CRSS/FANR 3060: *Soils and Hydrology* Name _____
Exam 2 / *SPRING 2009* Lab Section # _____

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

1. A "fertile" soil is defined (specifically) as a soil with--
   A. no limiting factors for plant growth.
   B. large numbers of soil organisms such as worms, insects, etc.
   C. a relative abundance of available nutrients and no excessive acids, salts, etc.
   D. no need for any additional fertilizer or other amendment to give maximum yields
   E. high concentrations of humus and other essential growth factors

2. . A major advantage of using organic fertilizers, compared to commercial synthetics, is--
   A. they have a high analysis compared to other fertilizers
   B. their nutrients are highly soluble and readily plant-available
   C. they add C to the soil, increasing humus levels, and also add other nutreints
   D. only small amounts need to be applied, which can lower fertilizer costs
   E. none of the above are true

3. Gypsum ($CaSO_4$) is--
   A. less soluble than lime.
   B. produced by removing SO_2 (acid rain) from power plants.
   C. useful for raising the pH of soils.
   D. often causes a large decrease in soil pH.
   E. too expensive for common agricultural use.

4. When a low (20:1) C:N residue is mixed into a soil, which of the following would occur?
   A. N is immobilized rapidly, but eventually released as the C:N ratio is lowered over time.
   B. N is readily mineralized due to the rapid decomposition by bacteria.
   C. some N is mineralized into solution, but is quickly nitrified and made unavailable.
   D. the C:N ratio increases rapidly as NH_4 and NO_3 are removed from the soil.
   E. very little decomposition occurs because this residue is probably mostly lignin.

5. A major role that soil organisms play in cycling of many nutrients is--
   A. enhancing the loss of nutrients by encouraging leaching.
   B. removing nutrients from cycles by permanently immobilizing them.
   C. adding large amounts of new nutrients to cycles by weathering soil minerals.
   D. converting organic nutrients back to inorganic forms during decompsition.
   E. more than one of the above.

6. Which of the following is a result of liming an acid soil?
   A. aluminum solubility increases
   B. (H^+) concentration in solution decreases
   C. % base saturation decreases
   D. soil pH decreases
   E. cation exchange capacity decreases

7. Which one of the general forms of nutrients in soils is the *least* plant-available?
   A. ions in the soil solution
   B. strongly adsorbed nutrients
   C. nutrients held within mineral structures
   D. ions held on CEC and AEC sites
   E. all of the above are equally plant-available

8. *Permanent* charge on clay minerals is caused by--
   A. replacement of one cation by another of lower charge during mineral formation
   B. cations being strongly held on the mineral surface (adsorption)
   C. adsorption of hydroxyl (-OH) groups from solution under alkaline conditions
   D. protonation of functional groups in the interlayer space
   E. changes in the structure of clays due to weathering over geologic time

9. The best way to sample soil from a field to evaluate fertilizer needs is to--
   A. lay out a grid on the field and sample at evenly spaced intervals.
   B. take a shovelful of soil from near the center of the field.
   C. take a composite sample of 10-15 random locations within the field..
   D. sample along a transect from one end of the field to the other.
   E. any of the above would be OK.

II. Matching: write the letter of the best answer in the blank; use each answer only once. 1 pt.

10. Clay Minerals:

_____low CEC, 1:1, common in highly weathered soils
_____2:1, high octahedral charge; large shrink/swell capacity
_____2:1, v. high tetrahedral charge; limited shrink/swell
_____initial weathering product of muscovite; partial K interlayer

A. illite (hydrous mica)
B. vermiculite
C. montmorillonite
D. kaolinite
E. chlorite

11. N cycle:

_____ N_2 (g) $\rightarrow$ organic N
_____ $NH_4^+ \rightarrow$ organic N
_____ organic N $\rightarrow$ NH_4^+
_____ $NO_3^- \rightarrow$ N_2 (g)

A. immobilization
B. denitrification
C. symbiotic N fixation
D. nitrification
E. mineralization

12. Laws/Principles:

_____ states how different growth factors affect plant yield
_____ explains how levels of inputs and outputs determine profit
_____ describes rate of settling of particles in water
_____ describes how chemical equilibria respond to disturbance

A. Stokes'
B. Liebig's
C. Le Chatilier's
D. Diminishing Returns

13. Fill-In: write a single word or phrase that matches the definition; 1 pt.

_____ pH of a solution containing 10^{-4} moles/L HCl
_____ symbiotic fungi that enhance plant root uptake of nutrients like P
_____ 6×10^{23} of something (like, atoms)
_____ a pollutant element that behaves in soil similarly to micronutrient anions
_____ element that can substitute for Si in tetrahedral structure of clay minerals
_____ lab instrument used to measure cation (Ca, Mg) concentrations in solution
_____ term for limestone that includes a significant amount of Mg
_____ method used to measure acid concentrations in solutions
_____ name or formula of most important charge-generating group on humus
_____ genus of bacteria that can symbiotically convert N_2(g) into organic N
_____ trade term referring the potassium, or fertilizer containing K

III. Short Answer/Calculation: write a short response to the following; do not restate the question, but give examples when necessary. For calculation, show all your work clearly.

NOTE: Ca: 40 Mg: 24 K:39 P: 31 O: 16 H: 1 N: 14 C: 12

14. List and briefly explain three ways that increasing levels of humus in soils tend to increase overall soil productivity. (3 pts.)

15. Show/explain how charge is developed on humus, and how pH affects this charge. (3 pts)

16. A soil contains the following exchangeable cations (in meq/100 g): Mg: 0.5; Ca: 2.3; K: 0.3; H: 0.5; Al: 1.9. Calculate:

A. CEC (2 pts)

B. %BS: (2 pts)

C. lbs K/afs: (3 pts)

17. A plastic-coated clod weighing 44 g was immersed in water and found to displace 35 g. of water. (4 pts.)

A. Calculate bulk density, showing *units*.

B. Calculate % pore space

C. If this sample came from a loamy A horizon, is this BD favorable value for plant growth?

18. A mechanical analysis on 50 g soil gave a 40-sec hydrometer reading of 18 g/L, and a 6-hr (second) reading of 8 g/L. Calculate the % sand, silt and clay in this sample, and estimate the textural class of the soil. (4 pts.)

19. Convert 1.55 g/cm^3 to lbs/ft^3 [454g=1lb, 2.54 cm=1 inch]. (3 pts)

20. In measuring CEC, cations are extracted from 2.5 g soil using 40 mL of salt solution. This solution is found to contain 1.7 meq/L of Ca. Calculate exchangeable Ca in meq/100 g. (3 pts)

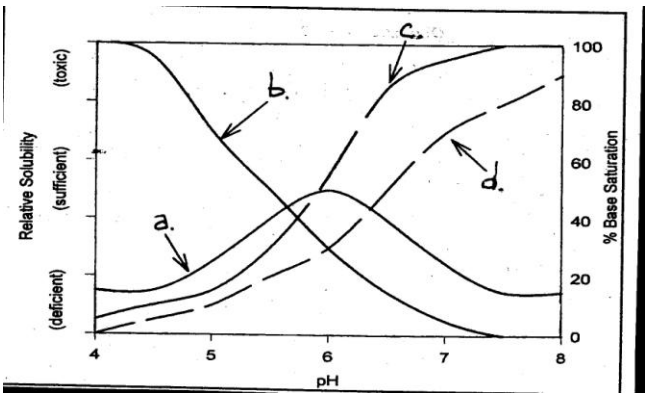
21. For the graph at right, identify the nutrient or nutrient *group* that corresponds with each line:

a._____ (4 pts)

b. _____

c. _____

d. _____



BONUS:

A. Nitrogen is NOT shown on the graph in 21. above. Explain briefly why not. (2 pts)

B. How many mL of 1 *N* acid would it take to completely neutralize 1 g of pure $CaCO_3$? (2 pts)

C. What is your favorite micro-nutrient cation? ____ (1 pt)