Moments

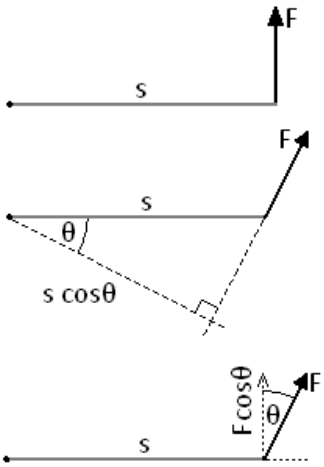
To be able to calculate the moment of a single pair of forces
To be able to explain what the centre of mass and gravity are
To be able to explain how something balances and becomes stable

Moments

The moment of a force is its turning affect about a fixed point (pivot).
The magnitude of the moment is given by:

moment = force x perpendicular distance from force to the pivot

$$moment = Fs$$



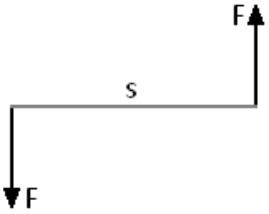
In this diagram we can see that the force is not acting perpendicularly to the pivot.
We must find the perpendicular or closest distance, this is $s\cos\theta$.
The moment in this case is given as: $moment = Fs\cos\theta$

We could have also used the value of s but multiplied it by the vertical component of the force. This would give us the same equation. $moment = F\cos\theta.s$

Moments are measured in Newton metres, Nm

Couples

A couple is a pair of equal forces acting in opposite directions. If a couple acts on an object it rotates in position. The moment of a couple is called the torque.

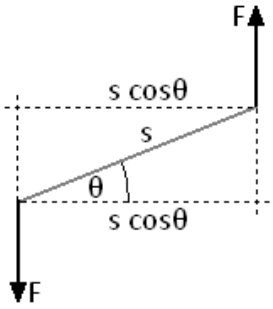


The torque is calculated as: torque = force x perpendicular distance between forces

$$torque = Fs$$

In the diagram to the right we need to calculate the perpendicular distance, $s\cos\theta$.

So in this case: $torque = Fs\cos\theta$



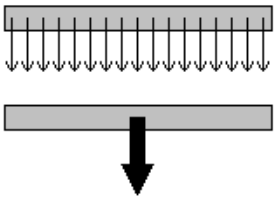
Torque is measured in Newton metres, Nm

Centre of Mass

If we look at the ruler to the right, every part of it has a mass. To make tackling questions easier we can assume that all the mass is concentrated in a single point.

Centre of Gravity

The centre of gravity of an object is the point where all the weight of the object appears to act. It is in the same position as the centre of mass.
We can represent the weight of an object as a downward arrow acting from the centre of mass or gravity. This can also be called the line of action of the weight.

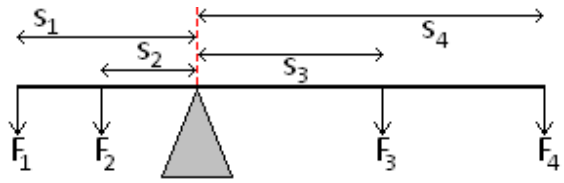


Balancing

When an object is balanced:

the total moments acting clockwise = the total moments acting anticlockwise

An object suspended from a point (e.g. a pin) will come to rest with the centre of mass directly below the point of suspension.
If the seesaw to the left is balanced then the clockwise moments must be equal to the anticlockwise moments.



Clockwise moment due to 3 and 4

$$moment = F_3s_3 + F_4s_4$$

Anticlockwise moments due to 1 and 2

$$moment = F_1s_1 + F_2s_2$$

So $F_3 s_3 + F_4 s_4 = F_1 s_1 + F_2 s_2$

Stability

The stability of an object can be increased by lowering the centre of mass and by widening the base.
An object will topple over if the line of action of the weight falls outside of the base.