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.

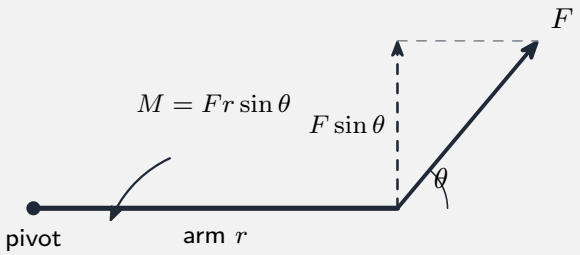
New ideas

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.

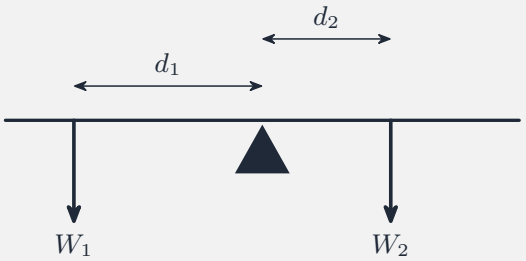
2 The principle of moments

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 $d = \dfrac{450}{450} = 1.0$ m.



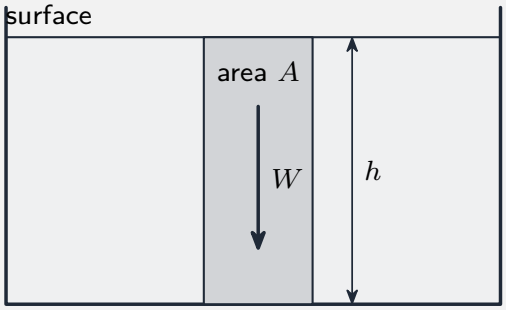
balanced when $W_1 d_1 = W_2 d_2$

3 Density and pressure

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

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

$$p = \rho g h.$$



$\Delta p = \rho g h$

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

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

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

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 ($\rho = 1000$ kg m^{-3}, $g = 9.8$ m s^{-2}). [2]

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