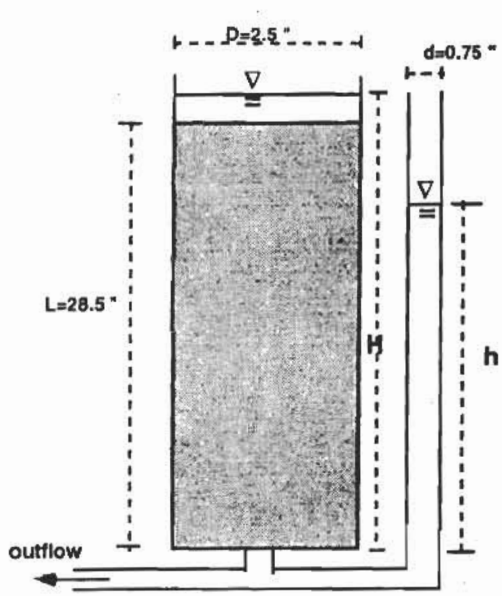
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

1.72 Groundwater Hydrology
Problem Set #2

Due Oct. 12

1. **Falling head permeameter.** The system begins at equilibrium. Water is removed from the bottom of the system, causing the manometer head (h) and the column head (H) to fall. Just after the valve is closed, the initial heads in the column (H_o) and in the manometer (h_o) are recorded. The manometer water elevation h(t) is measured over time as the system returns to equilibrium. *Record the data from the demonstration given in class*. Dimensions of the system are given:



   a) Use Darcy's Law to describe flow through the porous media in the permeameter column.

   b) Show how mass is conserved in the closed system of the permeameter (after the water has been removed). Hint: related head change in the manometer to head change in the column.

   c) Combine the equations in part a) and b) to construct an equation describing the head in the manometer (i.e., the little tube) as a function of time. Prove that head in the manometer is:

$$h(t) = \frac{H_o + (d/D)^2 h_o - (H_o - h_o) e^{-\left(1+(D/d)^2\right)(K/L)t}}{1+\left(d/D\right)^2} \qquad (1)$$

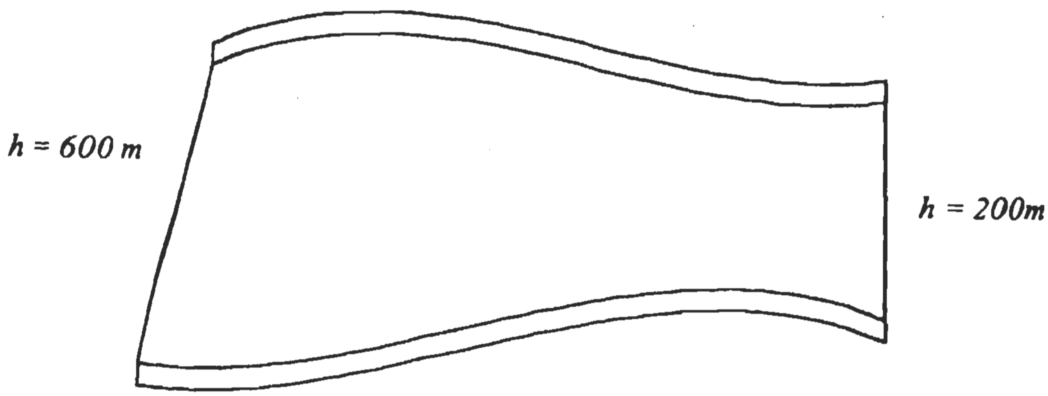
   d) Use the data from the in-class demonstration (head in the manometer tube over time) to fit a value to the parameter K (hydraulic conductivity) in cm/sec. We are not necessarily looking for the best statistical fit, just a reasonable fit to the relation:

$$h(t) = a + be^{-cKt} \qquad (2)$$

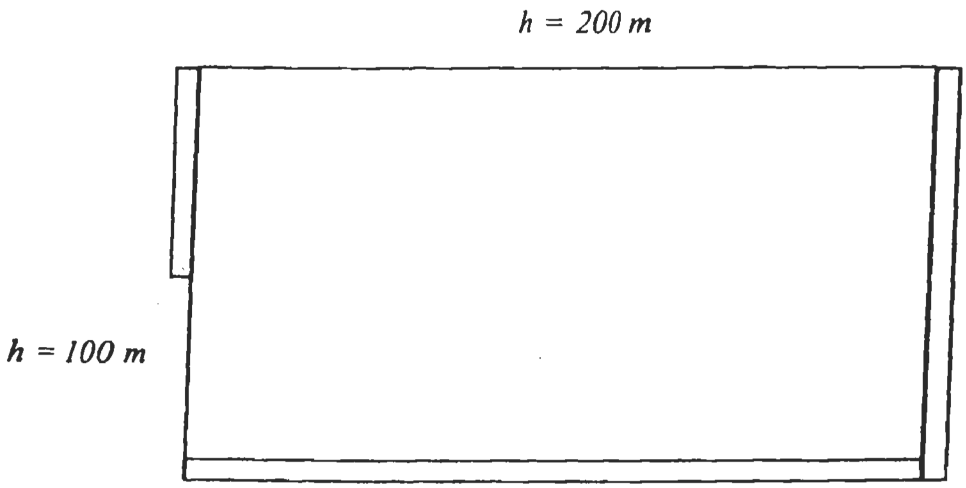
   where a, b, and c are constants.

2. An aquifer has three different formations. Formation A has a thickness of 30 ft and a hydraulic conductivity of 7.0 ft/day. Formation B has a thickness of 15 ft and a conductivity of 78 ft/day. Formation C has a thickness of 22 ft and a conductivity of 17 ft/day. Assume that each individual formation is isotropic and homogeneous. Compute both the overall horizontal and vertical conductivity. What is the aquifer transmissivity, assuming all three formations are saturated? What would be the flow per unit width through the aquifer if the gradient magnitude were 0.01?

3. Draw a quantitatively accurate flow net for the case below. Show flow direction **arrows on** the flow lines. Assuming that $K = 1 \times 10^{-3}$ m/s, what is the volume discharge per **meter** thickness of section?



4. Draw a quantitatively accurate flow net for the case below. Show flow direction **arrows on** the flow lines. Calculate the volume discharge per meter thickness of section if $K = 5 \times 10^{-2}$ cm/s (note the **change in units** for conductivity).



5. Draw a quantitatively accurate flow net for the case below: