Two adjacent fields contribute runoff to a collector. Field 1 is 2.0 acres in size and has a runoff coefficient of 0.35. Field 2 is 4.0 acres in size and has a runoff coefficient of 0.65. The rainfall intensity of the storm after the time to concentration is 3.9 in/hr. The peak runoff is most nearly

Select one:

- A. 8.7 $\frac{ft^3}{sec}$
- B. 10 $\frac{ft^3}{sec}$
- C. 13 $\frac{ft^3}{sec}$
- D. 16 $\frac{ft^3}{sec}$

Next page

FIELD 1 2AC. $C = 0.35$

FIELD 2 4AC. $C = 0.65$

$i = 3.9$ IN/HR

$Q = CIA$

$Q_{p_1} = (0.35)(3.9 in/hr)(2ac) = 2.73 cfs$

$Q_{p_2} = (0.65)(3.9 in/hr)(4ac) = 10.14 cfs$

Σ $\underline{\underline{12.87 cfs}}$ Q_p

$$C_{composite} = \frac{(2)(0.35) + (4)(0.65)}{2+4} = 0.55$$

$$Q_p = (0.55)(3.9 in/hr)(6ac) = \underline{\underline{12.87 cfs}}$$

NCEES pg 171 CIVIL ENGINEERING
(RATIONAL FORMULA)

CIVIL REVIEW MANUAL pg 10-5
"WEIGHTED RUNOFF COEFFICIENT"

The rational formula runoff coefficient of a 950 ft x 600 ft property is 0.35. A storm occurs with a rainfall intensity of 4.5 in/hr. The peak runoff from this property is most nearly

Select one:

- A. 21 $\frac{ft^3}{sec}$
- B. 30 $\frac{ft^3}{sec}$
- C. 62 $\frac{ft^3}{sec}$
- D. 90 $\frac{ft^3}{sec}$

$Q = CIA$

$A = 950 \times 600 = 570{,}000\,ft^2 \; \frac{1\,ac}{43{,}560\,ft^2}$

$= 13.08\,acres$

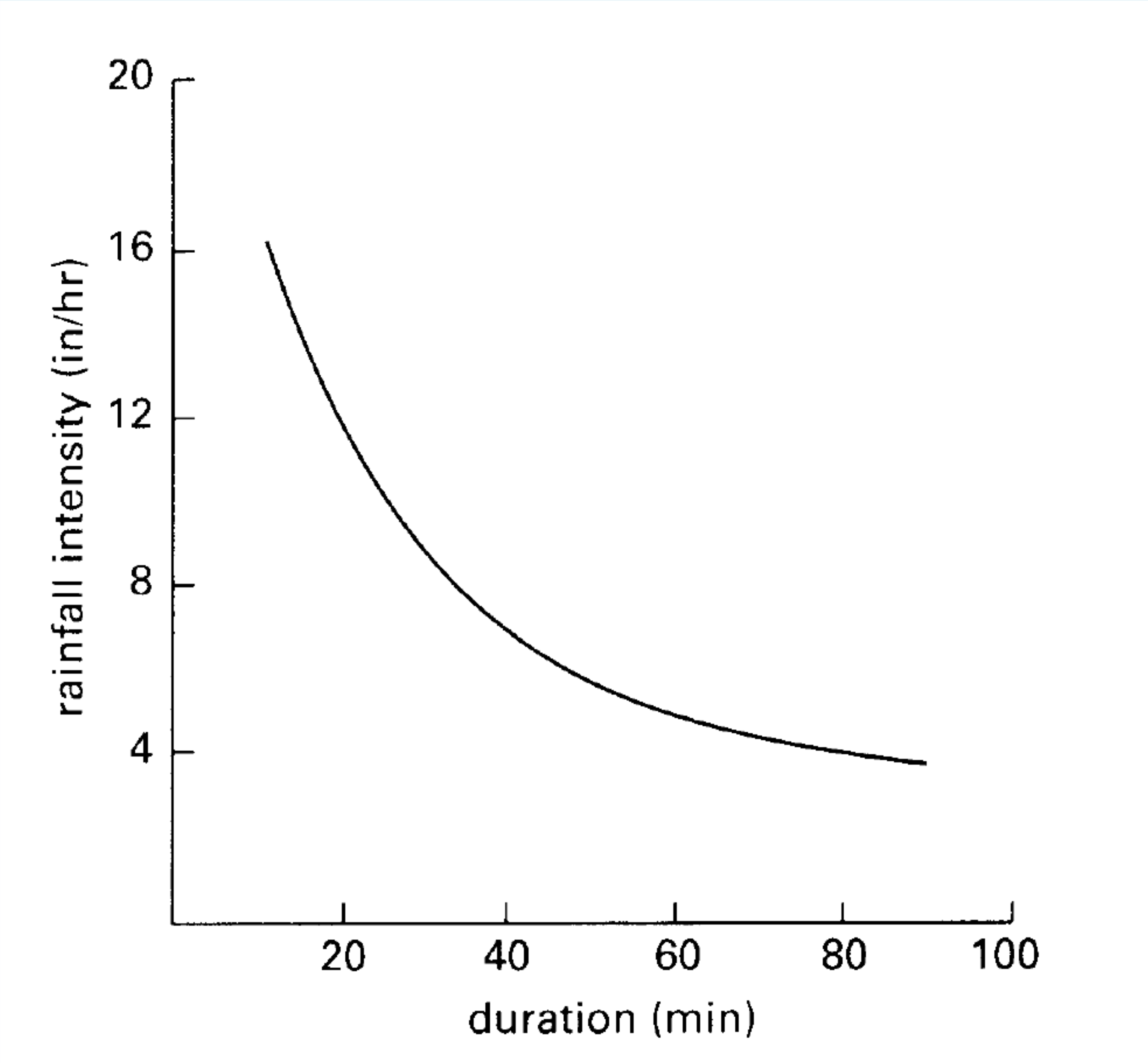
$Q_p = (0.35)(4.5\,in/hr)(13.08\,acres)$

$= 20.6\,cfs$

NCEES pg 2 CONVERSIONS

NCEES pg 171 CIVIL ENGINEERING
(RATIONAL FORMULA)

A watershed occupies a 70.0 acre site. 45 acres of the site have been cleared and are used for pasture land with a runoff coefficient of 0.13; 3.0 acres are occupied by farm buildings, a house, and paved surfaces and have a runoff coefficient of 0.75; the remaining 22 acres are woodland with a runoff coefficient of 0.20. The total time to concentration for the watershed is 30 minutes. The 20-year storm is characterized by the intensity duration curve shown.



The peak runoff for the 20-year storm is most nearly

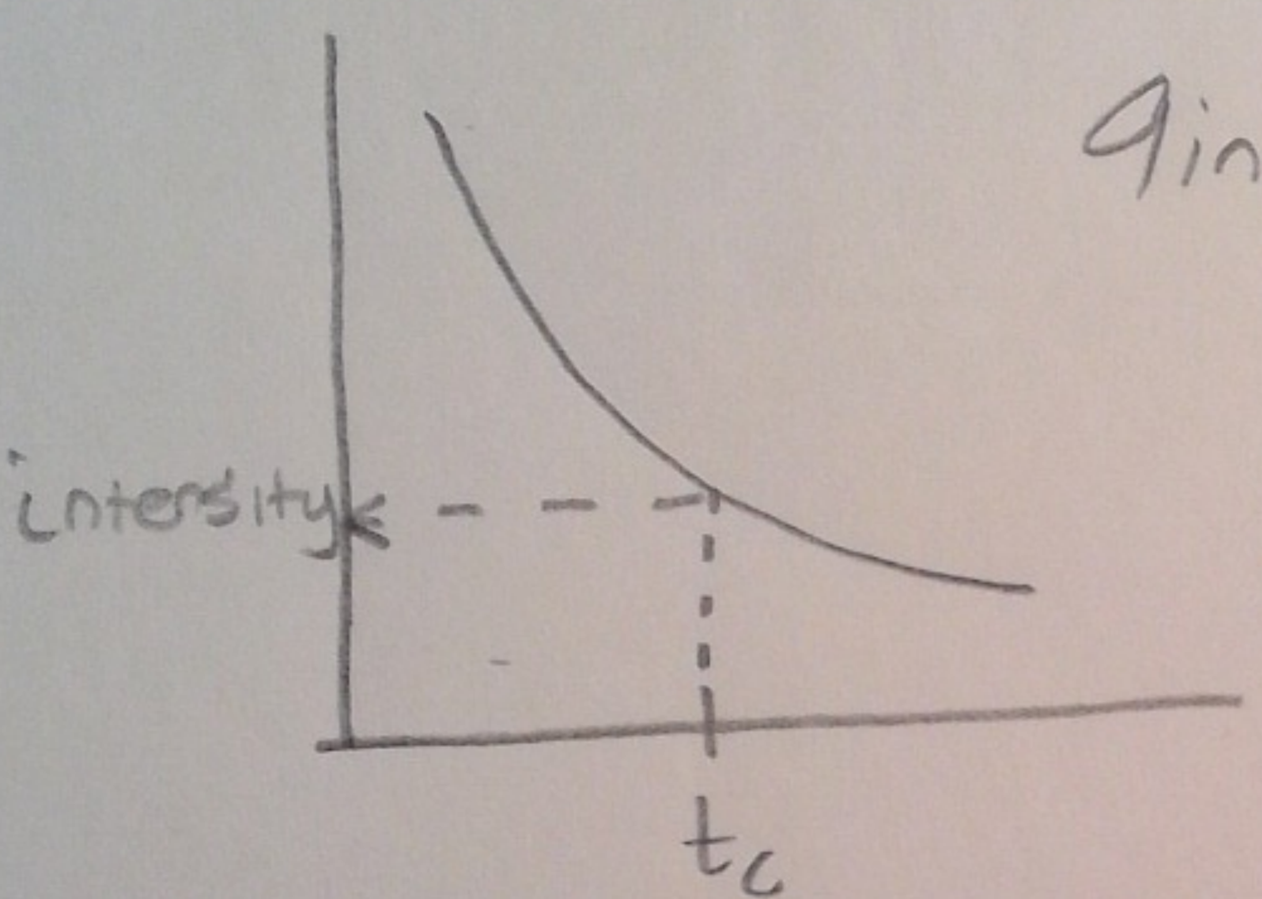
Select one:

- a. 50 $\frac{ft^3}{sec}$
- b. 110 $\frac{ft^3}{sec}$
- c. 240 $\frac{ft^3}{sec}$
- d. 530 $\frac{ft^3}{sec}$

70 acres

45 acres $C = 0.13$
3 acres $C = 0.75$
22 acres $C = 0.20$

$t_c = 30$ minutes



9 in/hr

$$\bar{C} = \frac{(0.13)(45\text{acres}) + (0.75)(3\text{acres}) + (0.20)(22\text{acres})}{45+3+22}$$

$$= 0.178$$

$$Q_p = CIA$$
$$= (0.178)(9\text{in/hr})(70\text{acres})$$
$$= 112.5\ \text{ft}^3/\text{sec}$$

NCEES pg 171 CIVIL ENGINEERING

CIVIL REVIEW MANUAL pg 10-5
"WEIGHTED RUNOFF COEFFICIENT"

The table shown contains curve numbers based on land use and soil type. A watershed contains 10.0 acres of residential land of soil type B and 5.0 acres of grassland of soil type A.

CN Values

land use	soil type A	soil type B
residential	57	72
grassland	30	58

If the total precipitation is 11 inches, what will be the approximate runoff from the watershed?

Select one:

- a. 5.4 inches
- b. 6.0 inches
- c. 6.7 inches
- d. 7.2 inches

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S}$$

$$S = \frac{1{,}000}{CN} - 10$$

$$CN = \frac{1{,}000}{S + 10}$$

10 acres, CN 72

5 acres, CN 30

$$\overline{CN} = \frac{(72)(10\,\text{acres}) + (30)(5\,\text{acres})}{10\,\text{acres} + 5\,\text{acres}}$$

$$= \underline{\underline{58}}$$

$$S = \frac{1000}{58} - 10 = 7.24$$

$$Q = \frac{(11 - 0.2(7.24))^2}{(11 + 0.8(7.24))} = 5.43 \text{ inches}$$

NCEES pg 171 CIVIL ENGINEERING

A drainage basin covers an area of 2.4 acres. During a storm with a sustained rainfall intensity of 0.6 inches per hour, the peak runoff from the basin is 320 gallons per minute. What is most nearly the runoff coefficient for the basin?

Select one:

- A. 0.38
- B. 0.50
- C. 0.65
- D. 0.85

Next page

$Q = CIA$

$A = 2.4$ acres

$i = 0.6 in/hr$

$Q = 320 gpm \quad \frac{0.134 ft^3}{1 gal} \cdot \frac{1 min}{60 sec} = 0.714 ft^3/sec$

$C = ?$

$$C = \frac{Q}{iA} = \frac{0.7146}{(0.6)(2.4)} = 0.496$$

NCEES pg 2 CONVERSION FACTORS

A model of a dam has been constructed so that the scale of dam to model is 15:1. The similarity is based on Froude numbers. At a certain point on the spillway of the model, the velocity is 5 meters per second. At the corresponding point on the spillway of the actual dam, the velocity would most nearly be

Select one:

- a. 6.7 $\frac{m}{sec}$
- b. 7.5 $\frac{m}{sec}$
- c. 15 $\frac{m}{sec}$
- d. 19 $\frac{m}{sec}$

NCEES p117 FLUID MECHANICS

$$[Fr_{DAM}] = [Fr_{MODEL}]$$

$$Fr = \frac{V}{\sqrt{g y_H}}$$

$$\frac{V_{DAM}}{\sqrt{g y_{H\,DAM}}} = \frac{V_{MODEL}}{\sqrt{g y_{H\,MODEL}}}$$

$$V_{DAM} = \frac{V_{MODEL}}{\sqrt{g y_{H\,MODEL}}} \sqrt{g y_{H\,DAM}}$$

$$= V_{MODEL} \frac{\sqrt{g}}{\sqrt{g}} \frac{\sqrt{y_{H\,DAM}}}{\sqrt{y_{H\,MODEL}}}$$

$$= V_{MODEL} \sqrt{\frac{15}{1}}$$

$$= 5\,m/s \sqrt{\frac{15}{1}} = 19.36\,m/s$$

An open channel has a cross sectional area of flow of 0.5 meters^2, a hydraulic radius of 0.15 meters, and a roughness coefficient of 0.15. The slope of the hydraulic gradient needed to achieve a flow rate of 10 liters per second is most nearly

Select one:

- a. 1.1×10^{-4}
- b. 1.1×10^{-3}
- c. 6.7×10^{-4}
- d. 6.7×10^{-3}

$$Q = \frac{1}{n} A R_H^{2/3} S^{1/2}$$

$A = 0.5 m^2$

$R_H = 0.15 m$

$n = 0.15$

$Q = 10 \frac{L}{sec} \cdot \frac{1 m^3}{1000 L}$

$S = ?$

$$S^{1/2} = \frac{Q \cdot n}{A R_H^{2/3}} = \frac{(0.01)(0.15)}{(0.5)(0.15)^{2/3}} = 0.0106$$

$$S = (0.0106)^2 = 0.\underbrace{0001}129$$

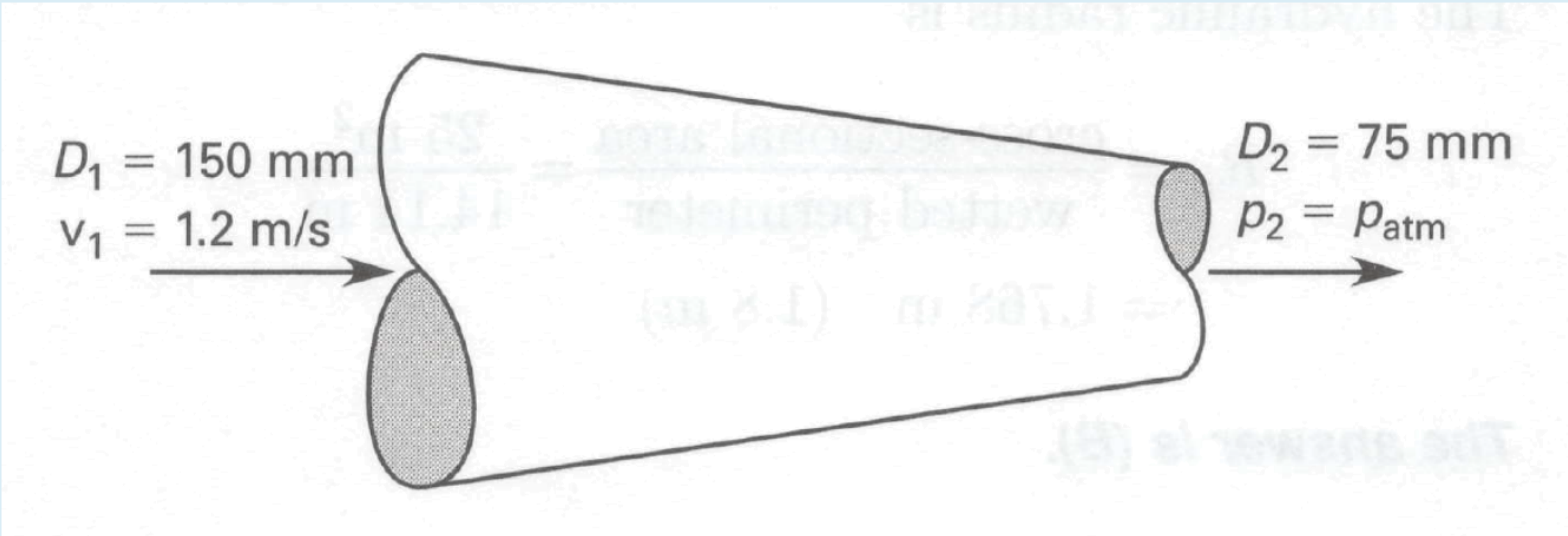
$1.129 \cdot 10^{-4}$

NCEES pg 111 FLUID MECHANICS

NCEES pg 173 CIVIL ENGINEERING

NCEES pg 2 CONVERSIONS

Water flows through a converging fitting as shown and discharges freely to the atmosphere at the exit. Flow is incompressible, and friction is negligible.



The gage pressure at the inlet is most nearly

Select one:

- A. 10.2 kPa
- B. 10.8 kPa
- C. 11.3 kPa
- D. 12.7 kPa

NCEES pg 109 FLUID MECHANICS

$A_1 V_1 = A_2 V_2$

NCEES pg 110 FLUID MECHANICS

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

1 = INLET 2 = OUTLET

$$\frac{P_1}{\gamma} = \cancel{\frac{P_2}{\gamma}}^{0\,gage} + \frac{V_2^2}{2g} - \frac{V_1^2}{2g} + \cancel{z_2 - z_1}^{=0}$$

$$\frac{P_1}{\gamma} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

$V_1 = 1.2\,m/s$

$$A_1 = \frac{D_1^2 \pi}{4}$$

$$A_2 = \frac{D_2^2 \pi}{4}$$

$$\frac{D_1^2 \cancel{\pi}}{\cancel{4}} V_1 = \frac{D_2^2 \cancel{\pi}}{\cancel{4}} V_2$$

$$V_2 = \frac{D_1^2}{D_2^2} V_1 = \left(\frac{D_1}{D_2}\right)^2 V_1 = \left(\frac{150\,mm}{75\,mm}\right)^2 V_1 = 4V_1$$

$V_1 = 1.2\,m/s \qquad V_2 = 4(1.2) = 4.8\,m/s$

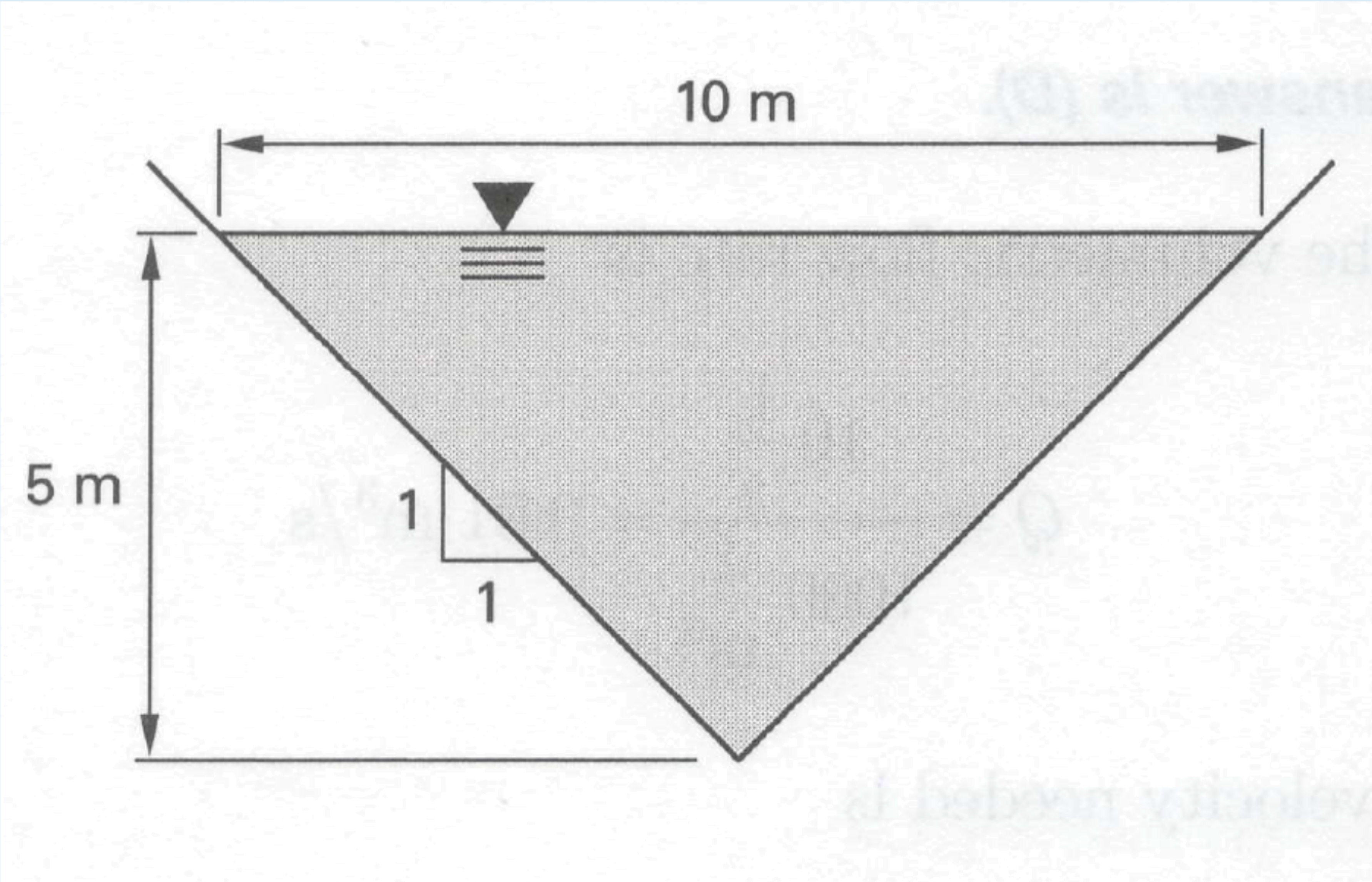
$$\frac{P_1}{\gamma} = \frac{(4.8\,m/s)^2}{2g} - \frac{(1.2\,m/s)^2}{2g}$$

$$P_1 = \left[\frac{(4.8\,m/s)^2}{2g} - \frac{(1.2\,m/s)^2}{2g}\right] \rho g$$

$$= \left[\frac{4.8^2}{2(9.8\,m/s^2)} - \frac{1.2^2}{2(9.8\,m/s^2)}\right]\left[1000\,\frac{kg}{m^3}\right]\left[9.8\,m/s^2\right]$$

$$= 10{,}800\,\frac{kg\,m}{s^2} = 10{,}800\,Pa = 10.8\,kPa$$

The hydraulic radius of a 5 meter deep triangular channel with 1:1 side slope is most nearly

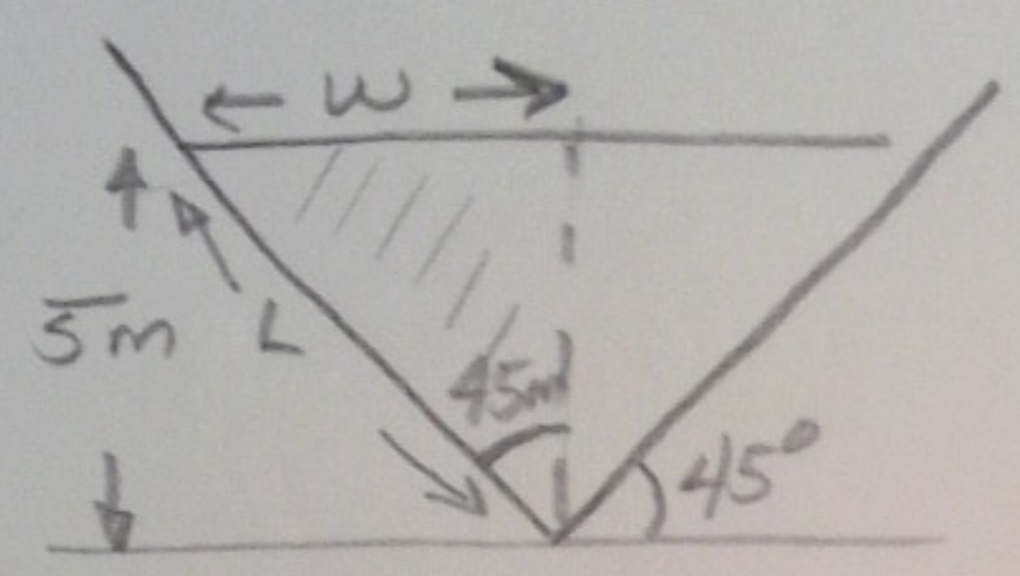


Select one:

- A. 1.0 meters
- B. 1.8 meters
- C. 2.0 meters
- D. 2.8 meters

NCEES pg 111 FLUID MECHANICS

$$R_H = \frac{A}{P_w}$$



$L \cos 45 = 5$

$L = \frac{5}{\cos 45} = 7.071\,m$

$A = \frac{1}{2} bh = \frac{1}{2}(5)(5) * 2 = 25\,m^2$

$L \sin 45 = w$

$7.071 \sin 45 = w = 5$

$P_w = 2L = 2(7.071) = 14.142$

$$R_H = \frac{25\,m^2}{14.142\,m} = 1.76\,m$$

A pipe carrying an incompressible fluid has a diameter of 100 millimeters at point 1 and a diameter of 50 millimeters at point 2. The velocity of the fluid at point 1 is 0.3 meters per second. What is most nearly the velocity at point 2?

Select one:

- A. 0.95 m/s
- B. 1.2 m/s
- C. 2.1 m/s
- D. 3.5 m/s

$$A_1 V_1 = A_2 V_2$$

$$A_1 = \frac{\pi D_1^2}{4}$$

$$A_2 = \frac{\pi D_2^2}{4}$$

$$V_2 = \frac{A_1}{A_2} V_1 = \frac{\frac{\cancel{\pi} D_1^2}{\cancel{4}}}{\frac{\cancel{\pi} D_2^2}{\cancel{4}}} V_1 = \left(\frac{D_1}{D_2}\right)^2 V_1$$

$$= \left(\frac{100\text{mm}}{50\text{mm}}\right)^2 V_1 = 4V_1$$

$$V_2 = 4(0.3\text{m/s}) = 1.2\text{m/s}$$

Water drains at a constant rate through a saturated soil column with a diameter of 1 foot and a height of 2 feet. The hydraulic head is maintained at 5 feet at the top of the column and 0.5 feet at the bottom of the column. After a period of 1 hour, 100 in^3 of water has drained through the column. What is most nearly the hydraulic conductivity of the soil?

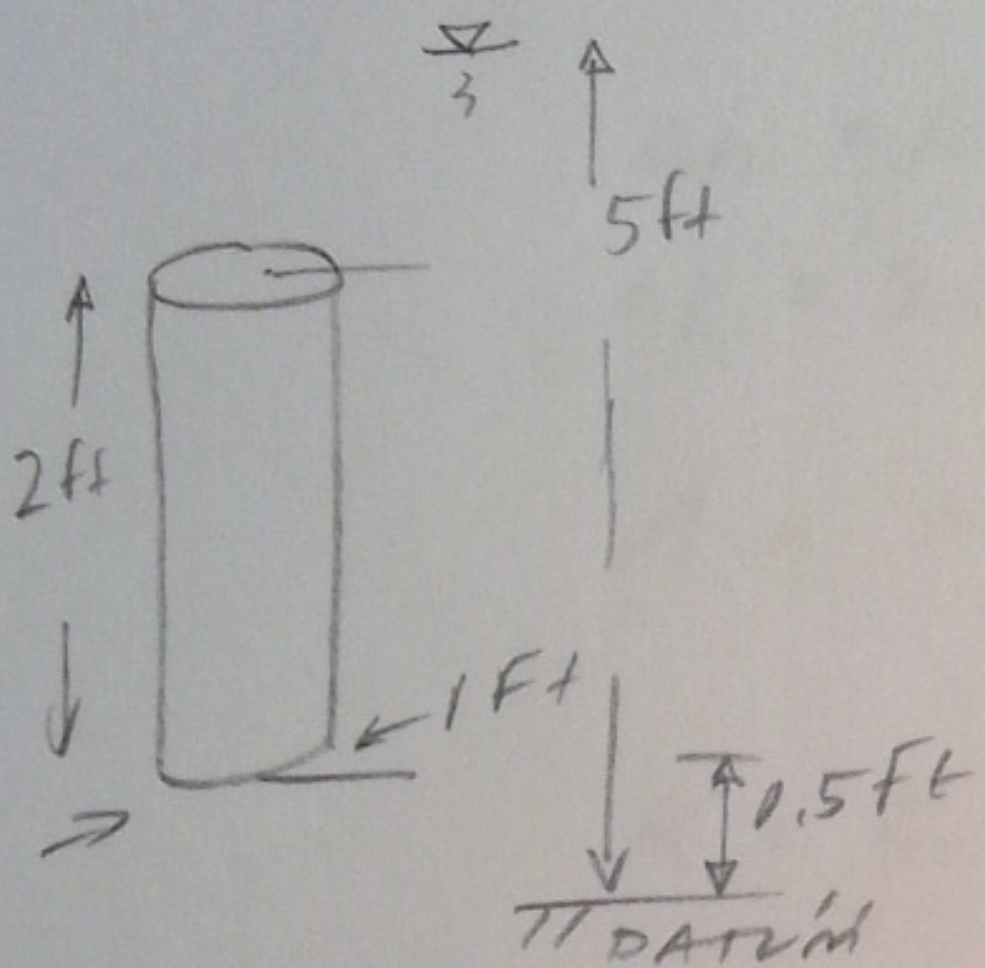
Select one:

- A. $3.5 \times 10^{-6}\ \frac{ft}{sec}$
- B. $4.6 \times 10^{-6}\ \frac{ft}{sec}$
- C. $7.3 \times 10^{-6}\ \frac{ft}{sec}$
- D. $9.1 \times 10^{-6}\ \frac{ft}{sec}$

NCESS pg 152 CIVIL ENGINEERING

$k = \frac{Q}{iAt_c}$ $\quad i = \frac{\Delta h}{\Delta L}$ $\quad Q$ = VOLUME OF WATER

A = CROSS SECTIONAL AREA



$i = \frac{5ft - 0.5ft}{2ft} = \frac{4.5ft}{2ft}$

$= 2.25$

$Q = 100in^3 \cdot \frac{1ft}{12in} \cdot \frac{1ft}{12in} \cdot \frac{1ft}{12in}$

$= 0.05787 ft^3$

$t_c = 1hr \frac{60min}{1hr} \frac{60sec}{1m} = 3600sec$

$A = \frac{\pi 1ft^2}{4} = 0.7854 ft^2$

$k = \frac{0.05787 ft^3}{(2.25)(0.7854ft^2)(3600sec)} = 0.00000909$

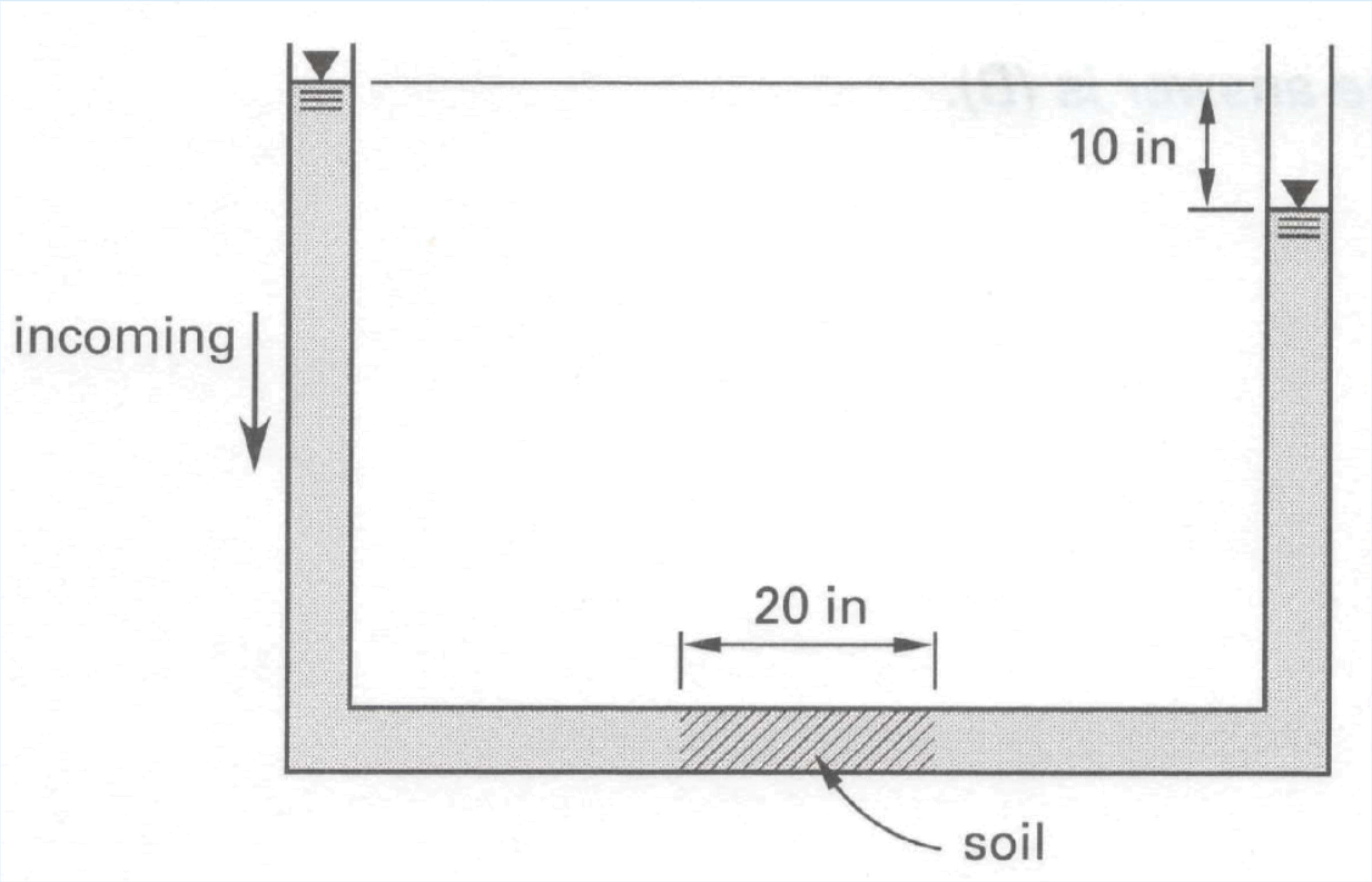
$9.09 \cdot 10^{-6} ft/sec$

Darcy's law is primarily associated with flow through

Select one:

- A. open channels
- B. pipes
- C. pitot tubes and venturi meters
- D. porous media
- E. V8 engines

A soil sample with a permeability of $5 \times 10^{-6}\ \frac{inches}{sec.}$ will be tested using the pipe setup shown. The pipe's diameter is 2 inches. The 10 inch head differential will be maintained.



The volumetric flow rate is most nearly

Select one:

- A. $2.5 \times 10^{-6}\ \frac{in^3}{sec.}$
- B. $4.9 \times 10^{-6}\ \frac{in^3}{sec.}$
- C. $7.9 \times 10^{-6}\ \frac{in^3}{sec.}$
- D. $3.0 \times 10^{-5}\ \frac{in^3}{sec.}$

NCEES pg 171 CIVIL ENGINEERING

$$Q = -KA\frac{dh}{dx} = KA\frac{\Delta h}{\Delta L}$$

$\Delta h = 10 in$

$\Delta L = 20 in$ $\quad \frac{\Delta h}{\Delta L} = \frac{10}{20} = 0.5$

$A = \frac{\pi (2in)^2}{4} = \pi in^2$

$K = 5 \cdot 10^{-6}\, in/sec$

$$Q = (5 \cdot 10^{-6}\, in/sec)(\pi\, in^2)(0.5)$$

$= 0.00000785$

$7.85 \cdot 10^{-6} \frac{in^3}{sec}$

An aquifer has a thickness of 52 feet and a transmissivity of 650 $\frac{ft^2}{day}$. What is most nearly the hydraulic conductivity of the aquifer?

Select one:

- A. 2.5 ft/day
- B. 6.3 ft/day
- C. 13 ft/day
- D. 33 ft/day

NCEES pg 171 CIVIL ENGINEERING

$$T = Kb$$

$$K = \frac{T}{b} = \frac{\frac{650\,ft^2}{day}}{52\,ft} = 12.5\,ft/day$$

The results of well pumping tests from a homogeneous, unconfined aquifer are shown. At the time of the tests, the pumping had continued long enough for the well discharge to become steady

Pumping Test Results

parameter	value
pumping rate	20 gal/sec
well diameter	1.5 ft
radius of influence	900 ft
aquifer depth at radius of influence	135 ft
drawdown in well	11 ft

The hydraulic conductivity of the aquifer is most nearly

Select one:

A. $1.2 \times 10^{-3}\ \frac{ft}{sec}$

B. $2.1 \times 10^{-3}\ \frac{ft}{sec}$

C. $5.0 \times 10^{-3}\ \frac{ft}{sec}$

D. $8.7 \times 10^{-3}\ \frac{ft}{sec}$

NCEES pg 171 CIVIL ENGINEERING

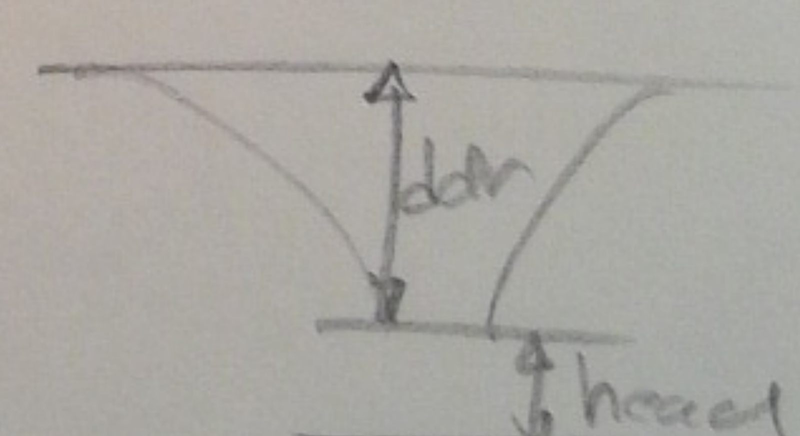
$$Q = \frac{\pi K (h_2^2 - h_1^2)}{\ln\left(\frac{r_2}{r_1}\right)}$$

$$Q \ln\left(\frac{r_2}{r_1}\right) = \pi K (h_2^2 - h_1^2)$$

$$\frac{Q \ln\left(\frac{r_2}{r_1}\right)}{\pi (h_2^2 - h_1^2)} = K$$

$$Q = \frac{20\,gal}{sec} \times \frac{0.134\,ft^3}{1\,gal} = 2.68\,\frac{ft^3}{sec}$$

$$K = \frac{\left(2.68\,\frac{ft^3}{s}\right) \ln\left(\frac{900\,ft}{0.75\,ft}\right)}{\pi\left((135\,ft)^2 - (135-11)^2\right)}$$



$$= \frac{2.68 \ln\left(\frac{900}{.75}\right)}{\pi\left(135^2 - 124^2\right)}$$

$$= 0.00212\ ft/sec$$

$$2.12 \cdot 10^{-3}\ ft/se$$