Pressure in fluids: depth and collisions

Student activity • observation and reasoning

YEAR 11 / LESSON 75 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

Why does liquid pressure increase with depth and act in every direction?

Use fluid diagrams and original calculations to connect pressure at a point with depth and particle collisions.

Equipment

- Booklet, original fluid diagrams, ruler and calculator

Paper modelling only. No pressurised vessels, needles, mercury manometers or pierced water bottles are used.

Course coverage: Shared Physics / Double Award: 5.6, 5.7, 5.15. Fluid pressure, $\Delta p = \rho g h$ and gas collisions.

Plan, model or apparatus sketch

Draw the apparatus or model and label the measured quantities and their units.

Method and reasoning

Read the whole sequence before starting

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1. Draw a stationary liquid in a container and mark three points at different depths. At each point draw equal pressure arrows in different directions, distinguishing direction from depth dependence.

2. Compare two points at the same depth in the same connected liquid. Explain why container shape alone does not change the pressure difference from the free surface.

3. Calculate the pressure increase at depths 0.10, 0.20 and 0.30 m in practice water with $\rho = 1000$ kg m^{-3} and $g = 9.8$ N kg^{-1}.

4. State that absolute pressure includes the pressure at the free surface. Do not call ρgh the total absolute pressure when the liquid is open to the atmosphere.

5. Draw gas particles moving randomly and colliding with a wall. Explain how changes in particle momentum exert forces, and how force per area gives pressure.

6. Compare the liquid-depth explanation with gas-wall collisions. Correct the claim that pressure acts only downwards or that all gas particles move at one speed.

Cleanup

- Return cards and retain corrected calculations.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Practice pressure increases are 980, 1960 and 2940 Pa. The hydrostatic equation uses vertical depth and assumes approximately constant density and g. At a point in a fluid at rest, pressure is isotropic; pressure force on a surface acts perpendicular to it.

Depth / m	ρgh substitution	Pressure increase / Pa
0.10		
0.20		
0.30		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. How does pressure vary with depth in the same liquid?

2. At one point, is pressure greater downwards than sideways?

3. Find Δp at 0.20 m.

4. Does ρgh alone include atmospheric pressure?

5. What causes gas pressure on a wall?

6. Which depth is used: vertical or sloping?