

Assigned: **July 20, 2009**
 Due: **August 5, 2009**

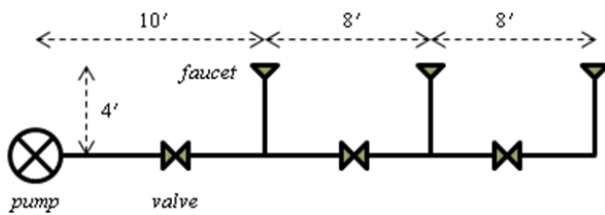
Type and print your report for submission.

- Problem 7.84 in the book provides us with experimental data to determine the head loss for flow through a valve. Download the data file from the book's website:
<http://bcs.wiley.com/he-bcs/Books?action=index&itemId=0470262842&bcsId=4489>
 - If it is desired to use dimensional analysis to investigate the behavior of the system for a particular number of turns, determine the π term(s). *Hint:* Identify first the *independent* variables that involve in the physical mechanism of the head loss.
 - Based on your answer in (a) plot comprehensive graphs showing *all* of the experimental data. Describe how you interpret the graphs physically.
 - If you include the number of turns as one of your π terms, plot a graph that relates the π terms. Describe how you interpret the graph physically.
 - Determine the functional relationship of the π terms in (c). *Hint:* Try to rescale the plot in (c).
- Design for plumbing job needs to take into account the loss due to major loss in pipes and minor losses at other components along the flow.

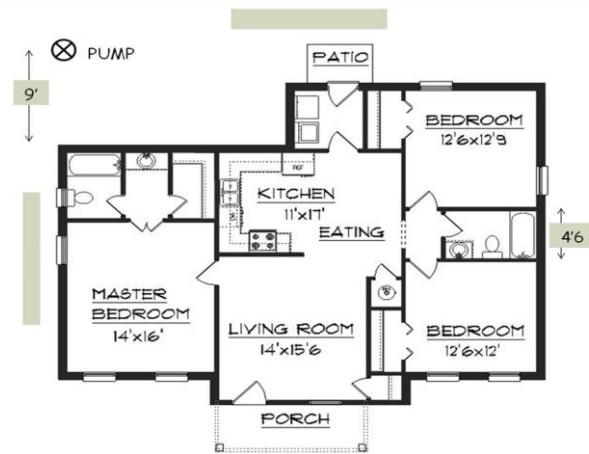
Flow rate [gpm]	1/2-in pipe	3/4-in pipe
1	1.13	0.14
2	4.16	0.35
3	8.55	2.19
4	14.8	3.70
5	22.2	5.78
6	31.0	7.85
7		10.6
8		13.4

- Listed in the table is the head loss (in feet per hundred feet of pipe) for polyethylene pipe (*source: Conergy Technical Services, Denver*). Note: 1/2-in pipe has an actual diameter of 0.662" and 3/4-in pipe has an actual diameter of 0.82". Based on the data, what is the friction factor for each size?
- Based on the data in (a), estimate the relative roughness of polyethylene pipes.

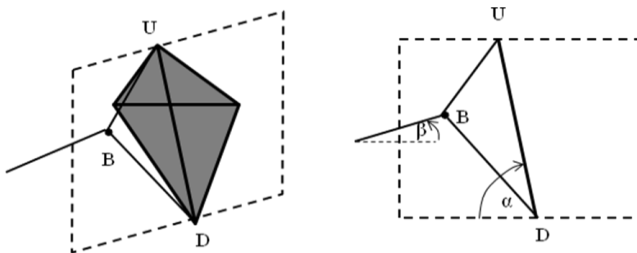
- You are to set up a simple line of faucets such as in the figure. If the faucets are to discharge a minimum flow rate of 1 gpm each, estimate the minimum power of the pump that draws the water from an open large pond immediately behind it. Horizontal main pipe must be of 3/4-in size, and the vertical pipes are of 1/2-in size.
Hint: Indicate first major and minor losses taking place along the flows.



- For a given floor plan of a single home shown in the figure, suggest the length of the pipe, and the type and the number of other components you need for piping downstream from the pump. Sketch your piping diagram on the floor plan. Indicate also the kind of loss you will need to account for at each component in your diagram.



3. We know that tees in piping cause energy loss. For line and branch flows, the loss coefficients of the tee are listed in Table 8.2 in your book. However, the energy losses caused by the combination of flow at a tee are not discussed in the book, and have been the subject of research for many years. One of research papers about these losses is that by Oka et al., JSME International Journal B, 39(3), 489-498, 1996, which you can download from: <http://ci.nii.ac.jp/naid/110002981307/>
- What is the loss coefficient for straight-through flow in the main pipe in terms of Q_2/Q_3 correlated from experiments for a sharp-edged tee with uniform diameters? For the same tee, what is the loss coefficient for the flow from the lateral pipe into the main pipe?
 - For $Q_1 = 4$ gpm and $Q_2 = 2$ gpm, what is the pressure drop for the straight-through flow? What is the pressure drop for the lateral flow into the main pipe? The pipe diameter is 1 inch everywhere.
 - Calculate the corresponding power loss for (b).
 - If the flow is reversed in direction with Q_3 as the input flow rate, what is the power loss across the tee? Compare it with that in (c), and give your comments.
4. It is well known that a motion in viscous fluid will experience resistance such that any acceleration eventually dies out. Watch the following video about skydiving: <http://videos.howstuffworks.com/hsw/9613-physics-of-motion-the-physics-of-skydiving-video.htm>
- What does the air resistance do during the diving, starting from jumping out the airplane, opening the parachute, until landing on the ground? Explain it using free-body force diagrams.
 - Draw a graph describing the progress of velocity of the falling skydiver and indicate each stage discussed in (a). How to calculate the height of the airplane from the graph?
 - Using what we learned from Chapter 9 in the book and your answer in (a), construct an equation that allows us to estimate the time needed to reach terminal velocity in the free-falling stage. Compare your estimate with that shown in the video. Give your comments.
 - In the spirit of problem 9.82, watch this video: <http://www.youtube.com/watch?v=Kem3fnopEsg&feature=related>
Now, solve the problem in this assignment.
5. Flying kites in the air is fun for grownups and kids. To learn how kites fly, visit the following NASA website: <http://www.grc.nasa.gov/WWW/K-12/airplane/kitefor.html>



- Read this webpage and the next two pages (by clicking the first NEXT button at the bottom on the page). Based on what you read, draw the forces on the given diagram for a diamond kite. Write down the force equilibrium equations for the kite and derive an expression to calculate the bridle angle β in terms of the forces.
- Learn also how to calculate the lift and drag forces on a flying kite from the website. Derive an expression to calculate the attack angle α of the kite that makes the flight stable. *Hint*: consider the rotational stability.
 - Go to the *Interactive Kite Modeler* page. Set up a diamond kite with 10" width and $UD = 18"$, bridle line $UBD = 21"$, knot line $BD = 15"$, and no tail. The crossing point of the diagonals is at 6" from U. Use the default material. Write down the weight of the kite, the locations of the center of gravity and the center of pressure. Now, fix the wind speed at 5 ft/s. What is α given by the simulator? Verify it with your equation in (b) and investigate the change of α with wind speed. Then, also calculate the bridle angle β resulting from the stable flight at wind speed of 5 ft/s.
 - It is promising to use kites to help us generate energy. Read a recent paper about this here: <http://www.mdpi.com/1996-1073/2/2/307>. Give your brief comments on the paper.