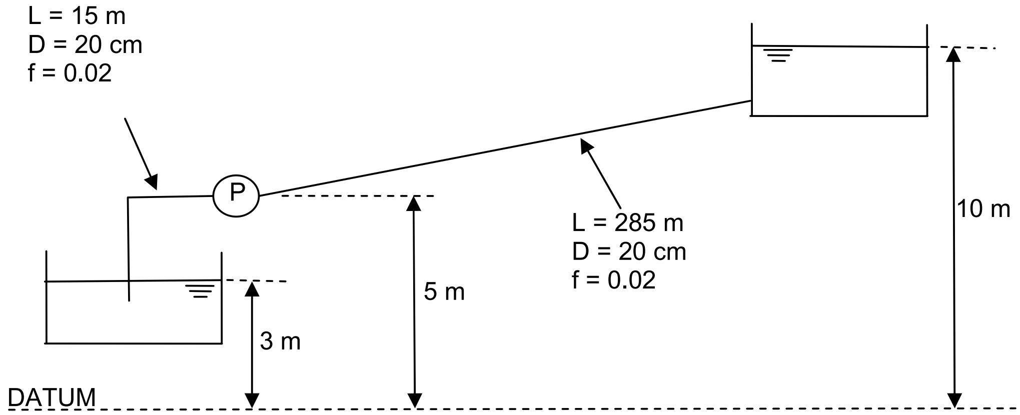
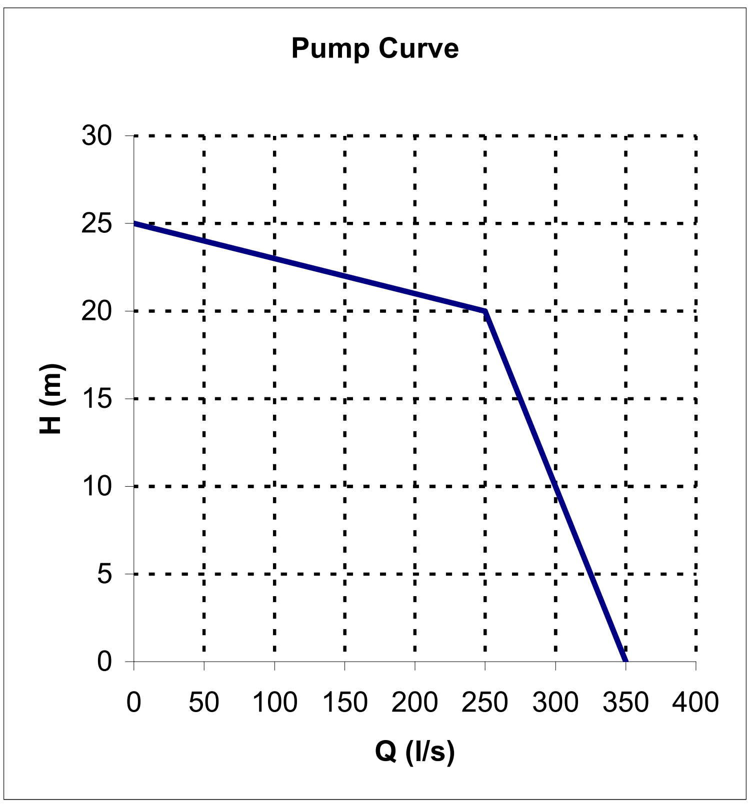
CVE 372 HYDROMECHANICS

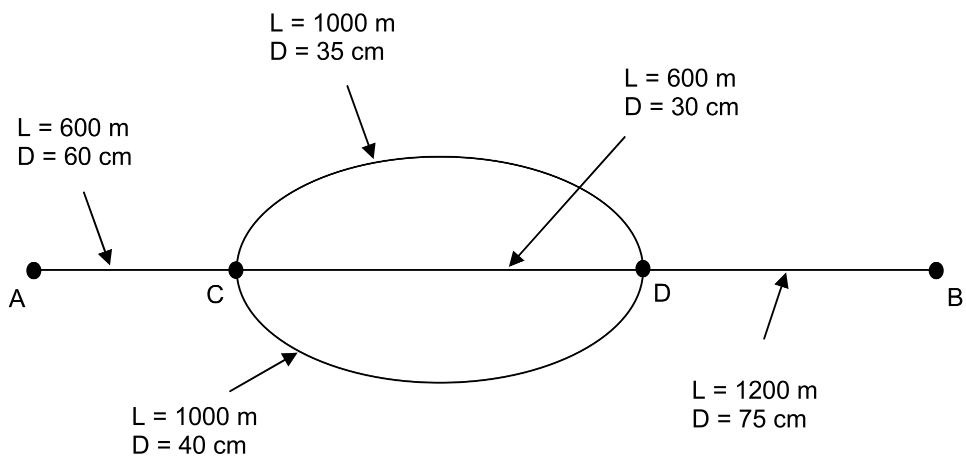
EXERCISE PROBLEMS

1. A pump that has the characteristic curve shown in the accompanying graph is to be installed in the system shown. What will be the discharge of water in the system? Take $\nu = 10^{-6}$ m^2/s.

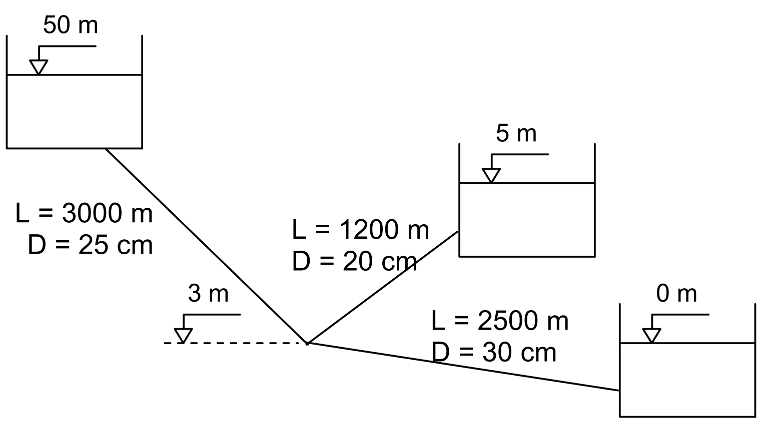




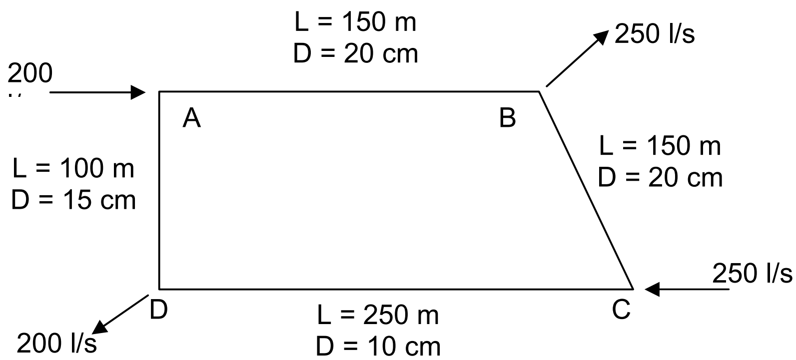
2. With a flow of 450 l/s of water, find the head loss and the division of flow in the pipes from A to B. Take $\nu = 10^{-6}$ m^2/s and ε = 0.1 mm for all pipes.



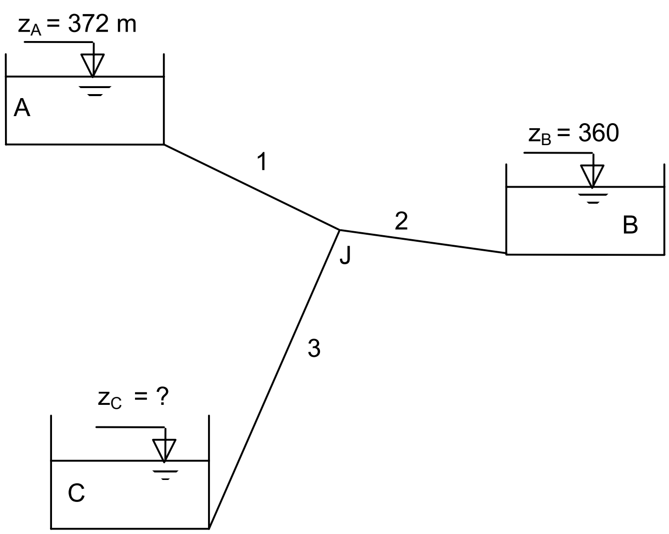
3. Assuming f = 0.020, determine the discharge in the pipes. Neglect minor losses. Take $\nu = 10^{-6}$ m^2/s.



4. Assuming f = 0.020, determine the discharge in the pipes. Neglect minor losses. Take Q_{AB}= 60 l/s for the first trial value. Stop iteration when $|\Delta Q| < 3$ l/s. Take $\nu=10^{-6}$ m^2/s.



5. Three reservoirs are connected with smooth pipes at a junction point. It is known that flow direction in pipe-2 is from reservoir B to the junction, and the discharge of pipe-1 is equal to the discharge of pipe-2, $Q_1= Q_2$. For pipe characteristics given in the table below, compute the water surface elevation in reservoir C. ($\nu = 1.0 \times 10^{-6}$ m^2/s)



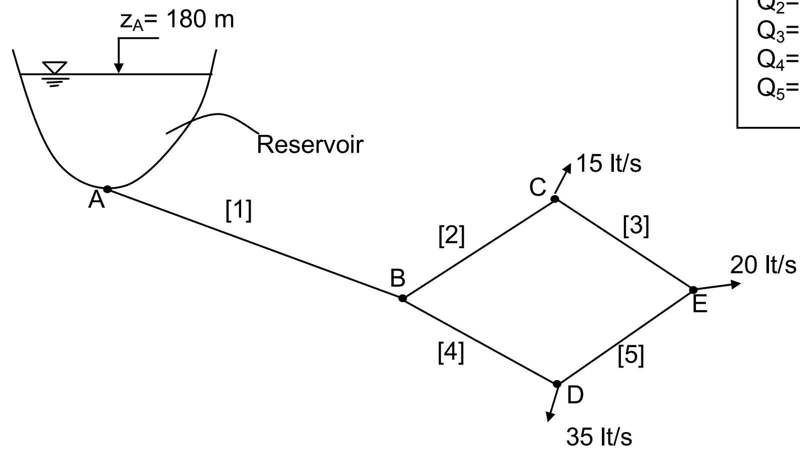
Pipe	D(m)	L(m)
1	0.2	300
2	0.2	140
3	0.4	190

Ans.:z_c=347.72 m

6. Assuming points B, C, D and E lie on the same plane ($z_B = z_C = z_D = z_E$), determine the direction and magnitude of the discharge in each pipe in the network shown in the figure. (Use at least two iterations)

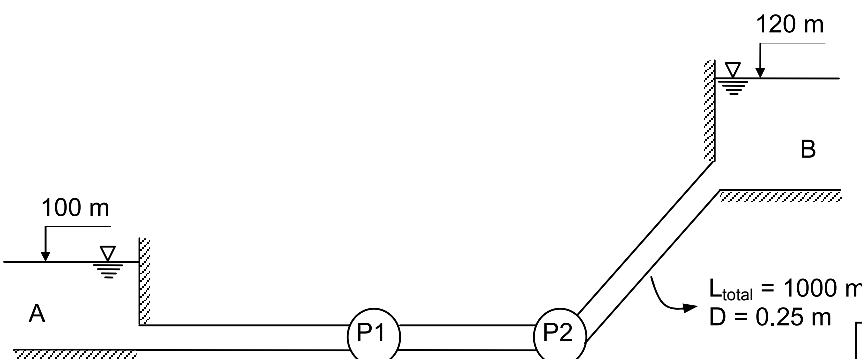
Given:
$K_2 = 3$, $K_3 = 5$, $K_4 = 2$ and $K_5 = 5$
where K has been defined as: $h_f =$

Ans.
Q_2=29.07 lt/s
Q_3=14.07 lt/s
Q_4=40.93 lt/s
Q_5=5.93 lt/s



7. Compute flow rate for the pipeline shown below. Also determine Hp values of each pump in the system. Pump characteristic head- discharge curves for the pumps are given in the table below. Use D = 0.25 m, L = 1000 m, assume that f = 0.02.

Q (lt/s)	0	40	80	120	160	200
$(H_p)_1$ (m)	50	48	45	39	30	18
$(H_p)_2$ (m)	30	28	25	21	16	11



Ans.: Q=138 lt/s
Hp_1=35 m
Hp_2=18 m

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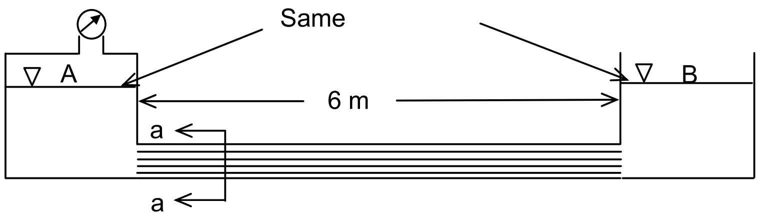
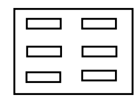
8. A viscous oil with a specific gravity, SG=0.8 and a viscosity of 0.001 Pa.s flows from tank A to tank B through the six rectangular slots indicated in figure. If the total flowrate is 3 lt/s and minor losses are negligible, determine the pressure in tank A. Assume hydraulically smooth flow.



Each slot
1cm x 1cm



Section a-

Ans.
P_A=131 kPa

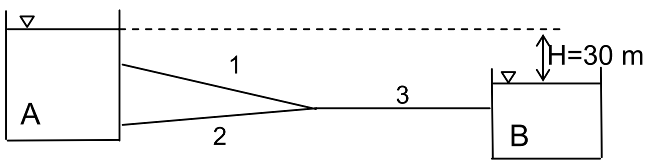
9. For H=30 m in the figure below,

a) Find the discharge through each pipe

b) What will be the equivalent length of a pipe having a diameter of 120 mm with □=0.0018m replaced instead of pipes 1 and 2 ?

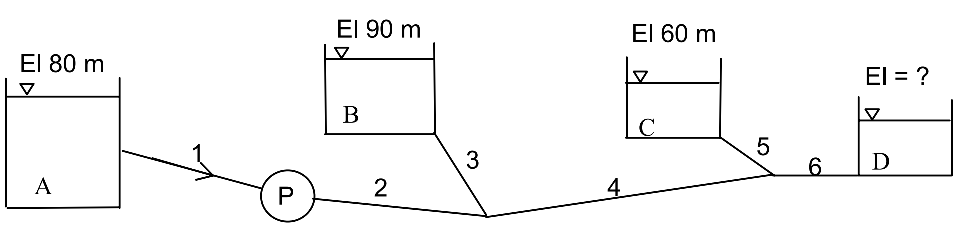
Neglect minor losses, $\nu_{water}=1\times10^{-6}\ m^2/s$

Pipe	L(m)	D(mm)	□ (m)
1	6	50	0.0005
2	10	100	0.001
3	20	120	0.0018



Ans.
Q_1=14.4 lt/s
Q_2=63.28 lt/s
Q_3=77 lt/s

10. For the system given in the figure, find the elevation of Reservoir D and the flow direction in pipe 6. Neglect minor losses.

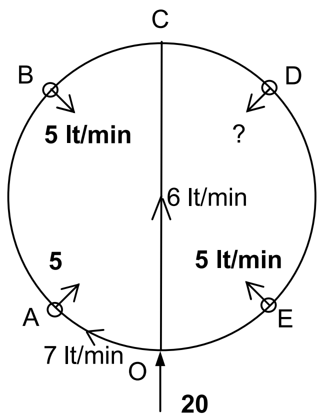


Pipe	L (m)	D(mm)	f
1	600	600	0.025
2	600	600	0.025
3	600	450	0.03
4	700	450	0.03
5	300	450	0.03
6	300	600	0.03

$Q_1 = 0.35 m^3/s$
Hp = 8m

Ans.
Q_2=350 lt/s
Q_3=271 lt/s
Q_4=621 lt/s
Q_5=549 lt/s
H_p=34.72 m

11. Find the discharge in each link using the given initial distribution by making 2 iterations and pressure drop between points O and C if they have the same elevation.



$K_{BC}=K_{CD}=K_{AO}=K_{OE}$
$K_{AB}=K_{DE}$
$K_{OC}=3K_{BC}$
$K_{AB}=2K_{BC}$
$K_{OC}=30\ min^2/dm^5$

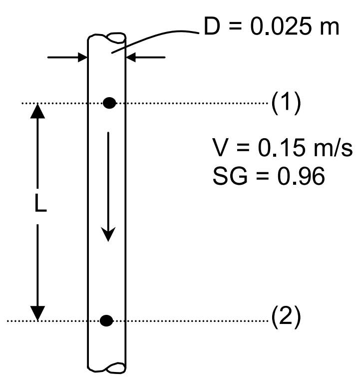
12. Two water reservoirs with a difference in elevation of 5m are connected by 800m of commercial steel pipe. The roughness height of the pipe is 0.18 mm. What size pipe must be used to convey 100 lt/s ? Neglect minor losses, $\nu_{water}=1x10^{-6}\ m^2/s$.

Ans.
D=30 cm

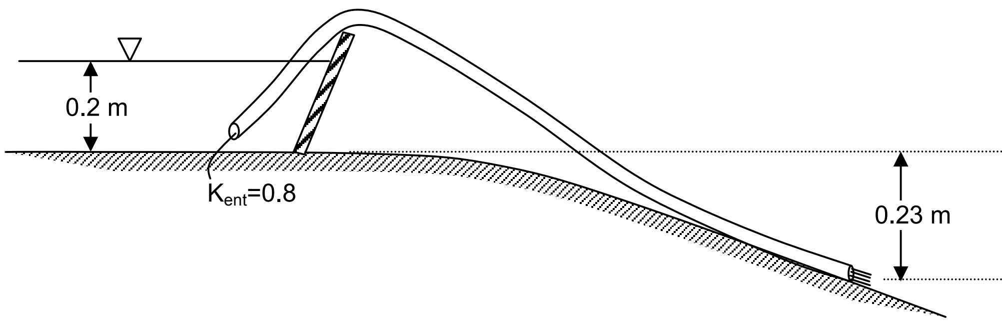
13. A fluid of specific gravity 0.96 flows steadily in a long, vertical 2.5 cm diameter pipe with an average velocity of 0.15 m/s.

a) If the pressure is constant throughout the fluid, what is the dynamic viscosity of the fluid?
b) Determine the shear stress on the pipe wall.

($\rho_w = 1000\ kg/m^3$, $g = 9.81\ m/s^2$)

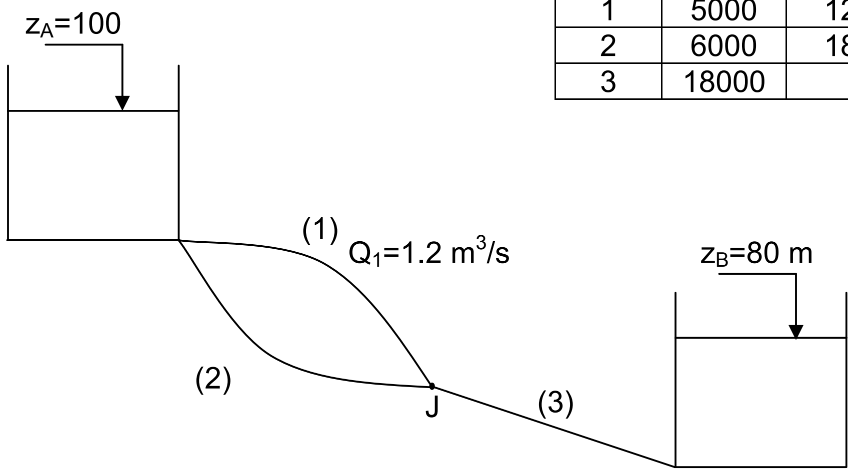


14. A smooth plastic, 10-m long garden hose with inside diameter of 15 mm is used to drain a pool as shown in the figure. Including both friction and minor losses, determine the flowrate from the pool. ($\nu = 1 \times 10^{-6}$ m^2/s)



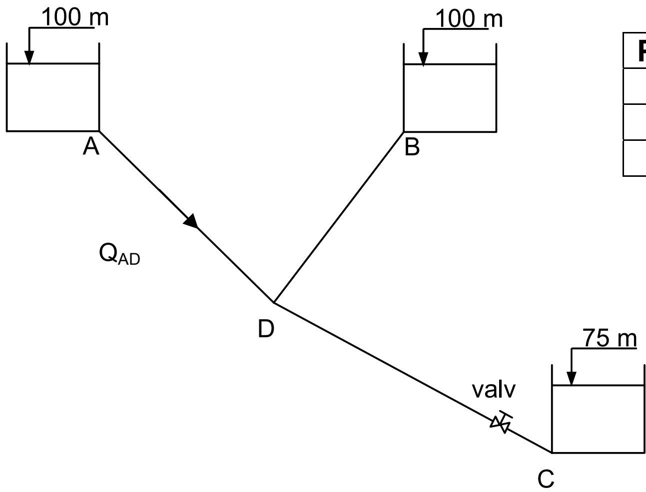
15. In the following pipe system, water discharge in pipe 1 is given as Q_1=1.2 m^3/s. The upstream and downstream reservoir water surface elevations are known, and they are z_A=100 m, and z_B=80 m, respectively. Relevant pipe data are provided in the table below. Determine the diameter in pipe 3. Velocity head at the junction and minor losses in the system will be neglected. ($\nu = 1 \times 10^{-6}$ m^2/s)

Pipe	L (m)	D (mm)	ε (mm)
1	5000	1200	3.6
2	6000	1800	3.6
3	18000	?	4.4



16. The water surface elevations in the three reservoir system are shown in the figure. In addition, the pipe data are provided in the table below. The discharge in pipe AD is 100 lt/s. Use f = 0.02 for all pipes.

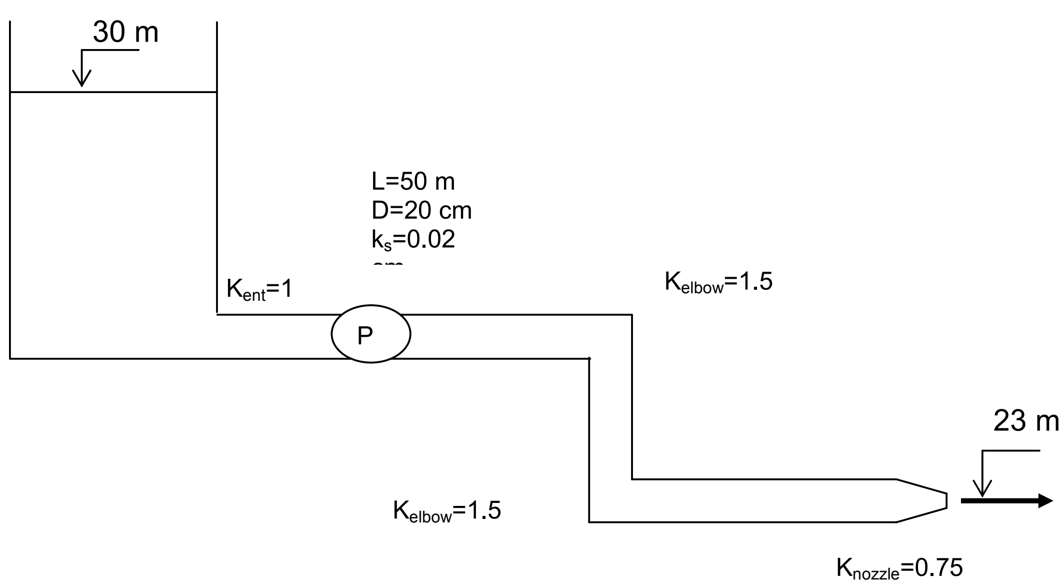
a) Determine the minor loss at the valve, h_{valve}, and minor loss coefficient, K_{valve}. (Note: Neglect all other minor losses.)
b) Draw the energy gradeline for the system.



Pipe	L (m)	D (mm)
AD	1000	300
BD	500	300
DC	1500	400

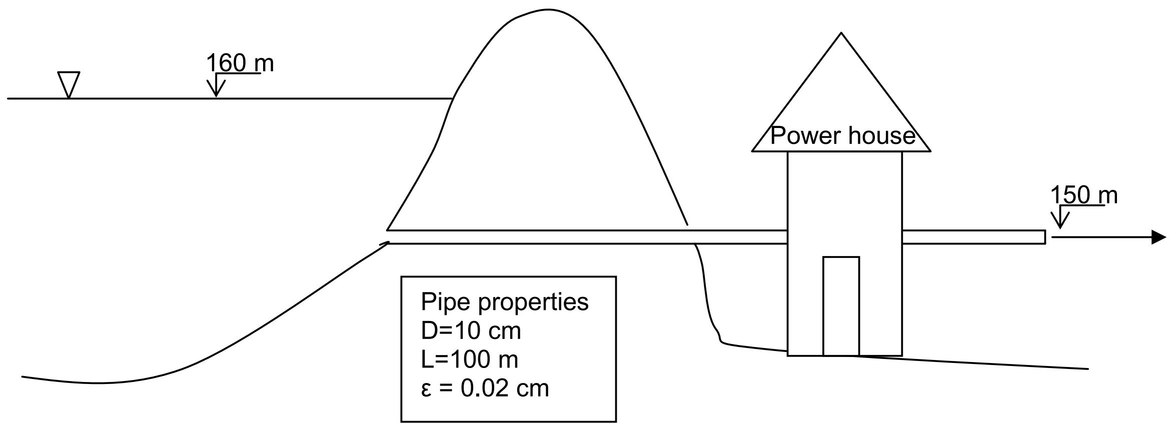
17. Water flows from the reservoir through a pipe as shown in the figure.

a) Calculate the discharge by assuming that flow is irrotational and inviscid.
b) Calculate the discharge and pump head by considering all the losses in the system



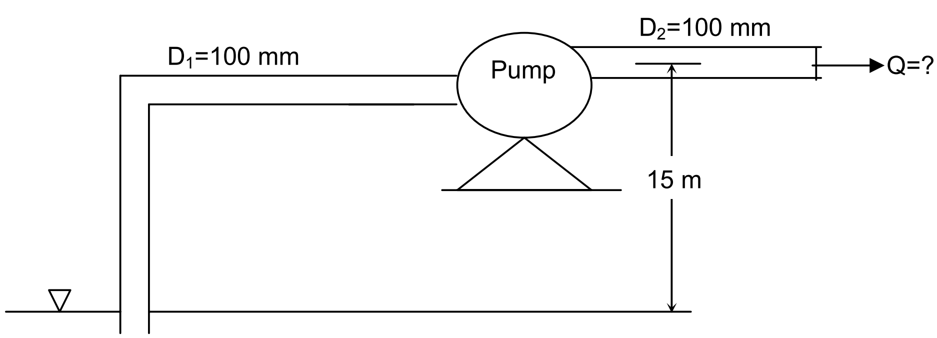
18. Water flows at a rate of 0.110 m^3/s from a lake as shown in the figure below. The pipe is 100 m long and the diameter of the pipe is 10 cm and the roughness height is 0.02 cm.

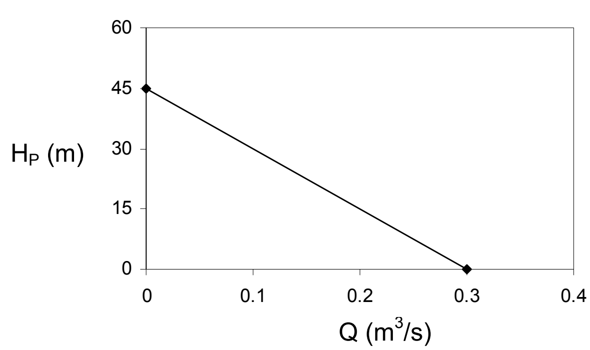
a) Is the device inside the building a pump or a turbine? Explain.
b) Determine the power of the device if the efficiency of the device is 86 %.



19. The pump in the figure has the performance characteristics shown. The mechanical energy loss in the piping and fittings in the suction and discharge pumping is given by

$h_L = K\frac{V^2}{2g}$ where V is the average fluid velocity in the pipe and K = 10. Find the flow rate through the pump and power supplied by the pump to the fluid.





20. In a chemical processing plant a liquid is pumped from an open tank through a 0.1-m-diameter vertical pipe into another open tank as shown in the figure below. A valve is located in the pipe, and the minor loss coefficient for the valve as a function of the valve setting is shown in the figure below. The pump head-capacity relationship is given by the equation:

$$H_p = 52.0\text{-}1.01\text{x}10^3\ Q_2 \text{ with } H_p \text{ in meters when } Q \text{ is in } m^3/s.$$

Assume the friction factor f = 0.02 for the pipe, and all minor losses, except for the valve, are negligible. The fluid levels in the two tanks can be assumed to remain constant. Determine:

(a) the flowrate with the valve wide open.

(b) the required valve setting (percent open) to reduce the flowrate by 50 %.