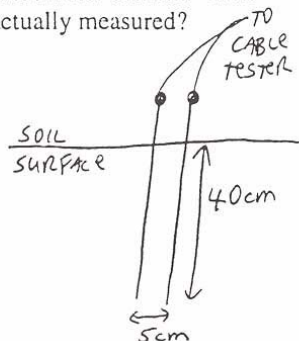


Name _____

Agry 465 Exam
November 6, 2002
(100 points) (8 pages)

We discussed at least 5 different types of ways to measure soil water content or soil water potential in the field: sampling and drying, electrical resistance, neutron probe, tensiometer, and time domain reflectometry (TDR). The following questions attempt to assess your understanding of these methods and their relative advantages and disadvantages.

- (4) 1. Tensiometers measure what in the soil? (circle all true statements)
- a) osmotic potential
 - b) matric potential
 - c) gravimetric water content
 - d) volumetric water content
- (4) 2. Neutron probes should be calibrated for your soil. What are the purposes of calibration? (circle all true statements)
- a) to adjust readings for hysteresis in the soil water retention curve
 - b) to adjust readings for slow neutron absorbers such as boron, chloride and cadmium (B, Cl, Cd)
 - c) to adjust readings for application of fertilizer salts such as potassium nitrate (KNO_3)
 - d) to adjust readings for soil pH
 - e) to adjust readings for hydrogen present in clays and soil organic matter
- (4) 3. The ceramic cups on tensiometers must remain saturated in order to function properly. At what tension will the pores in the cup desaturate?
- a) 15 bar
 - b) 1 bar
 - c) 0.33 bar
 - d) 0.1 bar
- (4) 4. TDR consists of 2 parallel stainless steel rods ("waveguides"), spaced about 5 cm apart, inserted into the soil to some depth (perhaps 40 cm). An electromagnetic wave is pulsed down the line, and the time required for the wave to propagate down the rods and then reflect back to the cable tester is measured. The travel time of the wave is related to the dielectric constant of the soil system, which changes greatly with water content. If the waveguides are inserted to a 40 cm depth as shown, what is actually measured?
- a) average volumetric water content of the 0 to 40 cm depth
 - b) volumetric water content at the 40 cm depth
 - c) volumetric water content at the 20 cm depth
 - d) volumetric water content of the top 5 cm of soil



- (4) 5. What is the force that causes water to flow out of the soil samples, and the soil to equilibrate at the desired matric potential, in the pressure plate method?
- a) the attraction of the ceramic plate for the water
 - b) the weight of the soil samples
 - c) the column of water from under the plate to the outlet tube
 - d) the higher pressure inside the pressure pot
- (4) 6. In the auger-hole method for measuring saturated hydraulic conductivity below a water table, what is actually measured?
- a) infiltration into dry soil
 - b) vertical conductivity
 - c) horizontal conductivity
 - d) some combination of horizontal and vertical conductivity
- (6) 7. You want to measure soil water content over 2-inch increments down to 12 inches (i.e. you want 0-2", 2-4, 4-6, 6-8, 8-10, and 10-12" water contents). Which of the following methods could be suitable for this application? (some may be more time consuming than others, but are they inherently suitable?) CIRCLE all correct answers! For all 4 methods, state why the method is suitable or why it is not suitable.
- a) electrical resistance blocks
Why or why not?
 - b) neutron probe
Why or why not?
 - c) TDR
Why or why not?
 - d) sampling with soil probe and oven drying
Why or why not?

(8) 8. Draw a sketch of a soil water retention curve (desorption), for a sand and a silt loam (include both curves on the same graph). Explain the reasons for the differences in the shapes of the two curves. (Be sure to label the axes!)

(4) 9. Over what range of water potentials should intact soil core samples be used, and over what range are <2mm sieved soil samples adequate, for measurement of water retention curves? Briefly explain your reasons.

(10)10. Describe the double ring infiltrometer method for measuring infiltration rates (equipment, procedures, theory, etc.). Be sure to include some discussion of the advantages and disadvantages of this technique as compared to the sprinkling infiltrometer method.

- (4) 11. Choose the best definition of “field capacity” from the choices below.
- a) field soil water content, after a soil has been fully saturated and then allowed to drain until further drainage is negligible
 - b) field soil water content, after a soil has been fully saturated and then allowed to drain for 24 hours
 - c) field soil water content, 24 hours after any major rainfall event
 - d) soil water content of an intact core sample equilibrated at -0.1 bar potential

(4) 12. On the field trip we saw an above-grade septic disposal system, or "mound system." What is the basic purpose of the mound compared to the standard septic disposal system?

(6) 13. Rank the following 3 soils (1 = highest, 3 = lowest) for each of the soil physical properties listed in the table.

	water content -0.1 bar	saturated hydraulic conductivity	water content -15 bar	plant available water
silt loam				
clay				
sand				

The following equations and information may or may not be needed to work some of the problems. They are here for your reference if you need them.

DARCY'S LAW

$$q_w = -K \frac{\Delta H}{\Delta L} \quad \text{OR} \quad Q = -KA \frac{\Delta H}{\Delta L}$$

POISEUILLE'S LAW

$$Q = \frac{-\pi R^4 \rho g \Delta H}{8 \mu L}$$

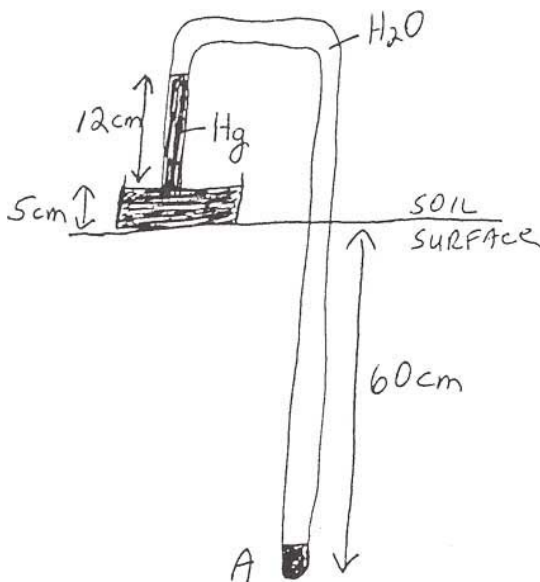
Assume $\rho_w = 1 \text{ g/cm}^3$

$g = 980 \text{ cm/sec}^2$

$\mu = 1.0 \times 10^{-2} \frac{\text{g}}{\text{cm sec}}$

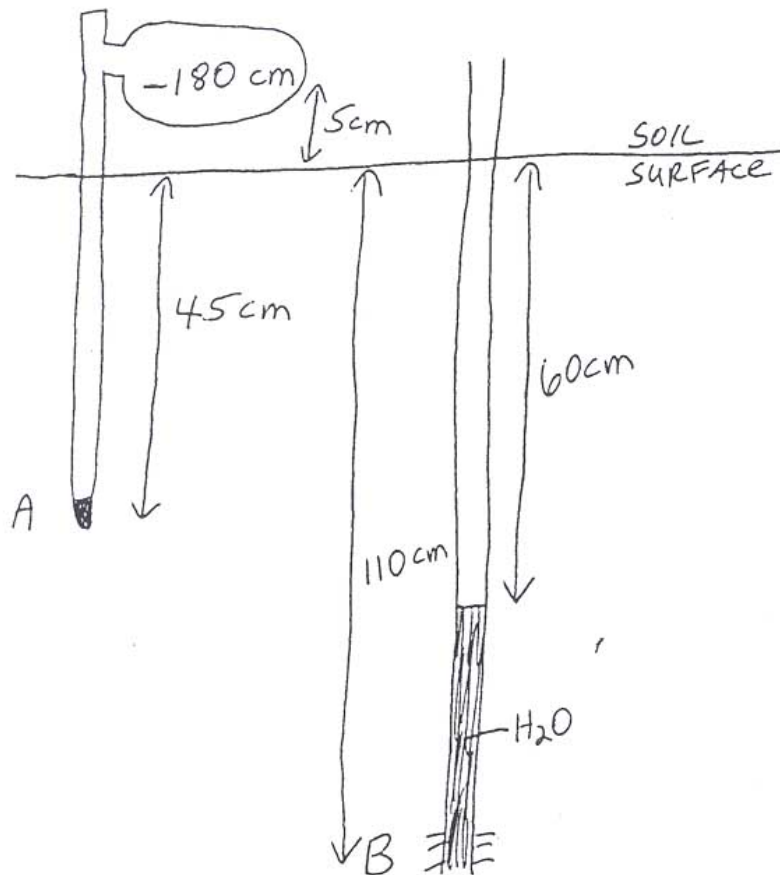
$$K_{\text{EFFECTIVE}} = \frac{L_{\text{TOTAL}}}{\left(\frac{L_1}{K_1} + \frac{L_2}{K_2}\right)}$$

- (8) 14. A mercury tensiometer is installed in the soil as shown. Calculate the pressure head, gravitational head, and total hydraulic head of the soil at point A, using the soil surface as the reference elevation. **SHOW ALL WORK AND UNITS!**



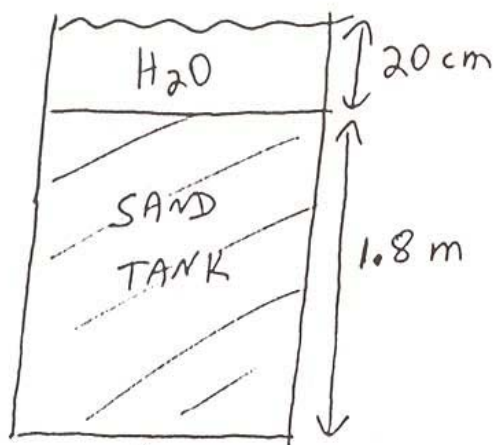
Assume
 $\rho_{H_2O} = 1.0 \text{ g/cm}^3$
 $\rho_{Hg} = 13.65 \text{ g/cm}^3$

- (10) 15. A piezometer and a gauge tensiometer are installed as shown. Calculate the pressure head, gravitational head, and total hydraulic head of the soil at points A and B, using the soil surface as the reference elevation.



- (8) 16. A water purification facility is using large sand columns for water filtration. They pond water on top of very large sand tanks and allow it to flow under saturated conditions to the bottom of the columns. They need to produce a total of $120 \text{ m}^3/\text{day}$ of purified water. What total cross-sectional area (m^2) of sand tanks do they need, in order to filter this much water? **SHOW ALL WORK AND UNITS!** Partial credit will be given when I can follow your work and thought process. (you may have been given more information than you need to solve the problem)

Saturated hydraulic conductivity = 75 cm/day
Saturated volumetric water content = 0.45
Sand content = 95%



DISCHARGE NEEDED IS $-120 \text{ m}^3/\text{day}$

↑ (i.e., DOWNWARD FLOW)

- (8) 17. A double-ring infiltration test was run in the field, with the same equipment we used in lab. Given the data below, calculate the infiltration rate over the time period given. **Final units must be expressed as cm/hr.**

SHOW ALL WORK AND UNITS! Partial credit will be given when I can follow your work and thought process.

Assume area of inner ring = 700cm^2
Remember $1\text{ ml} = 1\text{ cm}^3$

<u>Actual Time</u>	<u>Water Volume in Supply Jug</u>
9:00 AM	4.0 liters
9:25 AM	1.5 liters