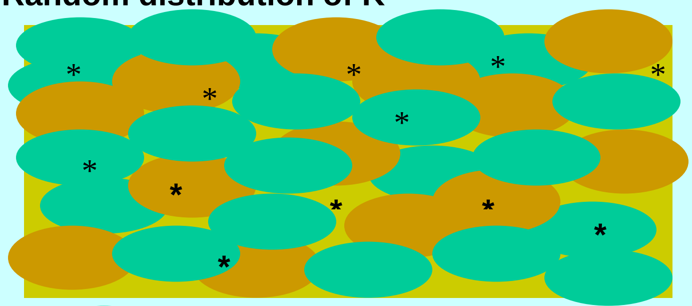
Random distribution of K



6 — $1x10^{-3}$cm/s

4 — $1x10^{-5}$cm/s

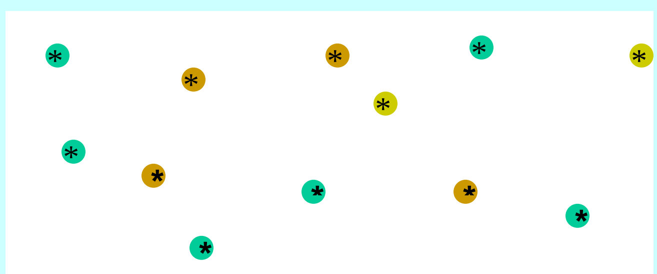
2 — $1x10^{-6}$cm/s

*** sample locations assumed to be representative of the proportions**

$$10^{\left(\frac{1}{N}(\log K_1+\log K_2+...+\log K_N)\right)} = 10^{\left(\frac{1}{12}(6\log(1x10^{-3})+4\log(1x10^{-5})+...+2\log(1x10^{-6}))\right)} = 6.8x10^{-5}$$

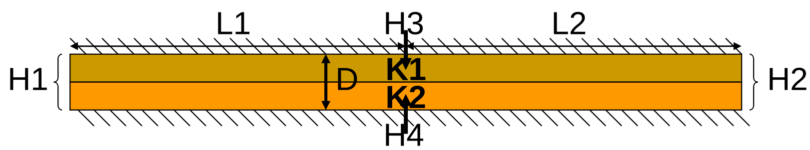
This would be treated as isotropic (same K in every direction)

Realize you would only know the values shown



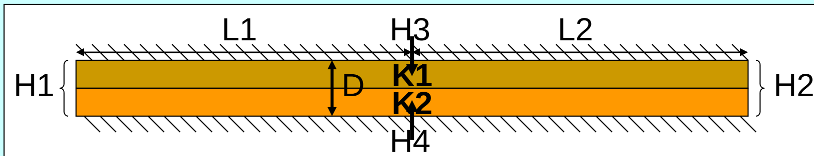
You might have clues based on lithology

Calculate Flow and Heads between boundaries



H1 = 20cm
H2 = 10cm
K1 = 1cm/sec
K2 = 0.2cm/sec
L1 = 30cm
L2 = 30cm
D = 2cm
Q @ H2 = ??
H3 = ??, H4 = ??

Calculate Flow and Heads between boundaries



H1 = 20cm
H2 = 10cm
K1 = 1cm/sec
K2 = 0.2cm/sec
L1 = 30cm
L2 = 30cm
D = 2cm
Q @ H2 = ??
H3 = ??, H4 = ??

$$K_{eq} = \text{Weighted Aritmetic Average} = \frac{1cm1\frac{cm}{\sec} + 1cm0.2\frac{cm}{\sec}}{2cm} = 0.6\frac{cm}{\sec}$$

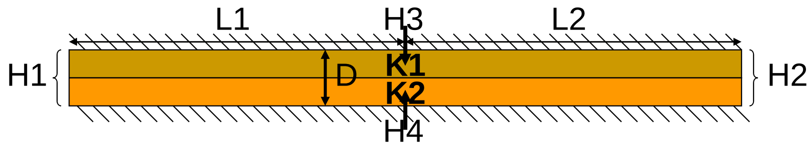
$Q = KiA$, no width is given so calculate per unit width

$$Q = 0.6\frac{cm}{\sec}\frac{20cm - 10cm}{60cm}2cm = 0.1\frac{cm}{\sec}2cm = 0.2\frac{cm^2}{\sec} \text{ per unit width}$$

by inspection gradient is linear,
and $H_3 = H_4$
and they are at the midpoint

$$H_3 = H_4 = \frac{20cm - 10cm}{2} + 10cm = 15cm$$

Calculate Flow and Heads between boundaries



H1 = 20cm
H2 = 10cm
K1 = 1cm/sec
K2 = 0.2cm/sec
L1 = 30cm
L2 = 30cm
D = 2cm
Q @ H2 = ??
H3 = ??, H4 = ??

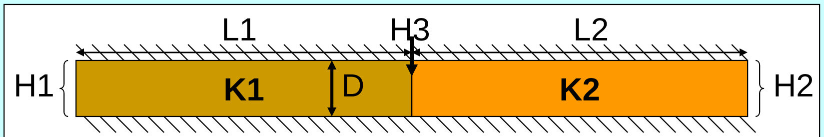
$$\text{OR : head loss from H1 to H3} \quad V = Ki = K\frac{\Delta h}{\Delta l} \text{ so } \Delta h = \frac{V\Delta l}{K}$$

Use proper combination:
All equivalent V and K
Or all layer 1 V and K
Or all layer 2 V and K

$$\Delta h = \frac{V\Delta l}{K} = \frac{0.1\frac{cm}{\sec}30cm}{0.6\frac{cm}{\sec}} = 5cm$$

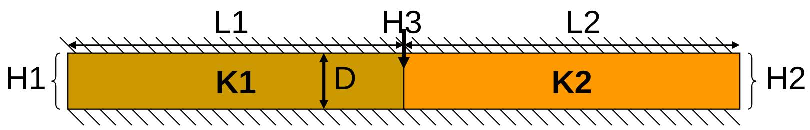
$$H3 = H1 - \Delta h = 20cm - 5cm = 15cm$$

Calculate Flow and Heads between boundaries



H1 = 20cm
H2 = 10cm
K1 = 1cm/sec
K2 = 0.2cm/sec
L1 = 30cm
L2 = 30cm
D = 2cm
Q @ H2 = ??
H3 = ??

Calculate Flow and Heads between boundaries



H1 = 20cm
H2 = 10cm
K1 = 1cm/sec
K2 = 0.2cm/sec
L1 = 30cm
L2 = 30cm
D = 2cm
Q @ H2 = ??
H3 = ??

$$K_{eq} = \frac{60cm}{\frac{30cm}{1\frac{cm}{\sec}} + \frac{30cm}{0.2\frac{cm}{\sec}}} = 0.33\frac{cm}{\sec}$$

Velocity

$Q = VA = KiA$, no width is given so calculate per unit width

$$Q = \left(0.33\frac{cm}{\sec}\frac{20cm - 10cm}{60cm}\right)2cm = 0.05555\frac{cm}{\sec}2cm = 0.11\frac{cm^2}{\sec} \text{ per unit width}$$

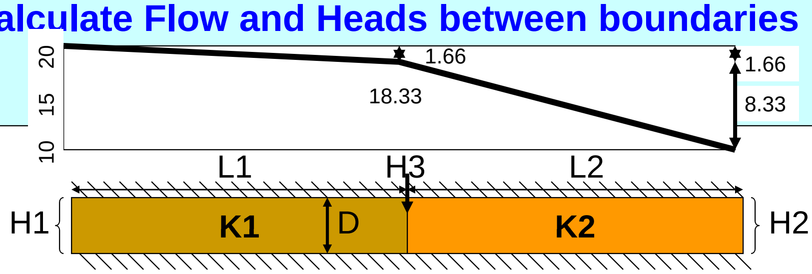
head loss from H1 to H3 $\quad V = Ki = K\frac{\Delta h}{\Delta l}$ so $\Delta h = \frac{V\Delta l}{K}$

$$\Delta h = \frac{V\Delta l}{K} = \frac{0.0555\frac{cm}{\sec}30cm}{1\frac{cm}{\sec}} = 1.66cm$$

K for path length of interest

$$H3 = H1 - \Delta h = 20cm - 1.66cm = 18.33cm$$

Calculate Flow and Heads between boundaries



H1 = 20cm
H2 = 10cm
K1 = 1cm/sec
K2 = 0.2cm/sec
L1 = 30cm
L2 = 30cm
D = 2cm
Q @ H2 = ??
H3 = ??

Confirm by calculating from the other side

head loss from H3 to H2 $\quad V = Ki = K\frac{\Delta h}{\Delta l}$ so $\Delta h = \frac{V\Delta l}{K}$

Velocity

$$\Delta h = \frac{V\Delta l}{K} = \frac{0.0555\frac{cm}{\sec}30cm}{0.2\frac{cm}{\sec}} = 8.33cm$$

K for path length of interest

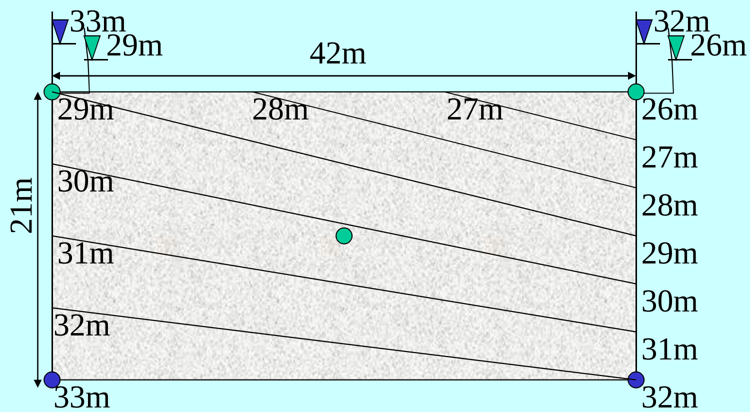
$$H3 = H2 + \Delta h = 10cm + 8.33cm = 18.33cm$$

Calculate a resultant velocity at the center

now the gradient is different at top and bottom and from side to side

$Kx=1x10^{-5}$ m/s $Ky=1x10^{-6}$m/s

Assume linear variation of head

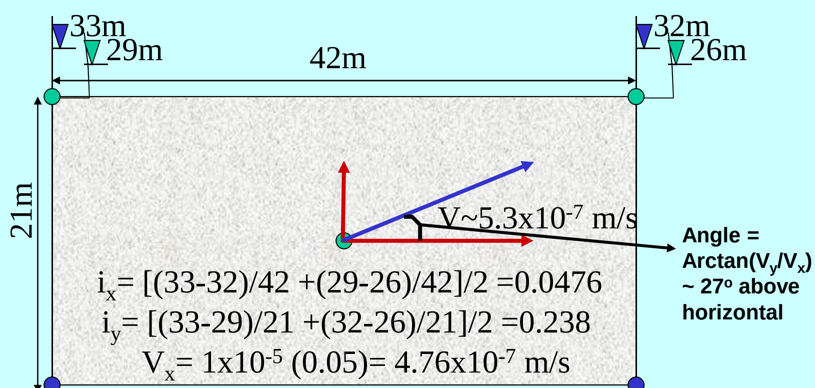


Now Calculate a resultant velocity at the center

Calculate a resultant velocity at the center

$Kx=1x10^{-5}$ m/s $Ky=1x10^{-6}$ m/s

Assume linear variation of head



i_x= [(33-32)/42 +(29-26)/42]/2 =0.0476

i_y= [(33-29)/21 +(32-26)/21]/2 =0.238

V_x= $1x10^{-5}$ (0.05)= $4.76x10^{-7}$ m/s

V_y= $1x10^{-6}$ (0.24)= $2.38x10^{-7}$ m/s

$V = \sqrt{(V_x^2 + V_y^2)}$ m/s

Review keys for homework from September 13 exercises 6c 6d 6e

Remember to continually work on your cheat sheets

And

Work the sample exam problems