

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

1. Protonation/deprotonation of surface hydroxyl groups is the primary way charge (CEC/AEC) is generated on--

- A. Humus B. Illite C. Kaolinite D. Montmorillonite E. Feldspars

2. One reason mollic A horizons nearly always have higher CEC's than Ultisol A's is because Molliols have--

- A. More acid pH's
B. More 2:1-type minerals
C. Higher base saturations
D. More Fe oxides
E. All of the above

3. The most important principle to follow in sampling soils for fertility evaluation of a field is to --

- A. be sure to sample unusual areas that might have different nutrient levels.
B. get a composite sample that accurately represents the entire field.
C. use your best judgement to sample a single area that might best represent the entire field.
D. take a number of separate samples for analysis, and average the results of the recommendations.
E. just sample from anywhere--most of the error in soil testing is in the analysis, not the sampling.

4. In a forest managed for timber production, which of the following is NOT a significant loss of nutrients such as N from the system over time?

- A. removal of nutrients in harvested trees
B. erosion, especially after harvesting
C. leaching out of the rooting zone
D. loss of minerals due to weathering
E. losses (gaseous) from burning during site preparation

5. One of the best things about organic fertilizers, compared to inorganic, commercial fertilizers, is--

- A. they are usually free, so your nutrients cost you nothing.
B. they are concentrated, so you don't have to put much on.
C. they add humus and a wide range of different nutrients.
D. they are rapidly water soluble, and are very fast-acting.
E. they contain magical, mysterious growth factors that stimulate plant growth.

6. Which of the following occurs when a soil is limed?

- A. soil pH increases B. (H^+) concentration in solution increases
C. % base saturation decreases D. Aluminum solubility increases
E. Cation exchange capacity decreases

7. Which of the following is NOT an important function of micro-organisms in forest and agricultural soils?
- synthesizing humus as part of the decomposition process.
 - helping to supply P to some plants by mycorrhizal association.
 - releasing organic C in residues back to the atmosphere as CO₂.
 - releasing bases into solution through weathering of parent material
 - mineralizing N and other nutrients from O horizon back to soluble forms.
8. Which of the following general forms of nutrients in soils can be considered to be *readily plant-available* (circle ALL correct answers)?
- soluble ions in the soil solution
 - strongly adsorbed nutrients
 - nutrients held within mineral structures
 - ions held on CEC and AEC sites
 - nutrients that form part of the structure of humus
9. For the reaction $\text{CaCO}_3 + 2\text{H}^+ \leftrightarrow \text{Ca}^{+2} + \text{H}_2\text{O} + \text{CO}_2 (\text{g})$, LeChatilier's principle would say that--
- lime is very soluble in water
 - lime will be more soluble as the atmospheric CO₂ pressure increases
 - lime dissolves more at higher pH than at lower pH
 - lime dissolves more at lower pH than at higher pH
 - nothing—none of the above have anything to do with Mr. LeChatilier.

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

10. Clay Minerals:

- _____ low CEC, common in highly weathered soils
- _____ 2:1, very high shrink/swell capacity
- _____ weathering product of muscovite, partial K interlayer

- illite (hydrous mica)
- vermiculite
- montmorillonite
- kaolinite

11. Nutrients:

- _____ macronutrient strongly adsorbed by Fe oxides
- _____ soluble at low pH, strongly adsorbed by humus at high pH
- _____ toxic at high pH, deficient under acid conditions
- _____ abundant in feldspars, also held on CEC sites

- N
- P
- K
- micronutrient cations
- micronutrient anions

12. N cycle:

- _____ $\text{NH}_4^+ \rightarrow \text{NO}_3^-$
- _____ organic N $\rightarrow \text{NH}_4^+$
- _____ $\text{NH}_4^+ \rightarrow$ organic N
- _____ $\text{N}_2 (\text{g}) \rightarrow$ organic N
- nitrification
 - mineralization
 - symbiotic N fixation
 - Immobilization
 - denitrification

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

- _____ a secondary nutrient that occurs (or, used to) in acid rainfall
- _____ most numerous, active, and common soil micro-organisms
- _____ how we measured exchangeable acids in soil in lab
- _____ a way in which nutrients can be lost from the nutrient cycling system
- _____ a pollutant metal that behaves in soil similarly to micronutrient cations
- _____ name or formula of most important charge-generating group on humus
- _____ major "input" needed to make NH₃ in the Haber process
- _____ chemical formula of most common K fertilizer sold

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

14. Discuss the benefits to plant growth (specifically) of higher humus levels in soil. Describe at least 3 distinct ways that humus improves plant production. (3 pts.)

15. Show/explain how charge is developed on clay minerals. (3 pts)

16. A soil contains the following exchangeable cations (in meq/100 g): Ca, 2.4; Mg, 0.5; K, 0.18; H: 0.5; Al, 1.7.
Calculate: (4 pts)
A. CEC

B. %BS:

C. lbs K/afs:

17. A plastic-coated clod weighing 40 g (after oven drying) was immersed in water and found to displace 32 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 a favorable value for plant growth? Y or N

18. A mechanical analysis on 50 g soil gave a 40-sec hydrometer reading of 36 g/L, and a 6-hr (second) reading of 22 g/L. Calculate the % sand, silt and clay in this sample, and estimate the textural class of the soil. (4 pts.)

19. A fertilizer recommendation calls for 80 lbs N per acre; how much 12-20-8 should you apply? How much K_2O and P_2O_5 would also be added with this application rate? (4 pts)

20. (*Bonus*): 3.5 g of soil is extracted with 50 mL of a salt solution (NaCl) and Ca is measured by AA spectroscopy in that solution; the reading is 14 mg Ca/L. (4 pts)

A. What is the Ca level in the soil in units of ppm? How many lbs/afs is this?

B. Convert this to meq/100 g.