Continuity and Volume Delivered Lab

Pipe area and speed at the same volume flow rate

Name _____ Period _____ Date _____

Compare equal-time deliveries, then investigate how area changes flow speed. Linearize the data and determine volume flow rate.

Time 50 minutes • Open buildphysics.com/?experiment=fluid-continuity

Model and measurements

The flow is steady and incompressible in an unbranched pipe. Keep the source and pipe horizontal. Area means the flow cross section.

$Q = Av \qquad \Delta V = Q\Delta t$

Q is volume flow rate. ΔV is volume delivered in elapsed time Δt. A and v are local area and flow speed.

Predict before running

If pipe area is halved at fixed Q, does flow speed halve or double? Predict and explain.

Part A Compare equal-time deliveries

1. Set Volume flow rate to 0.080 m^3/s. Test the Outlet areas below while leaving Inlet area at 0.080 m^2.
2. In Properties → Station C → Live values, read Area, Speed, and Volume delivered.
3. Use Auto-pause after to run each trial for 2.00 s. Reset between trials so delivered volume starts at zero.

Outlet area (m^2)	Station C A (m^2)	Speed v (m/s)	ΔV in 2 s (m^3)
0.020			
0.040			
0.060			

A1. Use two trials to compare speed and the volume delivered in the same time.

A2. Why can a narrower pipe carry the same volume each second even though its flow speed is larger?

Part B Design and collect

Suggested time 16 minutes

Investigation question How does local flow speed depend on cross-sectional area at fixed Q?

Keep Q at 0.080 m^3/s, Inlet area at 0.080 m^2, and Outlet area at 0.020 m^2. Choose at least five Station A positions spread along the taper.

B1. Identify the independent and dependent variables.

B2. What will you keep constant? How will you do this?

B3. List your station positions or target areas. Why will they reveal the relationship?

B4. How will you obtain matching area and speed readings at each station position?

B5. Write a procedure another group could follow.

Move Station A using Position along pipe in Properties (0 is the inlet; 1 is the outlet). Read Area and Speed while paused.

Record your measurements

Q = 0.080 m^3/s Fixed pipe geometry and source

Trial	Position (0–1)	Read A (m^2)	Speed v (m/s)
1			
2			
3			
4			
5			
Extra			

Part C Build and analyze a linear graph

Suggested time 14 minutes

C1. The relationship is $v = \frac{Q}{A}$. Describe how v depends on A for the same Q.

C2. Choose quantities for a straight-line graph. Label the table with your choices and units, and calculate the transformed values.

Trial	_____ Units _____	_____ Units _____
1		
2		
3		
4		
5		
Extra		

C3. Plot your transformed data and draw a best-fit line. Label both axes with quantities and units.



C4. Find slope and units using two separated points on your fitted line. Determine Q and interpret the intercept.

Part D Explain and predict

Suggested time 8 minutes

D1. A student claims, “The narrower section delivers less liquid each second.” Evaluate the claim using Parts A and B.

D2. Does your graph support continuity? Compare inferred Q with 0.080 m^3/s and use it to predict volume delivered in 5.0 s.

D3. Choose an unused Station A position within your range. Read its area and predict speed from your fit. Measure speed and compare.

New A (m^2)	Predicted v (m/s)	Measured v (m/s)

Comparison