the decomposition process.
B. helping to supply P to some plants by mycorrhizal association.
C. releasing organic C back to the atmosphere as CO_2.
D. immobilizing cation nutrients (Ca, etc) in mineral structures.
E. mineralizing N and other nutrients from litter back to soluble forms.

5. A fertile acre-furrow slice of soil contains about *how much mass* of living organisms?
A. 0.1 ton B. 1 ton C. 10 tons D. 100 tons E. 1000 tons

6. Which of the following is NOT a good reason to add lime to soil?
A. to supply additional Ca and Mg
B. to precipitate toxic Al as $Al(OH)_3$
C. to reduce the solubility of potentially toxic nutrients such as Mn
D. to optimize the availability of P in the pH range 5.5-6.5
E. to increase N solubility by reducing denitrification

7. The origin of permanent negative charge on clay minerals in soils is--
A. deprotonation of carboxyl functional groups at high pH
B. protonation of surface hydroxyl groups on the clays at low pH
C. substitution of lower valent cations (Mg) for higher valent ones (Al) in the mineral structure.
D. substitution of higher valuent cations (Si) for lower valent ones (Al) in the mineral structure
E. none of the above are correct.

II. <u>Matching</u>: write the letter of the best response in the blank; use each response only once; 1 pt.

8. Nutrients:

_____ soluble, even toxic, at low pH	N
_____ fixed in insoluble forms by some 2:1 type clays	Mo
_____ often deficient due to microbial immobilization	K
_____ deficient in sandy, low %BS subsoils	Ca
_____ strongly adsorbed by Fe oxides at low pH	Zn

9. Instruments in the Lab:

_____ used to measure slope gradient in the field	A. AA spectrometer
_____ used to measure cations such as Ca and Mg in solution	B. clinometer
_____ used in mechanical analysis; measures suspension density	C. hydrometer
_____ used to determine exchangeable acidity	D. titration

10. N cycle:

_____ NO_3^- → N_2 (g)	A. denitrification
_____ organic N → NH_4^+	B. nitrification
_____ NH_4^+ → NO_3^-	C. mineralization
_____ N_2 (g) → organic N	D. symbiotic N fixation

11. Clay Minerals:

_____ 2:1 with partial $Al(OH)_3$ interlayer; common in SE Ultisols	A. illite
_____ 2:1 with partial K interlayer; weathered from mica	B. chloritized vermiculite
_____ 1:1, common in Ultisols; low CEC	C. montmorillonite
_____ 2:1 with high charge, high shrink/swell properties	D. kaolinite

III. <u>Fill-Ins</u>: Write the best term described by the phrase in the blank provided; 1 pt. each.

12_____ German chemist who first stated the "law of the minimum"

13_____ micronutrient anion that is never deficient; can be toxic near the ocean

14_____ chemical symbol of a pollutant that is chemically similar to the microanions

15_____ term for lime that contains a significant amount of magnesium

16_____ a macro-nutrient for which there is *not* a suitable routine soil test

17_____ the most basic N fertilizer, produced directly by the Haber process

18_____ an element that can substitute for Al in octahedral positions in clay minerals

19_____ in the symbol “pH”, what the “p” actually stands for (chemically)

20_____ procedure used to measure the concentration of acid in a solution

21_____ the number of equivalents in 2 moles of Fe^{+3}

22_____ mineral produced when SO_2 (acid rain) is removed from power plants by reaction with lime

IV. <u>Problems / Short Essay</u>: show ALL calculations, neatly; write concise, to-the-point answers to questions.

<u>Atomic Masses: K=39 Ca=40 Mg=24 O=16 P=31 H=1</u>

23. Someone asks you whether they should use organic fertilizer (such as composted manure) or synthetic chemical fertilizer in their vegetable garden; explain to them the pro's and con's of these two types of materials (3 pts.)

24. Show how negative charge is developed on humus and explain the effect of pH on charge. (3)

25. Describe how to take a "composite" soil sample from a field to send to a soil testing lab for soil fertility evaluation. (3)

26. A steel ring (r= 4 cm, h=6.6 cm, empty wt= 45 g) was pushed into an Ap horizon, trimmed flush with the ring, and brought to the lab. Field moist it weighed 395 g, oven-dried 342 g.

A. Calculate bulk density, showing *units*. (2 pts.)

B. Calculate % pore space (1 pt.)

27. A mechanical analysis on 50 g soil gave a 40-sec hydrometer reading of 42 g/L, and a 6-hr reading of 12 g/L. Calculate the % sand, silt and clay in this sample, and estimate the textural class of the soil. (4 pts.)

28. A 2.5 g soil sample is extracted with 40 mL of salt solution, and found to contain 0.7 meq/L of Mg. What is the Mg content of the soil, in meq/100 g?

29. A fertilizer recommendation calls for 50 lbs P_2O_5 per acre and 80 lbs N; how much 30-5-0 and 0-20-0 should be applied per acre? (4 pts)

30. A soil contains the following exchangeable cations, in meq/100g:
Ca:2.0 K:0.4 Mg:1.5 Al:2.5 H: 0.7
(6)

A. Calculate CEC and base saturation.

B. Calculate lbs K/acre-furrow slice.

C. Calculate how much pure CaCO3 would be required (in lbs/afs) to completely neutralize the acidity in this soil.

BONUS 1. A soil contains 1.2% K; this K is released to a soluble form by weathering at a rate of about 0.1% of the total per year. How many lbs K/acre/yr is released?

BONUS 2. The hydrolysis reaction for Cu is

$$Cu(OH)_2 + 2H^+ \rightarrow Cu^{+2} + 2\ H_2O$$

Use Le Chatelier's principle to explain why Cu is soluble under acid conditions, and insoluble under alkaline conditions.

BONUS 3. A manure contains2% N, 4% P, and no K. What is the *analysis*?