1.) Please define, explain, or diagram the following terms: (2 points each)

Justice Von Liebig’s "Law of the Minimum":

Symplasmic Transport:

Calcareous Soil:

Soil pH Buffer Capacity:

Exchangeable Acidity:

Cation Exchange Capacity:

 Percent Base Saturation:

Total points this page = 14 out of 100.

2.) What is the pH of 0.00000125 M H₂SO₄? (3 points)
3.) What is the $H^+$ concentration of the solution given in question 2 (include units)? (2 points)

4.) I have a sulfuric acid ($H_2SO_4$) solution with a pH of 6.7. What is the molarity of this solution (include units)? (3 points)

5.) What is the pOH of the solution in question 4? (2 points)

6.) I have two solutions of sodium chloride ($NaCl$) with a pH of 5.0
   Solution A is a 0.5 M $NaCl$ solution
   Solution B is a 0.1 M $NaCl$ solution
   Based on your knowledge of the difference between activity and concentration:
   a. Which solution (A or B) has a higher $H^+$ concentration? (1 point)
   b. Why? (2 points)

7.) Please list four reasons why soil pH is important. (4 points, 1 point each)
   1.
   2.
   3.
   4.

Total points this page = 17 out of 100.

8.) In class we discussed two compounds that can be used to lower soil pH. Please list one of these compounds. (2 points)
9.) Given the following atomic weights: Cu = 63.5 g mole⁻¹, S = 32 g mole⁻¹, and O = 16 g mole⁻¹.

Show all work and include units!!!
What is the molecular weight of CuSO₄? (3 points)

What is the equivalent weight of CuSO₄? (3 points)

What is the milliequivalent weight of CuSO₄? (2 points)

10.) We know that the molecular weight of CaMg(CO₃)₂ = 184 g mole⁻¹, (the atomic weight of Ca = 40 g mole⁻¹, Mg = 24 g mole⁻¹, C = 12 g mole⁻¹, O = 16 g mole⁻¹, and H = 1 g mole⁻¹) and that the equivalent weight of CaMg(CO₃)₂ = 46 g mole⁻¹. We also know that the molecular weight of CaCO₃ is 100 g mole⁻¹ and that the equivalent weight of CaCO₃ is 50 g mole⁻¹. Show all work!!!

What is the calcium carbonate equivalent (CCE) of CaMg(CO₃)₂? (3 points)

11.) If the sieve analysis of the CaMg(CO₃)₂ from question 10 showed that 90 percent of this material passed an 8-mesh sieve and 50 percent of it passed a 60-mesh sieve:

What is the Fineness Factor for this material in the U.S.A.? (3 points)

What is the relative neutralizing value (RNV) of this material? (3 points)

Total points this page = 19 out of 100.

12.) Please list the 3 (three) criteria that must be met for an element to be considered essential for the growth and development of higher plants. (6 points, 2 points each)
13.) Given the following:
   Organic matter CEC = 200 cmol(+) kg\(^{-1}\), montmorillonite CEC = 80 cmol(+) kg\(^{-1}\), illite CEC = 30 cmol(+) kg\(^{-1}\), and kaolinite CEC = 8 cmol(+) kg\(^{-1}\)
   Silty clay loam soil:
      Organic matter content = 2%
      Clay content = 27%
         30% montmorillonite
         50% illite
         20% kaolinite

   Please estimate the CEC of this soil. Show all work!!! (10 points)

14.) (6 points, 2 points each) As secondary clay minerals form, isomorphic substitution
   results in the formation of ________________ charge in the clay mineral. During
   this process, ________________ partially replaces Si\(^{+4}\) in the tetrahedral layer and Mg\(^{+2}\)
   partially replaces ________________ in the octahedral layer.

15.) Please complete the figure below to show how both clay mineral CEC and organic matter
   CEC change with pH to change total CEC. Include both permanent and pH dependent
   charge in your diagram where appropriate. (9 points)
16.) Based on the following information:
Wheat crop transpired 3.5 million lbs of water
Root volume was 1.5% of soil volume all the way to 12 inches
Wheat crop accumulates 30 lb P/acre

Nutrient concentrations in soil solution and total available nutrients in top 12 inches.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Soil solution concentration</th>
<th>Total available in top 12 inches</th>
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<tbody>
<tr>
<td>P</td>
<td>0.12 mg L$^{-1}$</td>
<td>150 lb/acre</td>
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Please calculate how many lbs P acre$^{-1}$ would be delivered to the wheat crop via the following mechanisms: Show all work!!!

Root Interception: (3 points)

Mass Flow: (3 points)

Diffusion: (3 points)

Total points this page = 18 out of 100.

17.) Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, and iron are all considered essential for the growth and development of higher plants. There are 10 (ten) other plant-essential elements. Please complete the table below for these other ten plant-essential elements. (10 points, 0.5 points each)

<p>| Correct Spelling of | One ionic form |</p>
<table>
<thead>
<tr>
<th>Element</th>
<th>taken up by plants</th>
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Total points this page = 10 out of 100.