Moments and Pressure Workshop

This workshop will cover the following:

a. Moments
b. Moment units (Nm)
c. Anticlockwise moment = Clockwise moment
d. Pressure
e. Pressure in liquids

Moments

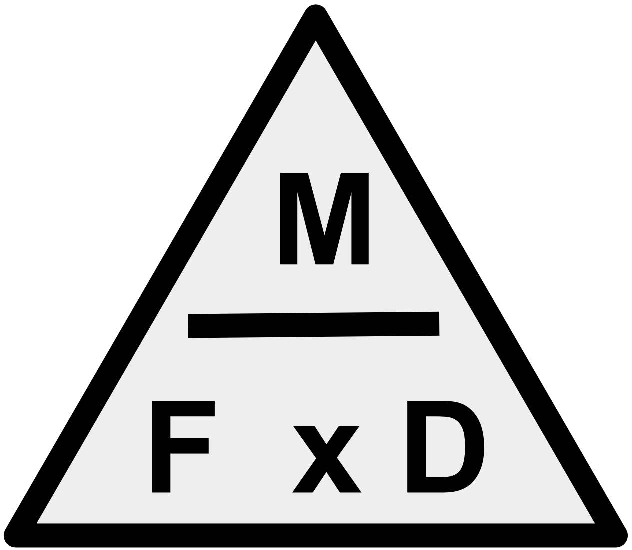
A **moment** is the turning effect of a force around a fixed point called a pivot. For example, this could be a door opening around a fixed hinge or a spanner turning around a fixed nut.

The size of a moment depends on two factors:

- the size of the force applied
- the distance from the pivot to the force

Moments

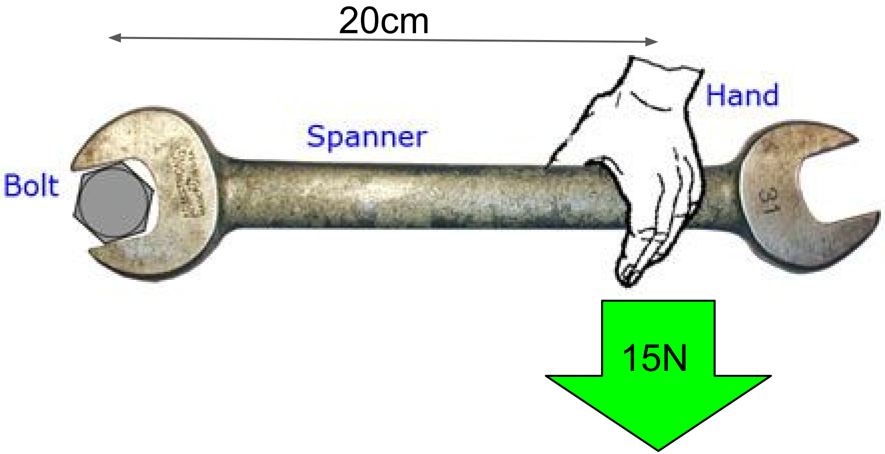
To calculate a moment you need the force in Newtons (N) and the distance from pivot in Meters (m)



Moment = Force x Distance

E.g Distance from pivot is 20 cm which is 0.2m

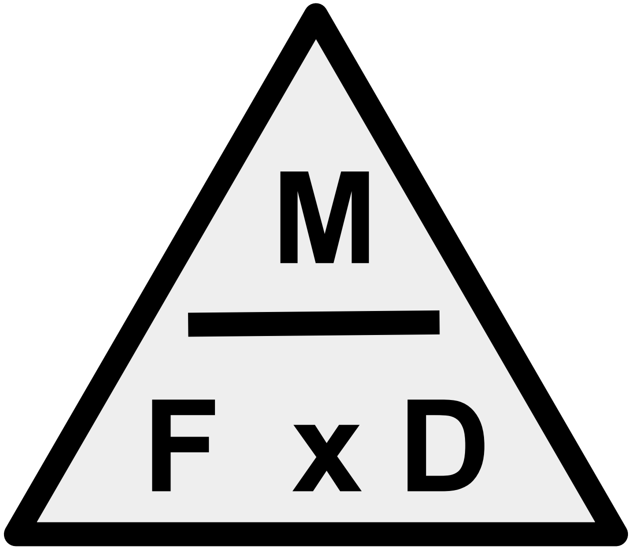
So Moment = 15N x 0.2m = 3Nm



Moments Units

As we are multiplying Force, measured in Newtons (N), and distance, measured in meters (m), the units for moments are Newton meters (Nm).

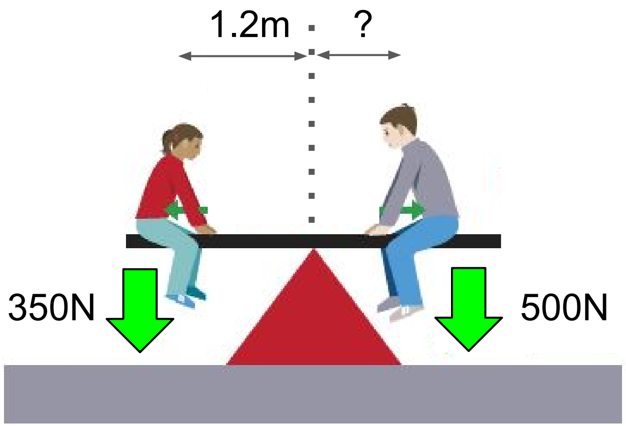
Sometimes you will be given other units to work with, forces measured in kN (kilo Newtons) or distance measured in cm or mm. **You must remember to convert these into Newtons (N) and Meters (m) before calculating the moment!**



Clockwise and Anticlockwise Moments

Consider this problem:

A boy and girl are sitting on a seesaw. We know the weight (force) of both children and the distance the girl is sitting from the pivot. We need to find how far the boy needs to sit from the pivot to balance the seesaw.



<u>To solve this problem we need to remember that in a balanced system the clockwise and anti-clockwise moments are the same!!</u>

Clockwise and Anticlockwise Moments

Clockwise Moment = Anticlockwise Moment

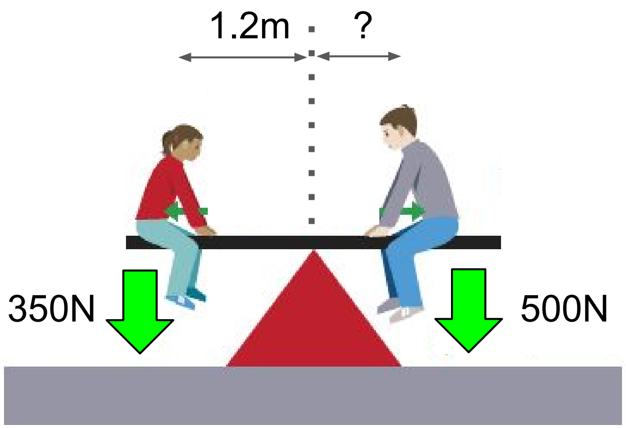
This means:

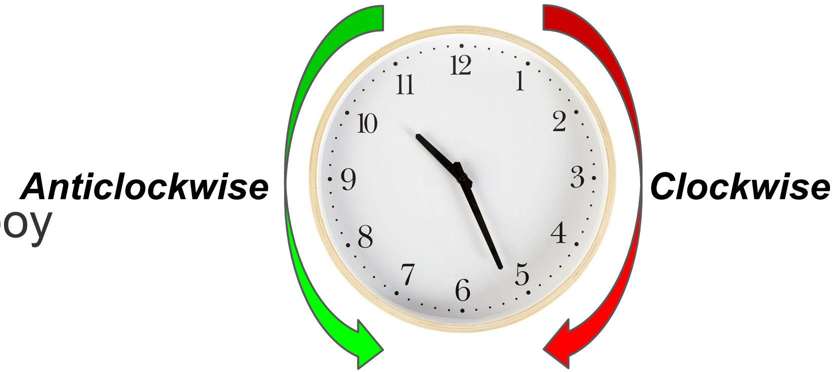
$Force_c$ x $Distance_c$ = $Force_a$ x $Distance_a$

So…

Which is the clockwise moment?

The force from the girl is acting in an anticlockwise direction so the force from the boy is acting in a clockwise direction.





Clockwise and Anticlockwise Moments

We can now fill out the equation…

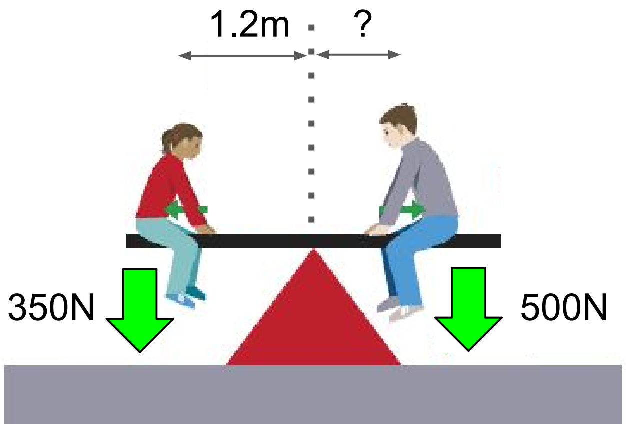
$Force_c$ x $Distance_c$ = $Force_a$ x $Distance_a$

500 N x ? = 350 N x 1.2m

Therefore:

500 N x ? = 420 Nm

We now need to isolate the ?....



Clockwise and Anticlockwise Moments

To get the ? on its own we would need to divide both sides of the equation by 500N!

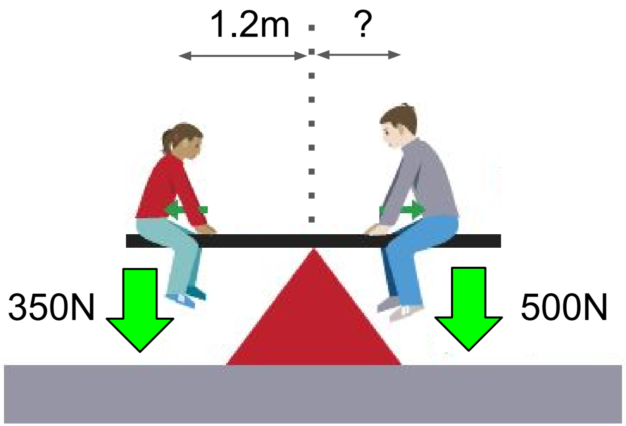
$$\frac{500\text{ N} \times ?}{500\text{ N}} = \frac{420\text{ Nm}}{500\text{ N}}$$

500N / 500N = 1 so we are left with…

1 x ? = 420 Nm / 500 N

Therefore:

? = 0.84m



Pressure

The concept of pressure is widely understood but often the details are not.

Consider someone walking on a frozen lake…

DO NOT DO THIS!! IT IS DANGEROUS AND STUPID!

Why is it dangerous? The answer comes down to pressure!

Pressure

Pressure relates to how force is spread across an area.

What is the force in this situation? - Gravity! Gravity is pushing the boy down onto the ice.

This force is equal to 450N.

We now need to see how large an area that force is spread over.

His feet are what is touching the ice so how much area to his feet cover? - We can estimate this to be $20cm^2$ per foot, so $40cm^2$ in total!

Pressure

Now we need the equation!

Pressure (N/m^2) = Force (N) / Area (m^2)

Notice that the area needs to be in m^2 but we have an area in cm^2

There are 10,000cm^2 in 1m^2

So, 40cm^2 / 10,000 = 0.004m^2

Therefore:

Pressure = 450N / 0.004m^2 =112,500N/m^2!!

Pressure

Now when the ice inevitably breaks under the boy because the the impressive pressure of 112,500 N/m^2 that he is exerting on the ice, the boy will need to be rescued. Why is this rescuer in a safer position?

His mass will be larger, and therefore the force due to gravity will also be larger (700 N). Surely this will cause him to break through easier?

The difference is the area over which his weight is applied to the ice.

Pressure

He is kneeling on a sled, this massively increases the area. The sled has an area of $1.2m^2$…

Pressure (N/m^2) = Force (N) / Area (m^2)

So;

Pressure = 700 N / 1.2 m^2 = 583.3 N/m^2

This, when compared to the 112,500 N/m^2 is a massive reduction in pressure!

This means the rescuer is far less likely to break through the ice!

Pressure in liquids

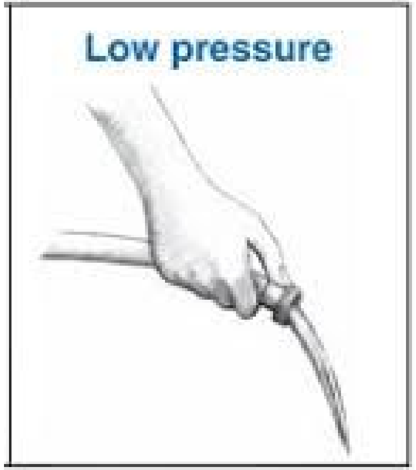
Here are two types of diving outfits. Why are they different?

The answer is that they are for working at different depths. The first one is for Deep Sea diving, while the second is for working at shallow depths.

As you move down through water you have more water above you. Water is heavy.

All this heavy water above you squashes the water (and you!). The weight of this water above causes the increased pressure your body will feel!

Pressure in liquids



We now know that the deeper you go in water the higher pressure of the water. That is why the deep sea diving outfit is made from metal and is super strong. Without it the pressure of the water would have squashed the diver almost flat!

How does water pressure affect our daily lives?

A more common application of water pressure is a garden hose.

Pressure in liquids

By holding your thumb over the end of the hose you are reducing the size of the hole the water can come out of. The water gets squashed inside the hose and is forced out of the smaller hole at a higher pressure!

What effect do you think that will have on the distance the water will travel?

What is happening to the speed the water is traveling at?