Study Questions Exam 1

1. What are the four general components of soil?

   Soil consists of 2 general solids and 2 general fluids –minerals and organic matter, and soil solution and air, respectively.

2. Define *regolith* and *solum.*

   Regolith is all unconsolidated (porous) material lying above rock. Except for the uppermost part, the regolith is geologic material. The upper part (perhaps a meter or two in depth) that has been altered by soil formation processes is the solum.

3. What are the five master horizons? Give distinguishing features of each.

   O –accumulation of organic matter above mineral soil; A –the uppermost mineral horizon, characterized by accumulation of organic matter and, therefore, being dark in color relative the underlying horizons; E –similar to A in texture but lacking accumulated organic matter so that it is lighter in color than the A; B –horizon underlying A or E, characterized by accumulation of clay or soluble salts from upper part of profile and commonly brighter in color than the overlying soil; C –parent material.

4. What is meant by an Ap horizon? Bt? Bg?

   Ap –physically altered A horizon, as by plowing (p); Bt –B horizon with sufficient accumulation of translocated (t) clay to be considered an argillic horizon; Bg –B horizon with gley (g) color due to presence of chemically reduced iron (Fe^{2+}).

5. List three means by which plant roots come into contact with nutrients.

   Mass flow of nutrients to roots with water as it moves to roots, diffusion of nutrients from a zone of relatively higher concentration away from the root to a zone of lower concentration near the plant root; and interception by the root system as it grows into a larger soil volume.

6. Soil color is defined in reference to what standard?

   Munsell color chart or book.

7. Black or brown color near the soil surface is usually due to what?

   Organic matter (see question #3).

8. Red in the subsoil is due to what? Yellow? Gray?

   Red –the iron-containing mineral hematite (the iron in it is oxidized, Fe^{3+}); yellow –the iron-containing mineral goethite (although the iron is oxidized, this is a hydrated mineral); gray –chemically reduced iron, indicative of poor aeration (oxygenation, see question #4)

9. What do the above soil colors indicate about aeration and drainage? Does mottling indicate good or poor aeration and drainage?

Along the sequence, red to gray, the soil environment is increasingly wetter and more poorly aerated (oxygenated). Mottling indicates a somewhat different drainage and aeration condition than indicated by the dominant color (e.g., gray zones in dominantly reddish-brown matrix suggest somewhat poor drainage and aeration, whereas zones of reddish colors in a gray matrix indicate that some parts of the profile are fairly well drained and aerated).

10. What does *gley* mean?

Very poor drainage and aeration as suggested by the presence of chemically reduced iron

11. Define sand, silt and clay according to the USDA classification system.

Sand, 2.000 to 0.0050 mm, silt, 0.050 to 0.002 mm, and clay, < 0.002 mm diameter.

12. What does soil texture mean?

Texture refers to the relative amounts of sand, silt and clay separates.

13. What are the two general approaches to determining soil texture?

Texture is quantitatively measured in the laboratory by a type of mechanical analysis, either pipette (as in lab exercise 1 or hydrometer). It can also be estimated to a fairly high degree of accuracy (by one experienced in this) simply by the feel of the soil.

14. Explain what is meant by *dispersion* and *flocculation* of soil colloids.

Dispersion –particles are physically separated from one another; flocculation –particles are loosely aggregated into larger compound bodies.

15. Given data for percents sand, silt and clay, use a textural triangle to give the textural class name of a soil.

Be able to use a textural triangle to give the textural class name of a soil.

16. Contrast sandy and clay soils in terms of:

a) ease of tillage
b) aeration and water movement
c) stickiness when wet
d) bulk density
e) surface area of particles

a) ease of tillage –sand easier; b) aeration and water movement --sand faster; c) stickiness when wet –clay stickier; d) bulk density –sand more dense; e) surface area of particles –clay larger in area per unit mass

17. What is the general relationship between texture and surface area of soil solids per unit mass? How does surface area per unit mass affect such soil properties as water holding capacity and nutrient (chemical) adsorption capacity?

The finer the texture, the smaller the particles and, therefore, the greater the surface area per unit mass. The greater the surface area, the greater the capacity to hold water and adsorb nutrients (and other chemicals).

18. What is soil structure?

Soil structure refers the state of aggregation of individual soil particles into much larger bodies that are variously called aggregates, structural units or peds.

19. Name the four general types of soil structure (geometries) and two types of structureless condition.

There are four general types, based on geometric shape, of aggregates –spherical (granular or crumb, the latter being more porous), platy (one dimension shortened with respect to the other two), prism (one dimension long compared to the other two, there being two types recognized, prismatic, with relatively sharp edges and flat faces, and columnar, with more rounded features), and blocky (all dimensions about the same, there being two types, angular and sub-angular blocky, analogous to prismatic and columnar). In some cases, however, a soil may not exhibit structure. This may occur in very sandy soils, in which case the particles are separate from one another as single grains, and in very clayey soils, in which case all the particles are stuck together, a condition called massive.

20. When Ca^{2+} is the dominant adsorbed cation, the soil is likely to be (more / less) aggregated than when Na^{+} is the dominant adsorbed cation.

When Ca^{2+} is the dominant adsorbed cation, the soil is likely to be (**more** / less) aggregated than when Na^{+} is the dominant adsorbed cation.

21. What texture of soil would be most likely to have a single-grain structure? Massive?

See question # 19.

22. How does soil structure affect aeration, infiltration and drainage?

Larger pores between structural aggregates increases all.

23. What is the relationship between soil organic matter and the formation and stability of soil aggregates, especially near the soil surface?

Organic matter acts something like glue among discrete particles, cohering them into aggregated bodies, particular at the soil surface where it is most abundant.

24. Define particle density.

Particle density is mass of solids divided the volume of solids (does not include pore space). As you know, the trick to determining it is measuring their composite volume and this is done by displacement of water in a picnometer.

25. Why is the particle density of mineral soils usually about 2.65 g / cm^3?

The density of most soil minerals is about 2.65 g / cm^3.

26. Define bulk density.

Mass of soil solids / volume in which they occur (includes pore space). Determine mass of solids (by oven-drying) contained in defined volume.

27. Define porosity and show how it can be calculated based on particle density and bulk density.

porosity = 1 – (bulk density / particle density)

$V_P = V_T - V_S$; porosity is V_P / V_T, therefore, porosity = 1 – V_S / V_T; write V_S in terms of particle density and mass of solids and write either mass of solids in terms of bulk density and V_T or V_T in terms of bulk density and mass of solids. On substitution, the above formula appears.

28. What is air-dry moisture content of soil?

Mass of water adsorbed from air onto soil solids per unit mass of soil solids. Dry the air-dry soil to oven dryness. The gravimetric water content of the air-dry soil is its air-dry moisture content.

29. Define volumetric water content.

Volume of water per unit volume of soil (includes pore space). Dry a known volume of soil to oven. The difference between the initial and final masses is the mass of water. Divide mass of water by its density (1 g cm^{-3}) and by the soil volume.

30. Work a bulk density and porosity problem. Here's an example: 1339 g of air-dry soil filled a 1000 cm^3 container. The particle density of the soil was 2.60 g / cm^3 and the air-dry moisture content was 3.00 %. What was the porosity? What was the volumetric water content?

porosity = 1 – (bulk density / particle density)

bulk density = mass of oven-dry soil / volume of soil mass of oven-dry soil = 1339 g / (1 + gravimetric water content of air-dry soil)

= 1339 g / (1.03) = 1300 g

Therefore,

bulk density = 1300 g / 1000 cm^3 = 1.30 g cm^{-3}

porosity = 1 – (1.30 / 2.60) = 0.50

31. Here's an easier one: A 200 cm^3 sample of soil weighed 300 g. After drying at 105 C for 24 h, it weighed 260 g. What was the bulk density of the soil? What was the volumetric water content of the field-moist soil?

bulk density = 260 g / 200 cm^3 = 1.30 g cm^{-3}

volumetric water content = [(300 g – 260 g) / 1.0 g cm^{-3}] / 200 cm^3 = 0.20

33. Is the bulk density of clay generally higher or lower than the bulk density of sand? Why?

Higher in sand because it lacks the intra-aggregate pore space that clay contains (clay composed of small aggregates, each containing internal pore space).

34. What effect does high bulk density have on root penetration?

High bulk density impedes root penetration.

35. What long-term effect does tillage have on soil porosity? Give two reasons why.

Tillage, in the long run, tends to decrease porosity and increase bulk density. Aggregates tend to be destroyed by compaction or physically broken and the loss of organic matter that occurs with continued tillage. Although a freshly made bed has a relatively low bulk density, it will collapse with time and the soil will be more dense.

36. Is the effect of tillage on porosity more important with respect to soil macro- or micropores?

It is the macropores that are most susceptible to destruction so that is the part of soil pore space that is lost.

37. What effect would each of the following have on bulk density?

a) repeated passes with heavy machinery
b) increasing depth in the profile

a) Repeated passes with heavy machinery	Decrease porosity / increase density
b) Increasing depth in the profile	Decrease porosity / increase density

38. What happens to infiltration rate if surface aggregates slake? The resulting surface feature is referred to a crust (True / False).

The term refers to disintegration of aggregates. The resulting surface does not have macropores so that water infiltration through this crust is slow.

39. Distinguish between physical and chemical weathering.

Physical weathering refers to a decrease in size of rock or mineral. Thermal shock, ice expansion and abrasion by sediment-laden water or air are means of physical weathering. Chemical weathering refers to change in mineral composition due to several different general types of reactions such as hydrolysis, hydration, acid dissolution and oxidation / reduction.

40. What are the five factors of soil formation?

Parent material, climate, organisms (particularly type of vegetative cover), topography and time.

41. Define soils from the perspective of soil formation.

I don't think I will ask you this but good to know anyway.

42. List 7 types of parent material.

There is residual parent material and there are 6 types of transported parent material – colluvial, alluvial (fan, flood plain and delta), exposed marine sediments, glacial, exposed lake sediments (lacustrine), and eolian.

43. The effects of residual parent material on soil properties are more clearly seen on an old, rather than young, soil (True / False).

True. The older is a soil formed in residual parent material, the less it resembles the rock from which it ultimately arose.

44. What is *colluvial* parent material?

Colluvial parent material is unconsolidated material that has moved down slope under gravity (mixed up landslide parent material).

45. What are the three types of alluvial parent materials?

See # 42.

46. Describe how a natural levee forms.

Due to rapid settling of sand, more material tends to be deposited near a stream or river than further away from it. Furthermore, the texture of the deposits near the stream are coarser (more sand and less clay) than further away. This also answers # 47.

47. How does soil texture vary with position on a natural levee and why?

See # 46.

48. What is the material comprising local eolian deposits called? It is composed primarily of what size soil particles? Why?

Loess is composed primarily of silt (with some fine sand and clay). Particles of this size range are comparatively easily transported by wind. They are not so large as to make this unlikely (like larger size sand) or so small that they cohere to one another making aggregates (like clay).

49. What is *peat*? Where in the landscape are these deposits generally found? What general environmental conditions are needed for the accumulation of peat?

Peat is an organic matter accumulation that is typically found in depressional areas where wetness favors production of plant biomass but slows the decomposition of plant residue resulting in a net accumulation of organic matter. Peat deposits are common in cool climates due to slower rate of organic matter decomposition but is also found in warm climates.

50. Contrast the morphology of soils formed under forest and grassland vegetation. Which is commonly more fertile?

Forest soil have A (relatively thin), E and Bt horizonation where as prairie soils have A (relatively thick) and B horizonation. Prairie soils typically have a higher concentration of base cations (calcium, magnesium and potassium) and lower concentration of acid cations (hydrogen and aluminum), thus higher pH and greater fertility than forest soils.

51. What effect do precipitation and temperature have on soil weathering and depth of development?

High precipitation and temperature increase weathering and deep pedogenesis.

52. High rainfall and / or temperature accelerate

Leaching of fairly soluble constituents like $CaCO_3$	(True / False)
Weathering of primary minerals to secondary clays	(True / False)
Translocation of clay from A and E horizons to B	(True / False)

Leaching of fairly soluble constituents like $CaCO_3$	True
Weathering of primary minerals to secondary clays	True
Translocation of clay from A and E horizons to B	True

53. Soil depth and profile development are generally greater on side-slopes than on summits or foot-slopes (True / False). Give a couple of reasons why or why not.

False. Increased erosion and decreased infiltration on side-slopes result in shallower soil development.

54. What effect does a water table very near the soil surface have on drainage? So, what effect does it have on soil development?

A shallow water table that roughly parallels the soil surface acts as a barrier to the downward movement of water carrying suspended solids (like clay) and therefore retards profile development.

55. What effect does slope direction have on soil development?

Side away from the sun is cooler and wetter, typically leading to higher organic matter content.

56. In comparing two soils that formed from the same general parent material, in the same climatic region, under the same type of vegetative cover and in very similar landscape positions (i.e., a chronosequence), you observe that profile development is deeper in one of the soils. Which one has likely be subject to pedogensis longer?

The deeper one is older.

57. What are the four processes of soil formation? Give an example of each.

Transformation, translocation, addition and loss. I'm sure you can give examples.

58. The youngest, most elementary soil is characterized by what? Or, in other words, what is the first step in soil formation?

Accumulation of organic matter in the surface soil to form an A horizon.

59. What is a pedon? Polypedon?

A pedon is the smallest mass of a soil needed to fully describe the soil. Strictly speaking, only a certain depth and width are needed to fully describe the horizonation of a soil, and a pedon is just a conceptual block of this depth and width. The concept is useful, however, inasmuch as many contiguous pedons, constituting a polypedon, define the extent of a soil individual, the occurrence of a particular soil at a location

60. List and very briefly describe five different epipedons.

Five epipedons presented in class are the mollic (deep A horizon, characterized by high content of organic matter and base cations –hence, dark and fertile, that developed under prairie vegetation), umbric (similar to mollic but developed under forest and usually lower organic matter content), melanic (similar to mollic but developed in volcanic parent material), ochric (A horizon that is light in color due to little accumulated organic matter), and histic (deep O horizon, not just a heavy forest litter layer, for example).

61. List and very briefly describe five different subsurface diagnostic horizons.

Five endopedons presented in class are the albic (very light colored E horizon), cambic (weakly developed B horizon), argillic (a B horizon characterized by accumulation of clay translocated, Bt, from the soil above it), spodic (a B horizon characterized by accumulation of organic matter or humus, Bh, translocated from the soil surface and A horizon, or humus and aluminum and iron oxides, Bs), and oxic (a highly weathered subsoil with mineralogy dominated by aluminum and iron oxides).

62. What is the most general level of classification used in Soil Taxonomy? The most specific?

Order is the most general level of classification used in Soil Taxonomy. Series is the most specific.

63. Name the 12 soil orders and very briefly describe each (diagnostic horizons and / or other major distinguishing properties).

Entisols (little profile development; A and C horizonation); Inceptisols (more development than Entisols; A, B and C, with weakly developed B); Aridisols (arid region soils with little accumulation of organic matter and limited translocation of clay and even soluble salts, the latter often found in the subsoil); Andisols (relatively weakly developed soils formed in volcanic parent material that have a melanic epipedon); Mollisols (prairie soils with a mollic epipedon); Alfisols (forest soils with A, E, Bt and C horizonation); Ultisols (similar to Alfisols but more weathered, acidic and less fertile); Oxisols (old and highly weathered soils with an oxic endopedon); Spodosols (sandy forest soils with a spodic endopedon); Vertisols (soils that are weakly developed due to high content of shrink-swell clay that leads to profile inversion given sufficient durations of dry conditions, a process called pedoturbation); Histosols (organic soils, have histic epipedon); Gelisols (cold region soils with limited profile development due to presence of permafrost and subject to cryoturbation, or profile disturbance / mixing due to freezing and thawing).

64. Which of the above are found in Louisiana?

Entisols, Inceptisols, Alfisols, Ultisols, Mollisols, Vertisols and Histosols are found in LA.

65. Give two possible reasons why there is little profile development in Entisols and Inceptisols.

The same causes are responsible for little profile development in Entisols and Inceptisols, however, the causes are more pronounced for the Entisols. Causes include lack of time for horizon development, mineralogy dominated by minerals resistant to weathering, erosion that tends to remove the surface of the developing profile nearly as fast as it can develop downward, deposition that tends to bury the developing profile nearly as fast organic matter can accumulate and materials can be translocated downward through it, generally quite dry conditions (though not as dry as for Aridisols), and generally quite wet conditions (though not as wet as for Histosols).

66. Why is profile development limited in Aridisols?

Lack of water.

67. Why does pedoturbation occur in Vertisols? Explain how it slows pedogenesis.

A horizon material falls down amongst C horizon material through large cracks that open when the Vertisols is dry. Upon re-wetting the cracks close and pressure develops within the soil, tending to cause local uplift. In long-term effect, the topsoil (A) and subsoil (C) are inverted, slowing, even prohibiting development of typical horizonation.

68. Give the typical horizon sequence found in Alfisols and Ultisols. What is the dominant pedogenic process in soils of these orders?

The sequence is A, E, Bt and C. Formation of the Bt horizon (with concurrent appearance of the E) due to translocation of clay is the dominant process.

69. At what depths are the E and Bt horizons found in the below profile?

Depth (cm)	% Clay	% Organic Matter
0 - 15	4	2.0
15 - 30	8	0.3
30 - 45	25	0.2
45 - 60	23	0.1
60 - 75	15	0.1

The Bt is located at the clay “bulge” or from 30 to 60 cm. The A is the surface horizon with high organic matter content and the E is in between.

70. Give the horizon sequence found in Spodosols. What soil and environmental conditions are necessary for the development of a spodic horizon?

A, E, Bh (or Bs, types of spodic horizons) and C (although in some cases a Bt is found below the spodic). These soils form in sandy parent material, allowing for the rapid infiltration necessary for movement of organic matter and Al and Fe oxides downward to form the spodic horizon. Typically, these form under coniferous vegetation which produces acidic litter, this, too, facilitating movement, particularly of the oxides. Spodosols are more common under cool climates but occur in warmer climates (e.g., Florida).

71. What is the mineralogy of an oxic subsurface horizon? Where are Oxisols found (topographically as well as geographically)?

Mineralology is dominated by Al and Fe oxides. Oxisols are found in the humid tropics but not just anywhere, only on stable landscape positions because even under intense weathering conditions it takes a long time for the oxic horizon to develop.

72. What conditions are necessary for the development of a histic epipedon? What happens when a Histosol is drained?

Very wet (as in a depressional area) and (generally) cool conditions such that organic matter production greatly exceeds its rate of decomposition. When a Histosol is drained aerobic microbes consume (oxidize) the Histosol and it subsides, eventually going away altogether.

73. What is cryoturbation? What other factor limits profile development in Gelisols?

Profile mixing due to freezing and thawing. The presence of permafrost in Gelisols also limits profile development because it is a barrier to free downward movement of water that carries suspended solids.

74. If given the Soil Taxonomy name of a soil, be able to say to which order it belongs. In other words, recognize final suffixes, like with the Stough series soil,coarse-loamy, siliceous, thermic Fragiaquic Paleud**ults**, an **Ult**isol.

Ending specifies order.

75. Delineations on a general soils map show soil associations. What are soil associations?

These are soils that tend to occur nearby one another and often differ principally in relative drainage and aeration.

76. Delineations on a detailed soils map (aerial photo) show mapping units. What types of mapping units are there? What is a phase of a soil series? What is the difference between a consociation and a complex?

Mapping units may be series, phases of series (not a Taxonomic level of classification but a minor variation on series that depends on slope, surface texture, or other property), consociations (two or more similar soils that occur in such a complicated pattern that it is not practical to delineate boundaries), or complexes (similar to consociations but the soils are distinctly different rather than similar).

77. Which land capability class, I or IIIe, can be more intensively produced?

I. The III capability class has limitations and the major one in this case (IIIe) is susceptibility to erosion.

78. You were cutting timber on two tracts of land but had to stop because it rained cats and dogs for two weeks. Now, fair weather is predicted for several days and you can go back to work. One of the tracts has soil of land capability class IIe and the other has soil of land capability class IVw. Do you immediately continuing harvesting both tracts?

I would try IIe. After all, since it is erodible, its surface must be well-drained. The IVw soil tends to be wet even without an extended rain so that after such, it is probably pretty sloppy.