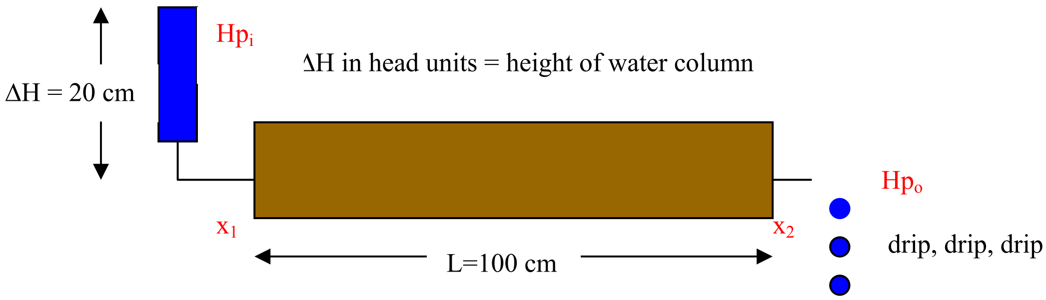
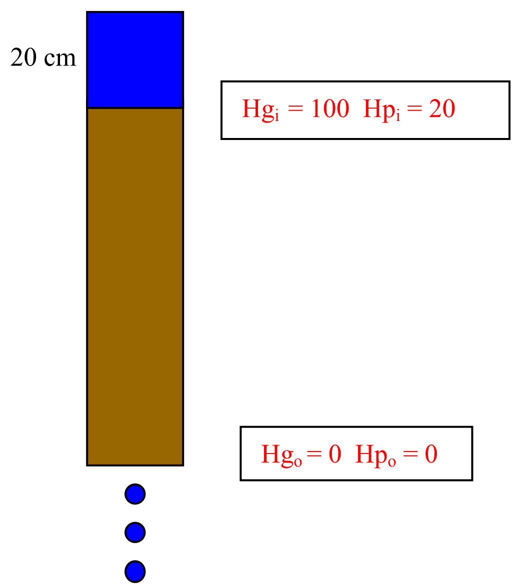
1. Under saturated conditions, the hydrostatic pressure head (H_p) is 0 or greater than 0. In a horizontal column, the hydraulic gradient it is easy to understand because there will be no water flow if $H_p = 0$ at both ends of the column. As one puts a column of water higher and higher at one end, the pressure difference steadily increases and so does flow.



In the above case, gravity potential is not a factor because the soil column is level. Again, the only "driving force" is the hydrostatic pressure difference or the height of the water column (which is kept constant by continually adding more water). This soil has a K_s of 1 cm per day.

a. What is the flux (q) from this column?
b. What would be the flux if the water column were only 10 cm high?
c. What would be the flux if the soil column was only 50 cm long and the ΔH was 20 cm?
d. What would be the flux, if any, if there was no ponded water ($Hp_i = 0$)?

2. Imagine, if you will, that the above column is turned to a vertical position and there is still 20 cm of ponded water on top. Now there is a gravitational component to the hydraulic gradient. The hydraulic head (H) at any point is equal to the distance to the gravity reference point (H_g or z) + the hydrostatic pressure potential (H_p) at that point. The confusing point, I think, is that it seems as if the hydrostatic pressure potential should be higher at the bottom of the column, not equal to zero. Because the water is freely dripping from the bottom, it has an H_p of zero. As soon as the slightest pressure develops, the water will drip. This would be different if the column was sealed. What is opposing the weight of the water in the column?--it is the resistance of the soil. The soil is slowing down the movement of the water, which is driven by both pressure and gravity. In the below case the hydrostatic pressure, H_p, drops from 20 cm at the soil surface to 0 at the bottom. The gravitational potential head, H_g, is the driving force that one intuitively might assign to H_p. Remember that $H = H_p + H_g$. Both contribute to the downward gradient.



Another possibly confusing point is that, in the case of vertical flow, the length of the column is used both as a unit of potential head (in H_g) and as a unit of length in the denominator (L).

Answer the same questions above in 1a through d.

3. Using the toolkit for steady-state water movement in uniform soil at calculate the following (use a 10 cm column and a K_s of 10 cm /day for all):

a. What is the flux when Matric Potential A is +20 cm (hydrostatic pressure in our terminology) and Matric Potential B is 0 cm?
b. What is the flux under these conditions when the column is vertical?
c. What is the flux in a vertical column (90^o) when Matric Potential A is -10 cm and B is 0 cm?
d. What is the flux in a vertical column when Matric Potential A is -20 cm and B is -10 cm?
e. What is the flux in a vertical column when Matric Potential A is -20 cm and B is -20 cm?
f. What is the flux in a vertical column when Matric Potential A is -20 cm and B is 0 cm?
g. What is the flux in a vertical column when Matric Potential A is -200 cm and B is -180 cm?
h. What is the flux in a vertical column when Matric Potential A is -900 cm and B is -800 cm?

Briefly explain why these fluxes are different.
Note: The results have the opposite sign than we are using. If the flux is negative, then water is moving upward. [Wouldn't it be nice if everyone did it the same way].