1. How much would it cost per year to fertilize 18 golf greens if you were annually applying 5 lbs of N per 1000 ft² assuming each green averaged 6,000 sq. ft. and you were using a fertilizer that contained 16% nitrogen and it sold for $12.50 per 50 lb bag. (4 points)

2. Fill in the blanks. (4 points)

   In soil test correlation studies we establish the relationship between ____________ and ____________. In calibration studies we establish the relationship between ____________ and ____________.

3. On the graph below, diagram the Build-up, Maintenance, and Drawdown portions of the Build-up and Maintenance philosophy of making fertilizer recommendations (Tri-State Fertilizer Recommendation Manual). Include in your diagram the shape of the curve (3 connected straight lines) and the three different regions of the diagram with appropriate labels: Build up, Maintenance, and Drawdown. Also, label the critical level. (7 points)
4. Describe a nitrogen deficiency on turfgrass and indicate how inadequate nitrogen levels might affect turfgrass wear and a disease like dollar spot. (4 points)

5. Given the following soil test:

<table>
<thead>
<tr>
<th>Organic Matter</th>
<th>pH</th>
<th>Buffer pH</th>
<th>CEC (cmol/kg)</th>
<th>P (Bray P1)</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>-- % --</td>
<td>4.0</td>
<td>6.4</td>
<td>6.8</td>
<td>?</td>
<td>12</td>
<td>80</td>
<td>900</td>
<td>120</td>
<td>2.5</td>
<td>55.6</td>
<td>12.3</td>
</tr>
</tbody>
</table>

a. Calculate the CEC of this soil (the exchangeable acidity is 2.4 cmol/kg)? (4 points)

b. What is the soil test P value in lbs/acre? (2 points)

c. What is the percent base saturation of this soil? (2 points)

d. Calculate (do not approximate) the nitrogen release (mineralization) in this soil assuming a 1.5% mineralization rate per year, a C:N ratio for O.M of 10:1 and that O.M. is 50% C. (2 points)

6. Describe the process for making anhydrous ammonia (in addition to naming the process, writing the equation, list the sources of N and H) and indicate how it is used to make 18-46-0 (DAP) (4 points)

7. On cool season grasses in Indiana, when should the majority of N on turf be applied – Spring, Summer, Fall? WHY? (At least two reasons) (3 points)

8. Please fill in the blanks using the phosphorus recommendation table for wheat below, answer questions A to E.
A. How many pounds of P$_2$O$_5$ are recommended for Wheat when the Bray P1 soil test is 15 ppm and the yield potential is 80 bushels per acre? 

______________________________________________ (2 points)

B. Does Arrow A, Arrow B, or Arrow C point to the maintenance recommendations for wheat? Also, indicate the critical level for wheat as defined by the Tri-State Report. (2 points)

C. Using the maintenance recommendation above for a Yield Potential (YP) of 80 bu. wheat/A, calculate the Crop Removal (CR expressed in lbs P$_2$O$_5$) for each bushel of wheat produced. (2 points)

D. Estimate the number of years it will take to build your P soil test from 15 ppm to 25 ppm (this is the same as going from 30 lb P/A to 50 lb P/A) if you continue to fertilize this wheat field as recommended in Part A. ____________ years (2 points)  

Show calculations and assumptions.

E. Draw the response curves on the graph below showing the expected response one might obtain when phosphorus fertilizer is applied to wheat when the soil test is 15 ppm and 50 ppm. You will draw two curves, each representing the response under one of the two soil test levels. Label each curve. Assume an 80 bu/A yield goal. (4 points)
9. **Define** each of the terms below **including the forms of nitrogen** involved in the transformation and **any microorganisms that would maximize these N transformations.** (8 points, 4 points each)

**Nitrification** (In addition to the complete definition, be sure to include the genus name for each organism responsible and indicate if autotrophs or heterotrophs)

**Denitrification** (In addition to the complete definition, be sure to include if the organisms involved are heterotrophic or autotrophic, aerobic or anaerobic)

10. If the superintendent of a golf course having limited resources and **no irrigation system** on the fairways asked you to recommend a N fertilizer source to use on her fairways, which of these materials would you recommend: a fertilizer containing **urea, ammonium nitrate, or ammonium sulfate**. Assume the cost of N per pound is the same. (Soil pH is 7.2) Justify your answer. **(4 points)**

11. Which of the soils on display is a well drained prairie soil? ___________ **(2 points)**

12. Briefly explain why it is difficult to develop a good soil test to predict nitrogen availability prior to planting an annual crop such as corn. Name one test used after planting corn that could be of potential help in developing an appropriate N management plan. **(3 points)**
13. Place a check beside each described situation in which a nitrification inhibitor would likely be of benefit: (5 points)

- 45-0-0 spring applied preplant (1 week prior to planting) for corn on a well drained silt loam soil
- 82-0-0 spring applied on a poorly drained clay loam soil 3 weeks prior to planting corn
- 28-0-0 (UAN) used for spring topdressing of wheat on a moderately well drained soil
- Anhydrous ammonia applied in the fall on a loamy sand soil with a CEC of 2 cmolc/kg
- 82-0-0 applied in the fall on a somewhat poorly drained soil with a CEC of 17 cmolc/kg

14. Using the diagram below show and discuss how adsorption of this “basic” herbicide might change as soil pH drops. (3 points)

15. Discuss the mechanism(s) by which sulfur coated urea and polymer coated N sources control the release of nitrogen. Be specific, include information on the way these are manufactured and the affect that physical, chemical, and/or biological release mechanisms work! (3 points)
Multiple Choice Questions (2 points each) – Record the best answer to each on the line provided.

1. Ammonium forms of nitrogen applied to the surface of a soil will most likely result in losses of NH₃ if the soil pH is:
   A. alkaline       B. neutral       C. acidic

2. If a fertilizer label reads 8-32-16, it contains:
   A. 8% total N
   B. 32 % water soluble P₂O₅
   C. 16 % total K
   D. All of the above

3. Which of these nitrogen fertilizers contain nitrate?
   A. 28-0-0       B. DAP       C. 46-0-0       D. 18-46-0

4. Which of these materials would result in the least loss of N when surface applied to no-till continuous corn preplant under warm temperature conditions?
   A. urea       B. UAN       C. NH₄NO₃

5. Ureaform and IBDU differ in their method of N release because
   A. Ureaform is coated with sulfur and this coating must be broken down before the N is released whereas IBDU is water soluble and more readily available than ureaform.
   B. Ureaform is dependent on soil microorganisms for hydrolysis to available forms of N whereas IBDU is not dependent of soil microorganisms.
   C. IBDU is dependent on the breakdown of plastic coatings on the particles and ureaform is dependent on Thiobacillus to solubilize the fertilizer.

6. 28-0-0 is a liquid N fertilizer which weighs 10.7 lb/gal. If you wanted to apply 120 lb N/A, how many gallons of 28-0-0 must you apply?
   A. 10       B. 25       C. 40       D. 60       E. 100

7. If a lawn needs 2.5 lb N, 1 lb P₂O₅ and 2 lb K₂O per 1000 square feet, which of these fertilizers could provide the correct ratio of material to satisfy the recommendation?
   A. 10-4-8       B. 16-12-8       C. 15-6-10       D. 18-5-10
8. **How many pounds of N** would be supplied from 18-46-0 if it was used to supply 80 lb P₂O₅/A

   A. 31 lb       B. 45 lb       C. 174 lb       D. 333 lb       E. 422 lb

9. Gypsum would be most useful in reclaiming

   A. acid soils.
   B. saline soils.
   C. sodic soils.
   D. soils high in CaCO₃.
   E. Midwestern soils with pH 7.0 having compaction problems.

10. 8-32-16 fertilizer would most likely have its source of potassium in which chemical form:

   A. K₂O
   B. P₂O₅
   C. Dicalcium Phosphate
   D. KCl
   E. Nitrogen Hydro-Potassium

11. Application of ammonium forms of fertilizer tend to _______ soil pH over time.

    A. raise
    B. lower
    C. not change

12. dy/dx = (A – y) C —— This equation is called

    A. Lieb’s Law of the Minimum and represents growth as a function of nutrients present in the soil and relates how the nutrient in the lowest amount reduces rate of growth.
    B. Mitscherlich’s Equation and represents the change in yield for a given change in growth factor (e.g. fertilizer input) --- with each additional input, change in yield is reduced.
    C. Berg’s Law of Success representing how a student’s grade changes in proportion to the amount they study.
    D. Walker’s Turf Quality Index representing how turf is better managed in proportion to the grade the Superintendent receives in Agry 365T.

**HAVE A GREAT AND SAFE SPRING BREAK !!!**