

1. Circle the nearest answer in the following multiple choice questions:

Given a triangular channel that has a 1H:1V side slope and a specific energy of 20 ft:

$$E_0 = E_c = \frac{2}{3} y_c$$

$$y_c = 30$$

$$E_c = y_c + \frac{V_c^2}{2g} \quad V_c = \frac{zy^2}{2zy} = \frac{1}{2} y$$

$$20 = y_c + \frac{1}{4} y_c = y_c (1 + \frac{1}{4}) \rightarrow y_c = 16 \text{ ft}$$

a) The critical depth is closest to:

{Answer [6.7], [13.3] **[16]** [20] units ft}

b) If the critical flow is closest to:

{Answer 170; 1400; 2000, 2200, **4000** units cfs}

$$Q_c = \sqrt{g D_c} z y_c^2 = \sqrt{g \frac{1}{2} y} y^2 = 4108 \text{ cfs}$$

$$c' = 1.486$$

c) If the critical slope is closest to (given $n = 0.015$):

{Answer **0.012**; 0.0012; **0.003**; 0.004} units m/A

$$S_0 = \left(\frac{n Q_c P^{2/3}}{c' A^{5/3}} \right)^2$$

$$= 40.38 \frac{[4 y_c^2 (z+1)]^{2/3}}{z^{2/3} y_c^{1/3}} = 0.0197$$

d) If $Q = 200$ cfs and $E = 20$ ft the alternate depths are closest to:

{Answer

[20, 2.5] [19.98, 2.62], [19.99, 2.63] **[19.99, 2.44]**}

units ft

$$20 = y + \frac{Q^2}{2g z^2 y^4}$$

$$20 = y + 621.1 \frac{1}{y^4} \rightarrow \phi = y^5 - 20y^4 + 621.1 \quad \left\{ \begin{array}{l} 19.99 \\ 2.44 \end{array} \right\}$$

e) If the slope 0.009 and $n = 0.015$ the normal depth is closest to:

{Answer 1.2; **4.0**; 5.1, 5.8, 6.3} units ft}

$$\frac{n Q}{c' S_0^{1/2}} = \frac{A^{5/3}}{P^{2/3}} \rightarrow C_Q = 21.28 = \frac{y^{1/3}}{(4y^2(2))^{1/3}} = \frac{y^{1/3}}{2 y^{2/3}} = \frac{1}{2} y^{1/3}$$

$$(42.56)^{3/9} = y_n = \underline{3.49} \text{ ft}$$

2. The specific energy for the open channel in Figure 1 is 12 ft. Given B= 10 ft

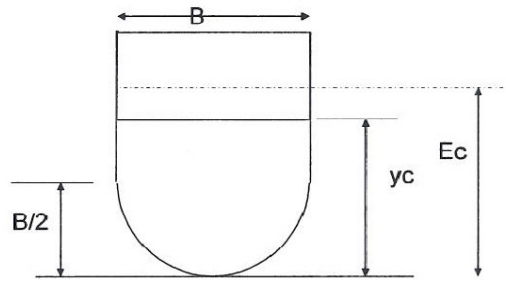


Figure 1.

- a) The critical depth is closest to:
 {Answer: 5.0; 6.5; 7.1; **8.4**} units

$$E_c = y_c + \frac{V_c^2}{2}$$

$$V_c = \frac{A}{\theta} = \frac{A_o}{B_o} + \frac{A_{\square}}{B_o} = \frac{(0.125)\pi b^2}{b} + \frac{yb - \frac{b^2}{2}}{b} = 0.3927b + y - 0.5b$$

$$b = 10'$$

$$A_o = \frac{1}{2} \pi \frac{b^2}{4}$$

$$A_{\square} = (y - \frac{b}{2})b = yb - \frac{b^2}{2}$$

$$B_{\square} = b$$

$$12 = y_c + 0.5y_c - 0.05365$$

$$12.05 = 1.5y_c \rightarrow y_c = 8.03$$

- b) The maximum flow is closest to:
 {Answer 440; 620; 830; **1125**; 2060} units ft^3/s

$$Q_c = Q_{\max} = \sqrt{g D_c} A_c = \sqrt{g} \sqrt{y_c - 1.073} \left(\frac{1}{8} \pi b^2 + yb - 0.5b^2 \right)$$

~~$$= 5.675 \sqrt{y - 1.073} (10y - 10.73) = \sqrt{g} \sqrt{8.03 - 1.073} \left(\frac{\pi(10)^2}{8} + 80.3 - 50 \right)$$~~

~~$$Q^2 = 32.2y - 34.56(10y - 10.73) = 14.967(69.57)$$~~

~~$$322y^2 - 345.5y - 345.5y + 370.8$$~~

$$= 1041$$

Forgot I knew y_c ...

3. For the stilling basin shown in Figure 2, determine:

a. the Froude number at section 1

{Answer 4.2, 5.2, 6.2, 8.2, 8.9}

b. the depth y_2 for a hydraulic jump to form if there wasn't a step

{Answer 15.5, 18.3, 25.3, 30.3) Units

$$y_2 = \frac{1}{2} y_1 \left(\sqrt{1 + 8 N_{F_1}^2} - 1 \right) = 14.56$$

c. the depth y_2 for a hydraulic jump to form with the step

{Answer 15., 18.0, 25.2, 30.3, 30.8.) Units

d. the energy loss from section 1 to 2.

{Answer 0, 45, 65, 75, 105.) Units

Given: $q = 100$ cfs/ft

$$\frac{Q}{W} = Q$$

$$A_1 = y_1(w) = 2.5 \text{ ft}^2$$

$y_1 = 2.5$ ft (Initial depth)

$$V_1 = \frac{Q}{A_1} = \frac{100}{2.5} = 40 \text{ ft/s}$$

$s = 3.0$ ft (Step height)

$$N_{F_1} = \frac{V_1}{\sqrt{g y_1}} = \frac{40}{\sqrt{g(2.5)}} = 4.46$$

Assume: $\alpha = \beta = 1$

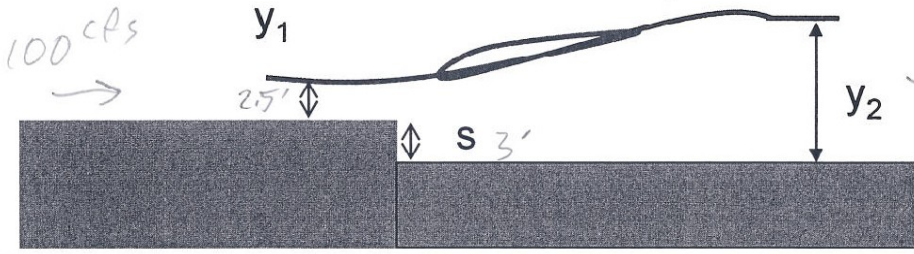
Hydrostatic pressure at sections 1 and 2

$$V_2 = \frac{Q}{A_2} = \frac{Q}{15.45(1)} = 6.47 \text{ ft/s}$$

$W = 1.0$ ft

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} + h_L$$

$$2.5 + 3 + \frac{40^2}{2g} = 15.45 + \frac{6.47^2}{2g} + h_L$$



$$h_L = 14.24 \text{ ft}$$

Figure 3.

$$P_1 + \rho Q V_1 = P_2 + \rho Q V_2$$

$$\frac{1}{2} \rho g (y_1 + s)^2 w + \rho Q V_1 = \frac{1}{2} \rho g (y_2)^2 w + \rho \frac{Q^2}{y_2(w)}$$

Solution:

$$8703.8 = 31.2 y^2 + 19400 \frac{1}{y^2} \quad \phi = 31.2 y^2 + 187.2 y + 280.8 + 19400 \frac{1}{y^2} - 7955$$

$$\phi = 31.2 y^2 + 187.2 y + 7674.2 y + 19400$$

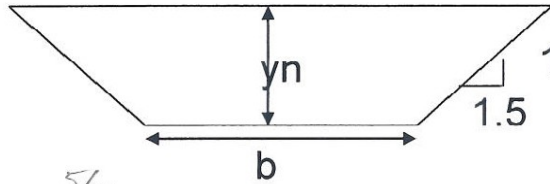
$$\phi = 31.2 y^3 - 8703.8 y + 19400$$

$$\left\{ \begin{array}{l} 15.45 \\ 2.27 \end{array} \right\}$$

$$y_2 = \left\{ \begin{array}{l} 2.91 \\ 11.98 \end{array} \right\}$$

4. Given: $Q = 5000$ cfs; $z = 1.5$; $n = 0.015$; $S_0 = 0.0009$ and $y_n = 8$ ft.

The value of b is closest to {110, 135, 155, 200} units _____



$$A = y(z y + b) = 12 + 8b$$

$$P = b + 2y \sqrt{z^2 + 1} = b + 28.84$$

$$\frac{nQ}{C' S_0^{1/2}} = \frac{A^{5/3}}{P^{2/3}}$$

$$C_Q = 1682.4 = \frac{(12 + 8b)^{5/3}}{(b + 28.84)^{2/3}}$$

$$\text{Try } b = 155 \rightarrow 4498$$

$$\text{try } 110 \rightarrow \underline{3082}$$