Applying Bernoulli's eqn b/w A and D.

$$\underbrace{\frac{p_A}{\rho g} + \frac{v_A^2}{2g} + z_A}_{H_A} = \underbrace{\frac{p_D}{w} + \frac{v_D^2}{2g} + z_D}_{H_D} + h_{L_1}$$

$$H_A = H_D + h_{L_1} \Rightarrow$$

$$H_A = H_D + \frac{.024 \times 1200 \times (.06)^2}{12 \times (.3)^5}$$

$$\boxed{H_D = 36.4 \, m.}$$

As the total head at B is greater than the total head at D. Therefore the flow is from B to D.

Applying Bernoulli's eqn b/w B and D.

$$H_B = H_D + h_{L_2}$$

$$38 = 36.4 + \frac{f_2 l_2 Q_2^2}{12 d_2^5}$$

$$38 = 36.4 + \frac{.024 \times 600 \times Q_2^2}{12 \times (.2)^5}$$

$$Q_2 = 0.02 \, m^3/s. \doteq 20 \text{ lits/s.}$$

from continuity eqn $Q_1 + Q_2 = Q_3$

$$60 + 20 = Q_3 = 80 \text{ lits/s.}$$

Apply Bernoulli's eq^n between B & D.

$$H_D = H_C + h_{f3}$$

$$36.4 = H_C + \frac{f l_3 Q_3^2}{12 \times d_3^5}$$

$$36.4 = H_C + \frac{.024 \times 800 \times (.08)^2}{12 \times .(.3)^5}$$

$$\boxed{H_C = 32.2\ m.}$$

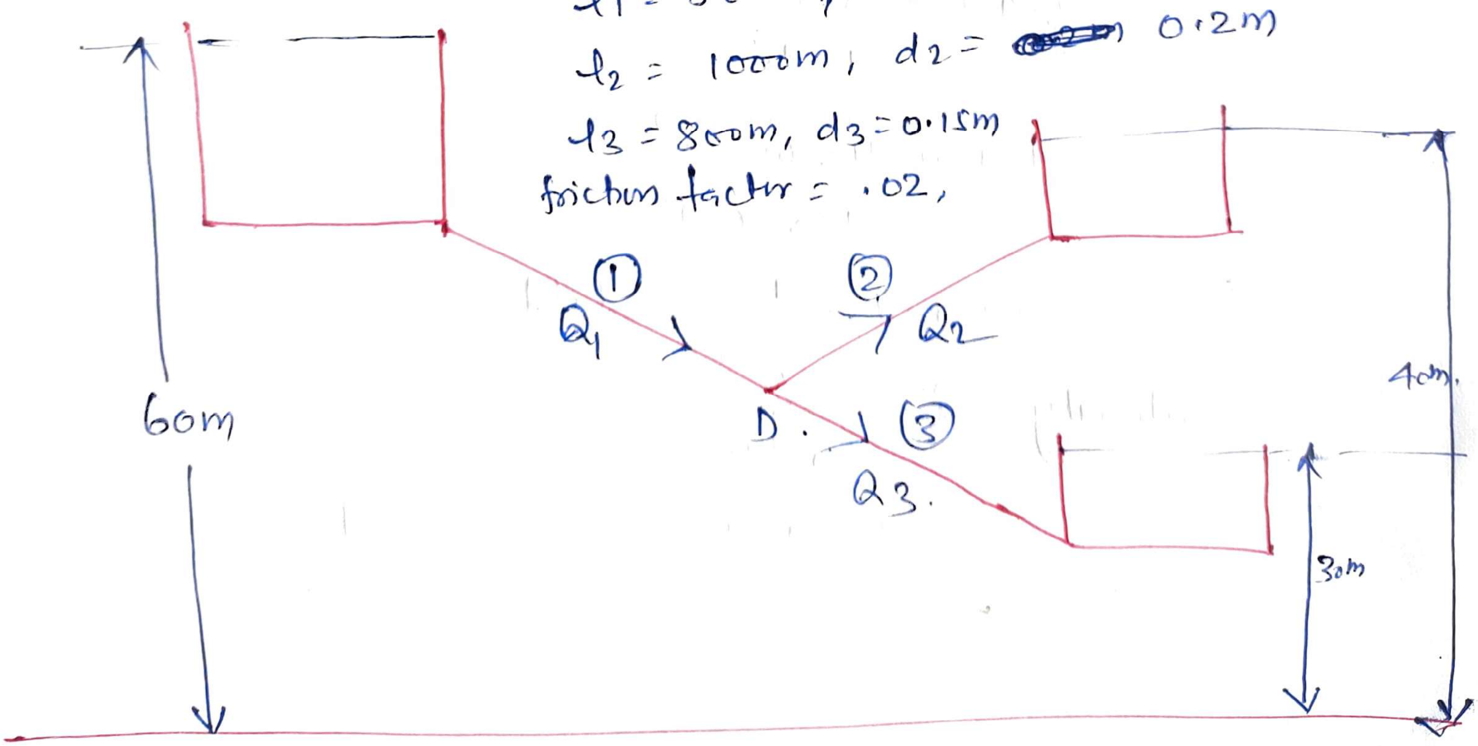
Q:- Three reservoirs A, B and C are connected by a pipe system as shown in fig. along with direction. Determine the total head at junction D.

$l_1 = 800\ m$, $d_1 = 0.3\ m$

$l_2 = 1000\ m$, $d_2 = 0.2\ m$

$l_3 = 800\ m$, $d_3 = 0.15\ m$

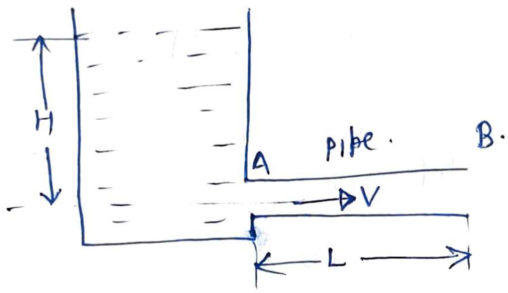
friction factor = .02,



Power transmission through pipe:-

The transmission of power through pipes carrying water or other liquids is commonly used for working of several hydraulic machines. The hydraulic power transmitted by a pipe however depends on.

a) The discharge passing through the pipe.
b) The total head of water.



weight of water flowing through the pipe per second:-

$\rho = \frac{m}{V}$

$m = \rho \times vol^m$

$= \rho \times A \times L = \rho V V$

$$= \dot{m} \cdot g = \rho \cdot A \cdot V \times g = wAV.$$

net head available at B. (neglecting minor loss)

$$= H - h_f = H - \frac{4fLV^2}{2g \cdot d}$$

$$\eta = \frac{H - h_f}{H}$$

efficiency of transmission

Power required to overcome the frictional loss.

$$P = \rho g Q \cdot h_f$$

h_f head loss due to friction.

Power available $= \rho g Q H.$

Power available at the outlet of the pipe.

$$P = \rho g Q (H - h_f)$$

$$P = \rho \times g \times AV(H - h_f)$$

condition for maximum power transmission

$$P = w \cdot A \left[H \cdot V - \frac{4fLV^2}{2gd} \times V \right]$$

$$P = f(V).$$

$$\frac{dP}{dV} = 0, \quad \frac{dP}{dV} = \rho \times g \times \frac{\pi}{4} \cdot d^2 \cdot \frac{d}{dV}\left[HV - \frac{4fLV^3}{2gd} \right] = 0$$

$$\Rightarrow H - \frac{4fL \times 3V^2}{d \times 2g} = 0$$

$$H - 3\,\frac{4fLV^2}{2gd} = 0$$

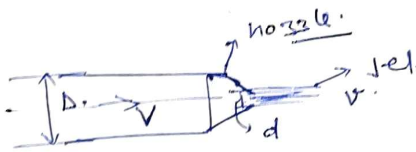
$$H - 3h_f = 0 \Rightarrow H = 3h_f.$$

$$\boxed{h_f = \frac{H}{3}},$$

condition for max^m power.

$$\eta = \frac{H - h_f}{H} = \frac{H - \frac{H}{3}}{H} = \frac{2}{3} = 66.7\%.$$

Flow through nozzle at the end of a pipe!-



D - Pipe diameter, L → Length of pipe, V → velocity of flow in pipe

H → head available [Height of water level in the reservoir above the centre-line of the nozzle]

f → co-efficient of friction for the pipe.

v - velocity of flow at the outlet of nozzle.

Head loss due to friction in pipe

$$h_f = \frac{4fLV^2}{2 \times g \times D}$$

available head at the base of nozzle.

$$= H - \frac{4fLV^2}{2 \times g\,D}$$

losses in the nozzle is neglected.

Total head at the nozzle outlet = $\frac{v^2}{2g}$

$$H = h_f + \frac{v^2}{2g}$$

from continuity eqn. $AV = a.v.$

$$V = \frac{av}{A}.$$

$$H = \frac{4fLV^2}{2\times g\,D} + \frac{v^2}{2g}. \Rightarrow \frac{4fL\,a^2v^2}{D\times 2g\times A^2} + \frac{v^2}{2g}$$

$$= \frac{v^2}{2g}\left[1 + \frac{4fLa^2}{D\times A^2}\right] \Rightarrow v = \sqrt{\frac{2gH}{1+\frac{4fLa^2}{DA^2}}}$$

discharge through the nozzle - $a.v.$

Power transmitted through the nozzle:-

$\dot{m} = \rho.av$ kg/s.

K.E. of jet at outlet of nozzle

$$= \frac{1}{2}m.v^2 = \frac{1}{2}\times \rho av \times v^2 = \frac{1}{2}\rho a v^3.$$

Power available at the outlet of nozzle:-

$$= \frac{1}{2}\rho a v^3 \text{ watt}$$

Power available at the inlet of pipe $= \rho g QH.$

effn. of power transmission through the nozzle.

$$\eta = \frac{\frac{1}{2}\rho a v^3}{\rho g QH} = \frac{v^2}{2gH} = \frac{1}{1+\frac{4fLa^2}{DA^2}}$$