Department of Environmental Science
and Technology

Agricultural Nutrient Management Program

EXAMPLE QUESTIONS
NUTRIENT MANAGEMENT CERTIFICATION EXAM

NOTE: The following questions were developed based on several of the knowledge areas for the nutrient management certification exam. They are the type of questions (multiple choice) of which the exam is composed. **This is not a complete list of potential questions for all knowledge areas.** It does, however, represent the kinds of questions that could be constructed in a multiple-choice format. Do not neglect to review materials from knowledge areas not included here.

1. A subsurface horizon that is usually finer in texture, firmer in consistence, and lower in organic matter than the surface horizon is called
   a) C
   b) A
   c) O
   d) B

2. The surface horizon, usually rich in organic matter and granular in structure, is called
   a) C
   b) A
   c) O
   d) B

3. The soil physical property that describes the proportion of void space in a soil is called
   a) bulk density
   b) particle density
   c) porosity
   d) texture

4. The soil physical property that describes the proportion of sand, silt, and clay-sized particles in a soil is called
   a) bulk density
   b) particle density
   c) porosity
   d) texture

Questions and Calculations, p. 2

5. The soil physical property that describes the density of the soil's solids only is called
    a) bulk density
    b) particle density
    c) porosity
    d) texture

6. The soil physical property that describes the density of the whole soil (solids and voids) is called
    a) particle density
    b) structure
    c) bulk density
    d) texture

7. The water in a soil that can be used by plants for growth is called
    a) field capacity
    b) wilting point
    c) available
    d) gravitational

8. The property that describes how particles are arranged into aggregates is called
    a) texture
    b) porosity
    c) structure
    d) bulk density

9. Soil test results from the same field analyzed by different labs may vary for many reasons. Indicate why they might differ.
    a) different chemical extractant
    b) different units of expression (ppm vs lb/A)
    c) different basis of expression (K_2O vs K)
    d) all of the above

10. What factors can lead to P loss to surface water?
    a) heavy repeated manure applications
    b) application of commercial fertilizer in excess of amount recommended based on soil test
    c) no-till
    d) all of the above

Questions and Calculations, p. 3

11. Nitrogen tends to leach during the winter and early spring for all the following reasons **except**
    a) evaporation is reduced
    b) transpiration is minimal
    c) it rains more during winter and early spring
    d) the soil profile is saturated

12. The percent of the total exchange sites occupied by basic cations is called
    a) soil structure
    b) base saturation
    c) porosity
    d) soil texture

13. Low pH can lead to all of the following **except**
    a) aluminum toxicity
    b) low available P
    c) manganese deficiency
    d) calcium deficiency

14. pH in the alkaline or basic range can lead to
    a) manganese deficiency
    b) iron deficiency
    c) low available P
    d) all of the above

15. Application of substantial amounts of municipal solid waste compost with a C/N ratio of 50 can lead to
    a) mineralization
    b) volatilization
    c) leaching
    d) immobilization

16. MDE regulations regarding sewage sludge require that credits from residual N from previous sludge applications be calculated for how many years?
    a) 1
    b) 3
    c) 5
    d) 10

Questions and Calculations, p.4

17. Application of UAN, ammonium nitrate or manure to the soil surface without incorporation can lead to
    a) mineralization
    b) volatilization
    c) leaching
    d) immobilization

18. The non-mineral nutrients include the following:
    a) Ca, Mg, and S
    b) N, P, and K
    c) C, H, and O
    d) Fe, Zn, and Mn

19. Micronutrients include the following:
    a) Ca, Mg, and S
    b) N, P, and K
    c) C, H, and O
    d) Fe, Zn, and Mn

20. The secondary nutrients include the following:
    a) Ca, Mg, and S
    b) N, P, and K
    c) C, H, and O
    d) Fe, Zn, and Mn

21. The Liebig-Sprengel Law of the Minimum recognizes that growth is limited by
    a) the nutrient required in the greatest amount
    b) the nutrient required in the least amount
    c) the nutrient present in the least adequate amount
    d) secondary nutrients

22. Sampling depth for the PSNT is
    a) 2 inches
    b) 8 inches
    c) 12 inches
    d) 24 inches

Questions and Calculations, p. 5

23. What is the probability of increased crop yield in response to K fertilizer application when the soil test level is excessive?
    a) very low
    b) low
    c) medium
    d) high
    e) very high

24. A very compacted plow pan has a bulk density of 1.54 g/cm^3 and a particle density of 2.68 g/cm^3. What is the percent porosity?
    a) 43
    b) 74
    c) 57
    d) 99

25. If a soil ped has a volume of 124 cm^3 and a dry weight of 138 grams, what is its bulk density?
    a) 0.9
    b) 1.7
    c) 1.1
    d) 1.3

26. If a farmer applied 600 pounds of 19-19-19 per acre, he applied
    a) 114 lb N, 114 lb P_2O_5, 228 lb K_2O
    b) 114 lb N, 114 lb P_2O_5, 114 lb K_2O
    c) 14 lb N, 95 lb P, 50 lb K
    d) 11,400 lb N, 11,400 lb P_2O_5, 11,400 lb K_2O

27. What is the nitrogen credit (expressed in pounds per acre) for poultry manure (2.9% N and 0.8% NH_4) applied 3 years ago at the rate of 8 tons per acre? (Assume an f_{min} of 0.03.)
    a) 4
    b) 10
    c) 14
    d) 20

28. A technician at a bulk blend plant was asked to formulate 5 tons of 10-15-10. The fertilizer materials in stock are ammonium nitrate (34-0-0), triple superphosphate (0-46-0), and muriate of potash (0-0-60). How many tons of ammonium nitrate would be required to make the blend?
    a) 3.2
    b) 1.5
    c) 0.6
    d) 0.9

Questions and Calculations, p.6

29. How many tons of solid dairy manure (0.7% N and 0.2% NH_4) should be applied to supply 110# PAN per acre if the producer incorporates the manure the day of application?
    a) 5
    b) 30
    c) 16
    d) 50

30. A farmer used the weight-area method of calibrating his manure spreader. He used five 10' x 10' sheets of plastic and averaged the weight of manure collected on each. The average weight was 42 pounds. At what rate (in tons per acre) is he currently spreading manure?
    a) 18,295
    b) 9
    c) 3
    d) 20

31. What is the nitrogen credit for an anaerobically digested sludge (NO = 2.5%) applied at the rate of 5 dry tons last year (Km = 1.60)?
    a) 5
    b) 10
    c) 15
    d) 20

32. What is the plant-available N (Np) in pounds per dry ton of anaerobically digested liquid sludge from the Deep Creek plant that will be surface-applied (5% N, 2% NH_4 and 0.1% NO_3) (F = 0.2)?
    a) 40
    b) 34
    c) 10
    d) none of the above

33. Your fertilizer spreader covers a swath with a width of 50 feet. After disengaging the drive chain, a container is attached to the delivery chute and the spreader containing 15-15-15 is driven for 100 feet. The contents of the container are weighed. It contains 39 pounds. What is the N application rate in pounds per acre?
    a) 25
    b) 100
    c) 50
    d) 75

34. Which of these soils would have the highest cation exchange capacity, assuming the amount of organic matter in all four soils was comparable?
    a) silt
    b) silt loam
    c) sand
    d) clay

35. At low pH, you might begin to see plant deficiency in
    a) phosphorus
    b) calcium
    c) potassium
    d) all of the above

36. Lime requirement is determined by
    a) reserve acidity
    b) target pH
    c) active acidity
    d) all of above

37. The transformation of ammonium (NH_4^+) to nitrate (NO_3^-) is the process of
    a) denitrification
    b) volatilization
    c) nitrification
    d) mineralization

38. The rate of nitrogen mineralization of an organic waste is affected by
    a) temperature
    b) moisture
    c) soil pH
    d) all of the above

39. Which of the following would not be acceptable in determining expected crop yields?
    a) average yields from nearby fields with similar soil types
    b) yield achieved by the "corn club" winner last year
    c) soil productivity information
    d) average of the 3 highest yielding years out of the last 5 years

40. Optimum soil pH
    a) cannot be determined
    b) is between 6.0 and 6.5
    c) is between 6.5 and 7.0
    d) varies for different crops

Questions and Calculations, p. 8

41. The leaching index for nitrates and soluble nutrients is an estimate of
    a) potential for nitrate and dissolved phosphorus loss
    b) rate of nutrient and pesticide infiltration
    c) average annual percolation below the one meter root zone
    d) soil nutrient and water holding capacity

42. Management practices may change all of the following soil properties **except**
    a) texture
    b) water holding capacity
    c) soil organic matter
    d) cation exchange capacity

43. At low pH, inorganic P forms insoluble compounds primarily with
    a) calcium
    b) organic matter
    c) iron & aluminum
    d) clay surfaces

44. At high pH, inorganic P forms insoluble compounds primarily with
    a) calcium
    b) organic matter
    c) iron & aluminum
    d) clay surfaces

45. Sewage sludge (biosolids) may not be applied on slopes greater than
    a) 8%
    b) 10%
    c) 12%
    d) 15%

46. Crops to be eaten raw by humans may not be grown on sewage sludge (biosolids) application areas for
    a) 6 months
    b) 12 months
    c) 18 months
    d) 36 months

47. What percent of the NO_3-N in biosolids is generally assumed to be available for plant uptake?
    a) 30%
    b) 50%
    c) 100%
    d) it depends on the N mineralization rate

Questions and Calculations, p. 9

48. Application of sewage sludge (biosolids) to agricultural land
    a) is prohibited on fields where crops are grown that are eaten raw by humans
    b) is prohibited on frozen ground
    c) can improve soil texture
    d) neither a, b, nor c
    e) a, b, and c

49. If sewage sludges (biosolids) are applied at rates to meet crop N requirements over a number of years, future nutrient management issues may have to address
    a) nitrogen
    b) heavy metals
    c) phosphorus
    d) pathogens

50. 60 lbs of P_2O_5 would contain ____ pounds of P.
    a) 12
    b) 26
    c) 36
    d) 60

51. A soil analysis recommends the application of 1,800 pounds of oxides per acre. The liming material contains 25% CaO and 35% MgO. What is the lime application rate in lbs/acre?
    a) 3,600
    b) 1,800
    c) 3,000
    d) 2,700

52. Application of sewage sludge (biosolids) to agricultural land
    a) is prohibited on saturated soils
    b) is prohibited within 100 feet of the mean high water line of tidal waters
    c) is restricted to materials that have been treated by a Process to Significantly Reduce Pathogens (PSRP)
    d) all of the above

53. To be considered conservation tillage, what percent of ground cover or residue must there be?
    a) 15%
    b) 30%
    c) 50%
    d) 75%

Questions and Calculations, p. 10

54. The transformation of organic forms of nitrogen to inorganic compounds containing nitrogen is called
    a) ammonification
    b) mineralization
    c) nitrification
    d) fixation

55. The conversion of atmospheric nitrogen to a nitrogen compound that is available for uptake by plants is called
    a) ammonification
    b) mineralization
    c) nitrification
    d) fixation

56. Which environmental factor(s) greatly influence(s) the nitrogen cycle?
    a) pH
    b) temperature
    c) moisture
    d) all of the above

57. From which of these materials could orthophosphate be released and become available for plant uptake during the growing season?
    a) P absorbed onto hydrated oxides of iron and aluminum and edges of clay minerals
    b) P that is a part of organic molecules
    c) both a and b
    d) neither a nor b

58. The plant-available form(s) of orthophosphate that exist(s) in the soil solution in a humid region like Maryland is/are
    a) $H_2PO_4^-$
    b) HPO_4^{-2}
    c) H_3PO_4
    d) a and b

59. What characteristic of organic materials will have the greatest effect on whether net-mineralization or net-immobilization will occur when a material is incorporated into soil?
    a) moisture content
    b) calcium content
    c) pH
    d) carbon to nitrogen ratio (C/N)

Questions and Calculations, p. 11

60. Since Ca and Mg are present in relatively high concentrations in the soil solution of most soils, most of the Ca and Mg that crops need is transported to the roots by what mechanism?
    a) diffusion
    b) root interception
    c) mass flow
    d) leaching

61. Which major nutrient is required by plants in approximately the same quantity as nitrogen?
    a) P
    b) K
    c) Ca
    d) S

62. What pH range should be maintained so that P availability to the plant is optimal?
    a) 5.5 to 6.5
    b) 7.0 to 8.0
    c) 4.8 to 5.5
    d) any of the above

63. Potassium is present in relatively high concentrations in most soils, but only a small fraction is readily available for plant uptake. Which of the following form(s) is/are considered available?
    a) K^+ in solution
    b) exchangeable K^+
    c) K^+ fixed between clay mineral platelets
    d) both a and b

64. A nutrient management license from MDA
    a) costs $50 for an individual and $100 for a company (except for governmental agencies)
    b) must be renewed annually
    c) must list at least one certified nutrient management consultant
    d) all of the above

65. If an individual wishes to develop a nutrient management plan for his/her own operation only, he/she must
    a) be a certified farmer operator
    b) be licensed by MDA
    c) post a $2,500 bond
    d) none of the above

Questions and Calculations, p. 12

66. What is the main cause of lower recovery in N from surface-applied manure than from incorporated manure applied to a relatively level field?
    a) the organic manure in non-incorporated manure cannot mineralize as well as when it is incorporated
    b) the manure N is denitrified more quickly when it is on the surface
    c) roots cannot obtain the manure N that is on the surface
    d) N is volatilized from the surface applied manure as NH_3

Understanding a Fertilizer Guarantee

X-Y-Z

X = % N (total nitrogen)
Y = % P_2O_5 (available phosphate)
Z = % K_2O (available potash)

Situation 1

a) How many pounds of phosphate are in a ton of 5-10-20?

b) How many pounds of potash are in a ton of 5-10-20?

Solution 1

a) 5-10-20 contains 5% N, 10% P_2O_5, and 20% K_2O.

Step (1) Convert 10% P_2O_5 to a decimal.

10% = 0.10

Step (2) Multiply the decimal by 2000 pounds (#).

0.10 x 2000# = 200# phosphate

b) 5-10-20 contains 5%N, 10% P_2O_5, and 20% K_2O.

Step (1) Convert 20% K_2O to a decimal.

20% = 0.20

Step (2) Multiply the decimal by 2000 pounds (#).

0.20 x 2000# = 400# potash

Questions and Calculations, p. 13

Situation 2

How many pounds of 8-16-24 would it take to provide 150 pounds of potash?

Solution 2

Step (1) Convert 24% potash to an equality.

$$24\% = \frac{24\#\ K_2O}{100\#\ 8\text{-}16\text{-}24} = \frac{100\#\ 8\text{-}16\text{-}24}{24\#\ K_2O}$$

Step (2) Solve for pounds of 8-16-24.

$$150\#\ \cancel{K_2O} \times \frac{100\#\ 8\text{-}16\text{-}24}{24\#\ \cancel{K_2O}} = ?\ \#\ 8\text{-}16\text{-}24$$

$$\frac{150 \times 100\#\ 8\text{-}16\text{-}24}{24} = 625\#\ 8\text{-}16\text{-}24$$

Bulk Blend Calculations

A technician at a bulk blend plant was asked to formulate 10 tons of 10-20-20. The fertilizer materials in stock are urea, triple superphosphate, and muriate of potash. Can this request be filled? If so, how much of each material and filler would be required to make the blend?

a) How much urea (46-0-0) would you need?

You need 10 tons of a material whose final analysis is 10% N. You have an input which contains 46% N.

Solution

$$46\%\ \text{N means } \frac{46\ \text{tons N}}{100\ \text{tons urea}} \text{ or } \frac{100\ \text{tons urea}}{46\ \text{tons N}}$$

10% of 10 tons = 0.10 x 10 = 1 ton N needed

$$1\ \cancel{\text{ton N}} \times \frac{100\ \text{tons urea}}{46\ \cancel{\text{tons N}}} = \frac{100}{46}\ \text{tons urea} = 2.2\ \text{tons urea}$$

Questions and Calculations, p. 14

b) How much triple superphosphate ("TSP" or 0-46-0) would you need?

You need 10 tons of a material whose final analysis is 20% P_2O_5. You have an input which contains 46% P_2O_5.

Solution

46% P_2O_5 means $\frac{46 \text{ tons } P_2O_5}{100 \text{ tons TSP}}$ or $\frac{100 \text{ tons TSP}}{46 \text{ tons } P_2O_5}$

20% of 10 tons = 0.20 x 10 = 2 tons

$2 \text{ tons } P_2O_5 \times \frac{100 \text{ tons TSP}}{46 \text{ tons } P_2O_5} = \frac{2 \times 100 \text{ tons TSP}}{46} = 4.3 \text{ tons TSP}$

c) How much muriate of potash (0-0-60) would you need?

You need 10 tons of a material whose final analysis is 20%. You have an input that contains 60% K_2O.

Solution

60% K_2O means $\frac{60 \text{ tons } K_2O}{100 \text{ tons } 0\text{-}0\text{-}60}$ or $\frac{100 \text{ tons } 0\text{-}0\text{-}60}{60 \text{ tons } K_2O}$

20% of 10 tons = 0.20 x 10 = 2.0 tons K_2O

$2.0 \text{ tons } K_2O \times \frac{100 \text{ tons MP}}{60 \text{ tons } K_2O} = \frac{2.0 \times 100 \text{ tons of MP}}{60} = 3.3 \text{ tons MP}$

Final Solution

2.2 tons urea + 4.3 tons TSP + 3.3 tons MP + 0.20 tons filler = 10 tons of 10-20-20

Yes, this blend can be made with these materials.

Questions and Calculations, p. 15

Converting from Oxide Basis to Elemental Basis and Visa Versa

Reminder

6-10-15 as a fertilizer guarantee means the material contains 6% N, 10% P_2O_5, and 15% K_2O.

Conversion Factors to Remember

$P_2O_5 \times 0.44 = P$ $\quad$ $P \times 2.29 = P_2O_5$

$K_2O \times 0.83 = K$ $\quad$ $K \times 1.21 = K_2O$

Situation 1

A farmer applies 150 pounds (#) per acre of 6-24-24 as a starter fertilizer.

a) How many pounds of N has he applied per acre?

b) How many pounds of P_2O_5 has he applied per acre?

c) How many pounds of P has he applied per acre?

d) How many pounds of K has he applied per acre?

Solution 1

a) How many pounds of N per acre?

Step (1) Convert % N to a decimal fraction.

6% = 0.06

Step (2) Multiply by the application rate.

0.06 x 150# 6-24-24/A = 9# N/A

Questions and Calculations, p. 16

b) How many pounds of P_2O_5 per acre?

Step (1) Convert % P_2O_5 to a decimal fraction.

24% = 0.24

Step (2) Multiply by the application rate.

0.24 x 150# 6-24-24/A = 36# P_2O_5/A

c) How many pounds of P per acre?

Multiply # P_2O_5/A by the conversion factor.

36# P_2O_5 x 0.44 = 15.8 ~ 16# P

OR

Multiply (decimal fraction x application rate x conversion factor)

0.24 x 150# P_2O_5/A x 0.44 = 16# P/A

d) How many pounds of K per acre?

Step (1) Convert % K_2O to a decimal fraction.

24% = 0.24

Step (2) Multiply (decimal fraction x application rate x conversion factor).

0.24 x 150# 6-24-24/A x 0.83 = 29.9 ~ 30# K/A

Questions and Calculations, p. 17

Situation 2

A bulk blend material contains 12% N, 20% P, and 15% K. What is this material's fertilizer guarantee?

a) for N?

b) for P_2O_5?

c) for K_2O?

Solution 2

a) for N?

12%

b) for P_2O_5?

Multiply the % P by the conversion factor.

20% x 2.29 = 45.8 ~ 46% P_2O_5

c) for K_2O?

Multiply the % K by the conversion factor.

15% x 1.21 = 18.2 ~ 18% K_2O

Final Solution

The fertilizer guarantee for the bulk blend material is 12-46-18.

Porosity

Equation

% PS = 100 - (BD/PD x 100)

PS = % porosity
BD = bulk density
PD = particle density

Situation

Laboratory analysis of a soil indicated that it has a bulk density of 1.08g/cm^3 and a particle density of 2.60g/cm^3. What is the percent porosity of this soil?

Solution

%PS = 100 - (1.08/2.60 x 100)
= 100 - (41.5)
= 58.5
~ 59%

Bulk Density

Equation

$$BD = \frac{\text{weight of soil}}{\text{volume of soil}} = g/cm^3 \textit{ or } \#/ft^3$$

Situation

Laboratory analysis of a soil ped indicated that its dry weight was 58 grams and its volume was 47 cm^3. What is this soil's bulk density?

Solution

$$BD = \frac{58g}{47cm^3} = 1.2g/cm^3$$

Determining Plant Available Nitrogen (PAN) for Organic Wastes

Terminology

PAN	Plant Available Nitrogen
NH_4-N	ammonium nitrogen
N	nitrogen or total nitrogen
NO_3-N	nitrate nitrogen
N_{org}	organic nitrogen (for manure)
f_{con}	ammonium conservation factor for manure
f_{min}	mineralization factor for manure
NO	organic nitrogen (for sludge)
Np	PAN for sludge; pounds of plant available nitrogen per dry ton of sludge
K	volatilization factor for sludge; 0.5 for surface-applied liquid sludge and 1.0 for cake or incorporated liquid sludge
F	mineralization factor for sludge (expressed as a decimal fraction) for the year of application (year 0-1)
Km	mineralization for sludge applied previous years (years 1-10)

Equations

$N_{org} = N - NH_4\text{-}N$

PAN (%) for manure = % N_{org} (f_{min}) + %NH_4-N (f_{con})

Np = [(% NH_4) (K) + % NO_3-N + (NO)(F)](20)

% x 20 = #/ton

Determining PAN for Manure the Year of Application

Situation

A broiler litter analysis follows:

- 3.2% N
- 1.3% NH_4-N
- 2.8% P_2O_5
- 3.1% K_2O

A farmer who has purchased this manure plans to incorporate it the day after application.

Questions and Calculations, p. 20

a) What is the % PAN under these circumstances?
b) What is the PAN in pounds per ton (#/ton)?

Solution

a) N_{org} = 3.2% - 1.3% = 1.9%
f_{min} = 0.5
f_{con} = 0.64

PAN (%) = (1.9)(0.5) + (1.3)(0.64)
= 0.95 + 0.83
= 1.78%
~ 1.8%

b) #/ton = % x 20
= 1.8 x 20
= 36 #/ton

Calculating Nitrogen Credits From Manure

Nitrogen credits from manure are typically taken for manure applied up to 2 years ago. The amount of nitrogen credit is a function of the rate of application, the type of manure, and the mineralization rate for the manure type/year of application.

Situation

What is the nitrogen credit (expressed in pounds per acre) for solid dairy manure (0.9% N and 0.3% NH_4) applied 2 years ago at the rate of 25 tons per acre? (Assume an f_{min} of 0.09.)

Solution

$PAN_{yr\ 2\text{-}3}$ (#/A) = $\%N_{org}$ x f_{min} x 20 x application rate
= 0.6 x 0.09 x 20 x 25
= 27 #/A

Questions and Calculations, p. 21

Determining Sludge Application Rate for Year of Application

Situation

How much Fort Meade cake-dry, lime-stabilized sewage sludge (3% N, 1.5% NH_4, and 0.2% NO_3) should be applied to supply 150 pounds of plant available nitrogen (F = 0.3)?

Solution

Np (#/ton) =[(%NH_4)(K) + NO_3 + (%NO)(F)]20
= [(1.5)(1) + 0.2 + (3.0 - 1.5 - 0.2)(0.3)]20
= (1.5 + 0.2 + 0.4)(20)
= 2.1(20) = 42# N/ton

150 ~~#N~~/A x $\frac{\text{1 ton sludge}}{\text{42 ~~\#N~~}}$ = 3.6 tons sludge/A

Calculating Nitrogen Credits from Previously-Applied Sludge

According to Maryland regulations, nitrogen credits for sludge must be calculated for 10 years prior to the year under consideration or

Nm1 + Nm2 + Nm3 + Nm4 + Nm5 + Nm6 + Nm7 + Nm8 + Nm9 + Nm10

where Nmx = (Km)(NO)(application rate).

Km values are specified in Maryland Department of the Environment's (MDE) sludge regulations.

Situation

What is the nitrogen credit for a lime-stabilized sludge (NO = 4%) applied at the rate of 10 dry tons 5 years ago (Km = 0.30)?

Solution

$Nm_{5\text{-}6}$ (#/A) = Km x %NO x application rate
= (0.30)(4)(10)
= 12 #/A