Module 3: Flow of Fluids and Bernoulli's Equation (CIVL 318)

Volume Flow Rate:	$Q = Av$
Mass Flow Rate:	$M = \rho Q$
Weight Flow Rate:	$W = \gamma Q$
Continuity Equation:	$A_1 v_1 = A_2 v_2$
Bernoulli's Equation:	$\frac{p_A}{\gamma} + z_A + \frac{v_A^2}{2g} = \frac{p_B}{\gamma} + z_B + \frac{v_B^2}{2g}$

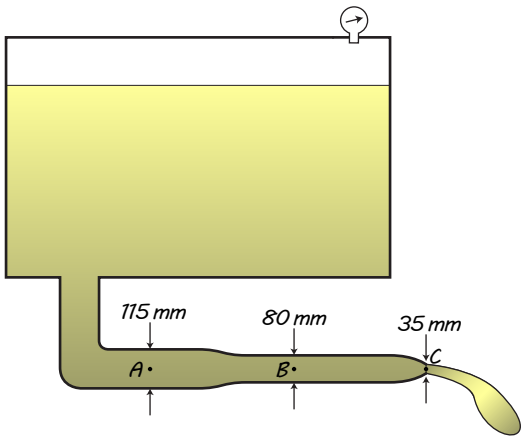
Table F: Schedule 40 Steel Pipe

Nominal Size (in)	Inside Diameter (mm)	Nominal Size (in)	Inside Diameter (mm)
$\frac{1}{8}$	6.8	4	102.3
$\frac{1}{4}$	9.2	5	128.2
$\frac{3}{8}$	12.5	6	154.1
$\frac{1}{2}$	15.8	8	202.7
$\frac{3}{4}$	20.9	10	254.5
1	26.6	12	303.2
$1\frac{1}{4}$	35.1	14	333.4
$1\frac{1}{2}$	40.9	16	381.0
2	52.5	18	428.7
$2\frac{1}{2}$	62.7	20	477.9
3	77.9	24	574.7
$3\frac{1}{2}$	90.1		

Table G: Dimensions of Steel Tubing

Outside Diameter (in)	Outside Diameter (mm)	Wall Thickness (mm)	Inside Diameter (mm)
$\frac{1}{8}$	3.18	0.813	1.549
		0.889	1.397
$\frac{3}{16}$	4.76	0.813	3.137
		0.889	2.985
$\frac{1}{4}$	6.35	0.889	4.572
		1.24	3.861
$\frac{5}{16}$	7.94	0.889	6.160
		1.24	5.448
$\frac{3}{8}$	9.53	0.889	7.747
		1.24	7.036
$\frac{1}{2}$	12.70	1.24	10.21
		1.65	9.46
$\frac{5}{8}$	15.88	1.24	13.39
		1.65	12.57
$\frac{3}{4}$	19.05	1.24	16.56
		1.65	15.75
$\frac{7}{8}$	22.23	1.24	19.74
		1.65	18.92
1	25.40	1.65	22.10
		2.11	21.18
$1\frac{1}{4}$	31.75	1.65	28.45
		2.11	27.53
$1\frac{1}{2}$	38.10	1.65	34.80
		2.11	33.88
$1\frac{3}{4}$	44.45	1.65	41.15
		2.11	40.23
2	50.80	1.65	47.50
		2.11	46.587

Example 1:



The average velocity of the flow at the nozzle C is $4.7\,\mathrm{m/s}$.
Determine:

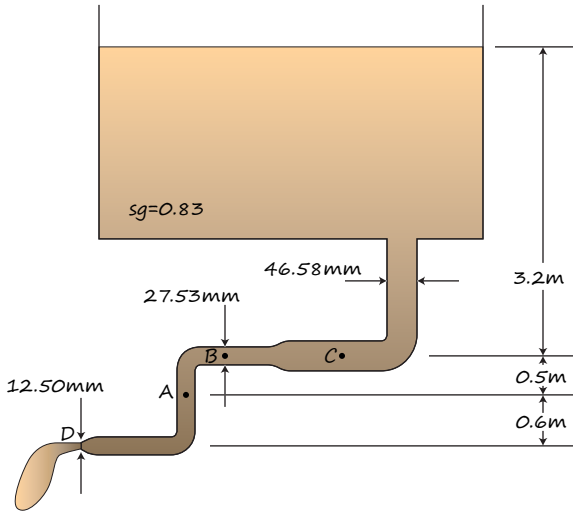
- the average flow velocity at A
- the average flow velocity at B
- the volume flow rate, Q, through the system in $\mathrm{L/s}$.

Example 2:

Water, at 70℃ flows through $\frac{7}{8}$-in. steel tubing, with $1.65\,\text{mm}$ wall thickness, at an average velocity of $5.7\,\text{m/s}$. Determine:

- the volume flow rate, Q
- the mass flow rate, M
- the weight flow rate, W

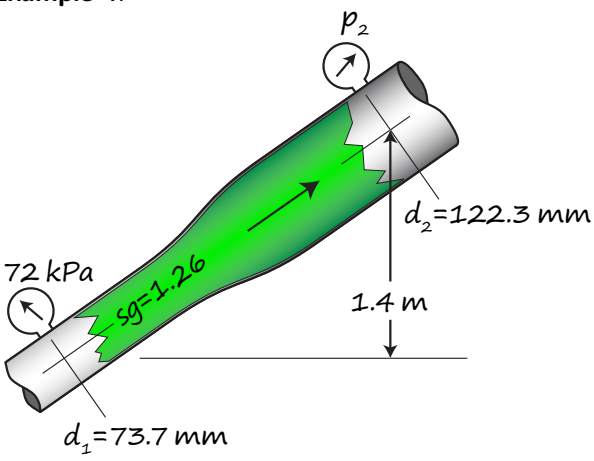
Example 3:



Oil, with a specific gravity of 0.83, flows under gravity from a tank, through a pipe system as shown, before entering the atmosphere through a nozzle at D. Determine:

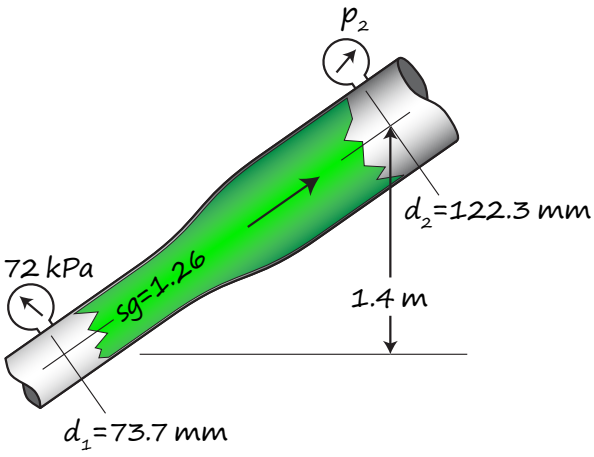
- the pressure at A
- the pressure at B
- the pressure at C
- the volume flow rate through the system

Example 4:



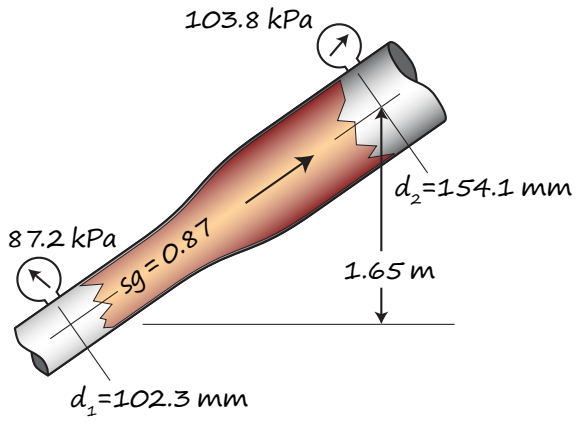
Determine the pressure reading p_2 if $Q = 25\,\mathrm{L/s}$

Exercise 1:



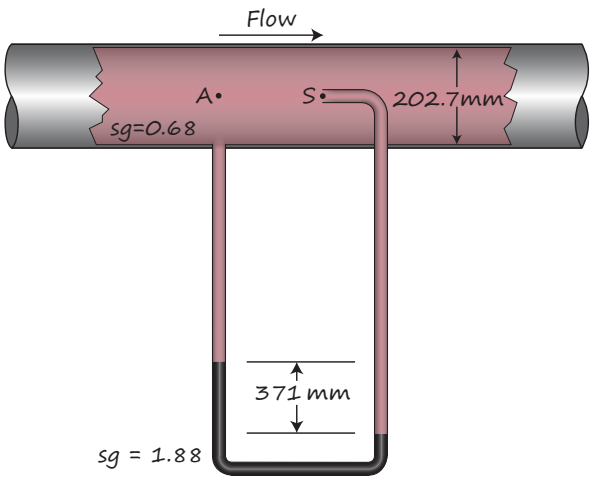
Determine the pressure reading p_2 if $Q = 20\,\mathrm{L/s}$

Example 5:



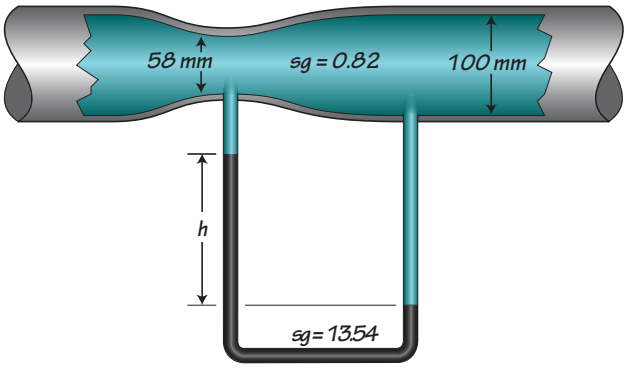
Determine Q, the volume flow rate.

Example 6:



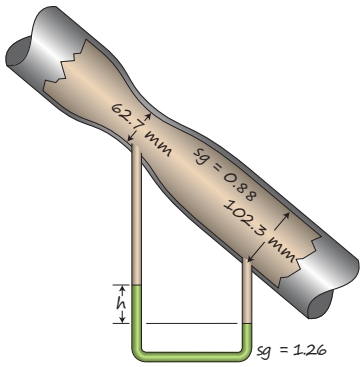
Determine Q, the volume flow rate.

Example 7:



Determine Q, the volume flow rate, if $h = 210$ mm.

Exercise 2:



Determine Q, the volume flow rate, if $h = 125$ mm.