Worksheet: Viscous flow in two connected pipes

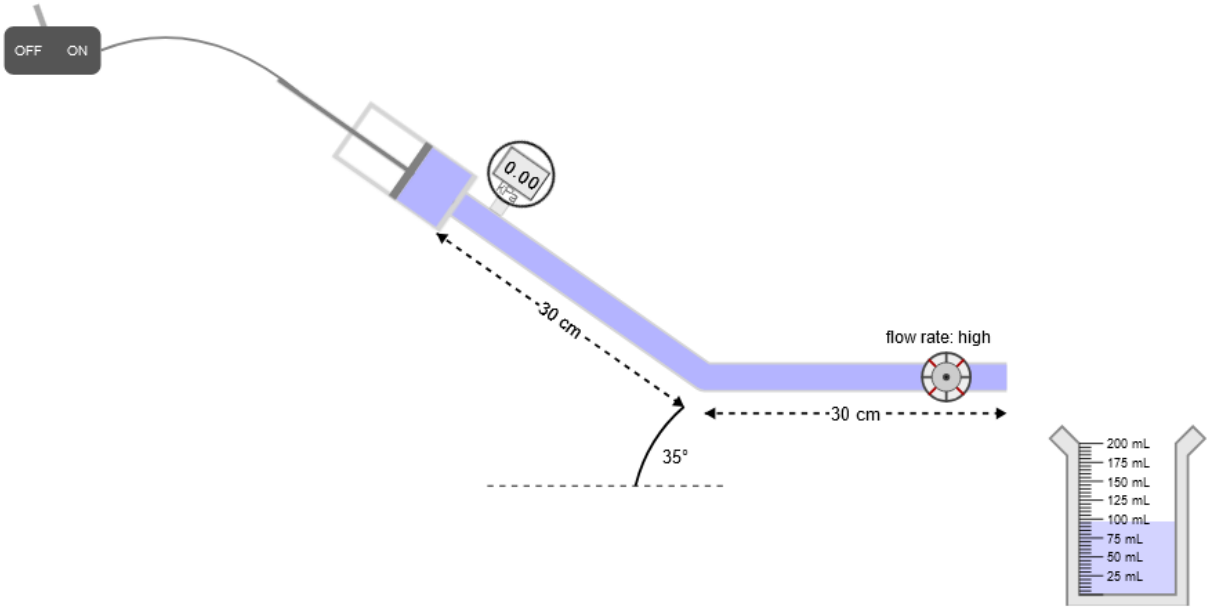
Name(s):_____

Fill in all sections.

Student learning objectives

1. Effect of gravity on laminar pipe flow
2. Understanding hydrodynamic resistance of a pipe flow in the laminar regime
3. Using experiments to calculate fluid properties

Dimensions and details of the experiment



The experiment consists of two cylindrical pipes of equal diameters and 30 cm in length. A syringe pump pushes liquid through the two pipes. The flowrate can be set to low, medium, and high by clicking on the valve near the exit of the horizontal pipe. Calculate the flowrate through the pipes by using a stopwatch and measuring the volume collected in the beaker. The gauge pressure near the inlet of the first pipe is measured with a pressure sensor. The goal of this experiment is to calculate the pipe diameter and the density and viscosity of the fluid that is flowing through the pipes.

Before starting the experiment,

1. If flowrate remains constant, and the angle increases, will the pressure increase or decrease? Explain your reasoning.

2. If the flowrate increases, will the pressure increase or decrease? Explain your reasoning.

Worksheet: Viscous flow in two connected pipes

3. How will you infer if the flow is laminar or turbulent?

4. Do you think the hydrodynamic resistance of the two pipes is similar or different? Explain your reasoning.

During the experiment.

1. Set the angle to zero and measure the pressure and flowrate for "low", "medium", and "high" settings. Record the values in the Table.

2. Repeat these measurements for two additional angles and record the values in the Table.

Angle (degrees)	Flowrate setting	Pressure (kPa)	Volume collected (mL)	Elapsed time (s)	Flowrate (mL/s)
0	low				
0	medium				
0	high				
	low				
	medium				
	high				
	low				
	medium				
	high				

After the experiment,

1. Assume the flow is laminar and derive the relationship between flow rate, pressure at the inlet. diameter, viscosity, density of fluid, pipe length, pipe diameter, and the gravitational constant.

2. Calculate the density and viscosity of the fluid. Can you calculate everything from the zero angle data? Why/why not? What fluid is used in experiments?

3. Calculate the diameter of the pipes.

4. Based on the calculations, is the flow laminar? Why?

5. The pressure gauge is not located at the entrance to the pipe, but 3 cm from the entrance. How much difference will that make in the calculations?