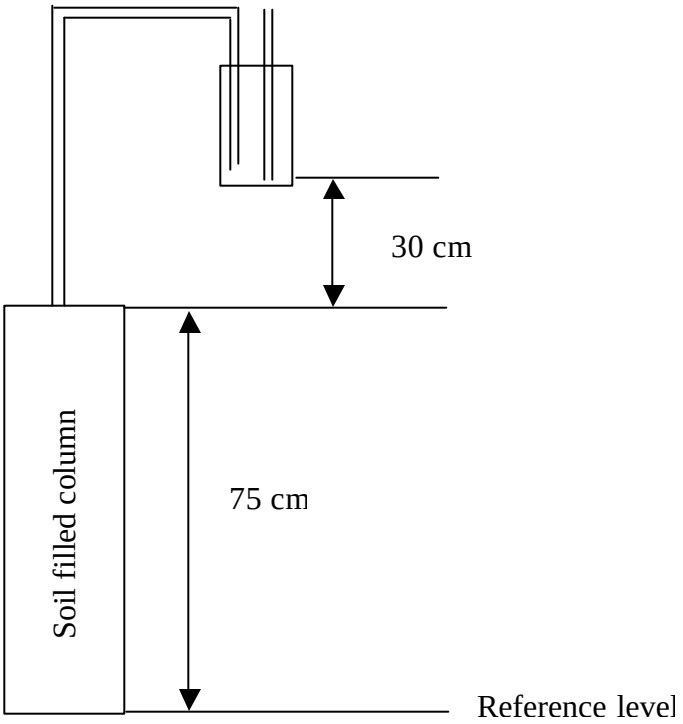
Soil Science 100 ID_____
Second exam Lab_____
Friday November 15, 2002

Value 100 points

Please answer all questions in the space provided.

1. (10) Use the figure and accompanying flux data to calculate the saturated hydraulic conductivity for the soil in the column pictured here.



The final measured flow rate (Q) was 24 mL/min. The cross sectional area of the column was 12 cm^2.

Answer: Darcy's law for saturated flow says the flux (q) = -K $\Delta H/\Delta X$ (3 points for correct Darcy equation)

q = Q/A = 24/12 = 2

The difference in head between the inflow and outflow sides of the column is:
Inflow Hp = 30, Hg = 75; outflow Hp=0 and Hg=0. The difference in head, or total head is 105 cm. The distance (ΔX) is 75 cm. (5 points for correct gradient)

2 = -K 105/75 = 1.43 cm/min (2 points for correct answer)

2. (16) a. What are the major components of water potential?
   b. Which are most important in saturated soils ?
   c. Which are most important in unsaturated soils?
   d. Explain your answers to parts b and c.

Answer: Water potential has four components. Gravity, pressure, matric, solute or osmotic. In saturated soils, gravity and pressure are most important and in unsaturated soils, matric and gravity are most important. In saturated soils, most of the water flows through the center of pores and is not in contact with the solid phase. Hence we ignore matric potential. Solute or osmotic potential is ignored because we assume a uniform salinity in the soil. Under unsaturated conditions, matric potential is the most important because the water is assumed to be in contact with the soil atmosphere (ignore pressure) and in close contact with the solid phase. Solute or osmotic potential is again ignored. Gravity always works.

3. (5) How do ion charge and hydrated ion size influence the exchange of one cation for another on clay surfaces?

Answer: Small highly charged ions are exchanged preferentially over larger or lower charged ions.

4. (5) Explain why cation exchange capacity goes down more in a soil high in organic matter than a soil low in organic matter when soil pH goes down?

Answer: Organic matter has much pH dependent charge. When soil pH goes down, the pH-dependent sites protonate, making them positive, thus reducing cation exchange capacity.

5. (12) Explain how the following factors influence soil temperature: soil water content in the spring, slope aspect, slope angle, surface mulch in the summer?

Answer: A wet soil warms more slowly in the spring than a dry soil because of the higher heat capacity of a wet soil compared to a dry soil. Slope aspect and slope angle affect the amount of solar radiation reaching the soil. As the aspect becomes more southern a soil will be warmer than a comparable soil on a less southern exposure. Slope angle determines how directly solar energy impacts a soil. A soil that gets more direct solar radiation will be warmer than a soil that gets less direct solar radiation. A surface mulch in summer helps to keep a soil cool because it intercepts the direct solar radiation. It also may decrease the rate at which the heat is transmitted to the soil (depending on its conductance).

6. (5) How does texture stratification (for example clay over sand) influence water flow through soil?

Answer: Stratification generally slows the flow of water through soil. Stratification of clay over sand causes the soil water to build up over the sand until the clay is saturated and the matric potential goes to zero or near zero. At more negative matric potentials, the water is held too tightly by the clay for the sand to pull the water out of the clay layer.

7. (6) What is consumptive use of water and how does it differ from non-consumptive use?

Answer: Consumptive use of water converts water from a liquid to a gas through evaporation and transpiration. It is no longer available for future use. Non-consumptive use is available for future use.

8. (5) Why do some microorganisms produce toxins?

Answer: They produce toxins as a method for reducing the competitive pressure on resources they need to survive.

9. (16) List the four requirements that soil organisms require to prosper in soil.

Answer: They require space, appropriate environment (temperature, water content, pH), food, and energy resources. (4 points each correct)

10. (6) What is the major difference in energy source between heterotrophic and autotrophic microorganisms?

Answer: Heterotrophic organisms require a preformed organic substrate for energy while autotrophic organisms do not.

11. (9) a. What is nitrogen fixation? b. Why is it important? c. Is it an oxidation or reduction of nitrogen?

Answer: Nitrogen fixation is the conversion of atmospheric N to mineral N (NH_3) by microorganisms. It is important because it converts an abundant (80% of the atmosphere) form of nitrogen that is not assimilated to one that can be assimilated by microorganisms and plants. It is an important "natural" source of nitrogen for plant growth. It is a reduction of N_2 (0) to NH_3 (-3).

12. (5) You extract phosphorus from 5 g of oven dry soil with 50 mL of extractant. You take 5 mL of the extract and dilute it to 100 mL and measure the absorbance. From the standard curve, you find that the solution has 12 micrograms of P per milliliter. Calculate the phosphorus concentration in the soil (mg/g).

Answer: 12 micrograms P/mL extract * 100 mL diluted extract/5 mL extract * .001 mg/microgram * 50 mL extractant/5.0g = 2.4 mg P/ g oven dry soil.