Pressure in a fluid (p = F/A)

4.5.5.1.1 · Forces · revision notes

A fluid (a liquid or a gas) exerts pressure on every surface it touches, and the force caused by the pressure acts at right angles to the surface. You need to use p = F ÷ A, with pressure in pascals. This is in GCSE Physics only, not in Combined Science.

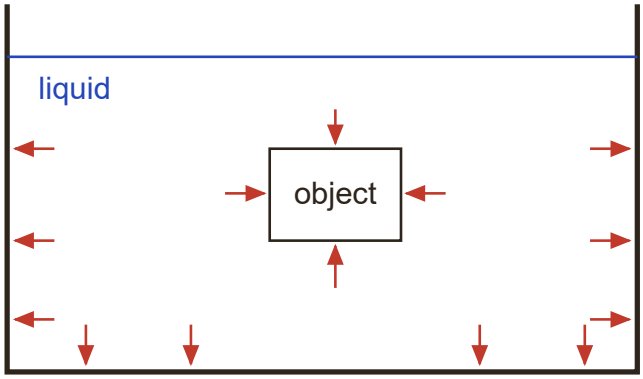
Key facts

- Fluid = liquid or gas
- p = F ÷ A (pressure = force normal to a surface ÷ area of that surface)
- 1 kPa = 1000 Pa
- F = p × A gives the force on a surface
- Fluid pressure causes a force normal (at 90°) to any surface
- Units: p in Pa (1 Pa = 1 N/m^2), F in N, A in m^2
- cm^2 to m^2: divide by 10 000

Notes

Fluids and pressure

- A **fluid** is either a liquid or a gas.
- The particles of a fluid collide with any surface in contact with it. The pressure in the fluid causes a force **normal** (at right angles) to that surface.
- A fluid pushes on the bottom and the sides of its container, and on every face of an object placed in it.



The pressure in a fluid gives a force at right angles to every surface it touches.

Calculating pressure

- pressure = force normal to a surface ÷ area of that surface: **$p = F \div A$**
- p in pascals (Pa), F in newtons (N), A in square metres (m^2).
- 1 Pa = 1 N/m^2. Larger pressures are often given in kilopascals: 1 kPa = 1000 Pa.
- Rearranged: $F = p \times A$ and $A = F \div p$.

Force, area and pressure

- The force a fluid exerts on a surface is $F = p \times A$, so at the same pressure a larger surface feels a larger force.
- Example: water at a pressure of 150 000 Pa pushes on a 0.020 m^2 porthole with a force of 150 000 × 0.020 = 3000 N.
- The same force spread over a smaller area gives a greater pressure; over a larger area, a smaller pressure.

Area conversions

- 1 m = 100 cm, so 1 m^2 = 100 × 100 = 10 000 cm^2.
- To convert cm^2 to m^2, divide by 10 000: 50 cm^2 = 0.0050 m^2.
- 1 m^2 = 1 000 000 mm^2, so divide mm^2 by 1 000 000.

How to answer each type of question

Calculate pressure 2 marks **Grade 5**

1. Check the force is in N and the area in m^2.
2. Write $p = F \div A$ and substitute.
3. Give the answer in Pa.

Example. The water in a tank exerts a force of 7200 N on the base of the tank. The base has an area of 1.5 m^2.
Calculate the pressure on the base due to the water.

Model answer.

$p = 7200 \div 1.5$ (1)
$p = 4800$ Pa (1)

State what fluid pressure does at a surface

1 to 2 marks | Grade 4

1. Say that the force from fluid pressure acts at right angles to the surface.
2. Say that it acts on every surface in contact with the fluid, not just downwards.

Example. A plastic bottle full of water has three small holes at the same depth, on different sides. Water comes out of all three holes, leaving each one at right angles to the side of the bottle.
What does this show about the force caused by the pressure in a fluid?

Model answer.

The pressure acts on every surface / in all directions, not just downwards (1).
The force it causes acts at right angles (normal) to the surface (1).

Rearrange to find area

3 marks | Grade 5

1. Convert kPa to Pa.
2. Rearrange to $A = F \div p$.
3. Give the answer in m^2.

Example. The gas in a cylinder is at a pressure of 400 kPa. The gas exerts a force of 2000 N on a piston.
Calculate the area of the piston.

Model answer.

400 kPa = 400 000 Pa (1)
$A = 2000 \div 400\,000$ (1)
$A = 0.005\ m^2$ (1)

Calculate force from pressure, with unit conversions

3 marks | Grade 5

1. Convert the pressure to Pa and the area to m^2.
2. Use $F = p \times A$.
3. Give the answer in N.

Example. Sea water exerts a pressure of 250 kPa on the glass of a diver's face mask. The glass has an area of 120 cm^2.
Calculate the force of the water on the glass.

Model answer.

250 kPa = 250 000 Pa and 120 cm^2 = 0.0120 m^2 (1)
$F = 250\,000 \times 0.0120$ (1)
F = 3000 N (1)

Don’t lose marks

- Dividing cm^2 by 100 instead of 10 000.
- Multiplying force by area when you should divide.
- Mixing kPa and Pa, e.g. using kPa in the calculation but giving the answer in Pa.
- Saying that fluid pressure only acts downwards. It acts on every surface, at right angles to it.

More tips

Memory tricks

- Pressure is force ÷ area: the force goes on top.
- Sense check: a smaller area should give a larger pressure.
- kPa × m^2 = kN. For example, 250 kPa × 0.012 m^2 = 3 kN, a quick way to check your answer.
- cm^2 to m^2: move the decimal point four places to the left.

Exam technique

- p = F ÷ A is on the equations sheet: force goes on top, and the area must be in m^2.
- Show every unit conversion as a separate line: each can earn a method mark.
- Give the unit Pa (or N/m^2) with your answer.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **State that fluids are liquids or gases**
Both liquids and gases are fluids and both exert pressure.

Grade 4 — **State that fluid pressure acts normal to surfaces**
The force caused by the pressure in a fluid acts at right angles to any surface.

Grade 5 — **Calculate pressure using p = F ÷ A**
For example, 600 N on an area of 0.20 m^2 gives 3000 Pa.

Grade 5 — **Find force or area from a pressure**
F = p × A and A = F ÷ p.

Grade 7 — **Convert areas and pressures to SI units**
1 m^2 = 10 000 cm^2, so divide cm^2 by 10 000; 1 kPa = 1000 Pa.

Grade 7 — **Explain how area affects pressure and force**
The same force on a smaller area gives a greater pressure; the same pressure on a larger area gives a greater force.

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