University of Salahaddin - Hawler
College of Engineering
Department of Mechanical Engineering

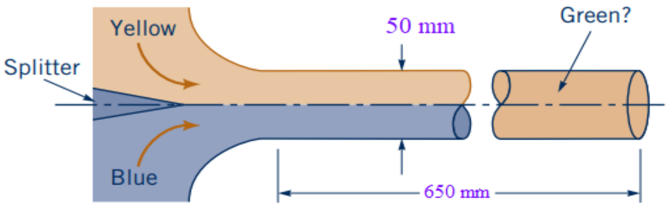
Problems on Fluid Dynamics

Academic Year 2023 – 2024

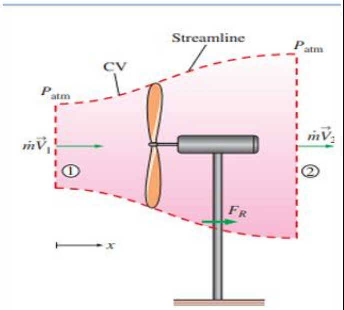
Senior Students (3rd Year)

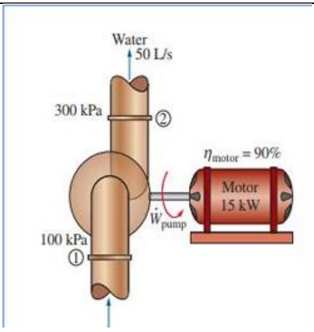
Lecturer: Mahde A. Molan

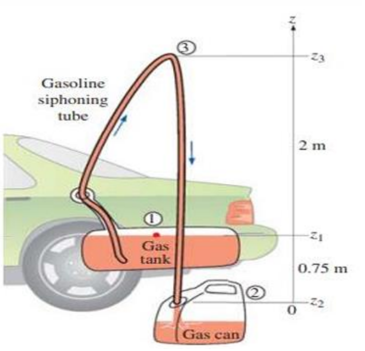
Chapter One

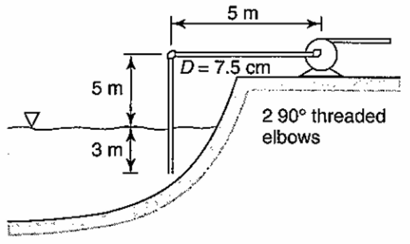
Pr.1	A Newtonian fluid having a viscosity of 0.38 N.s/m^2 and a specific gravity of 0.91 flows through a 25-mm diameter pipe with a velocity of 2.6 m/s. Determine the value of the Reynolds number.
Pr.2	A viscous liquid (ρ= 1.18×10^3 kg/m^3; μ=0.045 N.s/m^2) flows at a rate of 32 l/s through a horizontal, 4-cm-diameter tube. FIND the Reynolds No. of the liquid.
Pr.3	Determine the critical velocity for (a) gasoline at 20°C flowing through a 20-mm pipe and (b) water at 20°C flowing in the 20-mm pipe.
Pr.4	The present pumping rate of North Slope crude oil through the Alaska Pipeline, 48 in. diameter (≈122 cm), is about 600,000 barrels per day (1 bar.≈159 lit.) What would be the maximum rate if the flow were constrained to be laminar?
Pr.5	Blue and yellow streams of paint at 15 ^{o}C (each with a density of 825kg/m^3 and a viscosity 1000 times greater than water) enter a pipe with an average velocity of 1.2m/s. Would you expect the paint to exit the pipe as green paint or separate streams of blue and yellow paint? Explain. Repeat the problem if the paint were "thinned" so that it is only 10 times more viscous than water. Assume the density remains the same. 
Pr.6	Consider the flow of an incompressible fluid of density r and viscosity m through a long, horizontal section of a round pipe of diameter D. The velocity profile is V is the average speed across the pipe cross-section, which by conservation of mass remains constant down the pipe. For a very long pipe, the flow eventually becomes hydrodynamically fully developed, which means that the velocity profile also remains uniform down the pipe. Because of frictional forces between the fluid and the pipe wall, there exists a shear stress τw on the inside pipe wall as sketched. The shear stress is also constant down the pipe in the fully developed region. We assume some constant average roughness height ε along the inside wall of the pipe. In fact, the only parameter that is not constant down the length of pipe is the pressure, which must decrease (linearly) down the pipe in order to "push" the fluid through the pipe to overcome friction. Develop a nondimensional relationship between shear stress τw and the other parameters in the problem.

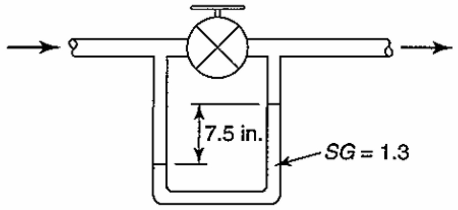
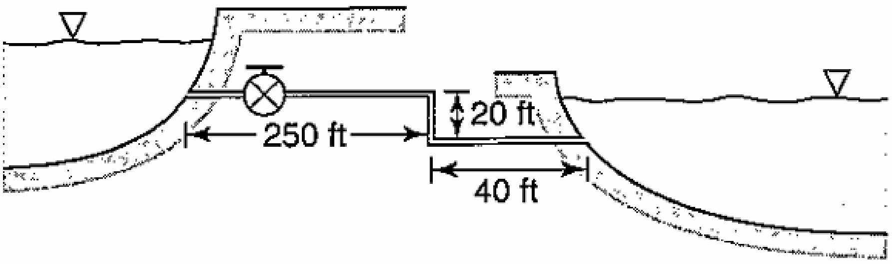
<table>
<tr><td>Pr.7</td><td>Consider flow of an incompressible fluid of density ρ and viscosity μ through a long, horizontal section of a round pipe of diameter D. The velocity profile is V. A shear stress τ. Develop a non-dimensional relationship between shear stress τ and the other parameters in the problem.</td></tr>
<tr><td>Pr.8</td><td>Water flows at a rate of 18.5 gal/min through a flanged faucet with a partially closed gate valve spigot. The inner diameter of the pipe at the location of the flange is 0.780 in (= 0.0650 ft), and the pressure at that location is measured to be 13.0 psig. The total weight of the faucet assembly plus the water within it is 12.8 lbf. Calculate the net force on the flange.</td></tr>
<tr><td>Pr.9</td><td>A wind generator with a 30-ft-diameter blade span has a cut-in wind speed (minimum speed for power generation) of 7 mph, at which velocity the turbine generates 0.4 kW of electric power. Determine (a) the efficiency of the wind turbine–generator unit and (b) the horizontal force exerted by the wind on the supporting mast of the wind turbine. What is the effect of doubling the wind velocity to 14 mph on power generation and the force exerted? Assume the efficiency remains the same, and take the density of air to be 0.076 lbm/ft3.


</td></tr>
<tr><td>Pr.10</td><td>The pump of a water distribution system is powered by a 15-kW electric motor whose efficiency is 90 percent. The water flow rate through the pump is 50 L/s. The diameters of the inlet and outlet pipes are the same, and the elevation difference across the pump is negligible. If the absolute pressures at the inlet and outlet of the pump are measured to be 100 kPa and 300 kPa, respectively, determine (a) the mechanical efficiency of the pump and (b) the temperature rise of water as it flows through the pump due to mechanical inefficiencies.

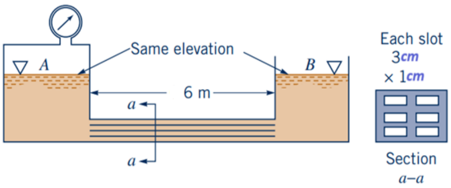
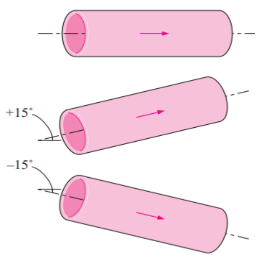
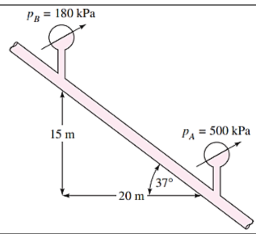

</td></tr>
<tr><td>Pr.11</td><td>During a trip to the beach (Patm = 1 atm = 101.3 kPa), a car runs out of gasoline, and it becomes necessary to siphon gas out of the car of a Good Samaritan. The siphon is a small-diameter hose, and to start the siphon it is necessary to insert one siphon end in the full gas tank, fill the hose with gasoline via suction, and then place the other end in a gas can below the level of the gas tank. The difference in pressure between point 1 (at the free surface of the gasoline in the

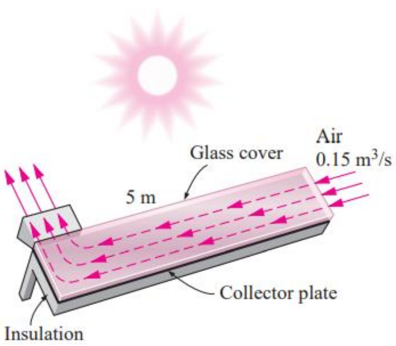
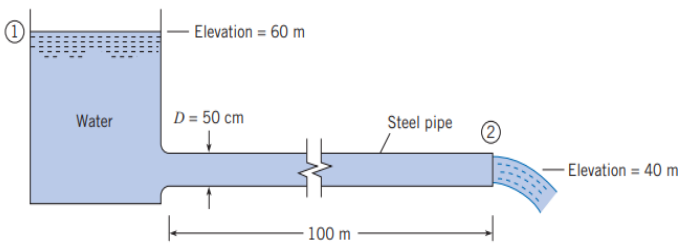
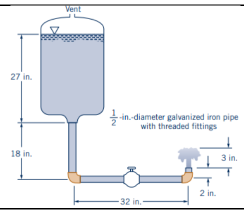
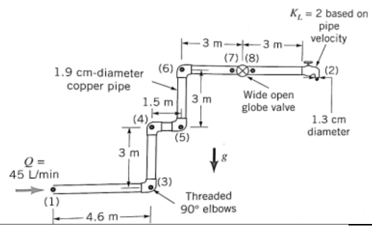
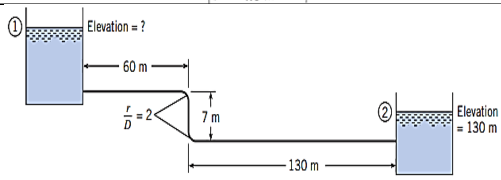

</td></tr>
</table>

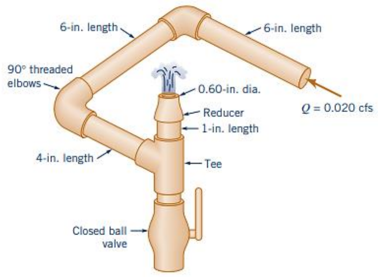
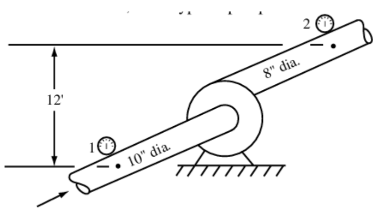
	tank) and point 2 (at the outlet of the tube) causes the liquid to flow from the higher to the lower elevation. Point 2 is located 0.75 m below point 1 in this case, and point 3 is located 2 m above point 1. The siphon diameter is 5 mm, and frictional losses in the siphon are to be disregarded. Determine (a) the minimum time to withdraw 4 L of gasoline from the tank to the can and (b) the pressure at point 3. The density of gasoline is 750 kg/m3.
Pr.12	Fully developed, laminar flow of a viscous fluid (fL 2.17 N . s/m2) flows between horizontal parallel plates 1 m long that are spaced 3.0 mm apart. The pressure drop is 1.25 kPa. Determine the volumetric flow rate (per unit width) through the channel (in m3/s·m).
Pr.13	journal bearings are constructed with concentric cylin ders with a very small gap between the two cylinders; the gap is filled with oi1. Because of the very small gap, the flow in the gap is laminar. Consider a sealed journal bearing with inner and ouler diameters of 50 and 51 mm, respectively, and a length of 75 mm. The shaft (inner cylinder) rotates at 3000 rpm. At start up the torque needed to turn the shaft is 0.25 N-m. Determine the viscosity of the oil (in N-s/m2). After an hour of operation, will the torque have increased or decreased? Explain.
Pr.14	An air-conditioning duct is 25 em square and must con vey 25 m3/min of air at 100 kPa, 25°C. The duct is made of sheet metal that has a roughness of approximately 0.05 mm. Deter mine the pressure drop for 25 m of horizontal duct run (in kPa and mm of water).
Pr.15	**P9-18** When pumping a fluid, the pressure at the entrance to the pump must never drop below the saturation pressure of the fluid. If the pressure does drop below the saturation pressure, cavitation (the forming of vapor bubbles) occurs, which can damage the pump impeller. Consider the system shown in the figure, which is constructed of commercial steel pipe and threaded connections. For water at 10°C, determine the maximum possible flow rate without cavitation occurring (in m^3/s). 

Pr.16	**P9-17** A manufacturer develops a new type of flow control valve. Before it can be advertised and sold, its loss coefficient must be determined. The valve is installed in a 6-in. pipe, and 2 ft^3/s of water flows through it. The pressure drop is measured with a manometer whose fluid has a specific gravity of 1.3. The manometer deflection is 7.5 in. Determine the loss coefficient for the valve. 
Pr.17	Ski resorts pump water to make snow when the weather does not cooperate. Consider a resort that uses 100 gaUmin of 35°F water. It is pumped from the water holding pond through a 4-in.-diameter, 3000-ft steel pipe to the top of the mountain. The elevation difference is 950 ft. The gage pressure required at the nozzle at the end of the pipe is 150 Ibf/in.2 Detennine the required pumping power (in hp).
Pr.18	**P9-32** A pipe connects two reservoirs at different elevations. The pipe is constructed of 12-in.-diameter commercial steel with flanged fittings. The gate valve is one-fourth closed. The water temperature is 50°F. Determine the required elevation difference between the two reservoirs to produce a water flow rate of 10 ft^3/s (in ft). 

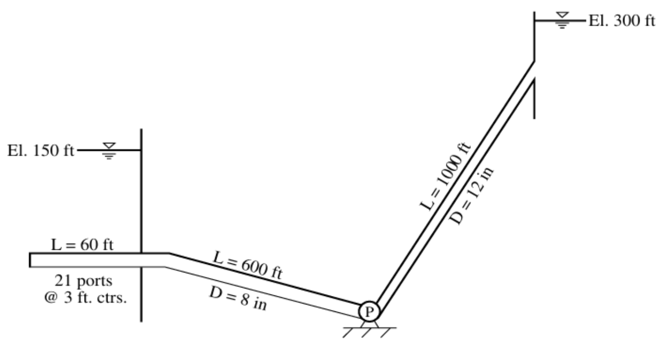
Chapter Two

Pr.19	Geothermal brine (saltwater) 900 kg/m^3, and the viscosity is 1.35x10^{-4} N.s/m. is flows from tank A to tank B through the six rectangular slots indicated in the figure. If the total flow rate is 126 cm^3/s, f=0.02, and minor losses are negligible, determine the pressure in tank A. 
Pr.20	Consider the flow of oil, ν=0.0026m^2/s, 40cm diameter pipeline with average velocity of 0.5 m/s. A 300 m long section of the pipeline passes through the icy waters of a lake. Disregarding entrance effects, find the pumping power required to overcome the pressure losses and to maintain the flow of oil in the pipe
Pr.21	Oil at 20°C (ρ=888 kg/m^3 and μ=0.8 kg/m·s) is flowing steadily through a 5cm diameter 40m long pipe. The pressure at the pipe inlet and outlet are measured to be 745 and 97 kPa, respectively. Determine the flow rate of oil through the pipe assuming the pipe is (a) horizontal, (b) inclined 15° upward, (c) inclined 15° downward. Also verify that the flow through the pipe is laminar. 
Pr.22	Oil (ρ=900 kg/m^3 & μ=0.4 N.s/m^2) flows in a 2cm pipe of diameter. FIND (a) Pressure drop Δp, is needed to produce a flow rate of 2×10^{-5} m^3/s; if the pipe is horizontal with x_1= 0 and x_2=10 m? (b) How steep a hill,θ, must the pipe be on if the oil is to flow through the pipe at the same rate as in part (a), but with p_1=p_2
Pr.23	SAE 30 (ρ=891 kg/m^3 & μ=0.4 N.s/m^2) oil at 20°C flows in the 3-cm-diameter pipe, which slopes at 37°. For the pressure measurements shown, determine (a) whether the flow is up or down and (b) Flow rate in m^3/h. 
Pr.24	Water at 20°C (***ρ***= 998 kg/m^3 and μ=1.002×10^{-3}) is flowing steadily in a 5 cm diameter horizontal pipe made of stainless steel at a rate of 0.006 m^3/s. Determine the pressure drop, the head loss, and the required pumping power input for flow over a 60 m long section of the pipe.
Pr.25	Kerosene at 20°C is pumped at 0.15 m^3 /s through 20 km of 16-cm-diameter castiron horizontal pipe. Compute the input power in kW required if the pumps are 85 percent efficient
Pr.26	Water at 15°C (***ρ***=999.1 kg/m^3 and μ=1.138×10^{-3} kg/m·s) is flowing steadily in a 30 m long and 4 cm diameter horizontal pipe made of stainless steel at a rate of 8 L/s Determine (a) the pressure drop, (b) the head loss, and (c) the pumping power

	requirement to overcome this pressure drop.
Pr.27	Consider an air solar collector that is 1m wide, 5m long and has a constant spacing of 3cm between the glass cover and the collector plate. Air flows at an average temperature of 45°C at a rate of $0.15 m^3/s$ through the 1m wide edge of the collector along the 5m long passageway. Disregarding the entrance and roughness effects, determine the pressure drop in the collector. 
Pr.28	Heated air at 1atm and 35ºC is to be transported in a 150-m-long circular plastic duct at a rate of $0.35 m^3/s$. If the head loss in the pipe is not to exceed 20 m, determine the minimum diameter of the duct
Pr.29	Gasoline at a rate of ($0.1 m^3/s$) is being discharged from a pipe at point 2 at elevation 66.66m. Point 1 is located 965.5 m along the pipe from point 2, is at elevation 82.65, and pressure there is 2.5 kPa. If the pipe roughness is 0.5 mm, what pipe diameter is needed for discharge gasoline. Assume the flow velocity is constant in each point ($\gamma = 7.05 kN/m^3$, $\mu = 2.92\times10^{-4}\ N.s/m^2$, $\rho = 719 kg/m^3$)
Pr.30	The head loss per kilometer of 20 cm asphalted cast-iron pipe is 12.2 m. What is the flow rate of water through the pipe?
Pr.31	Water (T=20°C) flows from a tank through a 50 cm diameter steel pipe. Determine the discharge of water 
Pr.32	Water flows from a container. If the water is to "bubble up" 3 in. above the outlet pipe, find the exit velocity. (Entrance is slightly rounded, valve is globe. 
Pr.33	Water at 15 ºC flows from the basement to the second floor through the 1.9 cm diameter copper pipe at a rate of Q=45L/min and exits through a faucet of diameter 1.3 cm. Determine the pressure at point 1. 
Pr.34	Oil (ν =$4\times10^{-5}\ m^2/s$) flows from the upper to the lower reservoir at a rate of $0.028 m^3/s$ in the 15 cm smooth pipe, what is the elevation of the oil surface in the upper reservoir? 

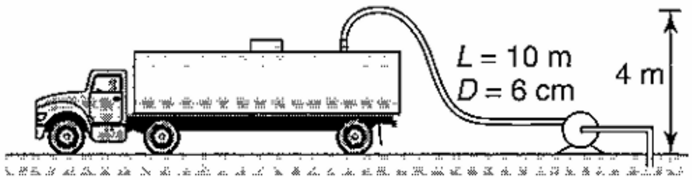
Pr.35	Water flows steadily through the 0.75-in.-diameter galvanized iron pipe system shown in figure at a rate of 0.020 cfs. Your boss suggests that friction losses in the straight pipe sections are negligible compared to losses in the threaded elbows and fittings of the system. Do you agree / disagree with your boss? Support your answer with appropriate calculations. 
Pr.36	A pump takes in water from a level 5 m below its centre line and delivers it at a height of 30 m above the centre line, the rate of flow being 3 m3/hr. The diameter of the pipe line allthrough is 50 mm (ID). The fittings introduce losses equal to 10 m length of pipe in addition to the actual length of 45 m of pipe used. Determine the head to be developed by the pump. The head to be developed will equal the static head, friction head and the dynamic head.
Pr.37	A pipe 250 mm dia, 4000 m long with f = 0.021 discharges water from a reservoir at a level 5.2 m below the water reservoir level. Determine the rate of discharge. The head available should equal the sum of frictional loss and the dynamic head.
Pr.38	Lubricating Oil at a velocity of 1 m/s (average) flows through a pipe of 100 mm ID. Determine whether the flow is laminar or turbulent. Also determine the friction factor and the pressure drop over 10 m length. What should be the velocity for the flow to turn turbulent? Density = 930 kg/m3 . Dynamic viscosity μ = 0.1 Ns/m2 (as N/m2 is call Pascal, μ can be also expressed as Pa.s)
Pr.39	A power plant is 16 km (52,500 ft) from a reservoir. A discharge of 25 m3/s (883 ft3/s) is to be delivered to the plant at an elevation that is 1120 m (3,670 ft) below the reservoir surface. What size of riveted steel pipe is required? Assume a temperature of 4oC (40oF).
Pr.40	The pump shown below delivers 8 ft3/s of water. The recorded pressures at sections 1 and 2 on the gauges are - 5.0 lb/in2 and + 35.0 lb/in2. (a) Draw a diagram of the system and locate the EL and HGL at sections 1 and 2 in the diagram. (b) Determine the required hp and power that must be supplied by the pump to the water to deliver this discharge. Neglect pipe friction and local losses. (c) If the rotative speed of the pump impeller is 1000 rev/min, what type of pump is this? 

Chapter Three

Pr.41	A farmer wants you to design his irrigation pipe line so it can be used in the winter to generate electricity for his home. He wants to run a 20 kW turbine-generator (70% efficient) from the 0.05 m3/s stream. The PVC pipe line is 1050 m long, and the up stream end is 75 m above the turbine. What pipe diameter should be selected? Assume a temperature of 10oC.
Pr.42	A discharge of 0.283 m3/s (10 ft3/s) flows in a 0.30 m (1 ft) diameter pipe. Compare the head losses for a completely open (a) angle valve, (b) gate valve, and (c) globe valve. Under what conditions would you select the gate valve? One of the other valves?
Pr.43	An irrigation siphon tube is 76 mm (3 in) in diameter and 3 m (9.84 ft) long. Estimate the discharge for a head difference of 0.5 m (1.64 ft), assuming a re-entrant entrance, an equivalent sand-grain roughness e = 0.06 mm (2.36x10- 3 in), and two bends with loss coefficients of 0.2. Draw the system, including the EL and HGL.
Pr.44	To obtain more electrical energy during the day when there is a shortage and use it during the late night when there is a surplus, a power company plans to pump water from a lake to a reservoir through a 0.5 m diameter pipe that is 2500 m long (e = 0.001 m); when the power is needed, the company will run that water through a turbine. The elevation difference between the reservoir and lake water surfaces is 90 m. Surplus electrical energy costs $0.02/kWh, prime time energy is worth $0.10/kWh, and the efficiencies of the pump and turbine are 80 percent. Analyze the hydraulics and economics of the proposed plan. Suggest the discharges that should be used.
Pr.45	Find the power which pumps must supply to 3 m3/s (106 ft3/s) of water at 20oC (68oF) which is to be delivered from the Snake River to the plateau 180 m (591 ft) above the river through 1100 m (3610 ft) of 1 m (3.28 ft) asphalt-dipped cast iron pipe.
Pr.46	Water is to be pumped from a lake to a canal which is 200 m (656 ft) distant and 20 m (65.6 ft) higher in elevation. If 0.5 m3/s (17.66 ft3/s) of water at 20oC (68oF) is to be delivered through a 0.5 m (1.64 ft) concrete pipe, what power must the pump deliver to the water?
Pr.47	Compute the discharge from reservoir A to reservoir B for the system shown below. Assume f = 0.02 and neglect local losses. The pump characteristic curve can be represented by hp = 300 - 20Q2 with hp in ft and Q in ft3/s.  Although the diameters of the intake ports are not stated, assume as an approximation that they cause the inflow over this section to be uniformly distributed.

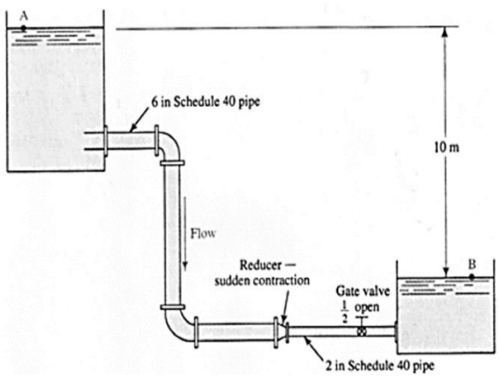
<table>
<tr><td>Pr.48</td><td>In an inclined 50-mm-diameter pipe, a fluid (SG = 0.88) flows with a volumetric flow rate of 0.003 m3/s. The gage pressure at the pipe inlet is 720 kPa. The pipe outlet is at atmospheric pressure and is 15 m above the inlet. Determine the head loss between the inlet and outlet (in m).</td></tr>
<tr><td>Pr.49</td><td>

P9-26 An oil transporter truck is filled from the top with 15 m^3 of fuel oil ($SG = 0.86, \mu = 5.3 \times 10^{-2}$ N·s/m^2) from a reservoir that is 4 m below the truck top. A 10-m-long flexible hose 6 cm in diameter whose surface roughness is equivalent to that of galvanized iron connects the truck to the reservoir. A one-third-closed ball valve and two bends that are equivalent to 90° threaded elbows are in the hose. For a filling time of 15 min and a pump mechanical efficiency of 75%, determine the required pump power (in kW).



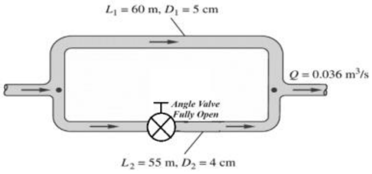
</td></tr>
<tr><td>Pr.50</td><td>In a large convention center, heated air at 85°F must be conveyed from the furnace room to the display rooms through a 500-ft smooth duct. The required flow rate is 7500 n3/min. If the pressure loss must not exceed 2.5 in. of water, a. Determine the minimum diameter required (in in.). b. Determine the pumping power required (in hp).</td></tr>
<tr><td>Pr.51</td><td>At an oil tank farm, a vandal opens a valve at the end of a 5-cm-diameter, 50-m-Iong horizontal pipe from the bottom of a large-diameter oil tank. The oil tank is open to the atmosphere, and the oil depth is 6.5 m. The oil has SG = 0.85 and a kinematic viscosity of 6.8 x 10-4 m2/s. Neglecting minor losses, determine the initial flow rate from the tank (in m3/s).</td></tr>
<tr><td>Pr.52</td><td>

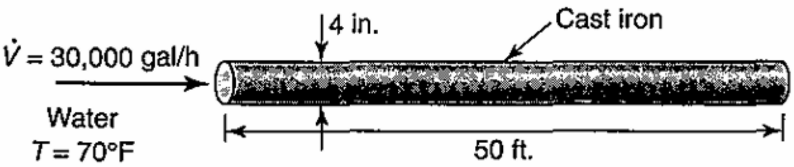
Water flows through the system shown in the figure. The piping system is commercial steel: 30 m of 6 in (0.15m) pipe and 15m of 2 in (0.05m) pipe diameter. There are two regular flanged 90° elbows, and a half opened threaded gate vale are in the system [Ignore the reducer (contraction Unit) losses]. The inlet pipe protrudes into the supply tank and the entrance loss K_L=1.0, when the pipe exit is sharped, Find the flowrate through the system. (ρ = 1000 kg/m^3, ν =10^{-6} m^2/s)

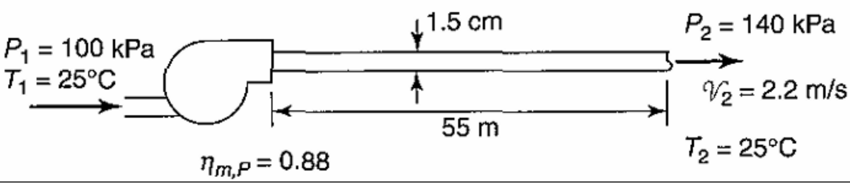


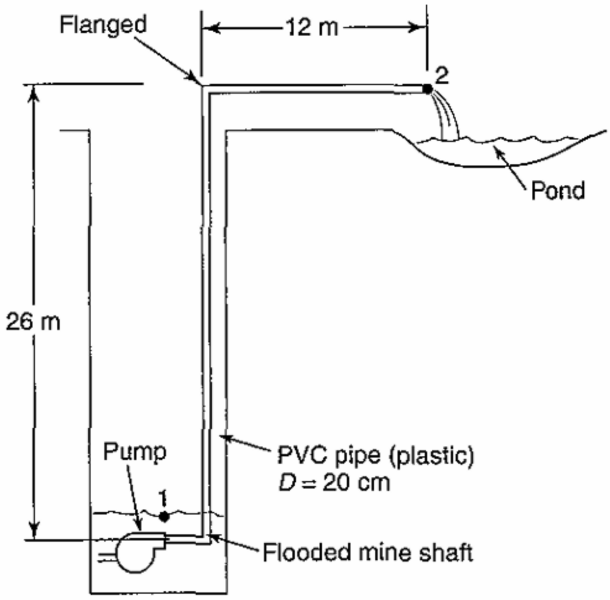
</td></tr>
</table>

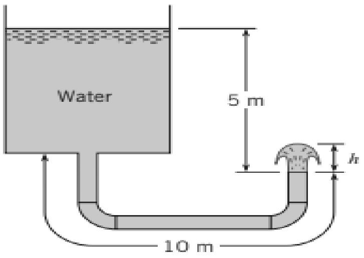
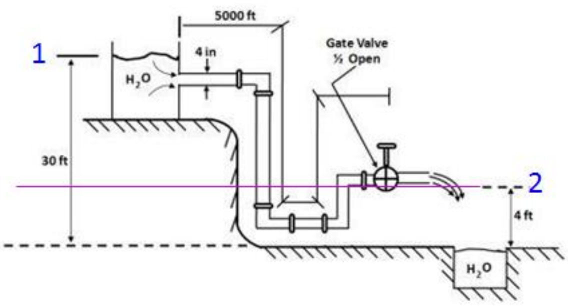
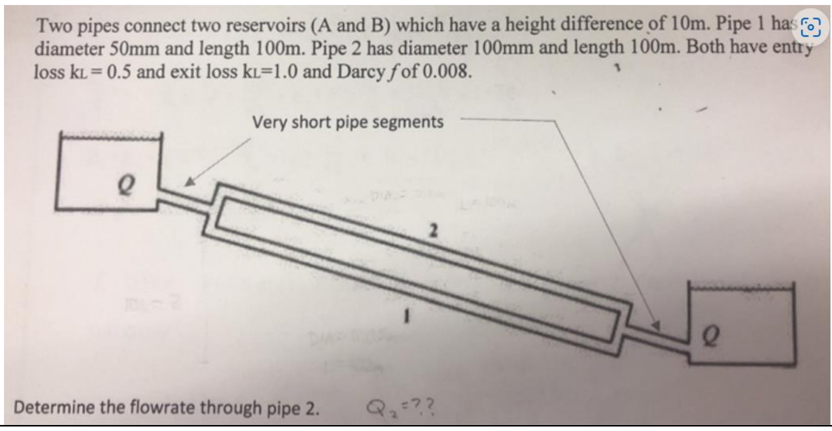
<table>
<tr><td>Pr.53</td><td>The parallel galvanized iron pipe system delivers water a total flow rate of 0.036 m^3/s. The valve is fully opened angle valve, determine the flow rate in each pipe. (f_1=0.026, f_2=0.024)

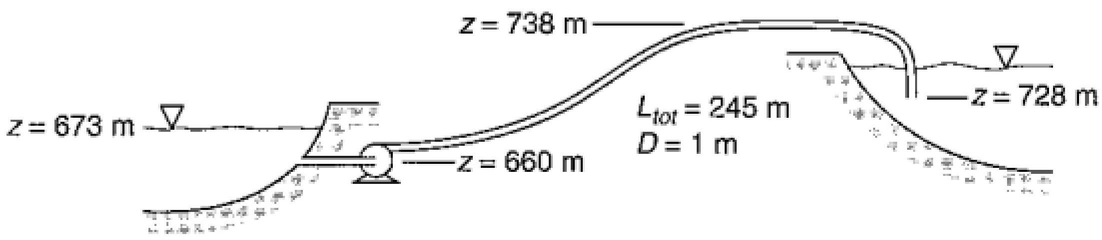

</td></tr>
<tr><td>Pr.54</td><td>A horizontal cast-iron pipe of diameter 4 in. carries 30,000 gal/h of water. The length of the pipe i 50 ft. Calculate the pressure drop using the Moody chart. Assume the water is at room temperatur


</td></tr>
<tr><td>Pr.55</td><td>A pump with a mechanical efficiency of 0.88 is used to pump water through a horizontal commercial steel pipe of length 55 m and inner diameter 1.5 cm. Water enters the pump at 100 kPa and exits the pipe at 140 kPa with a velocity of 2.2 m/s. Assume the water is at 25°C. Find the power input to the pump.

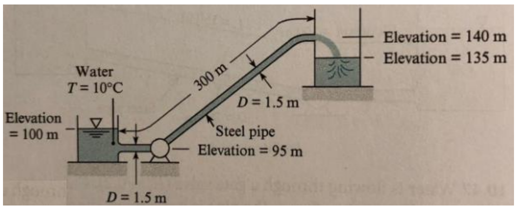

</td></tr>
<tr><td>Pr.56</td><td>A pump is needed to remove water from a mine shaft. How much pump power (in kW) is needed to remove water at a rate of 65 kg/s? Assume the pump is ideal and use data on the figure.


</td></tr>
<tr><td>Pr.57</td><td>To ensure adequate water supplies to a town, a municipal water department developed a second reservoir and wants to connect the new reservoir to the old one using a concrete pipe. The reservoirs are 4.5 km apart with a difference in surface elevations of 15 m. Determine the minimum pipe diameter needed to carry 0.48 m^3/s of water.</td></tr>
<tr><td>Pr.58</td><td>To ensure adequate water supplies to a town, a municipal water department developed a second reservoir and wants to connect the new reservoir to the</td></tr>
</table>

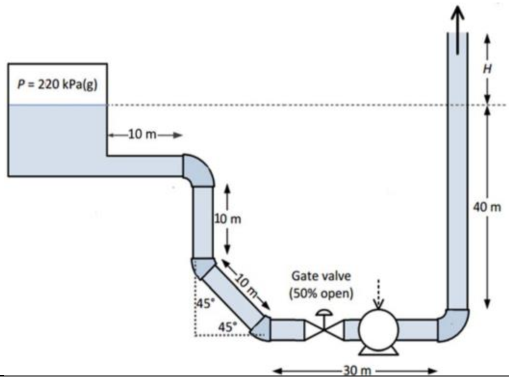
	old one using a concrete pipe. The reservoirs are 2.5 km apart with a difference in surface elevations of 8 m. Determine the minimum pipe diameter needed to carry 0.28 m^3/s of water.
Pr.59	A tank and piping system is shown. The galvanized pipe diameter is 1.5 cm, and the total length of pipe is 10 m. The two 90° regular elbows are threaded fittings. The vertical distance from the water surface to the pipe outlet is 5m. Find (a) the exit velocity of the water and (b) the height (h) the water jet would rise on exiting the pipe. ($\rho = 998\ kg/m^3$, $\mu = 0.001\ kg/m.s$) 
Pr.60	A culvert is supplied with water by the water tank system shown below. The discharge Q (ft^3/s) is controlled by opening and closing a "Gate Valve" at the end of the supply pipeline. The pipeline is 4-inch diameter cast iron pipe, 5000 feet long. All elbows are 90 degree - threaded fittings. The pipeline entrance is "squared edged". Assume no exit losses. Take into account "all" minor and frictional losses, and determine the discharge Q (ft^3/s) when the Gate Valve is half open. 
Pr.61	 Two pipes connect two reservoirs (A and B) which have a height difference of 10m. Pipe 1 has diameter 50mm and length 100m. Pipe 2 has diameter 100mm and length 100m. Both have entry loss $k_L = 0.5$ and exit loss $k_L = 1.0$ and Darcy *f* of 0.008. Determine the flowrate through pipe 2. Q_2=??
Pr.62	For the system shown in the figure, a water flow rate of 3 m3/s is to be pumped from the lower to the upper reservoir through a 1-m-diameter commercial steel pipe. The pump has a mechanical efficiency of 80%. Neglecting minor losses, determine the power required (in kW).



Pr.63 Water is pumped using a pump at a rate of 25 m3/s from the reservoir and out through the steel pipe, which has a diameter of 1.5 m as shown in the Figure. Assume ∝=1 for all calculations in this problem. Answer Problems (4-7): Note the following: Water: μ=1.31×10^(-3) kg/m.s, ρ=1000 kg/m^3 and γ = 9810 N/m3 Steel: roughness (ε = 0.046 mm) K_L for inlet (well-rounded) = 0.03 K_L for exit (sharp-edged) = 1.0

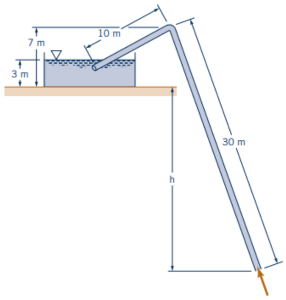


Pr.64 Water flows from a large tank through the pipe system shown in the diagram at a flow rate of6.2 kg/s. The pressure above the liquid in the tank is maintained at 200 kPa(gauge). The pipe from the tank is 2-inch schedule 40 pipe made of commercial steel. A pump delivers 1000 W of power at an efficiency of 75%. The exit of the pipe is open to the atmosphere. To what height above the liquid level in the tank can the water be pumped (H in m)? Include all friction losses in your calculation. Assume that the entrance from the tank and the exit to the atmosphere are sharp. P- 200 kP_{alg}) 90 standard elbow 30m Pump (75% efficiency) 10 m Gate valve (50% open) 1000 W 45" standard elbow

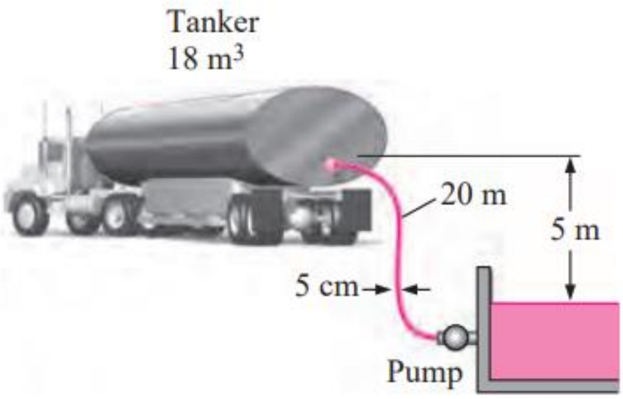


Pr.65 Gasoline is being discharged from a pipe at point 2 at elevation 66.66 m. Point 1, located 965.5 m along the pipe from point 2, is at elevation 82.65 m, and the pressure there is 2.50 kPa. If the pipe roughness is 0.500 mm, what pipe diameter is needed to discharge gasoline (y — 7.05 kN/m3 , //, = 2.92 x 10~4 N-s/m2 , p = 719 kg/m3) at a rate of 0.10 m3 /s?

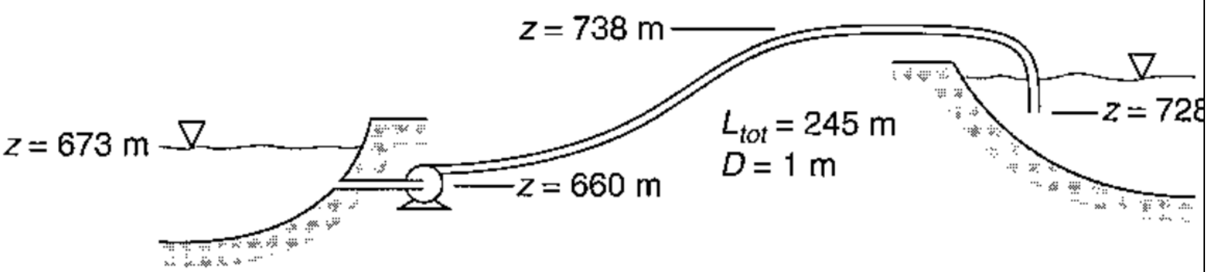
Pr.66 A 40-m-long, 12-mm-diameter pipe with a friction factor of 0.026 is used to siphon 30 °C water from a tank as shown in Fig. P8.50. Determine the maximum value of h allowed if there is to be no cavitation within the hose. Neglect minor losses.



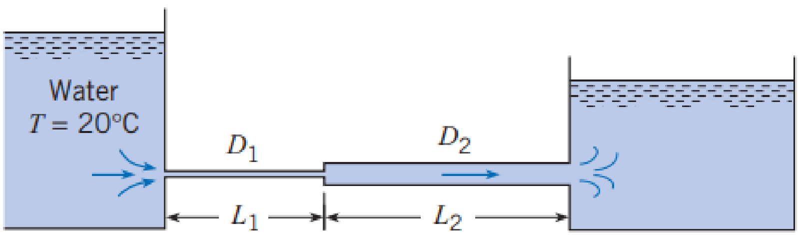
Pr.67 A vented tanker is to be filled with fuel oil (ρ=920 kg/m³ , μ=0.045 kg/m·s) from an underground reservoir using a 20m long, 5cm diameter plastic hose with a slightly rounded entrance and two 90° flanged smooth bends. The elevation difference between the oil level in the reservoir and the top of the tanker where the hose is discharged is 5 m. The capacity of the tanker is 18 m³ and the filling time is 30 min. Taking overall pump efficiency of 82%, determine the required power input to the pump (Neglecting the exit effect).

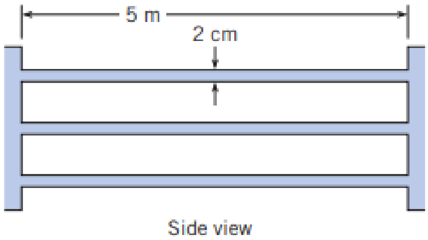
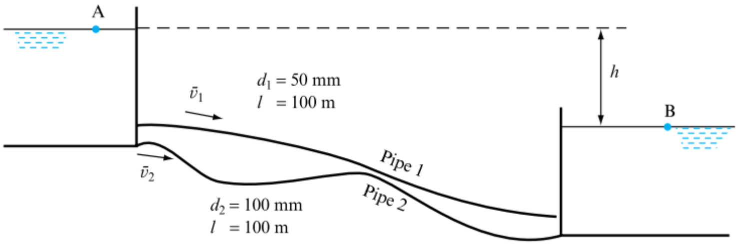
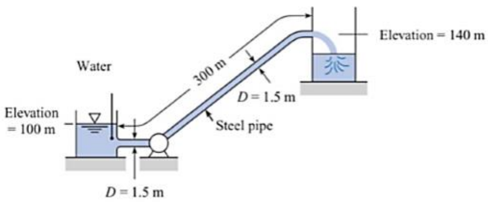


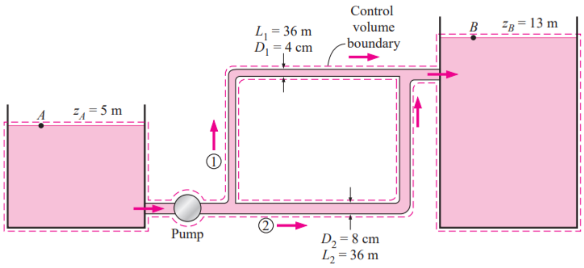
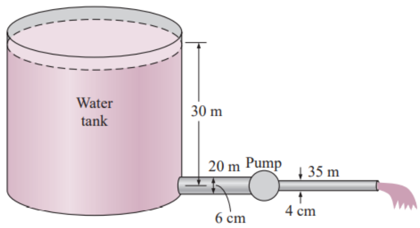
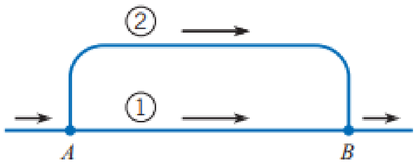
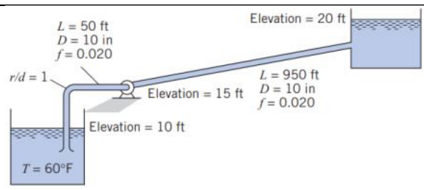
Pr.68 Water For the system shown in the figure, a water flow rate of 3 m3/s is to be pumped from the lower to the upper reservoir through a I-m-diameter commercial steel pipe. The pump has a mechanical efficiency of 80%. Neglecting minor losses, determine the power required (in kW).



Pr.69 Both pipes shown have an equivalent sand roughness ε of 0.10mm and a discharge of 0.1 m³/s. D_1 = 15 cm, L_1 = 50 m, D_2 = 30 cm, and L_2 = 160m. Determine the difference in the water-surface elevation between the two reservoirs. (Neglecting inlet and exit effects).

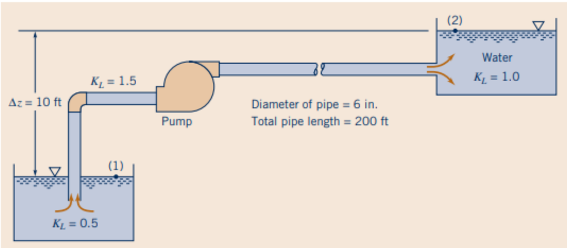


Pr.70	***Ex 3-4:*** A shell-and-tube heat exchanger is being designed as a component of a geothermal power system in which heat is transferred from the geothermal brine (saltwater) to a clean fluid. The heat exchanger consists of 100 galvanized-iron tubes 2cm in diameter and 5m long. The fluid temperature is 200^0C, the density is 860kg/m^3, and the viscosity is $1.35x10^{-4}$ N.s/m. The total mass flow rate through the exchanger is 50kg/s. Calculate the power required to operate the heat exchanger, neglecting entrance and outlet losses. After continued use, 2mm of scale develops on the inside surfaces of the tubes. This scale has an equivalent roughness of 0.5 mm. Calculate the power required under these conditions. 
Pr.71	***Ex 3-5:*** Two sharp ended pipes of diameter d_1=50mm, and d_2=100 mm, each of length L=100 m, are connected in parallel between two reservoirs which have a difference of level h=10 m. If the Darcy coefficient ***f=0.008*** for each pipe, calculate: (a) The rate of flow for each pipe, (b) the diameter ***D*** of a single pipe 100 m long that would give the same flow if it was substituted for the original two pipes. 
Pr.72	***Ex 3-6:*** Water is pumped at a rate of 25 m^3/s from the reservoir and out through the steel pipe, which has a diameter of 1.5 m and well-rounded at the inlet as shown in the Figure. What power must be supplied to the water? (ν=1.31×10^{-5} m^2/s) 

Pr.73	***Ex 3-7:*** Water at 20ºC is to be pumped from a reservoir (Z_A = 5 m) to another reservoir at a higher elevation (Z_B = 13m) through two 36 m long pipes connected in parallel. The pipes are made of commercial steel, and the diameters of the two pipes are 4 and 8 cm. Water is to be pumped by a 70 percent efficient motor–pump combination that draws 8 kW of electric power during operation. The minor losses and the head loss in that connect the parallel pipes to the two reservoirs are considered to be negligible. Determine the total flow rate between the reservoirs and the flow rate through each of the parallel pipes. 
Pr.74	Water at 15°C is to be discharged from a reservoir at a rate of 18 L/s using two horizontal cast iron pipes connected in series and a pump between them. The first pipe is 20 m long and has a 6 cm diameter, while the second pipe is 35 m long and has a 4-cm diameter. The water level in the reservoir is 30 m above the centerline of the pipe. The pipe entrance is sharp-edged, and losses associated with the connection of the pump are negligible. Determine the required pumping head and the minimum pumping power to maintain the indicated flow rate. 
Pr.75	In the commercial steel parallel pipe system shown, pipe 1 has a length of 1000 m and diameter of 50 cm. Pipe 2 is 1500m long and 40cm in diameter. What is the division of the flow of water at 100ºC if the total discharge is to be 1.2m³/s, and the two pipes have same friction factor. 
Pr.76	***Ex 2-7:*** A pump that has the characteristic curve shown in the accompanying graph is to be installed as shown. What will be the discharge of water in the system? 

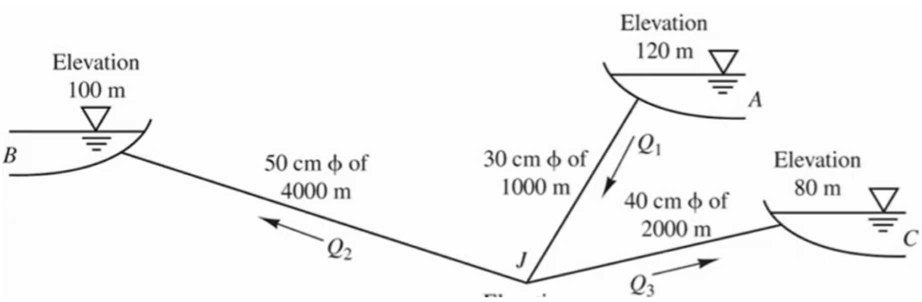
Pr.77

Ex 2-6: Water is to be pumped from one large, open tank to a second large, open tank as shown in the figure. The pipe diameter throughout is 6 in., and the total length of the pipe between the pipe entrance and exit is 200 ft. Minor loss coefficients for the entrance, exit, and the elbow are shown, and the friction factor for the pipe can be assumed constant and equal to 0.02. A certain centrifugal pump having the performance characteristics shown in the figure is suggested as a good pump for this flow system. FIND With this pump, what would be the flowrate between the tanks? Do you think this pump would be a good choice?



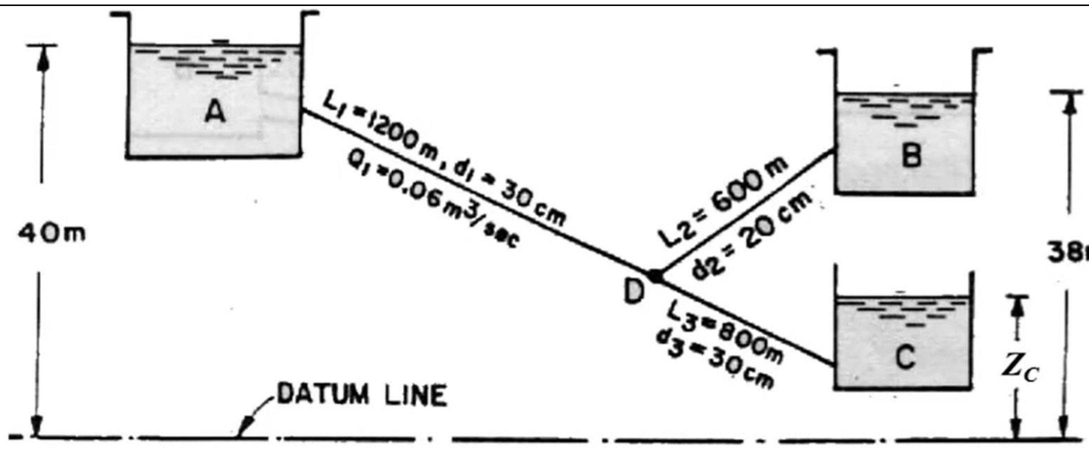
Pr.78

The three water-filled tanks shown in figure, are connected by pipes as indicated. Neglect minor losses, determine the flowrate in each pipe. (f_1=0.024, f_2=0.021, f_3=0.022)



Pr.79

Three reservoirs A, B, and C are connected by the pipe system shown in the figure. If the flow rate from reservoir A is 60 liters/sec, find the height of water level in reservoir C. Determine the discharge into or from the reservoirs B and C. Take f = 0.024 for all pipes.

	
Pr.80	The three water-filled tanks shown in figure, are connected by pipes as indicated. If minor losses are neglected, determine the flowrate in each pipe.