Pascal’s Principle Lab

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**Objectives:**

During this lab the students should be able to:

* Explain Pascal’s principle of fluids.
* Predict how pressure will change in a stationary fluid.

**Materials:**

* Vernier Computer interface
* Computer
* Vernier gas pressure sensor
* logger pro
* Closed system apparatus
* Syringe - 60cc (up to 200cc)

**Safety:**

During the completion of this lab, safety goggles should be worn at all times. Only use a syringe to add air, a larger pump could cause the closed system apparatus to burst.

**Procedure:**

1. Obtain, put on, and continue to wear safety goggles while performing the lab.
2. Turn on the computer (if it is not already on).
3. Make sure that all valves on the apparatus are closed before continuing.
4. Make sure that the gas pressure sensor is connected to the logger pro and is giving a reading of ~101.3kPa. Connect the pressure sensor to point B and open the valve.
   1. What is the pressure in the apparatus? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Was the pressure the same, more, or less compared to the pressure of the room? Explain in your own words why the pressure reading was different or the same.
5. Adjust the 60cc syringe to the 30cc mark. Connect the syringe to point A and open the valve(s).
6. Place 30cc of air into the apparatus. Record the pressure. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. Predict what you think the pressure will be at point C. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Close the valve at point B. Disconnect the pressure sensor and reattach it at point C. Open the valve at point C. Record the pressure. ­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. Was your prediction correct? Explain why your prediction was correct or not.
10. Predict what you think the pressure is at points D & E. \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_
11. Repeat step 8 and record the pressure at points D & E. \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_
12. Were your predictions correct? Explain why or why not.

All pressure readings in part A were taken while the syringe was attached at point A. Remove 30cc of air from the apparatus and then close the valve at point A. What do you think would happen if you changed the point where the air was injected into the system (assume that the same amount of air is put into the apparatus)?

Using the data table provided, record the injection point and take several pressure readings at different points on the apparatus. Give a prediction at each point and then take a reading.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Point | A | B | C | D | E |
| Injection (record number of cc injected) |  |  |  |  |  |
| Pressure Prediction |  |  |  |  |  |
| Pressure Reading |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Point | A | B | C | D | E |
| Injection (record number of cc injected) |  |  |  |  |  |
| Pressure Prediction |  |  |  |  |  |
| Pressure Reading |  |  |  |  |  |

Compare your predictions with the pressure readings that you made at the different points. Were your predictions correct? Explain why or why not.

**Background:**

Pascal’s principle states that a change in pressure at any given point in an enclosed fluid is transmitted equally and uniform in all directions throughout the fluid, ΔP = ρg(Δh). A fluid is any substance that assumes the shape of its container (liquids and gases are fluids). Pascal’s principle is used in many different applications; such as siphoning, hydraulic jacks, braking systems in automobiles, water towers, and dams. Even scuba divers must understand this principle. The visual often used is a 2-liter bottle and by squeezing the bottle pressure is applied at one point in the fluid. The picture will show magnitude arrows to help visualize this concept. This lab will allow for the students to actually see quantitative and qualitative results when a pressure in a fluid is changed at a given point.

The soda bottle is often seen in the classroom textbook with arrows representing magnitude. When the bottle is squeezed the magnitude arrows increase evenly, but are still different sizes to reinforce depth’s effect on pressure. The problem with this model becomes the ability for some students to see the theoretical or abstract aspect of this model. Put simply, they just can’t see it. They see that the arrows are different sizes and can’t always see that they increased in size, magnitude, equally. The problem with using a 2-liter plastic bottle is that equal force could not be accurately measured when taking the structural design of the bottle into account and the bottle may not hold up to multiple labs. With this lab the students will be able to see quantitatively how the pressure changes at a given point as well as throughout the entire fluid. To solve these problems a closed system apparatus was built out of schedule 40, ½ inch, pvc pipe. This allowed for a safer design; schedule 40 ½ inch pvc pipe has a magnitude of 10 greater burst pressure1,2 and sturdier design for future testing. Any design pattern would work when building the apparatus. The tested design is pictured below. This apparatus is designed to work with gases only and not liquids. At no time should any liquid ever be put into the closed system apparatus.

**Materials needed for building a closed system apparatus:**

* ½” schedule 40 pvc pipe
* ½” schedule 40 connectors – (couplers, y’s, elbows, etc.) make sure that some have pipe threads for the barbs.
* ½” pipe thread barbs that can be threaded into a connector.
* Clear vinyl tubing and barbs for connecting to stopcocks.
* Stopcocks
* Small barbs
* Pvc pipe cement and primer – for schedule 40 pvc

**Sources**

1. “PVC Pipes – Pressure Ratings”. *www.EngineeringToolBox.com.* Accessed 7/13/2013.
2. “Water-Rockets.com is rocket science”. *www.water-rockets.com.* Accessed 7/13/2013.

Credit: This lab was designed by Michael Coates