Pressure Below the Surface

Use data and a graph to connect fluid density, depth, and pressure.

HS-PSII-3.1 "For a static, incompressible fluid, develop and apply graphical and mathematical representations that describe the relationship between the density and the pressure exerted at various positions in the fluid..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the equation and the sentences that explain how depth and density affect pressure. Circle the two density values in the table, then number the two readings at 2 m so you can compare them.

Two Tanks, Two Pressure Patterns

1. A diver training tank has pressure sensors at different depths. Each sensor stays still while the liquid rests. The sensor reads gauge pressure, the pressure added by the liquid above it, rather than the air pressure at the surface. Depth is measured downward from the liquid's surface. Two separate tanks hold fresh water and mineral oil.

2. Because neither liquid is moving or being compressed, its density stays constant with depth. Gauge pressure follows $P = \rho g h$, where ρ is density, g is gravitational acceleration, and h is depth. Use $g = 10$ N/kg for this model. The measurements below use kilograms per cubic meter for density and pascals for pressure.

GAUGE PRESSURE IN SEPARATE LIQUID TANKS

Liquid	Density (kg/m³)	Depth (m)	Gauge pressure (Pa)
Fresh water	1,000	0	0
Fresh water	1,000	1	10,000
Fresh water	1,000	2	20,000
Mineral oil	800	1	8,000
Mineral oil	800	2	16,000

3. Graph depth on the horizontal axis and gauge pressure on the vertical axis. For each liquid, the points form a straight line through the origin. Its slope is ρg, so a greater density makes a steeper line. At a fixed depth, pressure rises in direct proportion to density. At a fixed density, pressure rises in direct proportion to depth.

2 ANSWER WITH EVIDENCE

Use the passage

1. If you graph the fresh-water readings, what is the slope of the line from 0 m to 2 m? Include units.

2. At 2 m, how much greater is the gauge pressure in fresh water than in mineral oil? Explain the difference using their densities.

3. Predict the gauge pressure in fresh water at 1.5 m. Where would this point fall between the 1 m and 2 m points on a pressure-versus-depth graph?

4. How deep must a sensor be in mineral oil to read the same gauge pressure as a sensor at 1 m in fresh water? Show how you know.

3 YOUR TURN

Your own words

A third tank holds a liquid with a density of 900 kg/m^3. On the grid, graph its gauge pressure at depths of 0, 1, 2, and 3 m; label both axes, then state the line's slope and compare its pressure at 2 m with fresh water in a sentence.



ANSWER KEY

Pressure Below the Surface

HIGH SCHOOL · HS-PSII-3.1

PART 1 · READ AND MARK

Underline the equation and the sentences that explain how depth and density affect pressure. Circle the two density values in the table, then number the two readings at 2 m so you can compare them. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	If you graph the fresh-water readings, what is the slope of the line from 0 m to 2 m? Include units.	**(20,000 Pa − 0 Pa) ÷ (2 m − 0 m) = 10,000 Pa/m.**
2	At 2 m, how much greater is the gauge pressure in fresh water than in mineral oil? Explain the difference using their densities.	**The pressure is 4,000 Pa greater in fresh water. At the same depth, fresh water has the greater density, so it exerts greater gauge pressure.**
3	Predict the gauge pressure in fresh water at 1.5 m. Where would this point fall between the 1 m and 2 m points on a pressure-versus-depth graph?	**15,000 Pa. The point would fall halfway along the straight line between the 1 m and 2 m points.**
4	How deep must a sensor be in mineral oil to read the same gauge pressure as a sensor at 1 m in fresh water? Show how you know.	**1.25 m. The fresh-water pressure is 10,000 Pa, so h = 10,000 Pa ÷ [(800 kg/m^3)(10 N/kg)] = 1.25 m.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Label the horizontal axis depth (m) and the vertical axis gauge pressure (Pa). Plot (0 m, 0 Pa), (1 m, 9,000 Pa), (2 m, 18,000 Pa), and (3 m, 27,000 Pa), then connect the points with a straight line. The slope is 9,000 Pa/m. At 2 m, this liquid exerts 2,000 Pa less gauge pressure than fresh water.

Accept equivalent calculations and comparisons with correct units. For the graph, check that pressure is on the vertical axis and that the plotted points form a straight line through the origin.