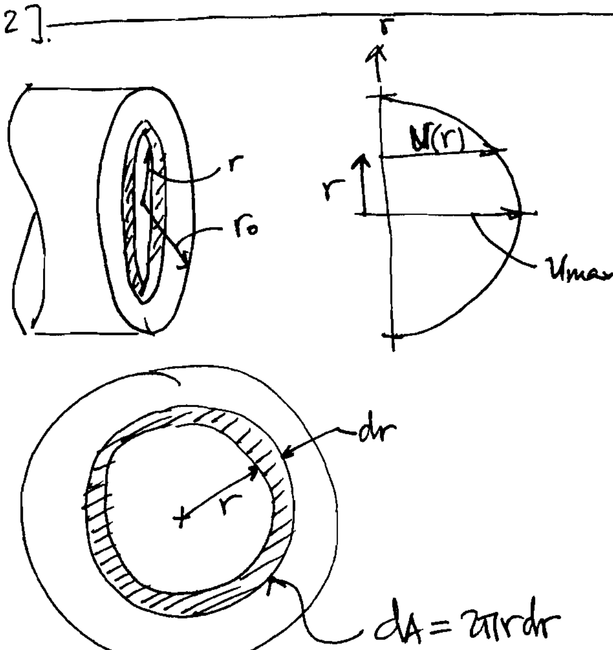
[1]. $s = 1.75$ is not needed. $D = 3\text{in} = \frac{3}{12}\text{ft} = 0.25\text{ft}$, $V = 1.2\text{ft/s}$

(a) $Q = V \cdot A = V \cdot \frac{\pi D^2}{4} = \left(1.2\frac{\text{ft}}{\text{s}}\right)\left(\frac{\pi \times (0.25\text{ft})^2}{4}\right) = 0.0589\ \text{ft}^3/\text{s}$

(b) if $D = 6\text{in} = 0.5\text{ft}$, $V = \frac{Q}{A} = \frac{Q}{\pi D^2/4} = \frac{4Q}{\pi D^2} = \frac{4 \times 0.0589\ \text{ft}^3/\text{s}}{\pi \times (0.5\text{ft})^2} = 0.3\ \text{ft/s}$

[2].



$u(r) = U_{max}\left[1 - \left(\frac{r}{r_0}\right)^3\right]$

↑ velocity distribution, function of r

⇒ at constant r, u(r) is the same in the area increment shown (a ring) with area $dA = 2\pi r dr$

Thus, discharge through dA is:

$dQ = u(r)dA = U_{max}\left[1 - \left(\frac{r}{r_0}\right)^3\right] \cdot 2\pi r dr$

and the total discharge is

$$Q = \int_A dQ = \int_0^{r_0} 2\pi U_{max}\left[1 - \left(\frac{r}{r_0}\right)^3\right] r dr$$

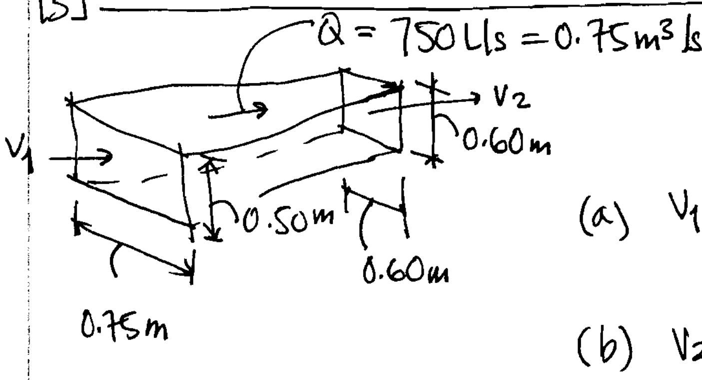
using HP calculator or TI calculator ⇒ E.g., in EQW for HP calculator

$$\int_0^{r0} 2 \cdot \pi \cdot um \cdot \left[1 - \left[\frac{r}{r0}\right]^3\right] \cdot r\, dr \quad \boxed{\text{EVAL}} \Rightarrow$$

ⓐ $$\boxed{Q = \frac{\pi U_{max}(3r_0^2)}{5} = \frac{3}{5}\pi U_{max} r_0^2}$$

ⓑ with $A = \pi r_0^2$, $$\boxed{V = \frac{Q}{A} = \frac{\frac{3}{5}\pi U_{max} r_0^2}{\pi r_0^2} = \frac{3}{5}U_{max}}$$

[3]



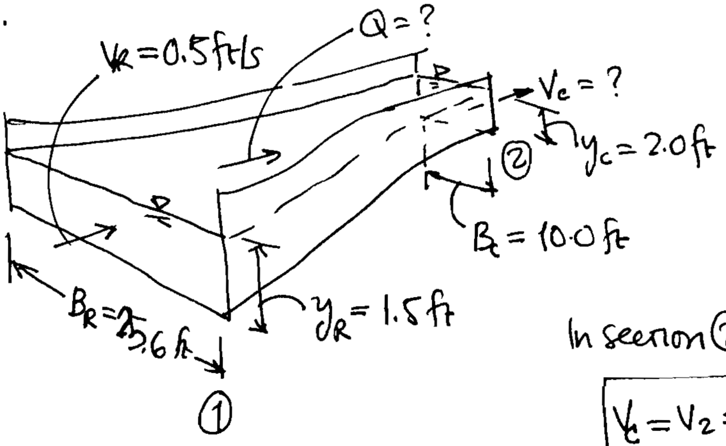
$A_1 = 0.75 \times 0.50\ \text{m}^2 = 0.375\text{m}^2$

$A_2 = (0.60\text{m})^2 = 0.36\ \text{m}^2$

(a) $V_1 = \frac{Q}{A_1} = \frac{0.75\ \text{m}^3/\text{s}}{0.375\ \text{m}^2} = 2.00\ \text{m/s}$

(b) $V_2 = \frac{Q}{A_2} = \frac{0.75\ \text{m}^3/\text{s}}{0.36\ \text{m}^2} = 2.08\ \text{m/s}$

[4].



In section ① $V_1 = V_R = 0.5$ ft/s

$$A_1 = B_R y_R = 25.6 \times 1.5 \text{ ft}^2 = 38.4 \text{ ft}^2$$

$$Q = V_1 A_1 = (0.5 \tfrac{ft}{s})(38.4 \text{ ft}^2)$$

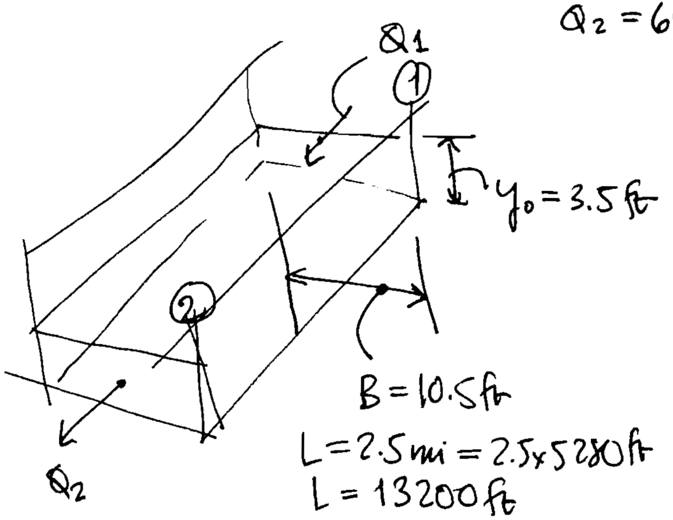
$$\boxed{Q = 19.2 \text{ cfs}}$$

In section ②, $V_2 = V_c = ?$, $A_2 = 10 \times 2 \text{ ft}^2 = 20 \text{ ft}^2$

$$\boxed{V_c = V_2 = \frac{Q}{A_2} = \frac{19.2 \text{ cfs}}{20 \text{ ft}^2} = 0.96 \text{ fps}}$$

[5]

$Q_1 = 80$ cfs
$Q_2 = 65$ cfs



$L = 2.5 \text{ mi} = 2.5 \times 5280 \text{ ft}$
$L = 13200$ ft

(a) $\frac{d\forall}{dt} = Q_1 - Q_2 = 80 - 65 = 15$ cfs

(b) For $B = 10.5$ ft, $y_0 = 3.5$ ft

$$A_1 = A_2 = By_0 = 10.5 \times 3.5 = 36.75 \text{ ft}^2$$

$$V_1 = \frac{Q_1}{A_1} = \frac{80}{36.75} \frac{\text{cfs}}{\text{ft}^2} = 2.17 \text{ fps}$$

$$V_2 = \frac{Q_2}{A_2} = \frac{65}{36.75} \frac{\text{cfs}}{\text{ft}^2} = 1.77 \text{ fps}$$

(c) $\forall = ByL \Rightarrow \frac{d\forall}{dt} = BL\frac{dy}{dt} \Rightarrow 15 = 10.5 \times 13200 \times \frac{dy}{dt}$

For $\Delta t = 15 \text{ min} = 15 \times 60 = 900$ s

$$\Rightarrow \frac{dy}{dt} = 1.08 \times 10^{-4} \text{ ft/s} \approx \frac{\Delta y}{\Delta t} \Rightarrow \Delta y = (1.08 \times 10^{-4})(900) = 0.097 \text{ ft}$$

$$y = y_0 + \Delta y = 3.5 + 0.097 = 3.597 \text{ ft}$$