Density and pressure: different ratios

Student activity • investigation and reasoning

YEAR 11 / LESSON 74 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

Why does turning a block change contact pressure but not its density?

Measure a small cuboid and calculate its pressure on three different faces without applying extra weights.

Equipment

- Small smooth cuboid, balance, ruler and calculator

Keep the small block on a stable bench and turn it gently. Do not stack weights, use sharp points, press blocks onto skin or stand on apparatus.

Course coverage: Shared Physics / Double Award: 5.1, 5.3, 5.5. Density and pressure = force / area.

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. Use one smooth cuboid of mass no more than 200 g per group. Measure its mass and three dimensions, recording SI conversions for later pressure calculations.

2. Calculate its volume and density. Explain why these do not change when the block is turned.

3. Calculate the areas of its three distinct rectangular faces. Place it gently on each face on a rigid bench and identify the area in contact.

4. Calculate its weight using $W = mg$ with $g = 9.8\ \text{N kg}^{-1}$, then calculate mean contact pressure W/A for each orientation. Do not add loads or stand on the block.

5. For an invented 0.20 kg block with faces 0.0020, 0.0010 and 0.00050 m^2, calculate the three pressures and order them.

6. Explain why smaller contact area gives larger mean pressure at the same normal force. Distinguish this from increasing density and state the assumption of uniform contact.

Cleanup

- Return blocks to trays and clear balances.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Practice weight = 1.96 N; pressures = 980, 1960 and 3920 Pa. One cm^2 is 10^{-4} m^2, not 10^{-2} m^2. Mean pressure uses normal force divided by contact area; real surfaces need not distribute pressure uniformly.

Orientation	Contact area / m^2	Weight / N	Pressure / Pa
Face 1			
Face 2			
Face 3			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Why is density unchanged on turning the block?

2. What force is used on a horizontal bench?

3. What happens to pressure if area halves at fixed force?

4. Convert 10 cm^2 to m^2.

5. Find the largest practice pressure.

6. Is pressure the same as force?