Pressure vs Volume

Pipe Trades

Grades
- 8

Learning objective
Students will demonstrate that pressure in a fluid is determined by the height of the fluid column, not its volume

Concepts
- Volume
- Pressure
- Using a Manometer

Description and Trades Connection

This lesson focuses on volume and pressure, using a manometer to measure pressure in different-sized pipes. Students will predict, measure, and compare the pressure in both larger and smaller pipes filled to the same height with water. The lesson emphasizes that pressure is determined by the height of the fluid column, not the volume of fluid. Through hands-on activities, students will gain a practical understanding of these scientific principles.

Plumbers need to understand that pressure in a pipe is determined by the height of the fluid column (head pressure), not the volume of fluid. This knowledge is crucial for designing systems where consistent pressure is needed, such as in water supply lines and gas lines. By using manometers, plumbers can measure and adjust pressure to ensure efficient and safe operation of plumbing systems, regardless of the pipe size.

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Scan to access video demonstrations, activities, classroom resources and more at learninginnovation.ca/k-12STEM

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Pressure vs Volume

Curriculum Connections

Grade 8: Mix and Flow of Matter

- Investigate and describe the composition of fluids, and interpret the behaviour of materials in solution
- Investigate and compare the properties of gases and liquids; and relate variations in their viscosity, density, buoyancy and compressibility to the particle model of matter.
- Identify, interpret and apply technologies based on properties of fluids

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Procedure

Preparation

Gather all the required materials, including clear pipes with valves, manometers, measuring cups, and water. Review the experiment video beforehand to familiarize yourself with the setup and procedure:

- Fluid properties kit: Volume and pressure (Lethbridge Polytechnic, 2023)

Lesson Activities (30 minutes total)

Introduction

- Start by explaining that volume is the amount of space a substance occupies, while pressure is the force exerted per unit area.
- Write the definitions on the whiteboard and provide examples of each.
- Explain that today's experiment will investigate if volume and pressure are directly related.

Setting Up the Experiment

- Distribute the clear pipes with valves, manometers, and measuring cups to each group.
- Instruct students to use the measuring tape to mark 13 inches on the side of both the larger and smaller pipes using an erasable marker.
- Fill both pipes with water up to the 13-inch mark.
- Prediction: Ask students to predict whether the larger pipe will have more, less, or the same pressure as the smaller pipe when measured with the manometer. Have them write down their predictions.

Measuring Pressure in the Larger Pipe

- Attach the manometer to one of the fittings on the larger pipe using the clear tubing.
- Prediction: Before opening the valve, ask students to predict the pressure reading in psi.
- Open the valve and measure the pressure. Record this reading using appropriate units, like PSI.

Time

30 minutes

Materials

- Whiteboard and markers
- Water
- Drain buckets (10) *(included in kit)*
- Tape measures (10) *(included in kit)*
- Manometers (10) *(included in kit)*
- Pipe stands (10) *(included in kit)*
- 1” & 3” pipe assembly (10) *(included in kit)*

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- Record the measurement and discuss with students why this pressure is observed.

Measuring Pressure in the Smaller Pipe

- Attach the manometer to a fitting on the smaller pipe.
- Prediction: Before opening the valve, ask students to predict whether the pressure will be higher, lower, or the same as in the larger pipe.
- Open the valve and measure the pressure.
- The pressure should read the same as (or very close to) the water in the larger pipe.
- Discuss with students why the pressure is the same despite the different volumes of water.

Explaining Head Pressure

- Explain that head pressure is the measurement of the height difference between the fluid being moved and the discharge point.
- Use the analogy of standing at the bottom of a swimming pool: the pressure felt is due to the height of the water above, not the total amount of water in the pool.
- Attach the clear tubing to the manometer. Lower the clear tubing slowly into the water-filled pipe and watch the pressure go up.
- Discuss how this concept is important in plumbing, where the height of the water column affects the pressure at a specific depth, not the total volume of water.
- Reflection: Ask students to think about other scenarios where head pressure might be important and predict how it would affect those situations.

Conclusion

- Recap the key points of the lesson, emphasizing the difference between volume and pressure and the concept of head pressure.
- Ask students to share their observations and discuss any surprises or challenges they encountered.
- Possible discussion questions: Why is it important for plumbers to understand head pressure? How can this knowledge affect the design of plumbing systems?

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Assessment and Online Resources

Assessment suggestions

- **Exit Slip:** Have students complete an exit slip where they explain the difference between volume and pressure and describe head pressure in their own words.
- **Observation Review:** Collect and review students' predictions and observations from the experiment to assess their understanding of the concepts.
- **Quiz:** Use a quick quiz at the end of the lesson to check for comprehension of key terms and their applications in plumbing.

Online resources

- Fluid Properties Kit Home Page (Lethbridge Polytechnic, 2024)
- Fluid properties kit: Overview video (Lethbridge Polytechnic, 2024)
- Fluid properties kit: Volume and pressure (Lethbridge Polytechnic, 2023)

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