LAB 38: PRESSURE VERSUS DEPTH

QUESTION

How does the depth of a liquid affect the pressure that it exerts?

SAFETY

Be extremely careful punching holes in the can. The nail and the can will be sharp.

MATERIALS

Empty aluminum soda can, nail

Plastic water bottle, etc., will also work

PROCEDURE

In this lab, you will be figuring out the equation for how pressure changes with depth in a fluid using a combination of observation and deduction. Remember that a fluid and a liquid are not the same thing. A fluid is something that flows, and that includes liquids and gases.

Plastic water bottle, etc., will also work

Part 1

1. Find an aluminum can and use a sharp object to carefully poke three holes in the can in a vertical line (see Figure 38.1, p. 158).
2. Predict what will happen if you fill the can with water and let the water flow out of the holes. Which hole will flow the farthest, or will they all flow the same distance?
3. Tip the can back and fill it with water above the top hole.
4. Hold the can over the sink and allow the water to flow out.
5. Sketch what you observed viewing the can from the side.

Figure 38.1

Can With Three Holes

Observation 1

The pressure of a fluid _____ (increases, decreases, stays the same) as its depth increases. This means that pressure and depth (h) are _____ (directly, inversely) related, which can be represented by _____ ($P \alpha h$, $P \alpha 1/h$).

Part 2

1. Take off your shoes and socks and go into the kitchen. Open the refrigerator door. What do you feel?
2. Imagine the refrigerator was filled with water, which is much more dense than air. Would the water pour out faster than the cold air?
3. Imagine that your can was filled with alcohol, which is less dense than water. Based on pressure alone, would the alcohol shoot out farther than or not as far as the water?
4. Imagine that your can was filled with mercury, which is much more dense than water. Based on pressure alone, would the mercury shoot out farther than or not as far as the water?
5. Imagine that the can was filled with air, which is much less dense than water. What would happen?

6. When you go from the top of a tall building to the bottom (hundreds of feet), your ears do not hurt. When you go 5 ft. underwater, your ears hurt from the pressure. Explain why.

Conclusion 2

The pressure of a fluid _____ (increases, decreases, stays the same) as its density increases. This means that pressure and density (ρ) are _____ (directly, inversely) related, which can be represented by _____ ($P \alpha \rho$, $P \alpha 1/\rho$), where ρ represents density.

Part 3

1. An object can experience apparent zero gravity when it is falling, similar to astronauts in orbit. Go outside and fill your can with water and cover the holes. Hold the can out and just as you uncover the holes, drop it. What happens?
2. Imagine that you took your can to the Moon, where gravity is much weaker. The water would shoot out _____ (farther than, less far than, the same as) on Earth?
3. Imagine that you took your can to Jupiter, where gravity is much stronger. Would the water shoot out _____ (farther than, less far than, the same as) on Earth?

Conclusion 3

The pressure of a fluid _____ (increases, decreases, stays the same) as gravity increases. This means that pressure and gravity are _____ (directly, inversely) related, which can be represented by _____ ($P \alpha g$, $P \alpha 1/g$).

Post-Lab Questions

1. To write the equation for pressure, put all the variables that were direct relationships on the top of the fraction and all the variables that were inverse relationships on the bottom.

   Pressure = _____

2. Using your new equation, calculate what the pressure would be at a depth of 40 m in water (density = 1,000 kg/m^3). Your answer will come out in Pascals, and don't forget that the pressure at the surface of the water is 101,300 Pa from atmospheric pressure so you must add that to the pressure of the water.
3. Now calculate what the pressure would be at 10 m below the surface of saltwater in the ocean (density = 1,150 kg/m^3).

Extensions

Every 10 m underwater that you go, the pressure increases 1 atm. What is the deepest under the ocean that a human has ever gone in a submersible vehicle? What is the pressure down there? What is the deepest that a diver has gone without any breathing apparatus? What is the pressure down there? How deep can a penguin dive? What is the pressure down there? What is the cruising altitude for passenger airplanes? Do research to find what the atmospheric pressure is up there.