

**Single-answer multiple choice**

Circle the *one answer* that *best* answers each question or completes each sentence. [2 points each]

- 1) If you were to compare the properties of soils formed in Washington under grassland vegetation compared to forest vegetation, the grassland soil would generally \_\_\_\_\_.
  - a) be more acidic
  - b) have more organic matter to deeper depths
  - c) have lower water-holding capacity
  - d) have a lower base saturation
  
- 2) If you compare a soil formed from bedrock that was fine-grained and had high concentrations of base-forming cations (like basalt) with a soil formed in coarse-grained bedrock with relatively low levels of base-forming cations (like granite), the soil formed in basalt would likely \_\_\_\_\_.
  - a) be less fertile
  - b) be sandier
  - c) have a higher base saturation
  - d) have a higher permeability
  
- 3) In many soil profiles:
  - a) the A horizon would likely have a granular structure.
  - b) the Bt horizon would likely have a blocky structure.
  - c) the C horizon would likely have a blocky structure.
  - d) a and b
  - e) a, b, and c.
  
- 4) The content of igneous rock is dependent on \_\_\_\_\_.
  - a) grinding action of moving rocks against each other.
  - b) deposition and re-cementation of weathering products.
  - c) chemical composition of molten magma.
  - d) differential expansion of minerals with changes in temperature.
  - e) alteration of pre-existing minerals at the earth's surface.
  
- 5) The type of rock that can form from cemented stream or ocean deposits is called \_\_\_\_\_.
  - a) sedimentary
  - b) organic
  - c) igneous
  - d) primary
  - e) secondary
  
- 6) Physical weathering processes change primarily the \_\_\_\_\_ of a rock.
  - a) oxidation state
  - b) mineral composition
  - c) color
  - d) crystallization temperature
  - e) size
  
- 7) Iron and/or magnesium are important elements in \_\_\_\_\_.
  - a) quartz
  - b) feldspar minerals
  - c) sandstone
  - d) ferromagnesium minerals

8) An A horizon takes about \_\_\_ years to form in a newly deposited sediment in Washington.

- a) 5
- b) 500
- c) 50,000
- d) 5 million

9) Which of the following soils has undergone the most soil development? (circle one)

Profile A	Profile B
<b>A</b>	<b>A</b>
<b>Bt</b>	<b>Bw</b>
<b>C</b>	<b>C</b>

10) Fill in the blanks with the appropriate numbers in the right column

- |   |              |
|---|--------------|
| ___ Thick, dark-colored surface horizon high in organic matter  | a. Alfisols  |
| ___ mineral soil with >30% clay and large cracks when dry       | b. Histosols |
| ___ organic soil  | c. Vertisols |
| ___ forest soil, with a subsurface horizon of clay accumulation | d. Mollisols |

11) Minerals found in soils change as the soil undergoes weathering processes. From the following options, choose the most likely weathering sequence as a relatively unweathered soil becomes a highly weathered soil.

Least weathered -----> Most weathered

- |                   |           |                |                |
|-------------------|-----------|----------------|----------------|
| a) Fe oxides      | 2:1 clays | 1:1 clays      | muscovite mica |
| b) 2:1 clays      | 1:1 clays | muscovite mica | Fe oxides      |
| c) muscovite mica | Fe oxides | 2:1 clays      | 1:1 clays      |
| d) 1:1 clays      | 2:1 clays | Fe oxides      | muscovite mica |
| e) muscovite mica | 2:1 clays | 1:1 clays      | Fe oxides      |

12) You have decided to return to nature and 'live off the land'. Considering their native fertility, which of the following soil orders would have the best soil to grow your food without adding fertilizers?

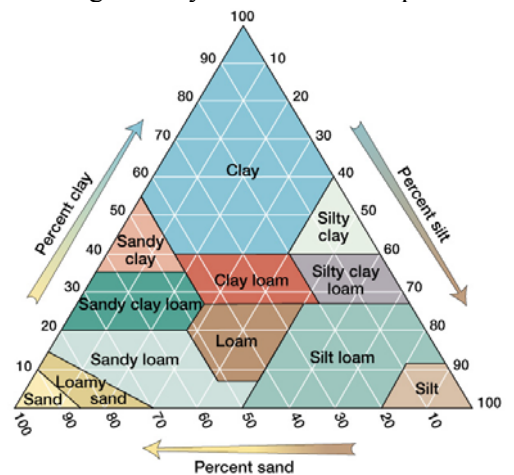
- a) Mollisol
- b) Oxisol
- c) Spodosol
- d) Ultisol
- e) Histosol

13) You collect a soil sample from the A horizon of the soil at your Ph.D. research site (yes, you!). Laboratory analysis tells you that it is a silty clay loam. All you were really interested in for your project was the percent clay in the soil. Using the soil texture triangle provided, determine the possible range in clay content this sample could have.

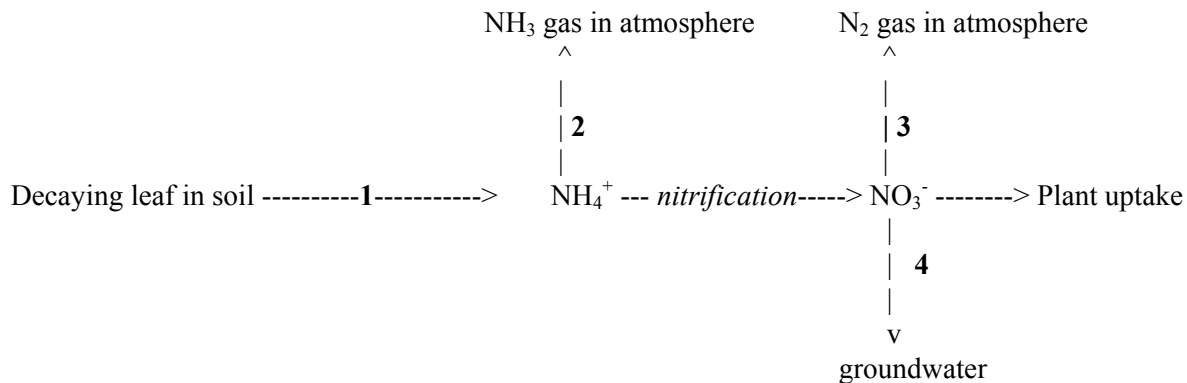
- a) 0-20%
- b) 27-40%
- c) 40-60%

14) The soil solution pH \_\_\_\_\_.

- a) is the major portion of the total acidity of a soil
- b) tends to increase with a decrease in base saturation
- c) determines the amount of lime to add to the soil
- d) measures the active acidity of the soil



- 15) The rate of decomposition of organic materials in soil \_\_\_\_\_.
- increases as the C:N ratio increases
  - decreases with additional soil tillage
  - would be greater if the lignin content was greater
  - would decrease if the soil was saturated with water for a long period of time.
- 16) At the 'field capacity' water content, a silty clay loam will have \_\_\_\_\_.
- less water than at the permanent wilting point water content
  - the same amount of water as a sandy loam at field capacity
  - less water than a sandy loam at field capacity
  - more water than a sandy loam at field capacity
  - a matric potential of about -15,000 cm water.
- 17) A possible sequence of events prior to  $\text{NO}_3^-$  uptake by plants is shown in the diagram below. The processes represented by the numbers 1, 2, 3, and 4 are :



- 1=mineralization, 2=volatilization, 3=denitrification, 4 = leaching
  - 1=mineralization, 2=immobilization, 3 denitrification, 4=leaching
  - 1= immobilization, 2=volatilization, 3=denitrification, 4=leaching
  - 1=denitrification, 2=immobilization, 3=volatilization, 4=leaching
- 18) If a bag of fertilizer is labeled “23-19-17”, then it
- contains 23% N, 19% K, 17% P
  - contains 23% N, 19%  $\text{P}_2\text{O}_5$ , 17%  $\text{K}_2\text{O}$
  - provides 23% of plant N needs, 19% of plant P needs, and 17% plant K needs
  - provides 23% of plant N needs, 19% of plant K needs, and 17% plant P needs
  - none of the above
- 19) Advantages of synthetic fertilizers include:
- relative ease of application
  - their ability to increase crop yields
  - their quick availability to plants once applied
  - all of the above
  - both a and b
- 20) Compared to synthetic (inorganic) fertilizers, organic fertilizers generally \_\_\_\_\_ compared to synthetic fertilizers.
- have lower nutrient contents per unit weight
  - contribute larger amounts of organic matter to the soil
  - supply nutrients to plant more slowly
  - all of the above
  - both a and b

- 21) A properly functioning septic system should treat home sewage waste to remove \_\_\_\_\_
- pathogens
  - phosphate
  - organic toxins
  - all of the above
  - a and b
- 22) Environmental damages caused by water erosion can include
- the pollution of streams.
  - the loss of productive topsoil.
  - the movements of pesticides adsorbed to topsoil into streams.
  - all of the above.
- 23) The constant determined from adsorption isotherm experiments ( $K_d$ ) \_\_\_\_\_
- is highest for strongly sorbing soil-chemical combinations (compared to little sorption).
  - is often normalized for the soil organic matter content to allow better use across more soil types.
  - is frequently used as an input when modeling the fate of contaminants in soil.
  - all of the above.
- 24) In the competition for available nutrients in the soil, \_\_\_\_\_ usually obtain their nutrient requirements first.
- microbes
  - plants
  - mammals
  - arthropods

**Multiple-Answer true/false [1 point each].**

Each question below has several possible answers. Mark 'T' (true) for each answer that correctly answers the question and 'F' (false) for each answer that is incorrect.

Which of the following are considered transported parent materials?

- \_\_\_ 25) loess  
 \_\_\_ 26) bedrock  
 \_\_\_ 27) glacial till

Organic soils

- \_\_\_ 28) generally have greater than 20% organic matter by weight.  
 \_\_\_ 29) are classified as Histosols.  
 \_\_\_ 30) form in deposits of organic matter whose decomposition is limited by a lack of oxygen.

Soil physical properties that would likely change when a soil is cultivated include:

- \_\_\_ 31) texture.  
 \_\_\_ 32) porosity.  
 \_\_\_ 33) particle density.  
 \_\_\_ 34) bulk density.

The cation exchange capacity of a soil would increase

- \_\_\_ 35) if the organic matter content increased.  
 \_\_\_ 36) if potassium replaced  $H^+$  ions on the exchange sites  
 \_\_\_ 37) if silt was replaced by clay.

Answer whether each of the following statements about unsaturated water flow is true or false.

- \_\_\_ 38) Water flow is due to differences in total water potential between locations in the soil.  
 \_\_\_ 39) Unsaturated hydraulic conductivity is greater for coarse-textured soils compared to fine-textured soils  
 \_\_\_ 40) In a given soil, saturated water flow is faster compared to unsaturated flow.

Soil surveys include:

- 41) soil profile descriptions
- 42) vegetation maps
- 43) suitability ratings for engineering uses
- 44) climatic data

Micronutrients or trace elements

- 45) are needed in large quantities by higher plants.
- 46) are just as essential as macronutrients.
- 47) include the elements Zn, Mn, Fe, and B.
- 48) availability is relatively unaffected by soil pH

Availability of the nutrient \_\_\_\_ is greatly reduced in soils with pH 8.0.

- 49) calcium
- 50) iron
- 51) phosphorous

Water quality concerns regarding plant nutrient (esp. N and P) contamination of surface and ground water include:

- 52) *Pfisteria* outbreaks
- 53) lake eutrophication
- 54) oceanic dead zones

In the six-class system used for classifying soil texture suitability for septic tank systems, \_\_\_\_ texture is considered suitable.

- 56) clay loam
- 57) silt loam
- 58) loamy sand
- 59) medium and coarse sand

The potential of a pesticide to adversely affect water quality *is higher* if

- 60) soil erosion is left unchecked.
- 61) the pesticide is quickly degraded.
- 62) the soil OM and CEC are low

As a soil dries out

- 63) the films of water around the soil particles become thinner.
- 64) the hydraulic conductivity increases.
- 65) the gravitational potential becomes more important.
- 66) the matric potential becomes more negative.

**Short answer** Respond to the following using a few words or sentences, and/or diagrams, as appropriate.

- 67) [4 pts] When water is added to a soil (for example, by rainfall), a portion of the water is held in soil pores. Name and briefly explain the two forces that cause soil water to be held in the soil (that is, the two forces responsible for matric potential).

68) [4 pts] Define *cation exchange capacity*. Why is this particular soil property important?

69. [4 pts] One of the processes of soil development is the movement (*translocation*) of materials within the soil profile. List two substances that are commonly translocated by water during soil development, and explain why they are of interest in the soil-forming process.

70) [6 pts] Define the following terms used in US Soil Classification and Soil Surveys

a) Soil Order

b) Soil Series

c) Soil Association

71) [6 pts] The mechanisms whereby plant nutrients become positionally available to plant roots are: a) root interception, b) diffusion; and c) mass flow. Define each of these terms and explain their role in nutrient availability

72) [6 pts] Nutrient management plans are becoming more commonplace for plant production – in fact, Washington State Law says that one can not allow nutrients to leave your land! Key goals of nutrient management plans include cost-effective plant production, efficient use and conservation of resources, protecting and maintaining soil quality, and protecting/enhancing the environment beyond the soil – quite a balancing act!.

=> Describe the most important approaches toward meeting these goals, and what are the key elements and activities of the nutrient management planning process?

73) [6 pts] Sustainable agriculture is often described as a process or goal based on three equally important components (likened to the legs of a three-legged stool).

a) List and briefly explain the three major components of the definition of sustainable agriculture.

b) We discussed case studies of several farmers who have been cited for their ‘sustainable agriculture’ practices. Describe the approaches used by two or more of the farmers highlighted in the case studies – especially noting any similarities or general trends.

74) [3 pts] Explain why the presence of ‘redoximorphic features’ in the soil profile complicates or disallows the development of an on-site septic system in that soil.

75) There are a variety of chemical compounds that can be considered pollutants - anything that has detrimental effects on non-target organisms in unintended places. These chemicals include both agricultural chemicals and byproducts of our industrial society. **Describe three important soil properties** that would tend to minimize offsite movement of chemical pollutants, and how they do so, for:

a) [6 points] surface runoff

b) [6 points] subsurface movement to ground water

**SHORT ESSAY** – Answer **one** of the two questions below using complete sentences, quality writing, and of course technically correct usage of your soil science knowledge. Diagrams can be included if appropriate. [9 points]

**Short Essay 1: Bioremediation**

a) [3 pts] Define phytoremediation, and explain how it can be used in remediation of polluted sites.

b) [6 pts] Describe two different approaches to using microorganisms in remediation of polluted sites.

**or Short Essay 2: Farmland Management**

You are a crop consultant. You have an important client who has just inherited the farm that has been in the family for over 100 years. It had been historically managed with the long term perspective of maintaining the soil's productivity and minimizing environmental hazards. You are asked how to best manage the soil resource so that under new ownership it remains healthy and of high quality for the next 100 years.

a) [6 points] Based on your knowledge of soil science, list the three most important soil properties/factors you would want monitored to see if the goal were being met. Explain your reasoning

b) [3 points] Describe at least three soil management practices you would suggest to meet the soil property goals of part (a) and explain your reasons.

**Extra credit**

A) [2 points] List the 18 essential elements.

B) i) [2 points] Using your knowledge of soils and nitrogen management, explain the relative advantages and disadvantages of fall vs. spring applications of nitrogen fertilizers in Washington (note regional differences, if applicable).

ii) [2 points] Do these hold for P and K also? Why or why not?