IGCSE PHYSICS 0625 · CHAPTER 5 NOTES · ~7 MIN READ

Pressure

Why a knife cuts, why skis stop you sinking, and why a dam wall is thicker at the bottom — pressure in solids and liquids.

Pressure = force ÷ area | Everyday examples | Liquid pressure, depth & density | Δp = ρgΔh

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No tag = **Core** (everyone) EXTENDED Extended only highlight = comes up again and again

Test yourself at the end

IN 30 SECONDS

- **Pressure = force ÷ area.** The same force on a smaller area gives a bigger pressure.
- Unit: the **pascal (Pa)**, which is 1 N for every m².
- Liquid pressure **increases with depth** and with the **density** of the liquid.
- EXT The extra pressure at depth is **Δp = ρgΔh**.

BY THE END YOU CAN

- Use p = F ÷ A, changing cm² into m² first.
- Explain everyday examples with large and small areas.
- State how liquid pressure depends on depth and density.
- Calculate liquid pressure with Δp = ρgΔh. EXT

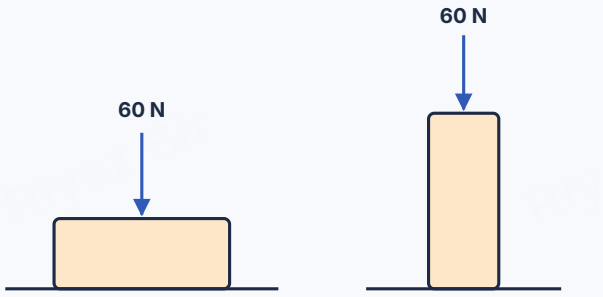
1 Pressure on a surface

Force and area

Pressure — the force acting on each unit of area, at right angles to the surface.

$$p = \frac{F}{A}$$

pressure (Pa) = force (N) ÷ area (m²)



area 0.12 m² → p = 500 Pa **area 0.04 m² → p = 1500 Pa**

same force, smaller area = bigger pressure

The same 60 N force acts on two areas. The smaller area gives three times the pressure.

- 1 Pa = 1 N/m². A pascal is tiny, so you often see kPa (1000 Pa). Atmospheric pressure at sea level is about 100 000 Pa.
- Rearrange: **F = pA** and **A = F ÷ p**.
- To get a **high** pressure: increase the force or **decrease the area**. To get a **low** pressure: decrease the force or **increase the area**.

Example	Area	Effect
knife edge, nail, drawing-pin tip	very small	huge pressure, so it cuts or pierces
skis, snowshoes, caterpillar tracks	large	low pressure, so you do not sink
wide rucksack straps	large	the load is spread over your shoulders
high heel	small	high pressure that can dent a floor

WORKED EXAMPLE

An 80 kg person stands on two feet, each of area 0.020 m². Find the pressure. Then find it on one foot. (g = 10 N/kg)

1. Force = weight = mg = 80 × 10 = 800 N
2. Two feet: A = 0.040 m², p = 800 ÷ 0.040 = **20 000 Pa**
3. **One foot: A = 0.020 m², p = 800 ÷ 0.020 = 40 000 Pa (double)**

WORKED EXAMPLE

A force of 200 N acts on an area of 5.0 cm². Find the pressure in pascals.

1. Convert first: 1 cm² = 0.0001 m², so 5.0 cm² = 5.0 × 10^{-4} m²
2. p = F ÷ A = 200 ÷ (5.0 × 10^{-4})
3. **= 4.0 × 10^{5} Pa**

WORKED EXAMPLE

The air presses with 1.0 × 10^{5} Pa on a table top of area 0.80 m². Find the force. Why doesn't it crush the table?

1. F = pA = 1.0 × 10^{5} × 0.80 = **8.0 × 10^{4} N** (80 000 N)
2. **The air also presses upwards on the underside of the table with the same force, so the forces balance**

COMMON MISTAKE

Using cm² with pascals. Convert to m² first (1 m² = 10 000 cm²).

COMMON MISTAKE

Mixing up force and pressure. Force is the push; pressure is how concentrated that push is.

PICTURE IT

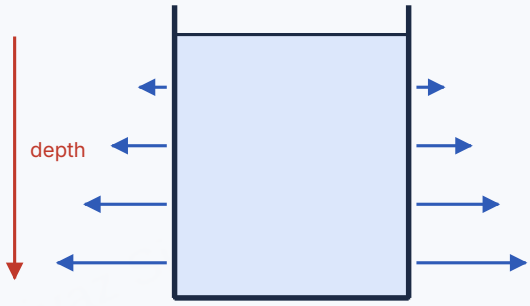
Stand on soft snow in shoes and you sink. Strap on skis and the same weight is spread over a bigger area, so the pressure is lower and you stay on top.

- Gas pressure comes from particles hitting the walls — see Thermal physics.

2 Pressure in liquids

Liquid pressure

- Liquid pressure **increases with depth**. At greater depth there is more liquid above, pressing down.
- It also **increases with density**. A denser liquid at the same depth gives more pressure.
- At a given depth the pressure acts equally in **all directions**, and pushes on side walls at right angles.
- At the same depth in the same liquid, the pressure is the same whatever the shape of the container.



p = ρ g h (more depth = more pressure)

The arrows on the wall get longer as the depth increases. That is why dam walls, submarines and deep-sea equipment are built extra strong.

PICTURE IT

In a stack of books the bottom book carries every book above it. In a liquid, the deeper you go, the taller the "stack of liquid" pressing on you.

EXT $\Delta p = \rho\, g\, \Delta h$

pressure change (Pa) = density (kg/m³) × g (N/kg) × change in depth (m)

WORKED EXAMPLE

EXT **Find the increase in pressure for a diver who goes down 25 m in sea water. (ρ = 1030 kg/m³, g = 9.8 N/kg)**

1. $\Delta p = \rho g \Delta h = 1030 \times 9.8 \times 25$
2. $= 252\,350$ Pa
3. **$\approx 2.5 \times 10^5$ Pa, on top of the atmospheric pressure at the surface**

WORKED EXAMPLE

EXT **A tank is filled to a depth of 0.80 m with water of density 1000 kg/m³. Find the pressure due to the water on the base. (g = 9.8 N/kg)**

1. $\Delta p = \rho g \Delta h = 1000 \times 9.8 \times 0.80$
2. **= 7840 Pa**

EXAM TIP

Liquid pressure depends only on **depth and density** — not on how wide the container is or how much liquid there is in total.

COMMON MISTAKE

"A wider tank has more pressure at the bottom." Only depth and density count.

3 Test yourself

Test yourself — cover the answers first

QUICK CHECK

1. A 500 N person stands on a total area of 0.050 m^2. What is the pressure?
2. Why do skis stop you sinking into snow?
3. Convert 4.0 cm^2 to m^2.
4. What two things does liquid pressure depend on?
5. Why is a dam wall thicker at the bottom?

EXAM-STYLE

6. A tank has a weight of 600 000 N. Its tracks create a pressure of 40 000 Pa. What area of track is in contact with the ground?
7. Explain why a sharp knife cuts better than a blunt one. [2]
8. EXT Oil of density 800 kg/m^3 fills a tank. Find the pressure due to the oil at a depth of 3.0 m. (g = 9.8 N/kg)
9. EXT A diver is 10 m below the surface of a lake (water density 1000 kg/m^3, atmospheric pressure 1.0 × 10^5 Pa, g = 9.8 N/kg). Find the total pressure on the diver.

Show answers

1. 500 ÷ 0.050 = 10 000 Pa
2. They spread your weight over a larger area, so the pressure is smaller.
3. 4.0 × 10^{-4} m^2
4. the depth and the density of the liquid
5. The pressure is bigger at greater depth, so the wall must be stronger there.
6. A = F ÷ p = 600 000 ÷ 40 000 = 15 m^2
7. The sharp edge has a smaller area
   so the same force produces a larger pressure
8. $\Delta p = \rho g \Delta h$ = 800 × 9.8 × 3.0 = 23 520 Pa ≈ 2.4 × 10^4 Pa
9. pressure due to water = 1000 × 9.8 × 10 = 9.8 × 10^4 Pa
   total = 9.8 × 10^4 + 1.0 × 10^5 = 1.98 × 10^5 Pa ≈ 2.0 × 10^5 Pa

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