Homework 2: Steady Flows

PHY250 - Fall 2021

Deadline: 10/11/2021

Exercise 1[1]

A cylindrical bucket, open at the top, is 25.0 cm high and 10.0 cm in diameter. A circular hole with a cross-sectional area $1.5cm^2$ is cut in the center of the bottom of the bucket. Water flows into the bucket from a tube above it at the rate of $2.4 \times 10^{-4} m^3/s$. How high will the water in the bucket rise?

Exercise 2[2]

Take into account the speed of the top surface of the tank shown in Fig. 1 and show that the speed of fluid leaving the opening at the bottom is

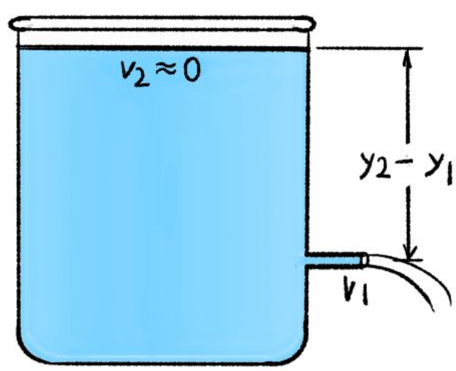

Figure 1: Exercise 2

where $h = y_2 - y_1$, and A_1 and A_2 are the areas of the opening and of the top surface, respectively. Assume $A_1 << A_2$ so that the flow remains nearly steady and laminar.

[1] 12.90 from Sears and Zemansky

[2] 13.55 from Douglas C. Giancoli

Exercise 3[3]

The horizontal pipe shown in Fig. 3 has a cross-sectional area of 40 cm^2at the wider portions and 10 cm^2 at the constriction. Water is flowing in the pipe, and the discharge from the pipe is $6 \times 10^{-3}\ m^3/s$ Find (a) the flow speeds at the wide and the narrow portions; (b) the pressure difference between these portions; (c) the difference in height between the mercury columns in the U-shaped tube.

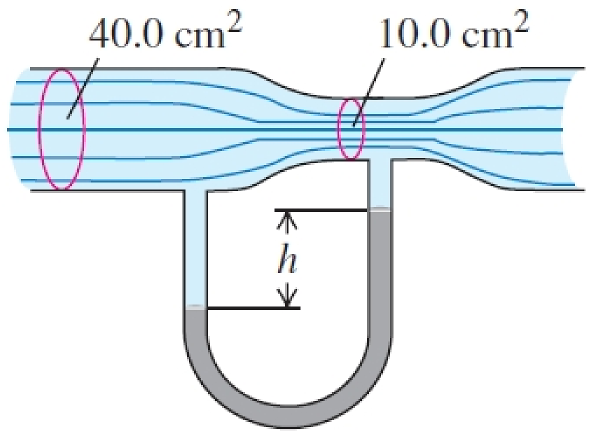

Figure 2: Exercise 3

Exercise 4[4]

A liquid flowing from a vertical pipe has a definite shape as it flows from the pipe. To get the equation for this shape, assume that the liquid is in free fall once it leaves the pipe. Just as it leaves the pipe, the liquid has speed v_0 and the radius of the stream of liquid is r_0 (a) Find an equation for the speed of the liquid as a function of the distance y it has fallen. Combining this with the equation of continuity, find an expression for the radius of the stream as a function of y. (b) If water flows out of a vertical pipe at a speed of 1.2 m/s how far below the outlet will the radius be one-half the original radius of the stream?

[3] 12.94 from Sears and Zemansky
[4] 12.95 from Sears and Zemansky

Exercise 5

Let us make a toy model of a fluid with Octave.

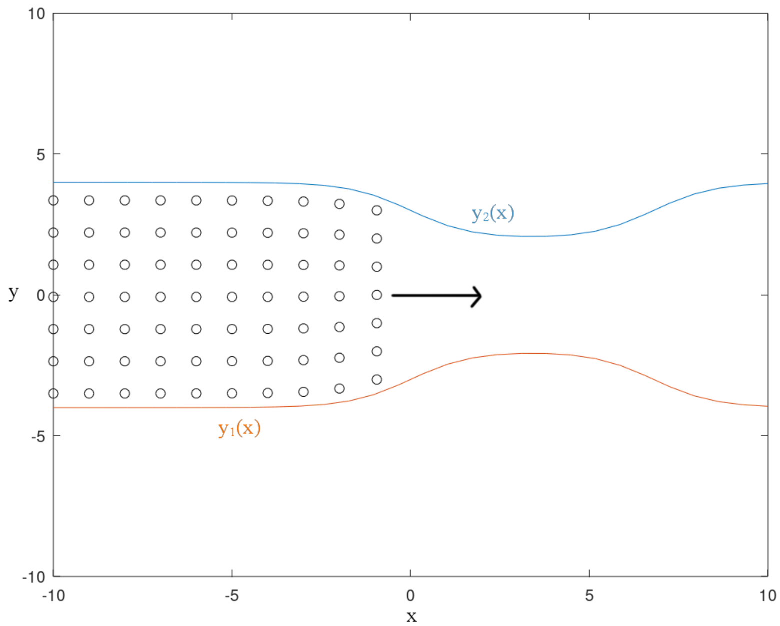

Figure 3: Toy model of a fluid.

- The walls of the tube are defined by the functions:

$$\begin{aligned} Y_1(x) &= -tanh(Ax) + tanh(Ax - B) + B \ (A = 0.06, \ B = 4) \\ Y_2(x) &= -Y_1(x) \end{aligned}$$

- Create a mesh grid in the plane (x,y).
- Create a matrix containing the particles positions.
- The velocity at the point $(0, 0)$ is $\vec{v}_0 = (0.5, 0)$.
- Create a velocity vectorial field: assign a velocity to each point in the mesh. The y component of the velocity is always 0.
- **Start time step**
- For each time step actualize the particles positions: each particle is going to get a velocity according to its position (use the function interp2).

- The y component of the particles must satisfy: $y_1 < y < y_2$
- Make a plot for each time step and build an animation.