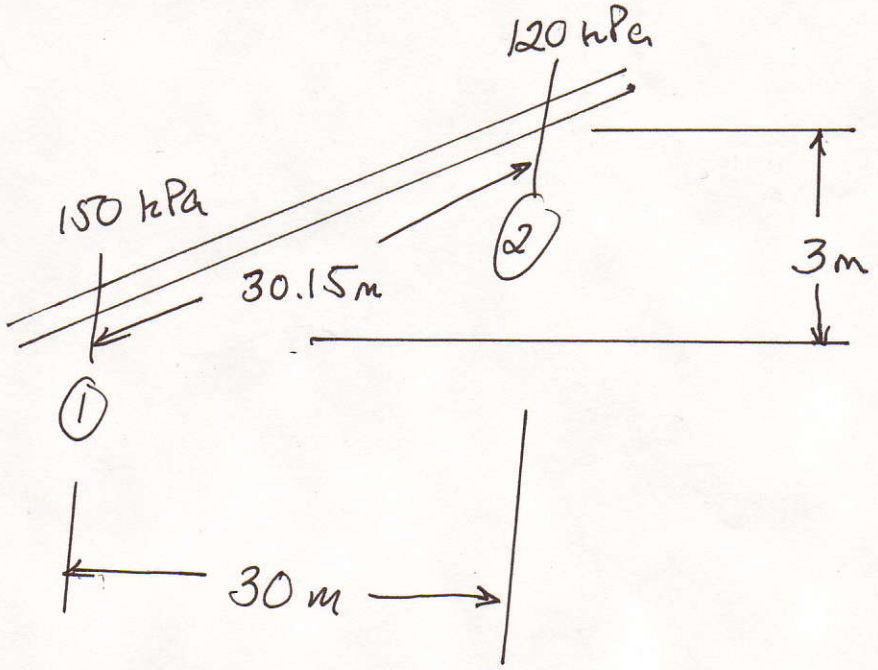
10.63



Students should assume flow is from section 1 TO section 2.

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

$$\frac{P_1 - P_2}{\gamma} + z_1 - z_2 = h_L$$

* assume turbulent flow, such that $h_L = f\frac{l}{D}\frac{V^2}{2g}$

→ take off points if $h_L = \frac{64}{Re}$ or $\frac{64\nu}{VD}$

$$\frac{P_1 - P_2}{\gamma} + z_1 - z_2 = f\frac{l}{D}\frac{V^2}{2g}$$

$$\frac{(150{,}000 - 120{,}000)\frac{N}{m^2}}{9.81\frac{m}{s^2} \cdot 900\frac{kg}{m^3}} + 0m - 3m = f\frac{(30.15m)}{(0.08m)}\frac{V^2}{2 \cdot 9.81\frac{m}{s^2}}$$

$$\frac{30{,}000}{8829} - 3 = f19.21\,V^2$$

$$0.0207 = fV^2$$

$$f = \frac{0.0207}{V^2}$$

* We don't know f, so we use a trial & error method

* guess $f = 0.02$

if so, then $V = 1.017\frac{m}{s}$

* find Re, $Re = \frac{VD}{\nu} = \frac{(1.017\frac{m}{s})(0.08m)}{0.000001\frac{m^2}{s}} =$ 81415

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* go to Moody diagram

$\frac{\varepsilon}{D} = \frac{0.015}{8} = 0.001875$

$Re = 72,820$

⟶ Moody says $f = 0.025$

* if $f = 0.025$

then using eq. $f = \frac{0.0207}{V^2}$ ⟶ $V = 0.91 \frac{M}{S}$

$Re = 72820$

$f \approx 0.025$ ✓

$V = 0.91 \frac{M}{S}$

$Q = VA = \left(0.91 \frac{M}{S}\right) \cdot \left(\frac{\pi}{4}(0.08\,M)^2\right) = \boxed{0.0045 \frac{M^3}{S}}$