

4 Forces, density and pressure – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)
pivot	支点	_____
Density	密度	_____
pressure	压强	_____
moment	力矩	_____
perpendicular distance	垂直距离	_____
clockwise	顺时针	_____
anticlockwise	逆时针	_____
equilibrium	平衡	_____
principle of moments	力矩原理	_____
centre of gravity	重心	_____
hydrostatic pressure	流体静压强	_____
upthrust	浮力	_____

Recall

At IGCSE you met turning forces, density and pressure. Bring this with you:

- A force can turn an object about a **pivot** 支点 (a fixed turning point).
- **Density** 密度 is mass per unit volume; **pressure** 压强 is force per unit area.

At AS we calculate turning effects exactly and look at pressure inside a liquid.

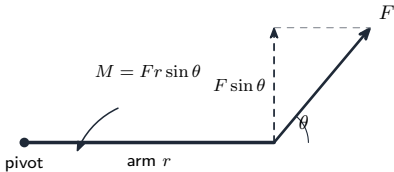
New ideas

■ 1 Moments

The **moment** 力矩 of a force measures its turning effect:

$$\text{moment} = F \times d,$$

where d is the **perpendicular distance** 垂直距离 from the pivot to the line of the force. The unit is the newton metre (N m). A moment turns either **clockwise** 顺时针 or **anticlockwise** 逆时针.



Watch out: d is the *perpendicular* distance from the pivot to the line of the force — not the distance measured along the force itself.

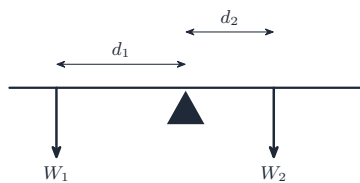
■ 2 The principle of moments

When an object is balanced (in **equilibrium** 平衡), the **principle of moments** 力矩原理 says:

$$\text{total clockwise moment} = \text{total anticlockwise moment}.$$

The object's whole weight acts at one point, its **centre of gravity** 重心.

Worked example. A 300 N child sits 1.5 m left of a seesaw's pivot. How far right must a 450 N child sit to balance? Anticlockwise = clockwise: $300 \times 1.5 = 450 \times d$, so $d = \frac{450}{450} = 1.0 \text{ m}$.



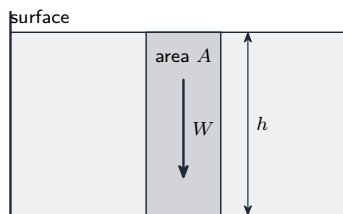
balanced when $W_1 d_1 = W_2 d_2$

■ 3 Density and pressure

Density $\rho = \frac{m}{V}$, and pressure $p = \frac{F}{A}$.

Inside a liquid, pressure grows with depth — this is **hydrostatic pressure** 流体静压强:

$$p = \rho gh.$$



$$\Delta p = \rho gh$$

This pressure also pushes a submerged object upward, giving it an **upthrust** 浮力.

Worked example. Water pressure 2.0 m below the surface ($\rho = 1000 \text{ kg m}^{-3}$, $g = 9.8 \text{ m s}^{-2}$):

$$p = \rho gh = 1000 \times 9.8 \times 2.0 = 1.96 \times 10^4 \text{ Pa}.$$

Practice

4.1 A spanner is turned by a 25 N force acting 0.20 m from the bolt. Find the moment.[2]

4.2 A light beam balances on a pivot. A 40 N weight sits 0.30 m to the left; a weight W sits 0.20 m to the right. Find W . [3]

4.3 A block has mass 240 g and volume 30 cm^3 . Find its density in g cm^{-3} . [2]

4.4 A force of 50 N presses on an area of 0.25 m^2 . Find the pressure. [1]

4.5 Find the water pressure 5.0 m down ($\rho = 1000 \text{ kg m}^{-3}$, $g = 9.8 \text{ m s}^{-2}$). [2]

4.6 **Challenge.** A dam is built much thicker at the bottom than at the top. Using $p = \rho gh$, explain why. [2]