4 Forces, density and pressure – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	**Write it 3 times** (English)		
pivot			
Density			
pressure			
moment			
perpendicular distance			
clockwise			
anticlockwise			
equilibrium			
principle of moments			
centre of gravity			
hydrostatic pressure			
upthrust			

Recall

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

- A force can turn an object about a **pivot** (a fixed turning point).

- **Density** is mass per unit volume; **pressure** is force per unit area.

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

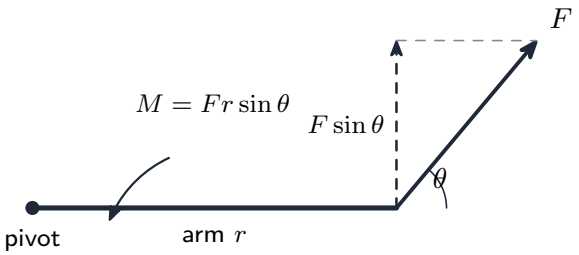
New ideas

1 Moments

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

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

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



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

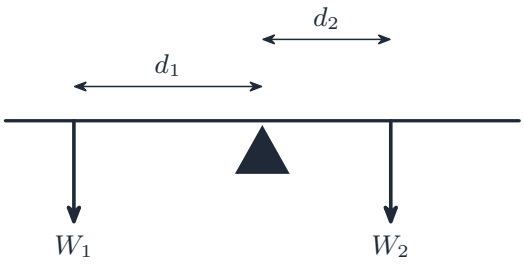
2 The principle of moments

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

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

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

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 $W_1 d_1 = W_2 d_2$

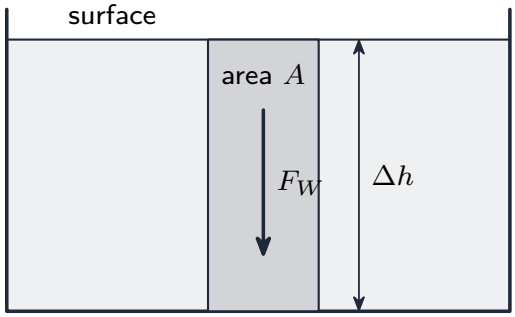
exercises.lol exercises.com.cn

■ 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** :

$$p = \rho g h.$$



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

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

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]

exercises.lol exercises.com.cn

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]