2. Saturated flow application of the Darcy equation (vertical flow)
   - water ponded to a depth of 1 m
   - depth (length) of soil = 20 m
   - \( k_s = 0.4 \text{ m/hr} \)
   - \( q = \frac{K(\frac{1+L}{L})}{v_0} \), where \( v_0 = 0.4 \text{ m/hr} \) (\( \frac{1+20}{20} \))
     - taking \( z = 0 \) datum at G.W. aquifer = 0.42 m/hr

   The average speed of the wetting front from the pond is 0.42 m/hr.
   The time required to move 20 m is \( t = \frac{L}{v_0} = \frac{20}{0.42} = 47.6 \text{ hr} \approx 2 \text{ days} \)

   Letting the basin desaturate or drain would lower the recharge rate.

4. At steady-state, the flow through the sand filter column is equal to the leakage
   \[ q = \frac{Q}{A} = K_s \frac{dh}{dx} = \frac{(0.2 \text{ cm/sec})(dh)}{300 \text{ cm}} = 0.0007 dh \]
   \[ q = \frac{(0.2 \text{ cm/sec})}{(6.25 \text{ ft}^2 \text{/hr})} = 0.0255 \text{ cm/sec} \]
   \[ dh = \frac{0.0255 \text{ cm}}{0.0007} = 38.25 \text{ cm} \]

6. Intrinsic permeability is a property of the porous medium only, therefore, as with
   any length measurement it is independent of where it is measured.
   (a) \( k = 0.8 \mu \text{m}^2 \) on earth, moon, mars & uc davis
   (b) \( \rho = 0.75 \mu = 0.025 \)
   \[ K_{earth} = \frac{(0.8 \mu \text{m}^2)(10^{-6} \text{cm}^2/\mu \text{m}^2)(0.75)(980)}{0.025} = 2.35 \times 10^{-4} \text{cm/sec} \]
   \[ K_{moon} = \frac{K_{earth}}{\rho} = 0.29 \times 10^{-4} \text{cm/sec} \] since \( \rho_e = 6 \mu \text{m} \)
   (c) for water, \( \rho = 1.0 \mu = 0.01 \)
   \[ K_e = \frac{(8 \times 10^{-9} \text{cm}^2)(1.0)(980)}{0.01} = 7.64 \times 10^{-4} \text{cm/sec} \]
   \[ K_m = \frac{K_e}{\rho} = 1.31 \times 10^{-4} \text{cm/sec} \]

3. The saturated zone above the water table is associated with the "capillary fringe" and
   its thickness is given by \( h_d = 85 \text{ cm} \)
   Using the capillary rise equation, surface tension (dry): \( 107.2 \text{ dyn/cm} \)
   \[ h = \frac{2 \cos \theta}{eg} \] and replacing \( r \) with the hydraulic radius \( R = \frac{r}{2} \)
   \[ h_d = \frac{2 \cos \theta}{eg R} \] and noting that \( 6 \cos \theta = 60 \text{ dynes/cm} \) for soil-water
   and solving for \( R \) yields
   \[ R = \frac{(60 \text{ dynes/cm})}{eg h_d} = \frac{60}{(1)(980)(85)} = 0.0007 \text{ cm} = 0.0072 \text{ mm} \]
   \[ 0.0072 \text{ mm} \]
10. Plot $h_c = z$ for the $z$-layer profile using Brooks-Corey Eqn.

$$\Theta_c = \frac{\Theta - \Theta_r}{\Theta_m - \Theta_r} = \left( \frac{h_d}{h_c} \right)^3$$

where $z$ is positive up from W.T.

<table>
<thead>
<tr>
<th>Range in $z$</th>
<th>$\Theta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 25 cm</td>
<td>0.36a</td>
</tr>
<tr>
<td>25 - 80 cm</td>
<td>$(\frac{25}{z})^3(0.36 - 0.05) + 0.05$</td>
</tr>
<tr>
<td>80 - 95 cm</td>
<td>0.50</td>
</tr>
<tr>
<td>95 - 120 cm</td>
<td>$(\frac{95}{z})^{1.5}(0.5 - 0.2) + 0.2$</td>
</tr>
</tbody>
</table>