92 very good!

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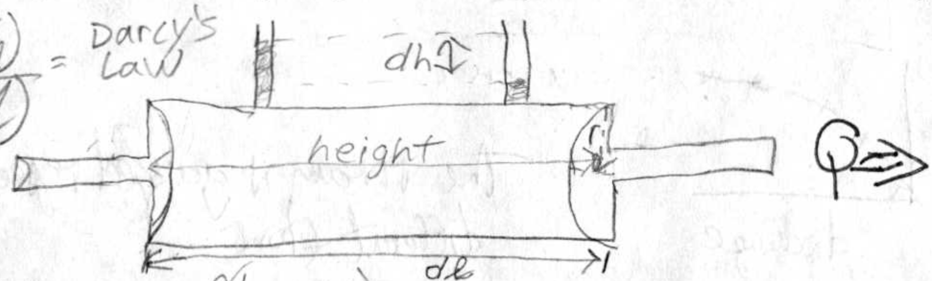
Fall 2009

Geology 127 (Hydrogeology)
Test #1

The first ten questions are short answer, worth 5 points each. The last 4 questions are essays, worth 15 points each. Balance your time so that you can complete both sections.

1) Draw a picture of a Darcy tube, and label the parts that are variables in Darcy's equation.

$Q = -KA\frac{(dh)}{(dl)}$ = Darcy's Law



$A = \pi r^2(\text{height})$

2) Recent workers have pointed out that Darcy's hydraulic conductivity (K) is a function of several other measurable properties of the fluid and the medium. Write an expanded form of Darcy's law that includes properties of the medium and properties of the fluid. (5 points)

$Q = -\frac{Cd^2 \gamma A(dh)}{\mu(dl)}$

Cd^2 = medium properties, C = shape factor, d = grain size

$\frac{\gamma}{\mu}$ = fluid properties

$\gamma = \rho \cdot g$

μ = dynamic visc

3) What is the difference between storativity in a confined aquifer and storativity in an unconfined aquifer? Give an equation for each.

S=storativity $S = bS_s$ in a confined aquifer. It is the amount of water expelled per unit Δ in head in a conf aquifer. Compressibility is important in a conf aquifer because it has a heavy low permeability or imperm layer on top of it. $S_s = \rho_w g(\alpha + n\beta)$, where α = compressibility of the mineral skeleton, β = compressibility of water.

weight isn't the only issue.

$S = S_y + hS_s$ in an unconfined aquifer. It is the amount of water absorbed or expelled per unit Δ head.

S_y = spec. yield = the important factor, instead of compressibility b/c relativity little weight on top

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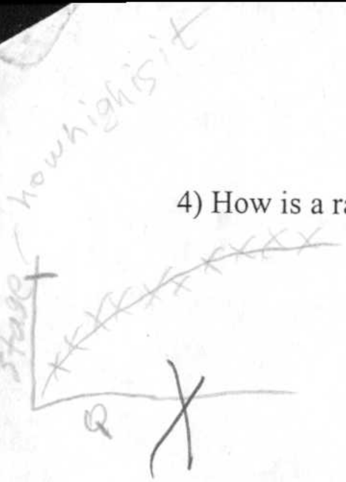
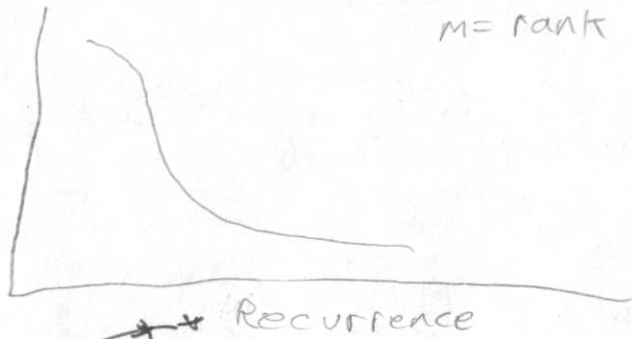
4) How is a rating curve constructed? Draw a simple sketch of a rating curve.



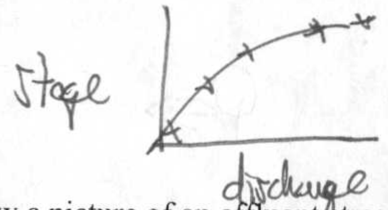


M= rank

$P = \frac{100m}{n+1}$ = periodicity of recurrence

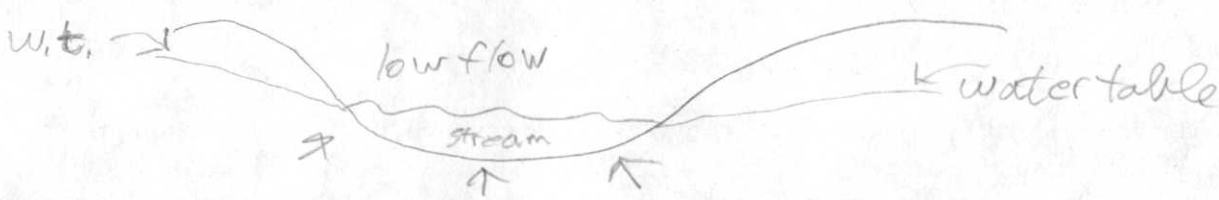
Probability = $\frac{1}{\text{Periodicity}}$ x100

(5)

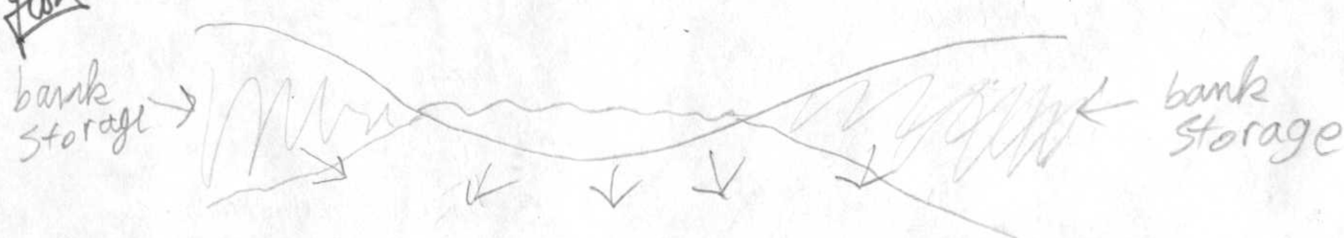


The stream is gauged repeatedly at different flows.

5) Draw a picture of an effluent stream during low flow conditions. Draw a second picture of the same stream that shows groundwater/surface water exchange during flood stage.



good



6) Describe specific yield and specific retention for a clay and a coarse, well-sorted gravel.

Sy = Spec yield   Sr = Spec retention

✓ Sy is high in coarse, well-sorted gravel, porosity ≈ 25-35%
the grav easily relinquishes the water

✓ Sr in low for gravel

✓ Sy is low in clays b/c although clays have high porosity
(~60% typically) the pores are not connected, so
the water is not easily relinquished

✓ Sr is high in clays since water is easily retained

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7) Solve this equation for the recession constant. Show your work.

$$Q = Q_o e^{-at}$$

$\frac{Q}{Q_o} = e^{-at}$

$(\ln)\frac{Q}{Q_o} = e^{-at}(\ln)$

$(\ln)\frac{Q}{Q_o} = -at$

✓ $a = -\frac{\left(\ln \frac{Q}{Q_o}\right)}{t}$

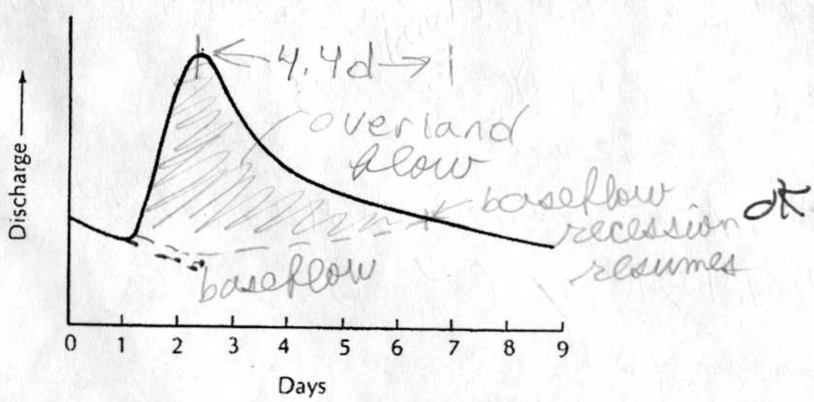
$(\ln)Q = Q_o e^{-at}(\ln)$

$Q = Q_o(-at)$

$(\ln)\frac{Q}{Q_o} = -at$

$\frac{(\ln)Q/Q_o}{t}$

8) This event hydrograph is for a rainfall event on a river with a drainage basin of 1700 mi^2. Separate overland flow from baseflow on the hydrograph.



$D = 1700^{0.2}_{mi^2}$

$V = 4.4$ days

1.0

9) The hydraulic conductivity of a sandy gravel is 75 ft/day. What is the intrinsic permeability if the pore water temperature in the gravel is 16° C? (~~15~~ 10 points)

$K = 75\,\frac{ft}{day}$ $t = 16°C$

$K = \frac{k_i(\rho g)}{\mu}$

$75\frac{ft}{day} = \frac{k_i(\gamma)}{\mu}$

$75\frac{ft}{day} = \frac{k_i(0.998943\,g/cm^3)(981\,cm/s^2)}{0.011111\,g \cdot s/cm}$

$0.03\,cm/s = \frac{k_i(980\,g/(cm^2 \cdot s^2))}{.011111\,g \cdot s/cm}$

✓ $.03\,cm/s = k_i(88{,}200\,cm^{-1} \cdot s^{-1})$

3.0

$k_i = 3.4 \times 10^{-7}\,cm^2$

Conversion

$1\,ft/day = 3.53 \times 10^{-4}\,cm/s$

$75\,\frac{ft}{day} \times 3.53 \times 10^{-4}\,cm/s = .02649 \approx 0.03\,cm/s$

$1\,ft \times \frac{12\,in}{1\,ft} \times \frac{2.54\,cm}{1\,in} = 30.48\,cm$

$1\,cm/s = 2835\,ft/day$ $75\,ft/day \times \frac{30.48\,cm}{ft} = 2{,}286\,cm/day \approx 2{,}300\,cm/day$

$2835\,\frac{ft}{day} \times 75\,\frac{ft}{day} = 2.12625 \times 10^5\,cm/day \approx 2.1 \times 10^5$

10) A confined aquifer has a specific storage of 3.5 x 10^{-6} ft^{-1} and a thickness of 210 ft. How much water would it yield if the water declined an average of 2.5 ft over a circular area with a radius of 375 ft.? (~~15~~ 10 points)

$S = 3.5 \times 10^{-6}\,ft^{-1}$ $b = 210\,ft$ $\Delta h = 2.5\,ft$ $r = 375\,ft$

$S = bS_s$ $S = (210\,ft)(3.5 \times 10^{-6}\,ft^{-1}) = 7.35 \times 10^{-4}$

$V_w = SA\Delta h$

$A = \pi(375\,ft)^2 = 4.42 \times 10^5\,ft^2$

$V_w = (7.35 \times 10^{-4})(4.42 \times 10^5\,ft^2)(2.5\,ft)$ ✓

$= 812\,ft^3 \approx 810\,ft^3$

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$Q = VA$

11) The American River drops 24 m between Hazel Ave. and Sunrise Blvd, a lateral distance of approximately 5100 m. Bed composition in this stretch of the river is rocky, with abundant coarse, cobble-sized material. If the average depth of the river is 1.8 m and the average width of the river is 175 m, what is the estimated *discharge* of the river? Draw a sketch that shows the variables used in your solution. Assume that the river has a broad, flat bottom. The following table from your book may help: (~~15~~ 20 points)

Mountain streams with rocky beds:	0.04–0.05 ≈ 0.045
Winding natural streams with weeds:	0.035
Natural streams with little vegetation:	0.025
Straight, unlined earth canals:	0.020
Smoothed concrete:	0.012

$Vel = \frac{R^{2/3} \cdot S^{1/2}}{n}$

$\Delta height = 24m$ $S = \frac{24m}{5100m} = 0.0047$ $\ell = 5100m$

$d = 1.8m$ $w = 175m$

$n = 0.045$

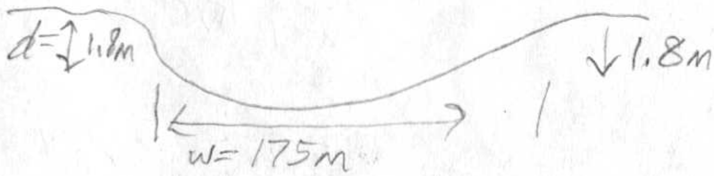
$Q = VA$

$R = \frac{A_{bottom}}{\text{wetted perim}}$

$= \frac{(1.8m)(175m)}{1.8 + 1.8 + 175m}$

$R = \frac{315m^2}{180m}$

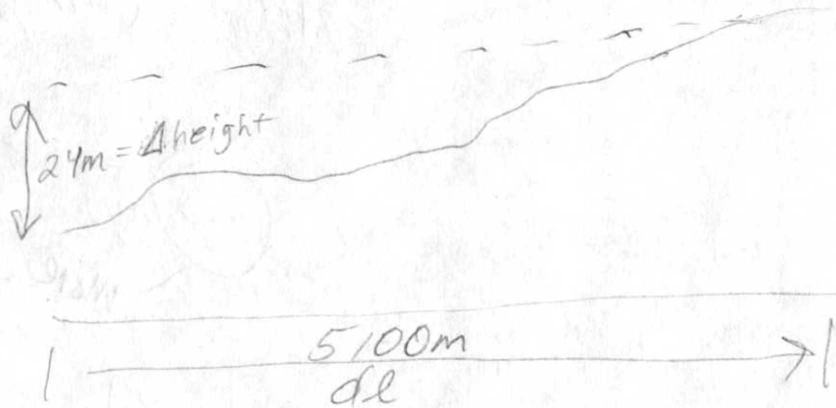
$= 1.75m$



$V = \frac{1.75m^{2/3} \cdot 0.0047^{1/2}}{0.045}$

$= \frac{1.45m \cdot 0.069}{0.045s}$

$V = 2.2 m/s$



$A = 315m^2$

$Q = (2.2 m/s)(315m^2)$

$= 693 \frac{m^3}{s}$ ($\approx 690 \frac{m^3}{s}$)

good

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12) An aquifer contains three different water bearing intervals. Interval A has a thickness of 30 ft. and a hydraulic conductivity of 7.1 ft/d. Interval B has a thickness of 15 ft and a hydraulic conductivity of 78 ft/d. Interval C has a thickness of 22 ft. and a hydraulic conductivity of 17 ft/d. What is the overall horizontal hydraulic conductivity of these intervals? What is the overall vertical hydraulic conductivity? (~~15~~ 20 points).

$b_A = 30 ft$ $K_A = 7.1 \frac{ft}{d}$

$b_B = 15'$ $K_B = 78 ft/d$

$b_C = 22'$ $K_C = 17 ft/d$

$$K_v avg = \frac{b}{\sum_{m=1}^{n} \frac{b_m}{K_v m}}$$

$$= \frac{67 ft}{\left(\frac{30 ft}{7.1 ft/day}\right) + \left(\frac{15 ft}{78 ft/d}\right) + \left(\frac{22 ft}{17 ft/d}\right)}$$ ok

$$= \frac{67 ft}{3.3 days} \rightarrow \boxed{K_v = 20 ft/day}$$ = 12 ft/d

more (-3)

$$K_h avg = \sum_{m=1}^{n} \frac{K_h m b_m}{b_{tot}}$$

$$= \frac{(30' \times 7.1 ft/d) + (15 ft * 78 ft/d) + (22' \times 17 ft/d)}{67 ft}$$

$$= \frac{1757 ft^2/d}{67 ft}$$

✓

$$\boxed{= 26 ft/d}$$

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