Water in Motion

Use pipe measurements to test constant volume flow.

HS-PSII-3.3 "Develop and apply the principle of constant volume flow rate to determine the relationship between cross-sectional area of a pipe and the velocity of an incompressible fluid flowing through a pipe."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the conditions that keep volume flow rate constant, circle the flow-rate equation, and number the area-speed pairs in the table from widest to narrowest opening.

Through a Changing Pipe

1. A lab pump sends water through a sealed pipe with several widths. Imagine a tiny slice of water crossing each section every second. If the pipe does not leak and the water is nearly incompressible, the same volume must pass every section each second. During steady flow, water cannot pile up in one part of the pipe.

2. At three sections of the lab pipe, students measure the opening's cross-sectional area and the average speed of the water. The table records their measurements. Area describes the space inside a cut straight across the pipe, not the length of that section. Speed describes how far the water travels along the pipe each second.

MEASUREMENTS ALONG ONE PIPE

Section	Area (cm^2)	Speed (cm/s)
A	12	2
B	6	4
C	3	8

3. Volume flow rate equals cross-sectional area multiplied by average speed: $Q = A \times v$. With area in cm^2 and speed in cm/s, Q has units of cm^3/s. For steady flow of incompressible water through a leak-free pipe, $A \times v$ stays constant. To find an unknown speed, divide the shared flow rate by that section's area.

2 ANSWER WITH EVIDENCE

Use the passage

1. Calculate the volume flow rate at section A. Include units.

2. From section B to section C, how does the area change? How does the speed change?

3. A fourth section of the same pipe has an area of 4 cm^2. Predict the water's speed there. Show your calculation.

4. A student claims that more water passes section C each second than section A because the water moves faster at C. Use the measurements to test the claim.

3 YOUR TURN

Your own words

Design a new two-section pipe with a starting area and speed that differ from every value in the table. Choose a second area that also differs from the table values, then calculate the flow rate and the speed at the second section. Explain how the area change affects speed.

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PART 1 · READ AND MARK

Underline the conditions that keep volume flow rate constant, circle the flow-rate equation, and number the area-speed pairs in the table from widest to narrowest opening. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Calculate the volume flow rate at section A. Include units.	**$Q = 12\ cm^2 \times 2\ cm/s = 24\ cm^3/s$.**
2	From section B to section C, how does the area change? How does the speed change?	**The area is halved, from 6 to 3 cm^2, while the speed doubles, from 4 to 8 cm/s.**
3	A fourth section of the same pipe has an area of 4 cm^2. Predict the water's speed there. Show your calculation.	**The shared flow rate is 24 cm^3/s, so $v = 24 \div 4 = 6$ cm/s.**
4	A student claims that more water passes section C each second than section A because the water moves faster at C. Use the measurements to test the claim.	**The claim is false. At C, $Q = 3 \times 8 = 24\ cm^3/s$. At A, $Q = 12 \times 2 = 24\ cm^3/s$.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My first section has an area of 10 cm^2 and a speed of 3 cm/s, so $Q = 10 \times 3 = 30\ cm^3/s$. The second section has an area of 5 cm^2. Its speed is $30 \div 5 = 6$ cm/s. Halving the area doubles the speed, keeping the flow rate constant.

Accept any positive starting area and speed, and any different positive second area, as long as the chosen values meet the prompt's table restrictions and both calculations are consistent. The explanation should link the area change to an inverse change in speed.