

Name _____

AGRY 560 EXAM
October 3, 2001
(100 points, 7 pages total)

- (8) 1. Listed below in the left column are 6 methods that are used to measure some aspect of soil structure. In the right column are listed the actual information which we would like to know about the soil. For each item in the right column, choose the one best method from the choices on the left (a-f).

<u>Methods</u>	<u>Desired Information</u>
a. air-to-water permeability ratio	___ Stability of aggregates to breakdown by wind erosion
b. pore size distribution	___ Relative stability of different soils under long-term wastewater disposal fields
c. dry crushing between 2 plates	___ Stability of aggregates to breakdown by water erosion
d. dry sieving	___ Volume of pores of suitable size for root growth
e. wet sieving	
f. bulk density	

- (6) 2. Various types of penetrometers and other devices are used to obtain quick estimates of soil strength for different purposes. Listed below in the left column are instruments that can be used. In the right column is listed the type of process for which an index is desired. For each item in the right column, choose the one best instrument from the choices on the left (a-d).

<u>Instruments</u>	<u>Index desired</u>
a. cone penetrometer	___ Soil crust strength
b. Proctor penetrometer	___ Bearing capacity of soil for wheel traffic
c. shear vane	___ Ability of roots to grow through soil
d. modulus of rupture	

- (4) 3. Why are earthworm populations usually higher under no-till systems than under conventional moldboard plow systems?

- (5) 4. You have been asked to assess a popular city park for some potential compaction problems. The park manager suggests that you take bulk density cores in the top 12 inches (in 0-4", 4-8", and 8-12" increments), in several spots in the "problem" area and in several spots without problems. You agree, but you also suggest that you make some cone penetrometer readings as well. Why? i.e. what additional factors does a penetrometer assess, that simple bulk density measurements do not?
- (9) 5. a) Sketch a graph (label the axes) of soil bulk density vs. gravimetric water content, after compaction in a Proctor Test apparatus. What is the purpose of the Proctor Test, and what does the curve you drew illustrate?
- b) Now assume that the curve you already drew represents the curve from a silt loam soil with 1% organic matter. Draw another curve on the graph you've already drawn, showing a silt loam soil with 4% organic matter. (Be sure to label the curves.) Explain the differences between the curves and why they exist. (Do not be constrained by the data obtained from 560/465 lab groups, since there were likely many experimental errors in those tests. Discuss what should have happened, if everything was done properly.)

- (4) 6. Why does the clod bulk density procedure overestimate the true B.D. of the soil?
- (4) 7. When we perform particle size (texture) analysis, why must we remove organic matter and carbonates, and disperse clays?
- (4) 8. Of the 5 major assumptions used in Stoke's Law analysis of particle size distribution (texture) methods, which 2 assumptions are most likely to not be as good or correct? State those 2 assumptions and briefly explain the limitations of each of them.
- (4) 9. In each of the following pairs of soils, indicate which one would have the greatest volumetric heat capacity, and which would have the greatest thermal conductivity. (It is possible that the same soil could have both the highest heat capacity and the highest thermal conductivity.)
- | | heat
capacity
(a or b?) | thermal
conductivity
(a or b?) |
|--|-------------------------------|--------------------------------------|
| a) wet sand at
BD=1.4 g/cm ³ | | |
| b) dry sand at
BD = 1.4 g/cm ³ | _____ | _____ |
| a) compact soil
at saturation | | |
| b) loose soil
at saturation | _____ | _____ |

- (6) 10. For each of the following surface soil treatments listed below, 1) state whether the average soil temperature in the top 5 cm will probably increase or decrease, compared with a bare, flat, smooth soil surface, and 2) briefly explain the reasons for the increase or decrease. (Assume it is in the spring of the year, when the soil is starting to warm up.)

a) black plastic

b) loosening (tilling) the soil

- (10) 11. How many cm of water are stored in the top 60 cm of this soil profile? We measured gravimetric water content (θ_g) and bulk density (BD) as follows: **(SHOW ALL WORK AND UNITS!)**

<u>Depth (cm)</u>	<u>θ_g(g/g)</u>	<u>BD(g/cm³)</u>
0-15	0.18	1.17
15-35	0.24	1.28
35-60	0.31	1.34

- (8) 12. Given the following data from the clod bulk density procedure, calculate the soil bulk density. **SHOW ALL WORK AND UNITS!**

Moist soil clod	= 340 g
Moist soil clod + saran	= 352 g
Saran density	= 1.3 g/cm ³
Bucket + water	= 500 g
Bucket + water + suspended clod	= 665 g
Water density	= 1 g/cm ³
Oven dry soil + saran	= 280 g

- (8) 13. You are doing an experiment to try to prolong the autumn growth of newly-established turf in a golf green. During construction of the green you installed some heating plates above the drainage system, so you could heat the soil from below. As a first approximation (estimate) of the amount of heat lost from the top of these buried plates up through soil to the air above, let's assume steady-state 1-dimensional flow of heat through the soil and no movement of water or vapor. Calculate the heat loss per m^2 out the top of the heating plates, assuming you maintain constant surface soil temperature of 10°C , constant temperature of the heating plates of 45°C , heat plate depth of 35 cm, and soil thermal conductivity of $3.2 \times 10^{-3} \text{ cal/cm sec}^\circ\text{C}$. SHOW ALL WORK AND UNITS! Your final answer must be expressed in scientific notation and in units of $\text{cal/m}^2 \text{ day}$!

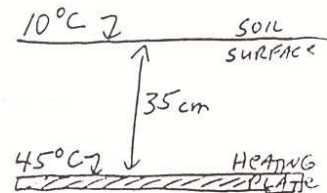
INFORMATION YOU MAY OR MAY NOT NEED:

$$\text{Heat flow equation } q_H = -K \frac{\Delta T}{\Delta Z}$$

Soil thermal conductivity = $3.2 \times 10^{-3} \text{ cal/cm sec}^\circ\text{C}$

Soil organic matter content = 1.7%

Soil bulk density = 1.45 g/cm^3



- (20) 14. You have been asked to talk to a group of scientists about soil structure and tilth, including the potential role of soil fauna in tilth improvement. These scientists include a mix of chemists, physicists and biologists who have no experience with soils or agriculture (other than their own gardens!). Prepare a written summary that could accompany your lecture to this group (3 pages maximum, i.e. back of this sheet and front and back of attached sheet of paper). Your written discussion should include at least some attention to all of the following 7 main questions:

- 1) What is soil structure?
- 2) Why is good soil structure important?
To help with your discussion here, you might include some of the ideas you read in the Karlen et al. article, about the following questions:
 - a) What were the characteristics of ideal soil tilth as outlined by Yoder?
 - b) Discuss the issues implied by the question of Yoder (1937), "will it be more economical to continue to use our soils in a poor state of tilth or to promote the regeneration of a more desirable soil structure," as quoted by Karlen et al. (1990) on p. 154.
- 3) How are aggregates created? destroyed?
- 4) Compare soil tilth and organic matter content from the following systems, and explain why those differences occur:
 - a) uncultivated (virgin) soil vs. cultivated soils
 - b) row crops vs. crop rotations that include some hay crops (alfalfa, clovers, grasses, or other perennials) or "meadow" or pasture
- 5) Discuss Wardle's main findings (as discussed in Kladvko article) about the effects of tillage on abundance and variance of soil fauna. Discuss the main reasons for the tillage effects.
- 6) If you want to design tillage or planting equipment to maximize soil faunal populations, what are some of the objectives you would consider? In other words, what types of soil/residue conditions would you like to achieve with your new equipment?
- 7) What are some of the research questions that you think should be studied, related to soil structure, tilth, or faunal interactions with tilth?